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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 23

VASE TO ZYGOTE

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VASE TO ZYGOTE

VASE, a vessel, particularly one of ornamental form or decoration; the term is often confined to such vessels which are uncovered and with two handles, and whose height is greater in proportion to their width. (*See* POTTERY AND PORCELAIN.)

VASSAL, the tenant and follower of a feudal lord (see FEUDALISM). The etymology of the word remains obscure. Under the Frankish empire the *vassi dominici,* essentially servants of the royal household. were great officers of state, sent on extraordinary missions into the provinces. to supervise local administration in the interests of the central power. Sometimes they were sent to organize and govern a march; sometimes they were rewarded with benefices; and as these developed into hereditary fiefs. the word *vassus* or *vassallus* ("servant," "retainer") was naturally retained as implying the relation to the king as overlord. and was extended to the holders of all fiefs. In course of time the word came to acquire a military sense, and in medieval French poetry *vasselage* is commonly used in the sense of "prowess in arms." or generally of any knightly qualities. In this sense it became acclimatized in England; in countries not feudally organized —*i.e.,* Castile — vassal meant simply subject. and during the revolutionary period acquired an offensive significance as being equivalent to slave. For usage in international law *see* also SUZERAINTY.

VASSAR COLLEGE, a privately endowed. nonsectarian institution of higher learning for women, was founded by Matthew Vassar at Poughkeepsie. N.Y., in 1861. First called Vassar Female college, it took its present name in 1567. See POUGHKEEPSIE.

VÄSTERÅS (VESTERÅS or WESTERÅS). a town and bishop's see of Sweden. capital of the district *(län)* of Västmanland. on a northern bay of Lake Mälaren. 60 mi. N.W. by W. of Stockholm by rail. Pop. (1960) 77,778. The original name of the town was Västra Aros ("western mouth"). as distinct from Östra Aros. the former name of Uppsala. Several national diets were held in Västerås. the most notable being those of 1527, when Gustavus Vasa formally introduced the Reformation into Sweden. and 1544. when he had the Swedish throne declared hereditary in his family. Its Gothic cathedral, rebuilt by Birger Jarl on an earlier site and consecrated in 1271. was restored in 1850–60, and again in 1896–98. The episcopal library contains the valuable collection of books which Count Axel Oxenstjerna, the chancellor of Gustavus Xdolphus, brought away from Mainz near the end of the Thirty Years' War. A castle overlooking the town was captured by Gustavus Vasa and rebuilt by him, then was rebuilt in the 17th century, and remains the seat of the provincial government,.

VASTERNORRLAND (VESTERNORRLAND or WESTERNORRLAND). county *(län)* of northeast central Sweden, on the Gulf of Bothnia. Pop. (1960) 285.620. Area. 9.921 sq.mi. The heavily forested highland furnishes timber for the sawmilling, woodworking and wood-processing industries throughout the county. Härnösand is the capital and a seaport for shipping timber products.

VATICAN, THE, official residence of the pope. the nucleus of the Vatican City State which forms an enclave in the city of Rome, the geographical centre of the Roman Catholic Church.

GOVERNMENT AND FAMIGLIA

Government. — The hierarchical power of the Roman Catholic Church culminates in the person of the pope *(q.v.)*, whose residence is in the Vatican palace; and the basilica of St. Peter (the Vatican basilica) is the church that occupies the first place in the minds of Catholics. In ancient times. however. the popes habitually resided in the Lateran palace and only at a later date in the Vatican. St. Peter's is the only basilica within the confines of the Vatican City State: but the pope exercises sovereign rights over all the patriarchal basilicas in Rome.

By the Lateran treaty of June 7, 1929. the Italian government recognized the Vatican City State as independent and sovereign, thus restoring the temporal power of the pope, which had been liquidated when Italian forces occupied Rome in 1870.

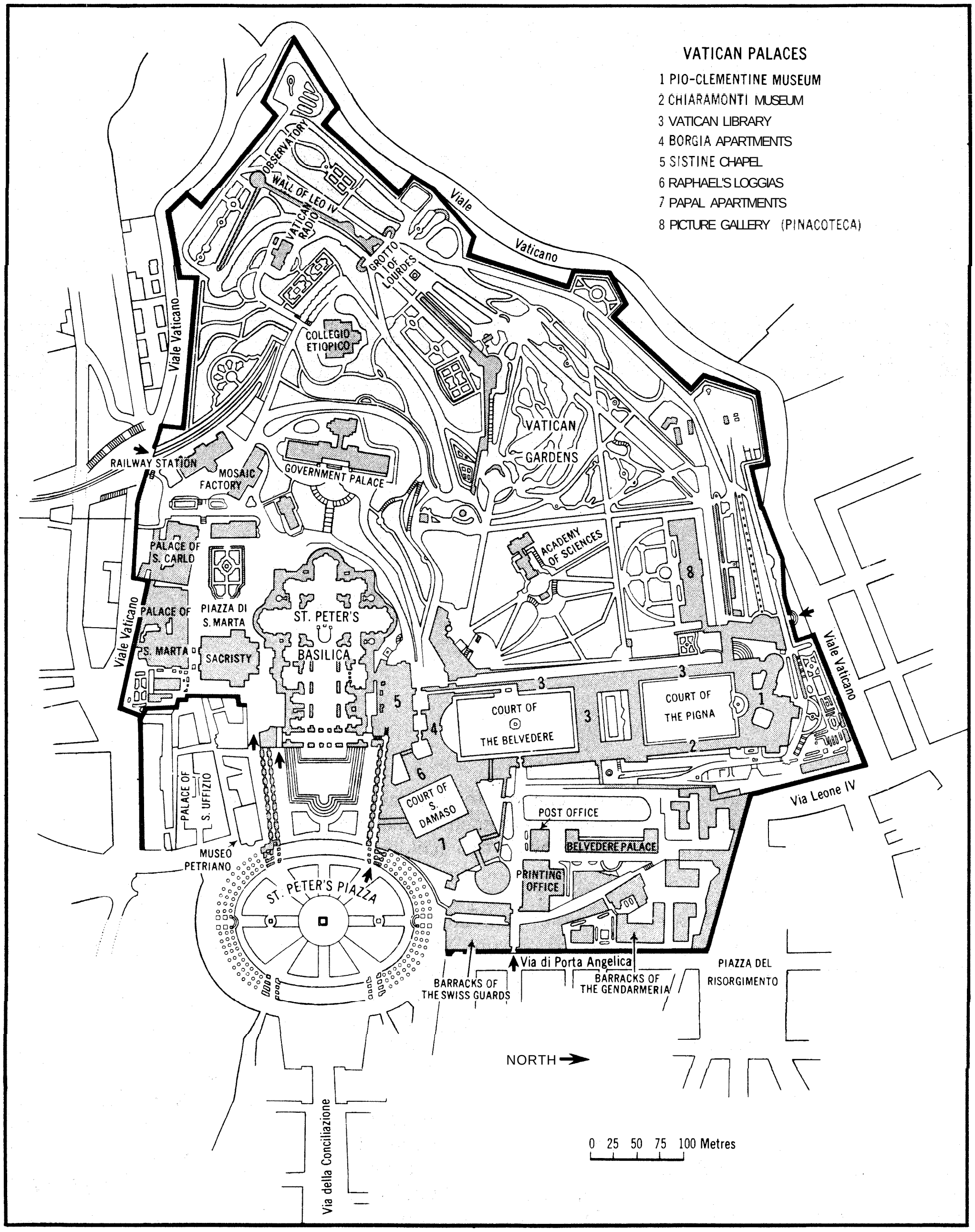
Being the seat of the pope, the Vatican is also the seat of the Sacred College of Cardinals (see CARDINAL), whose members are his closest advisers. The business of ecclesiastical government is administered by the Roman curia (see Ct-RIAROMANA).

All Catholic bishops are obliged to present a report on the state of their dioceses and at the same time to pay periodic visits to the basilica of St. Peter. European bishops have to make this visit every five years, bishops in other parts of the world every ten years.

The permanent representatives of the Holy See with the Catholic hierarchy of other countries are called apostolic delegates. These are prelates, usually with the titular rank of archbishop. According to the country in which they serve. their delegation is subordinate to the Consistorial congregation. to the Congregation for the Eastern Church or to the Congregation de *Propaganda Fide* ("for the propagation of the faith").

Prelates sent abroad by the Holy See on temporary missions for ecclesiastical purposes are called apostolic visitors. On certain important religious occasions a cardinal may be sent by the pope with the title of legate.

The diplomatic representatives of the Holy See with foreign governments are either nuncios or internuncios. the distinction corresponding to that between ambassadors and ministers plenipotentiary. Tuncios. who generally have the titular rank of archbishop, may be of the first or of the second degree. according to the actual or historical rank of their particular post; the diplomatic career of a nuncio of the first degree usually is completed by elevation to the cardinalate. (See NUNCIO.)



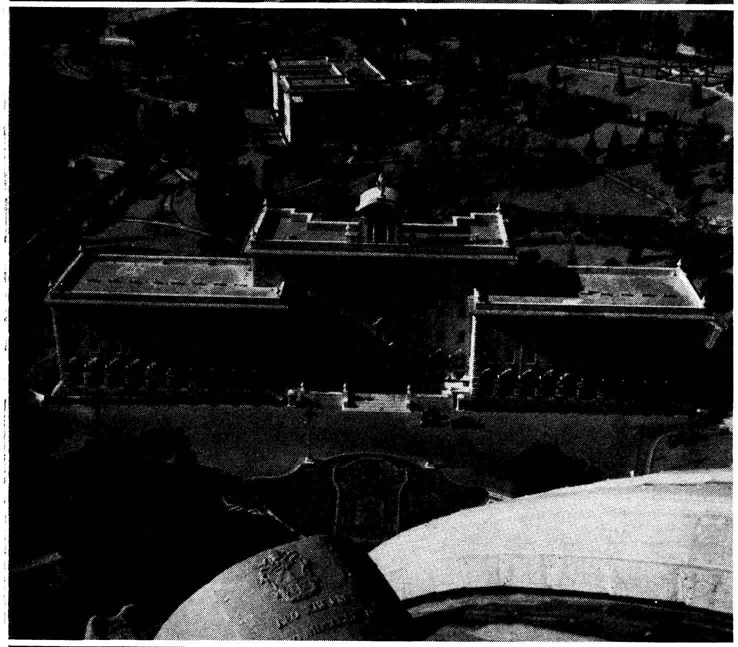
THE VATICAN. SHOWING LOCATION OF PRINCIPAL BUILDINGS. DARK ARROWS INDICATE ENTRANCES

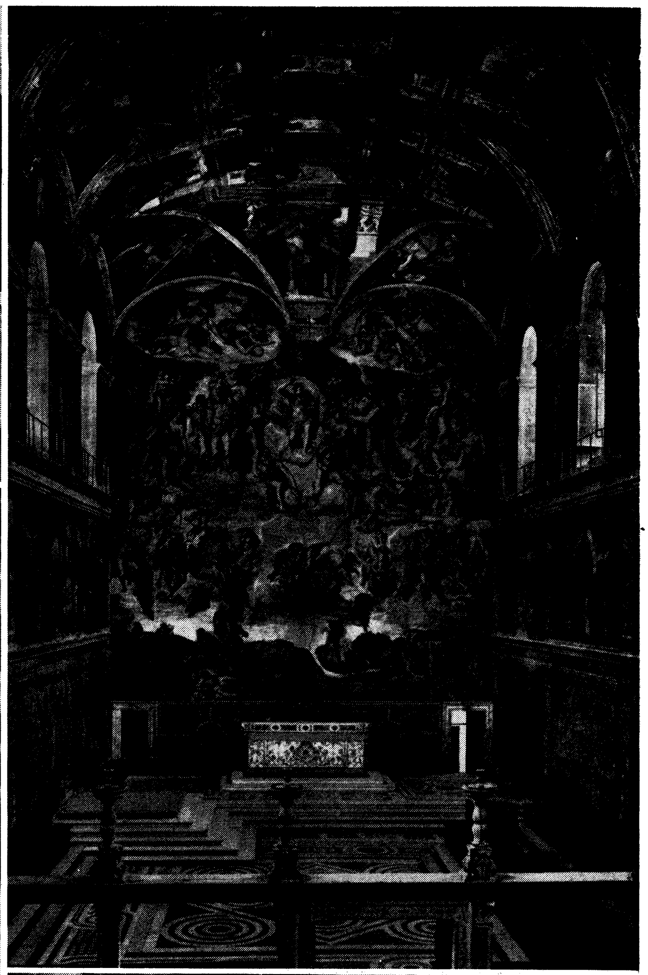
Famiglia.—The personal entourage of the pope. as distinct from the government of the church. is known as the *famiglia pontificia*. A great part of this *famiglia* consists of the members of the *cappella pontificia*, the collective name for those participating in the *cappella papale*, that is. in ritrs performed or attended by the pope himself or specifically requiring his presence.

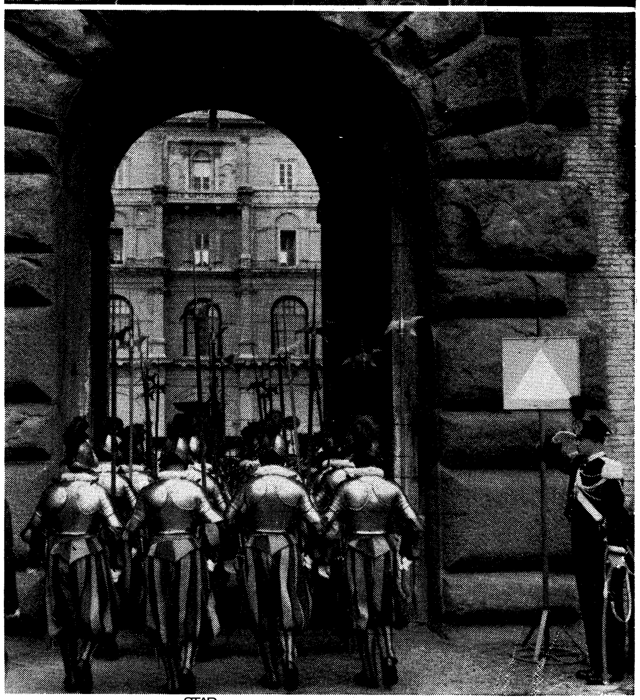
The *cappella* includes all cardinals, patriarchs. bishops assistant at the papal throne and other bishops who happen to be present at the time in the curia: other high officials of the curia: the princes assistant at the throne: the secretaries and assessors of the Sacred Congregations: the apostolic protonotaries: the generals and procurators of the religious orders; the consistorial advocates: the ecclesiastical privy chamberlains: etc. Within the *famiglia*, the cardinals most closely associated with the pope are the palatine cardinals. The privy chamber includes the palatine prelates (the prefect of the Apostolic Palace; the prefect of the bedchamber: the auditor; and the master of the Apostolic Palace) and several groups of privy chamberlains. both ecclesinstical and lay. Certain posts in the *famiglia* are always entrusted to members of certain religious orders. Thus the master of the palace. the theologian of the *famiglia*, is always a Dominican; the sacristan, an Augustinian friar; the apostolic preacher. who delivers the Advent and Lent sermons in the pope's presence, a Capuchin: and the confessor. a Servite.

The principal laymen of the *famiglia* are the heads of the great families of the old Roman nobility. Thus the prince Colonna and the prince Orsini may have the title princes assistant at the pontifical throne and take it in turn to attend upon the pope: the prince Massimo is grand master of the pontifical posts (in the sense of stages in the journeys of the pope. should he have to travel); the prince Ruspoli is grand master of the Sacred Hospice (responsible for hospitality to visiting heads of state and princes); the marchese Sacchetti is *foriere maggiore* (superintendent of buildings, water supply and furnishings) of the Sacred Palaces: the marchese Patrizi is standard bearer of the Holy Roman Church; and the mnrchese Serlupi is master of the horse. The lay privy chamberlains are called "chamberlains of s\\-ord and cloak" (*camerieri* di *spada e cappa*) because of their distinctive ceremonial dress—in the fashion of the 16th-century Spanish nobility. The protection of the pope's person is ensured by the *guardia nobile* which consists of officers drawn from noble families; and by the s\\-iss guard. a corps instituted by Julius II and consisting of Swiss citizens recruited at first from the original cantons of the Swiss confederacy and in modern times from nearly all the others as well. There is also a guard of honour recruited from among the citizens of Rome (*guardia palatina d'onore*). A corps of police known as the *gendarmeria pontificia* is responsible for maintaining order in the Vatican City State and in the palaces that belong to it.

Papal ceremonies are attended by the diplomatic corps accredited







PHOTOGRAPHS, (TOP LEFT) ALINARI, (TOP RIGHT, BOTTOM LEFT) ANDERSON, (CENTRE LEFT) PAUL PIETZSCH FROM BLACK STAR, (BOTTOM RIGHT) UNITED PRESS

VIEWS OF THE VATICAN

Top left: Salon of Raphael in the Vatican Pinacoteca constructed by Pius X in 1909. It contains the "Madonna of Foligno," "The Coronation of the Virgin" and the "Theological Virtues and Mysteries," all painted by Raphael

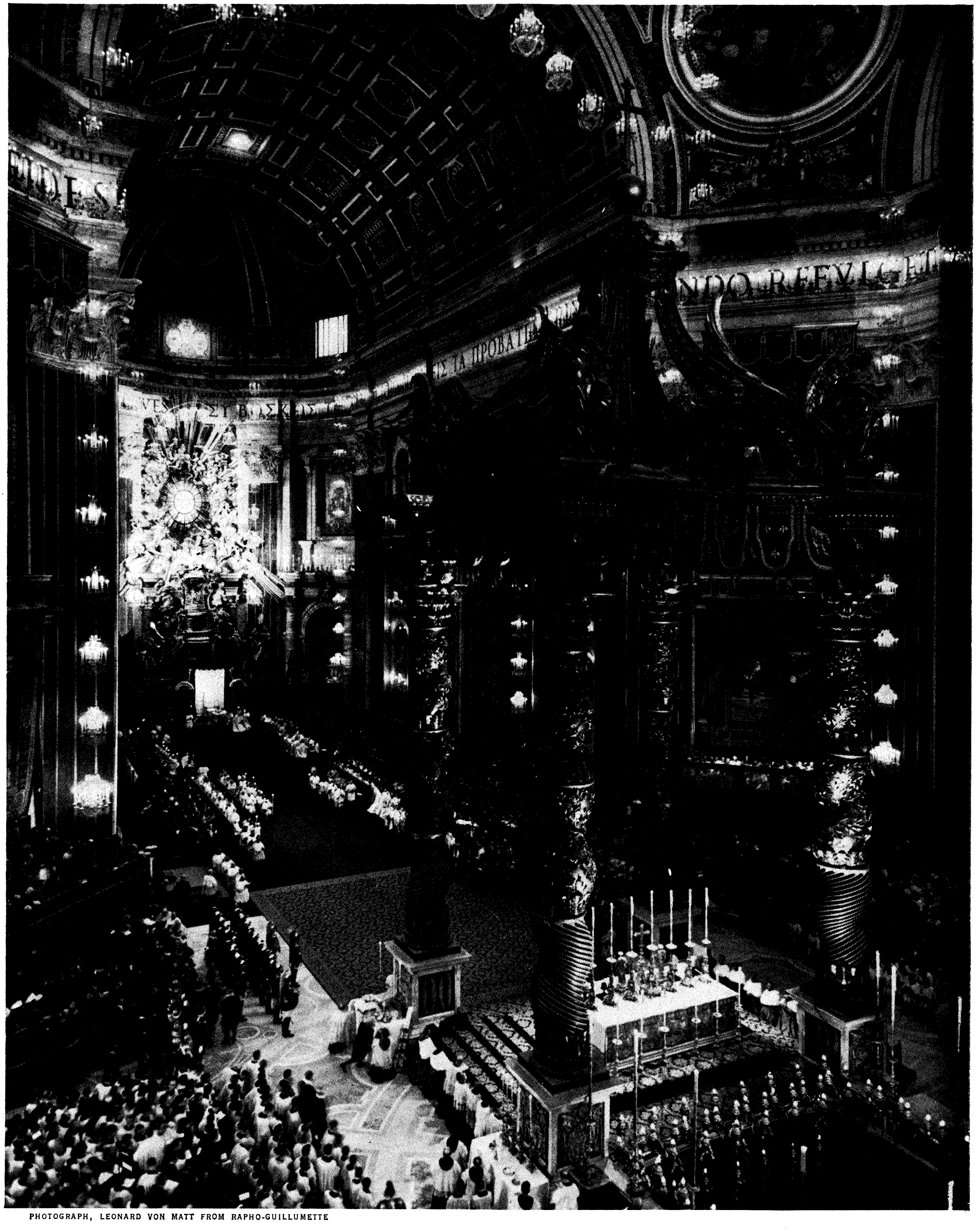
Top right: Interior of the Sistine chapel. Ceiling frescoes, painted by Michelangelo in 1508–12, embody the story of Genesis. Above the altar is Michelangelo's "Last Judgment," completed in 1541

Centre left: Vatican City Government palace viewed from the cupola of St. Peter's. The building in the background houses the Vatican radio transmitter

Bottom left: Sala Rotonda, a circular room containing Greek and Roman sculpture in the Pio-Clementine museum, was designed by Simonetti (1840–92) after the Pantheon. The basin in the centre is of porphyry

Bottom right: The Swiss guard, part of the army of the Vatican, were organized by Pope Julius II in the early 16th century. Their uniforms were allegedly designed by Michelangelo or by Raphael

VATICAN



PHOTOGRAPH, LEONARD VON MATT FROM RAPHO-GUILLUMETTE

ST. PETER'S BASILICA

The interior of St. Peter's showing the bronze baldachino (canopy) by Bernini (1598–1680) over the papal altar. At the far end of the apse is a bronze throne, also by Bernini, containing the wooden chair of St. Peter, and above it is an aureole of gilded stucco to the Holy See; by the Roman patriciate and nobility; by the knights of Malta and of the Order of the Holy Sepulchre. When the papal entourage appears as a whole, in procession, it provides a spectacle of dazzling splendour. It includes cardinals and bishops wearing *cappae magnae* trimmed with ermine or gold-embroidered vestments; Roman princes with cloaks edged with lace: chamberlains "of sword and cloak"; prelates in violet soutanes: representatives of the religious orders: knights of Malta in scarlet tunics; officers in armour of steel damascened with gold; and the Swiss guards in the blue. red and yellow uniform allegedly designed by Michelangelo or by Raphael. Last in the procession comes the pope on the *sedia gestatoria,* a sort of throne on a platform carried on the shoulders of 12 servants wearing liveries of crimson damask. Above the *sedia* is a canopy of cloth of silver. the golden supports of which are borne by eight prelates. Two privy chamberlains. one on either side of the throne. carry *flabelli* or immense fans adorned with ostrich feathers.

CEREMONIES AND RITES

The Vatican basilica is served by a chapter of canons (who in virtue of their office. like the canons of the chapters in the patriarchal basilicas of St. John Lateran and Sta. Maria Maggiore, rank as supernumerary apostolic protonotaries) and by a large body of clergy under the episcopal jurisdiction of a cardinal. who has the title of archpriest. Some of the ceremonies and rites peculiar to the basilica or to the chapels of the Vatican palace may be mentioned here.

The coronation of a new pope, which takes place within a few days of the preceding conclave. is, in itself. not quite a religious ceremony (see PAPACY). On his way to the place oi coronation. the pope is met by a master of ceremonies holding a silver-plated staff at one end of which a piece of tow has been fixed and by a cleric holding a lighted candle; three times the flame is applied to the tow and the staff raised, each time with the words *Sic transit gloria mundi* ("Thus passes an-ay the glory of the world"). The tiara (*q.v.*) is set on the pope's head by the senior cardinal deacon. who says, in Latin: "Receive the tiara with the three crowns, and know that thou art the Father of kings and princes, the pastor of the universe. and the vicar on earth of our Lord Jesus Christ. to whom belongs honour and glory. world without end.!' Pius XII and John XXIII were crowned on the balcony of the basilica.

The rite of beatification (see CANONIZATION) begins with the reading of a papal brief proclaiming the new blessed in the presence of the cardinal archpriest, of the Vatican chapter and of the members of the Congregation of Rites, and is concluded in the afternoon of the same day, when the pope goes in procession to the basilica: prays before an image of the new blessed and receives the Benediction of the Holy Sacrament. The rite of canonization is of a much more solemn character: after a "postulation" made by the "consistorial advocate" and special prayers for the help of the other saints and for light from the Holy Ghost. the pope himself proclaims the new saint and then celebrates the pontifical mass.

At the beginning of a holy year or jubilee *(see* JUBILEE YEAR) the pope opens a special door, the holy door, in the Vatican basilica. so that the faithful may accomplish the rite of passing through it; and at the end of the year he closes it, after which it remains sealed until the next jubilee. (There are also such doors in the patriarchal basilica.: of the Lateran. of S. Paolo-fuori-le-Mura and of Sta. Maria Maggiore.)

On the eve of the feast of St. Peter every year the pope blesses the pallia in the Vatican basilica; they are then stored in a coffer near the tomb of St. Peter until they are required ior new archbishops.

Another unique ceremony is the washing (*lavanda*) of the principal altar of the basilica with wine and balm. done on the evening of Holy Thursday after the singing of the Tenebrae by the cardinal archpriest and the chapter. A further custom. performed at the great festivals of the church, is the showing (*ostensio*) of certain relics from the balcony of a small chapel in one of the piers supporting the dome of the basilica. These relics are (1) Veronica. the veil n-ith n-hich, according to tradition, a pious woman named Veronica wiped our Lord's face as He was going up to Calvary and on which His features are believed to have remained imprinted; and (2) what is believed to be the point of the lance that pierced the side of Jesus on the cross, discovered at Antioch during the first crusade, later captured by the Moslems and eventually presented to Pope Innocent VIII by the Turkish sultan Bayezid II in 1492.

The blessing of the golden rose (*q.v.*), on the fourth Sunday in Lent (annually in former times. but less frequently in the 20th century), takes place in the pope's private chapel in his official apartments. In the same chapel, which is to be distinguished from the private chapel in his private apartments. important visitors are sometimes allowed to hear mass and to receive the sacrament from the pope himself. For the blessing of the Agnus Dei medallions *see* AGNUS DEI.

The Sistine chapel in the Vatican palace is reserved for papal ceremonies (*i.e.,* for ceremonies performed or attended by the pope accompanied by the *cappella*) and for the conclave (*q.v.*). The Pauline chapel is convenient for the spiritual needs of the inhabitants of the Vatican. The parish church. however, is that of St. Anne, by the Porta di Sant' Anna. (X.)

HISTORY

The Vatican Hill and Necropolis. — Before the erection of the basilica of Constantine, the area of the Vatican had an altogether different appearance from what it has today. The Vatican valley. occupied in part by the circus of Gaius (roughly n-here the palace of the Holy Office is now). was about 59 ft. above sea level. The elevation of the square in front of the present-day sacristy rises from 82 ft. at its eastern corner to about 92 ft. at its western one. The new basilica covers an area nearly 99 ft. above sea. level. while the base of the obelisk in St. Peter's square is at less than 63 ft.; advancing northward up the Vatican hill one encounters a level of 127 ft. for the courtyard of S. Damaso. while the highest point of the entire complex is found in the gardens. 264 ft. above sea level. To the casual observer. however, the diiference of more than 205 ft. between valley and summit is not immediately apparent because of the maze of buildings.

The valley was in antiquity somewhat boggy and consequently considered by the Romans to be unhealthful. This situation was remedied in part by the elder Agrippina (d. A.D. 33), who drained the valley and erected terraces for gardens on the hillside; and it was there that her son. the emperor Gaius (Caligula), constructed the circus. which was joined to the Tiber by a portico. The emperor Nero in A.D. 59 took over other gardens there (Tacitus, *Annals,* xiv, 14) that had belonged to his aunt Doniitia Lepida.

The Vatican zone was reached by three main highways: the Via Triumphalis, which left Rome in a northwesterly direction toward the present-day Monte Mario; the Via Cornelia, perhaps the oldest. which passed near the spot where the emperor Hadrian erected his remarkable tomb; and the Via Aurelia Nova. which must have passed between the circus and the necropolis discovered in the 1940s. The numerous clay deposits in the vicinity were used by the Romans in manufacturing wine jugs. cooking utensils and, especially. bricks and tile.

The Vatican area, from the right bank oi the Tiber up to the top of the hill. lying as it did outside the city walls. was, extensively used by the ancient Romans as a burial ground. Many of their large tombs were given strange names by medieval Romans; for instance the "Pyramid of Romulus." a large mausoleum demolished in 1499 by Alexander VI. and the "Terebintus" or "Obelisk of Nero," a large circular tomb likewise demolished in the 15th century. Many of these tombs belonged to the charioteers of the nearby circus. and some were even used to bury famous race horses in the reigns of the emperors Domitian. Trajan and Antoninus Pius. Roman tombs were found in the time of Pope Nicholas V, when in 1452 work n-as begun on the apse for the new basilica; and others were uncovered as the construction progressed into the 16th and 17th centuries in the area today occupied by the façade of the basilica and St. Peter's square. An immense Roman necropolis was discovered between 1887 and 1908 in the zone between the modern Via di Porta Angelica and the edge of Monte Mario. containing some very ancient tombs. among them those of freedmen of the emperor Claudius. Other Roman tombs were found while foundations for the Vatican governor's palace were being laid. and still others were uncovered in the Vatican gardens and under the Annona Vaticana. Even in 1956, during the construction of an edifice north of the Vatican post office. tombs were discovered bearing inscriptions dating from the 1st century A.D., two of them mentioning a male and a female slave of Nero.

The most interesting necropolis, however, came to light during the excavations carried out by personal initiative of Pius XII during the years 1941–49 under the central nave of St. Peter's basilica. In the zone south and east from the basilica's high altar were discovered two rows of mausoleums belonging for the most part to freed slaves of aristocratic and imperial families. Arranged in two parallel rows. the more ancient mausoleums occupied the north row. the one nearest the hillside; but all had their entrances on the south side, that is. facing the Roman road separating the necropolis from the circus. In fact, above the door of the easternmost mausoleum an inscription was found, in which the heirs of Gaius Popilius Heracla transcribed that section of his will stipulating the erection of this mausoleum for himself. his wife and descendants *in Vaticano* ad *circum* ("on the Vatican near the circus").

The mausoleums. embellished with stucco work and frescoes, were almost all employed for cremation as well as for inhumation; in the case of cremation the ashes were deposited in urns of terra cotta. of marble or even of alabaster; for inhumation the bodies were interred in sarcophagi of terra cotta or of marble richly decorated with scenes from Dionysian mythology or at times even with portraits of the defunct.

Inscriptions on the sarcophagi furnish some idea of the social class of the Romans buried there; they include freedmen of many of the aristocratic families, as well as freedmen of the emperors Antoninus Pius. Diocletian and Maximian. In some of these mausoleums Christian tombs were found; in one inscription can be read the date of the burial; in another a husband wishes for his wife Aemilia Gorgonia eternal rest, the inscription being framed between two doves with olive branches and the carved portrait of Gorgonia. A small mausoleum. first employed for cremation burial and later converted to inhumation. was decorated with a beautiful mosaic depicting on the ceiling Helias (the sun) in a chariot drawn by four white horses, the entire figure a symbol of Christ, the sun of salvation: on the side walls of the mausoleum were represented the Good Shepherd, the Fisher of Souls and Jonah swallowed by the whale. Since these mosaics are patently from a period before Constantine, they are the oldest known Christian examples of such art. Those mausoleums near and under the south side of the high altar of the basilica were partially destroyed by the construction of the *confessio* at the end of the 6th century and partially by the insertion of the foundations for the two south columns of G. L. Bernini's canopy in 1626.

On the ground level south of Constantine's basilica were two massive circular mausoleums, considered for a long time to have been constructed after the basilica itself. When. however, in 1776, the easternmost one was demolished. Gaetano Marini stated that its masonry was from the and century; and later G. B. de Rossi expressed a similar opinion about the other mausoleum. In this latter, Maria, wife of the emperor Honorius. and others were buried. Pope Stephen II (III; 752–57) transformed it into a chapel dedicated to St. Petronilla. whose relics were transferred there by his successor Paul I in 757. Restored by Louis XI of France. it became then the chapel for the French kings. It was chosen by the French cardinal Jean de Villiers de la Groslaie for his tomb, and it was for him that Michelangelo carved his famous "Pietà," seen today in the first chapel on the right in the basilica. After the sarcophagus of St. Petronilla was moved to the new basilica. this mausoleum was demolished during the construction of the south transept (1544). The other mausoleum. the one to the east, was transformed by Pope Symmachus (498–514) into the oratory of St. Andrew, with many altars dedicated to various martyrs; it was demolished in 1776, when Pius VI erected the new sacristy.

The Tomb of **St.** Peter.—If one descends today into the open *confessio* of Paul *V*, one finds immediately under the high altar a gilded bronze grille, behind which is another of smaller dimensions with a metrical inscription of Innocent III (1198–1216); this latter opens on an oaken slab decorated with a representation of Christ among the apostles in Limoges enamel. part of which is today preserved in the Museo Sacro of the Vatican library. Loner down is the niche of the pallia. with a 9th-century mosaic of Christ flanked by other mosaics of St. Peter and St. Paul. On the floor of this niche rests a silver chest containing the pallia and emblazoned with the coat of arms of Benedict XIV.

This chest stands on a bronze plate, placed there by Innocent X (1644–55), engraved with a cross in the right arm of which is a small lid. In 1892 this lid was opened by H. Grisar, who found that it covered a rectangular shaft, the aperture measuring $8\frac{3}{4}$ in. by 63 in. The excavations carried out under Pius XII showed that this shaft. once encased in marble. is more than 14 in. deep and opens on a hollow trenchlike tomb in the earth, where the bones, with the exception of the head, of a robust elderly person were subsequently found This tomb is not at the level of the Roman necropolis. but rather farther north and somewhat higher up the hillside in another inhumation area; some of the surrounding tombs are older than it (for example, a terra-cotta sarcophagus furnished with a libation tube).

Tno stairways gave access to this zone from the south, one flanking the west wall of the early 2nd-century mausoleum of the Matucci, the other farther west between two other mausoleums; this latter led through a door to a small open space provided with a brick bench on the east wall. Beneath this stairway, to carry off rain water and to prevent flooding the tombs, was a drain. some of the tiles from which, dating from the years 147–161, bear the factory stamp of Aurelius Caesar and Faustina. To protect the area on its west side, a wall was erected, running north and south. Covered with red plaster, it is called "the red wall"; a portion of it about 2j ft. long was uncovered during the excavations. In this wall, which passes over the west end of the tomb, was an irregular niche. covered by a marble slab. Higher up on the same wall was a second niche. with marble sheathing topped by a Travertine slab: this slab was once supported by two white marble colonnettes 4 ft. 7 in. high, standing in front (that is, east) of the niche and, as is shown by a cut in the bases of the colonnettes, accommodating a marble grille. Finally. above the second niche, was yet a third one. 3 ft. high and 3 ft. 8 in. wide. This decoration above the tomb is an indication that the monument was visited, and it is evidently to it that the priest Gaius referred when. writing in the time of Pope Zephyrinus (*c.* 199–217), he stated that he could point out the "trophies" of St. Peter and of St. Paul on the Vatican hill and beside the Via Ostiensis, respectively (Eusebius, *Historia Ecclesiastica,* ii, *a* j).

As a further protective measure, another wall was erected on the north side of this area, which was covered with the graffiti of pilgrims. Soon the zone became filled with other tombs arranged around that under the three niches. But this tomb was the only one among all others that was at the same time an object of veneration and of depredation. From this open tomb were collected more than 1,800 coins from all countries from the time of Xugustus to the early part of the reign of Pope Paul V (1605–21); among others. there were 26 from England. dated from the Anglo-Saxon kings of the 7th and 8th centuries to Edward III (1327–77). Among the ex *voto* objects was found a 7th-century gold tablet with a gemmed cross between two eyes. From the tomb the excavations also brought forth traces of fine silver sheeting as well as three thin sheets of lead. undoubtedly used as protection.

This burial monument was encased by Constantine in slabs of precious marbles and was chosen by him as the focal point of his grandiose basilica of five aisles. At the end of the 6th century Gregory the Great raised the sanctuary floor and erected an altar immediately above the tomb monument. This altar. in turn, was enclosed in another constructed by Calixtus II in 1123. Immediately above these two is to be found today the papal altar of Clement VIII. These three altars, one above the other. document in a very special manner the localized veneration paid this tomb throughout the centuries.

Constantine's Basilica.—Scholars are not unanimous in assigning a date for the beginning of the construction of Constantine's basilica, opinions varying from the year 326 to the year 333. Because of the difficulties to be overcome in erecting a five-aisle basilica over the tomb of St. Peter, the enterprise must have lasted about 30 years. Besides having to build on a hill that sloped steeply in two directions, from south to north and from east to west, it was also necessary to demolish the Roman necropolis still in use, cutting off the roofs of the mausoleums and the other protruding structures blocking the construction. First. three massive foundation walls were laid on the south side of the hill; one to support the outside wall of the basilica, one to support the columns separating the two left-side aisles and the third to support the left row of columns of the central nave. Then. after smaller walls had been erected. joining many of the mausoleums together for further support, the Roman necropolis was covered up. On the north or higher side, the foundation walls were naturally less extensive and less massive. The excavations of the 1940s brought to light many new characteristics of Constantinian construction work and furthermore showed the error in the supposition. held from the time of Paul V, that the south aisles of the basilica rested on the north walls of the circus of Gaius and Nero. Furthermore, the excavations brought forth no trace of the Via Cornelia, long considered by Roman topographers to have been on the same line as the axis of the basilica.

Constantine's architects were forced also to carry out extensive fillings and levelings in the area around the basilica. From the street level 35 steps led up to a large portico measuring 203 ft. by 184 ft, and supported by 46 columns; entrance to this was provided by three bronze doors. This portico enclosed a garden, called Paradise. with fountains (one of these fountains can be seen today in the courtyard of the Pigna, so called because the fountain is in the shape of a pine cone). In the course of time three small chapels were erected within the area of the portico. That of Sant' Apollinare. constructed by Honorius I (625–638), was demolished during the erection of the new façade early in the 17th century; that of Sta. Maria in Turri was destroyed by fire in 1167; that of Sta. Maria in Febbre was located near the ancient tomb of St. Gregory the Great.

Entrance from the portico into the basilica proper was provided by five portals, called, from left to right, Porta Judicii. Porta Ravenniana, Porta Mediana or Regia or Xrgentea. Porta Romana and Porta Guidonea. The interior of the basilica formed a rectangular area divided into aisles by four rows of 22 columns each; the central nave measured nearly 79 ft. across and was 131 ft. high, with marble columns 29 ft. high. Its clerestory, pierced by 11 windows. was richly decorated with frescoes; and Pope Liberius (352–366) added a series of portraits of the popes, to which others were added later under Nicholas III (1277–80). Above this zone were three registers, the highest containing the representations of the patriarchs, of the prophets and of the apostles, the two lower ones containing, on either side of the nave, 46 scenes of the Old and New Testaments. Restored by Gregory IV (827–844) and by Formosus (891–896), these frescoes were repainted by P. Cavallini and by Giotto. The flanking aisles were about 29 ft. wide with columns nearly 20 ft. high; the two inner aisles were 62 ft. in height. while the outer two were 46 ft.

At the head of the central nave was the triumphal arch decorated in mosaic and inscribed in golden letters commemorating Constantine, who was also represented in the mosaics in the act of presenting a model of the basilica to the Saviour; this arch was destroyed in 1525. On the axis of the basilica in the centre of the transept. which was 59 ft. wide. stood the tomb of the apostle Peter, vested in porphyry and in blue-veined marble and with four porphyry columns, and surmounted by a gold cross inscribed with niello letters, the donation of Constantine and his mother Helena. The monument was enclosed in a pergola supported by six white spiral columns from the top of which hung a golden votive crown with 50 lamps in the form of dolphins. The entire monument is depicted on a carved ivory box discovered at Samagher near Pola.

The constructions carried out by Constantine interfered with the natural drainage from the springs on the slope of the Vatican hill, with the result that water seeped into the tombs located there. Pope Damasus (366–384) tapped these springs to provide water for the baptistery that he erected in the north transept of the basilica. Later Symmachus added there three small chapels dedicated to the Holy Cross, to St. John the Baptist and to St. John the Evangelist.

Under Sixtus III (432–440) the emperor Valentinian added to the embellishment of the apostle's tomb by donating a representation in gold and precious gems of the Saviour in the midst of the 12 apostles arranged in front of the 12 gates of the heavenly Jerusalem. Leo I (440–461), with the help of the senator Rufus Viventius Gallus. repaired the damage done to the monument by the earthquake of 443 and, with the help of the former prefect and consul Marinianus and his wife Anastasia, restored the facade, where in mosaic were depicted the figures of Christ. the Virgin Mary and St. Peter as well as the symbols of the evangelists and below, between the windows. the 24 elders of the Apocalypse. The mosaic was again restored under Sergius I (687–701), who substituted the figure of the Lamb of God for that of Christ, and yet again, much later. under Gregory IX (1227–41). A reproduction of this mosaic is found in an 11th-century manuscript from the abbey of Farfa. preserved today at Eton college, Windsor.

Pelagius II (579–590) was responsible for the construction of the pulpit in the sanctuary. Gregory the Great (590–604). after raising the level of the sanctuary. erected an altar above the tomb leaving visible, through a small window. only the eastern face of the ancient tomb monument. Further, having changed the pergola with its six Constantinian spiral columns for a screen in front of the apse of the basilica, he then excavated and added the semicircular crypt with its block altar. John VII (705–707) added to the basilica the chapel of the Virgin Mary (often called the Praesepe), richly decorated with mosaics; this was demolished in 1606. Gregory III (731–741) added six spiral columns to the existing six in front of the main altar. Stephen II (III) erected the bell tower and remodeled one of the fountains of the atrium, adding eight porphyry columns and a gilded bronze cupola. Leo III (795–816) enlarged the baptistery and donated three porphyry columns. Paschal I (817–824) constructed the chapel dedicated to the martyrs Processus and Martinianus.

The basilica was sacked and pillaged by the Saracens in 846. and Leo IV (847–855) had to repair the damage. Calixtus II (1119–24) erected a new high altar that enclosed the previous one of Gregory the Great. both of them directly above the tomb housed in the Constantinian monument. The basilica underwent further damage in the time of Innocent II (1130–43).

In 1298 the cardinal Giacomo Stefaneschi commissioned Giotto to execute a mosaic for the portico. Often called the "Navicella" ("little boat") of Giotto, it depicted Christ walking on the waters and stilling the storm that was terrifying the apostles in the boat (Matt. xiv, 22–33); today it is to be seen, considerably altered. in the ceiling of the atrium. During the Avignonese period of the papacy, the basilica was neglected! only Benedict XII (1334–42) repairing the roof. Eugenius IV (1431–47) added a new central door in bronze. designed and executed by Filarete (Antonio Averulino); this same door was used for the central portal of the new basilica in 1619.

Although the construction of the new basilica had already begun. Sixtus IV (1471–84) erected a new altar canopy in 1479 embellished with bas-reliefs depicting episodes from the lives of the apostles Peter and Paul; these today can be seen in the *confessio* of Clement VIII.

The Tombs of the **Popes.**—According to the available written sources. the tombs of all the popes down to Victor I (d. 199), with the exception of that of Clement I. were near that of St. Peter. After Victor, the popes were buried in the various cemeteries around the city, burial on the Vatican being resumed only with Leo I. Today, in the corridor leading to the basilica's sacristy, there is a marble inscription naming more than 140 popes buried there, including some who reigned in the 20th century. There are. however, few the remains of whose monuments or tombs have been preserved; many were destroyed by Saracens in 846, while still more mere lost in the sack of Rome in 1527. For some, only the text of the burial inscription has been .recorded in the later epigraphic collections. Many such monuments were demolished by Bramante (called by some "the ruinous builder") in the construction of the new basilica; those surviving are preserved in the Grotte Vaticane. where Paul y. from 1606 onward, assembled the material left over from the old basilica. In the Grotte are also the tombs or the monuments of Gregory V (996–999), Adrian IV. Nicholas III. Boniface VIII. Urban VI. Innocent VII. Nicholas V. Julius III. Marcellus II and Innocent IS, as n-ell as the tombs of some later popes. for instance Innocent XIII. Benedict XV and Pius XI. After the excavations of the 1940s the remains of the monument of Paul II and Antonio Pollaiuolo's grandiose bronze monument of Sixtus IV were transferred there. together with certain remains from the old basilica previously preserved in Benedict XV's Museo Petriano (no longer existing). In the Grotte are also the monuments of the emperor Otto II. who was interred in the atrium in 983: of Charlotte de Lusignan. queen of Cyprus (d. 1487); of Christina of Sweden (d. 1689); and of "Henry IX," the last of the Stuarts (the cardinal duke of York).

In the old basilica, moreover. were buried certain kings and princes who died while on pilgrimage at Rome: for example. Ceadwalla of Wessex (d. 689); Coenred of Mercia and Offa the son of Sigehere of Essex, who together entered one of the monasteries nearby (*c.* 709); and Ine of Wessex.

During the construction of the new basilica, many inscriptions and sarcophagi were removed from the area under the old Constantinian one: and the excavations of the years 1941–49 showed that the area under the ancient basilica was occupied not only by sarcophagi but also by other tombs in masonry covered with tiles or with marble. The more important sarcophagi and inscriptions from this area were all removed to the Grotte Yaticane. It may be remarked that the floor level cf the Grotte is the same as that of the ancient Constantinian basilica, that of the new basilica being more than ten feet higher up.

The Monasteries. — To provide choir service at St. Peter's four monasteries were founded in the course of time around the basilica. The oldest. dedicated to SS. John and Paul and first mentioned during the time of Leo I. was located on the north side of the basilica; its remains were seen during the construction of the north side of the transept of the new basilica. The second. dedicated to St. Martin. was situated under the southwest pilaster of the cupola. where today is the statue of Veronica. The third monastery, that of St. Stephen Major, called also *cata Galla Patricia*, is found today behind the apse of the new basilica; its church. restored on various occasions from the time of Leo III. was called also St. Stephen of the Moors or Xbyssinians. The fourth was that of St. Stephen Minor, founded by Stephen II (III); it later became the hospice for Hungarians, but it was demolished in 1776 during the construction of the new sacristy. After the 11th century these monasteries became residences for the canons of the basilica; finally Nicholas III erected a residence for the canons on the south side of the basilica on the site of the present one. The site of a fifth monastery. the Jerusalem. probably housing a convent of nuns, may be supposed to have been near the oratory of the same name founded by Symmachus.

The **Diaconiae.**—From the time of Symmachus small edifices for the care of the poor were constructed on the south side of the basilica; they were subsequently restored by Sergius I. by Gregory III and by Leo III. Bathing facilities were also provided nearby. Continuing the care of the poor, the diaconiae (deaconries) were established. The first was that of SS. Sergius and Bacchus. situated on the north side of the basilica and located in the Palatium Caroli. Another diaconia was that of St. Mary. called *in caput Portici* (being at the head of the portico that led from the Tiber to the basilica). Stephen II (III) also erected a hospice there (where today the obelisk stands); but under Pius IV this hospice was demolished. as also n-as the third diaconia. called St. Silvester and recorded from the 8th century. The fourth diaconia was first called *in Hadrianum* because of its nearness to the mausoleum of Hadrian (Castel Sant' Angelo) and later Sta. Maria in Traspontina; it occupied a site somewhat east of that of the existing church of Sta. Maria in Traspontina and lasted till the 15th century. The fifth diaconia, that of St. Martin de *Curtina* or *juxta Porticum,* was located near the second and third ones; it disappeared in the 17th century.

The **Scholae** for Pilgrims. — Around the basilica were erected *scholae* or hospices for pilgrims. who could find lodging and clergy from their native lands there. The oldest hospice was the *schola Saxonum* for the English. which was founded, according to Matthew of Paris. by King Ine of Wessex c. 727–730 or, according to William of Malmesbury, by King Offa of Mercia at the end of the 8th century: and the entire vicinity of the present church of San Spirito in Sassia was called *burgus Saxonum.* This hospice was destroyed by fire under Paschal I and again under Leo IV; both incidents were depicted by Raphael in the *stanze* of the Vatican palace. The *schola Francorum* or hospice for the Franks was on the site now occupied by the oratory of St. Peter and by the palsce of the Holy Office; its chapel was called S. Salvatore de Ferrione. Later,' for German and Flemish pilgrims. Sta. Maria in Campo Santo and the *schola Teutonum* were erected. The *schola Longobardorum,* for the Lombarda, is said to have been founded c. 770 by Xnsa. the wife of King Desiderius; attached to it was the church of St. Justin. The present chapel of SS. Michele e Magno is all that remains of the *schola Frisonum,* for the Frisians, at the upper left part of Bernini's colonnade. Near the present entrance to the sacristy was the hospice for the Hungarians, founded at the beginning of the 11th century in the buildings of the older monastery of St. Stephen Minor. called also *de Agulia* (with reference to the Vatican obelisk nearby).

The Leonine City. — The emperor Lothair I, immediately after the Saracen invasion of 846, wanted to construct a fortified mall around the basilica of St. Peter; but work on it actually began under Pope Leo IV. Lasting through his reign, much of the work was done by Saracen prisoners. Extending for 2½ Roman miles, this wall numbered 48 towers and 3 gates. inscriptions from which are preserved in fragments and in epigraphic collections. Later, Innocent III constructed another fortified wall within the perimeter of the older one. One of the defensive ton-ers from this wall was identified in 1947; about 8; ft. high. this tower had been incorporated in the construction of Nicholas 111's palace.

The New Basilica. — The idea of a new basilica was first conceived by Pope Nicholas V (1447–55), prompted by the state in which he found the old one. The architect Leon Battista Alberti observed that its south wall was leaning 5 ft. 9 in. out of the perpendicular: and the frescoes on the south side of the central nave. leaning by 3 ft. 7 in., were covered with dust. In 1452, then. Nicholas V ordered Bernardo Rossellino to begin the construction of a new apse west of the old one, but the work stopped with the pope's death. Paul II, however. entrusted the project to Giuliano da Sangallo in 1470. Sixtus IV ordered the erection of a new baldachin (canopy) over the high altar, the bas-reliefs of which are preserved today in the Grotte.

On April 18. 1jo6. Julius II laid the first stone for the new basilica. It was to be erected in the form of a Greek cross according to the plan of Donato Bramante, who began the demolition of the old basilica, laying the foundations for the four pilasters of the cupola. saving, however, the apse and main altar. On Bramante's death (1514), Leo X commissioned as his successors Raphael, Fra Giovanni Giocondo and Giuliano da Sangallo. n-ho modified the original Greek-cross plan to a Latin one with three aisles separated by pilasters. Also active at this stage were the architects Antonio da Sangallo (the elder). Baldassare Peruzzi and Andrea Sansovino. After the sack of Rome in 1527 Paul III (1534–49) entrusted the undertaking to Antonio da Sangallo (the younger). who returned to Bramante's plan and erected a dividing wall between the area for the new basilica and the eastern part of the old one. which was still in use.

On Sangallo's death (1546) Paul 111 commissioned Michelangelo Buonarroti as chief architect for the task. Although criticized by many for a lack of flexibility in the execution of his plans. Michelangelo was confirmed in his position by Julius 111 (1552) and by Pius IV (1561). At the time of his death in 1564 the drum for the massive cupola was practically complete. He was succeeded by Pirro Ligorio and by Giacomo Barozzi. called Vignola. Gregory XIII (1572–85) placed Giacomo della Porta in charge of the work. The dome was finally completed at the insistence of Sixtus V (1585–90), who was also responsible for moving the Egyptian obelisk to the centre of the piazza in front of the basilica in 1586, a task directed by Domenico Fontana. Gregory XIV (1590–91) ordered the erection of the lantern above the cupola.

The pavement of the new basilica was laid at a level more than ten feet above the old one. Clement VIII (1592–1605) demolished the old apse and erected the new high altar over the altar of Calixtus II. Paul V (1605–21) adopted Carlo Maderno's plan of giving the basilica the form of a Latin cross by extending the eastern arm. With the completion of the work in 1613, the new edifice measured 613 ft. in length; the atrium, 233 ft. long. 42 ft. wide and 65 ft. high. contained Giotto's "Navicella." The façade is 377 ft. long and 151 ft. high. In front of the high altar, the work of Maderno and Martino Ferrabosco, Paul V opened a large *confessio* covered with coloured marble and decorated with bronze statues of the apostle? Peter and Paul. Urban VIII (1623–44) entrusted Giovanni Lorenzo Bernini, the successor of Maderno, with the execution of the new canopy; in gilded bronze. it is 92 ft. high and 136.392 Ib. in weight, with columns modeled after the earlier Constantinian ones (much of the bronze was taken from the beams in the atrium of the Pantheon). Bernini was also responsible for the embellishment of the four huge pilasters on the sides toward the high altar: the lower registers contain four niches with statues of St. Longinus (by Bernini). St. Helena (by A. Bolgi), St. Veronica (by F. hfocchi) and St. Andrew (by F. Duquesnoy). Above are four loggias containing eight of the ancient spiral columns from the sanctuary of the old basilica. In 1637 the bell tower was begun, but the resulting construction was demolished in 1641 for technical reasons.

The marble decoration of the interior. as well as the medallions representing the first 40 popes and 28 allegories of virtues. were ordered by Innocent X (1644–55) and executed by Bernini. The same architect, commissioned by Alexander VII (1655–67), designed and erected the two semicircular cplonnades: they consist of 284 columns of Travertine placed in four rows and surmounted by a balustrade on which are 140 statues of martyrs and confessors. At the same time Bernini also executed the bronze throne (chair) in the apse resting on statues of two Latin doctors of the church, St. Xugustine and St. Xmbrose. and two Greek doctors. St. Athanasius and St. John Chrysostom. He also erected the fountain to the left of the obelisk, substituting it for the one placed there by Innocent VIII; the other fountain was the work of Carlo Fontana. commissioned by Clement X in 1670.

In the pavement of the central nave are indicated the comparative lengths of the world's largest churches, all less than that of St. Peter's.

The Papal Palaces.— From the 4th century until the Avignonese period (1309–76) the customary residence of the popes was at the Lateran. On the Vatican. Pope Symmachus erected two episcopal residences. one on either side of the basilica. to be used for brief stays and certain functions in the church. On the north side of the basilica Chnrlemagne constructed the Palatium Caroli to house his subjects during their visits to Rome. Other edifices were added by Leo III and later by Eugenius III (1153); modernized by Innocent III, they received added protection in the form of a second fortified wall within that of Leo IV. Remains of the towers of this wall have been found in the Vatican gardens. in the large hall of the palace (chapel of Nicholas V). in the rooms flanking the courtyard of the Pappagallo and beneath the Sala Ducale.

Nicholas III, who began the first of the many edifices known today under the name of papal palaces, built a palace decorated remains of which have been discovered on two levels: in the Sala dei Paramenti, in the Sala della Falda, in the Sala dei Pontefici and in the Cubicolo di Niccolo V for the first floor and in the halls of the Chiaroscuri and of Constantine for the second. Rectangular in form, its chapel occupied the same position as the present Sistine chapel, and its gardens covered the area where today is the courtyard of the Belvedere. Nicholas V rebuilt the north and west walls of the palace of Nicholas III, adding also the fortified bastion called after him. He also founded the Vatican library, making use of the services of the architects Leon Battista Alberti, Bernardo Rossellino, Aristotele di Fioravante, Giacomo da Pietrasanta and Antonio di Francesco. For the same pope Giovanni da Fiesole, better known as Fra Angelico, painted the stories of St. Stephen and St. Lawrence in the chapel of Nicholas V. Paul II constructed the stairway to the right of the archway from the courtyard of the Pappagallo to that of S. Damaso.

Cnder commission from Sixtus IV, Giovanni dei Dolci carried out the construction of the Sistine chapel, embellished with the paintings of Perugino. Pinturicchio. Ghirlandaio. Botticelli. Signorelli and others. He also remodeled and decorated the Vatican library. Innocent VIII (1484–92) rebuilt the lower palace betn·een the basilica and the courtyard of the Maresciallo and also erected the small palace of the Belvedere on the north edge of the hill (its chapel of St. John the Baptist. decorated by Mantegna, was later demolished to make room lor the gallery of statues put up under Clement XIV and Pius VI). Alexander VI (1492–1503) constructed the Korgia tower on the northwest side of the palace and remodeled the rooms on the north flank. called the Borgia apartments. Under Julius II (1503–13), Bramante completed the north façade, two of the so-called *logge* (to which Raphael added a third) and the extensive corridor occupied today by the Chiaramonti and inscription galleries. Julius also commissioned Michelangelo to paint the ceiling of the Sistine chapel (1508–12) and Raphael to decorate the rooms of the Signatura and of Heliodorus. Under Leo X (1513–21), Raphael painted the loggia overlooking the courtyard of the Maresciallo, restored in 1943, as well as the bath of Cardinal Bibbiena. At the same time the small palace flanking the north side of the *logge,* considerably altered under Paul V, was erected.

To the period of Clement VII (1523–34) belongs the bath in the edifice next to the papal stairs. Under Paul III, Antonio da Sangallo (the younger) erected the Sala Regia. the Pauline chapel, the *logge* in the courtyard of the Maresciallo and the bastion on the northwest corner. The painters Giorgio Vasari. Taddeo Zuccaro, the two Della Portas arid Daniele da Volterra decorated the Sala Regia: Michelangelo painted his "Last Judgment" (1535–41) in the Sistine chapel, as well as episodes from the lives of St. Peter and St. Paul in the Pauline chapel (1542–50). Pius IV (1559–65) completed the west side of the corridor of the Belvedere and erected the Casino of Pius IV in the gardens. his architects being Pirro Ligorio and Giovanni Salustio I'eruzzi: today this edifice is the seat of the Pontifical Academy of Sciences. From the time of Pius V (1566–72) are the three chapels of St. Stephen, of St. Peter and of St. Michael, embellished with paintings by Vasari and with stuccoes by Giacomo della Porta. and also the chapel of the Swiss guards painted by Giulio Mazzoni and Daniele da Volterra. Gregory XIII (1572–85) was responsible for the wing closing the north side of the present courtyard of S. Damaso, containing rooms decorated by Antonio Tempesta and Mathys Bril; for the famous Gallery of Maps, designed by Ottaviano Mascherino, with maps of the regions of Italy proposed by the Dominican friar Ignazio Danti: and for the observatory in the Tower of the Winds, with pictures by Niccolo dalle Pomarancie and by M. Bril.

The present papal residence along the eastern side of the courtyard of S. Damaso was erected in the time of Sixtus V (1585–90) by Domenico Fontana. who also constructed a new wing for the Vatican library with the Sala Sistina. thereby cutting in half the Belvedere courtyard. Under Clement VIII (1592–1605) Giovanni and Cherubino Alberti decorated the Clementine hall, while Paul Bril undertook the painting of the Hall of the Consistory; the main entrance to the palaces mas rebuilt with the addition of the bronze doors, executed by Martino Ferrabosco and Giacomo Vasanzio; and the building that flanks the Street of the Lluseums, the halls of the Museo Profano and the fountains of the Specchi, the Torri and the Scoglio (all three in the gardens) also date from this pontificate. Urban VIII (1623–44) constructed the Hall of Countess hlatilda, today called the Matilda chapel, decorated by Pietro da Cortona. Under Alexander VII (1655–67), Bernini constructed the Sala Regia, uniting it with the Sala Ducale. Clement XII (1730–40) added a new wing to the Vatican library, and his successor Benedict XIV joined the Museo Sacro or Christian museum to the library. Clement XIII (1758–69) erected the Gallery of the Candelabra.

Clement XIV (1769–74) and Pius VI (1775–99) were responsible for the construction of the Pio-Clementine museum; this complex includes the Porch of the Four Doors, the Simonetti stairway (named after the architect Michelangelo Simonetti), the Hall of the Greek Cross, the Rotonda, the Hall of the Muses, the Hall of the Animals, the Octagonal courtyard, the Room of the Busts, the Cabinet of Masks and the uncovered loggia. Pius VII (1800–23) founded the Chiaramonti museum and the new wing that intersected the Belvedere courtyard. Under Gregory XVI the Gregorian, Etruscan and Egyptian museums were erected at the north end of the courtyard of the Pigna. Pius IX (1846–78) constructed the magnificent stairway leading up from the bronze doors to the courtyard of S. Damaso and opened. in the Borgia tower, the Hall of the Immaculate Conception, decorated by Francesco Podesti. Leo XIII (1878–1903) added the Gallery of the Chandeliers, painted by Ludwig Seitz and others: he also founded the Vatican observatory in one of the towers of the Vatican gardens. Pius X (1903–14) constructed the underground passage between the corridor of Bramante and the gardens, as well as the stairway between the Viale del Belvedere and the courtyard of the Holy Office. He also located the Pinacoteca in the west wing of the Belvedere corridor.

The activities of Pius XI (1922–39) were many and varied. He erected the radio station in the gardens and the new seat of the Pinacoteca with its entrance formed of a double spiral ramp; added a hall to the Casino of Pius IV; renovated the Vatican library; rearranged the gardens; constructed the governor's palace; and erected the edifices housing the post office, the tribunals, the railroad station, the mechanical centre and the studio for the restoration of art works. After the signing of the Lateran treaty, he remodeled Castel Gandolfo and moved the observatory there. Pius XII (1876–1958) renovated the offices of the secretariat of state, founded the television station and restored the Vatican palaces. A new and more powerful radio station. near Sta. Maria di Galeria, was dedicated by Pius XII at the end of 1957.

The Vatican Library.— From the ancient library of the popes at the Lateran nothing remains except the registers of Innocent III, some inventories for the years 1295, 1327 and 1339, others for the Avignonese period and the *Borghesiana* codices. Xlthough a new library had been developing since the time of Eugenius IV, the true founder of the Vatican library was Nicholas V. Its first permanent seat was in the palace of Nicholas V, located there by Sixtus IV according to a plan made by Bartolomeo Platina. Sixtus V erected the present seat of the library in the courtyard of the Belvedere between 1587 and 1589. Considerably enriched during the 17th and 18th centuries, the library suffered severely when numerous manuscripts and incunabula mere transported to France at the end of the 18th. Leo XIII gave the library its famous consultation hall. and Pius XI was responsible for its modernization. The library contains about 60.000 manuscripts, 7,000 incunabula. 100.000 engravings and maps and more than 700,000 printed books. In 1952 it received through the generosity of Francis Cardinal Spellman the only copy in Europe of the Princeton *Index of Christian Art*, begun by Charles Rufus Morey in 1917.

The Vatican Archives.— Founded in 1612 by Paul V, the Vatican archives contain the acts and documents relative to the government of the church. Leo XIII made these documents available to interested scholars. With it is connected the school of paleography. diplomatic and related sciences, founded by Leo XIII in 1884.

The Medal and Coin Collection.— After the loss in 1798 of the collection of coins and medals from the museums of Benedict XIV and Clement XII. a new collection was begun and enlarged by the acquisition of other collections. Pius XII enriched this with the coins found during the excavations of the 1940s.

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VATICAN CITY STATE, the name created for the territory in Rome (area .17 sq.mi., pop. [1959 est.] 1,000) belonging to the Holy See by the Lateran treaty, signed by Cardinal Gasparri, on behalf of the pope, and by Benito Mussolini on behalf of the king of Italy. on Feb. 11, 1929. *See* PAPACY: *The Pupacy in the International Crisis, From 1914;* ITALY; VATICAN, THE.

VATICAN COUNCIL, the most recent ecumenical council of the Roman Catholic Church. It was convened in 1869 and prorogued in 1870; it was never formally dissolved. The principal achievement of the council was the decree *Pastor Aeternus,* asserting the infallible authority of the pope in matters of faith and morals.

Since the Council of Trent (1545–63), no general council' had assembled. In the meantime the rise of rationalism, liberalism and materialism had brought forth systems of thought that denied such fundamental Christian dogmas as the possibility of divine revelation: the existence of God and the immortality of the soul. The desire for a condemnation of these errors and the need for a reform of church law were the principal motives that led Pope Pius IX to begin in 1864 to prepare for a general council. The critical political situation in Europe, and particularly in Italy, seemed to offer but little hope for a successful council. but thanks to the presence of French troops in Rome and to the indifference of the powers. Pius IX was able not only to prepare and assemble the council but also to carry through some important actions between the close of the Seven Weeks' War (*q.v.*) between Prussia and Austria (1866) and the occupation of Rome by the forces of Victor Emmanuel II (1870).

The formal summons to the council was issued on June 29, 1868. At the outset the prospect of a council was greeted with joy by Catholics and benevolent neutrality by Protestants. But not long after the official convocation a storm arose that had repercussions within and without the church. Of little importance was a council of freethinkers assembled at Naples in opposition to the council by Italian Freemasons. The oriental churches, not in union with Rome. rejected an invitation to appear at the council, as did the Protestant churches. Far more important were the reactions within the church itself. Manifestations of discontent soon were observed, particularly in Germany, France and England. In those countries a statement of the papal prerogatives was foreseen and feared. Although the Catholic teaching on this subject had formerly provoked opposition in Gallican and Febronian circles, papal infallibility was looked upon by a majority even of the French episcopate as a truth revealed by God, but the opportuneness of defining it (stating it precisely and making it obligatory doctrine for the whole church) was an open question. It soon became obvious that the question of papal infallibility was destined to dominate the council.

The occasion of the controversy was a communication from France that appeared in the Feb. 1869 issue (series vii. vol. v. p. 34j ff.) of the *Civiltà Cattolica*, organ of the Italian Jesuits. The writer divided the French Catholics into those who were simply Catholics (*Cattolici semplicemente*) and those who were liberal

Catholics *(Cattolici liberali)*. He stated that the former formed the great majority of the Catholics of France and would welcome the proclamation'of papal infallibility.

Thereupon a series of articles (afterward published in book form as *Der Papst und das Konzil* ["The Pope and the Council"]), angrily attacking the doctrine of papal infallibility. appeared in the Augsburg *Allgemeine Zeitung*. The author disguised his identity under the pen name of Janus but was apparently Ignnz von Dollinger (*q.v.*), one of the leading Roman Catholic historians of Germany. Certainly Prince Hohenlohe, foreign minister of Bavaria. acting under Döllinger's influence, tried to induce the powers to take concerted action to prevent the definition. but his efforts were futile. In France Bishops H. L. C. Maret and Félix Dupanloup wrote against the definition of papal infallibility. and answers appeared from the pens of Archbishop Henry Edward Manning (*q.v.*) in England, of Xrchbishop Xdolphe Dechamps in Belgium and of Joseph Hergenrother of Würzburg (*Anti-Janus*, Freiburg, 1870). German opinion was particularly agitated, and 14 of the 22 German bishops thought it advisable to warn Pius IX that a definition of papal infallibility was inopportune. The consequence of this controversy was that before the council began, the Fathers (cardinals. archbishops, bishops, abbots and generals of orders) were already divided into two groups: those for the definition and those against it. Archbishop Manning was the leader of the former group. Bishop Dupanloup of the latter.

Organization. — In186j Pius IX named a commission of cardinals, known as the central commission. to direct the preparations for the council. The central commission named subsidiary commissions on faith and dogma. on ecclesiastical discipline and church law. on religious orders, on oriental churches and ioreign missions. on politico-ecclesiastical affairs and relations of church and state. and on rites. In all, these subcommissions comprised 102 members, of whom 10 were bishops. 69 secular priests and 23 religious priests. The labours of the commissions were conducted in the greatest secrecy. They resulted in 51 schemata (proposed decrees), carefully prepared for the consideration of the Fathers of the council.

The Vatican council was formally opened by Pius IX on Dec. 8, 1869. Of the 1,055 Fathers who had a right to vote. 774 eventually appeared. Principally because of the differences with the Italian king, the pope had judged it opportune to break with a custom that went back to Constantine the Great and not invite the Catholic princes to attend.

The schemata were discussed in general congregations of the Fathers. Such alterations as were considered necessary could be introduced. In order to facilitate the work of the congregations, four permanent committees were established. the most important of which was the Committee on Faith. The leaders of the majority endeavoured to exclude from this committee any member of the minority opposed to a pronouncement on papal infallibility. In so doing they were acting against the wishes of Pius IX. who would have welcomed the choice of Bishop Dupanloup. Xrchbishop Manning. who said. "Heretics come to a council to be heard and condemned. not to take part in formulating doctrine." was chiefly responsible. The bishops of the minority could of course defend their position in the general congregations: but it was strange that a group comprising so many learned and distinguished men should have little or no representation (a member of the minority had been included by mistake) on the most important committee.

Decree **"Dei Filius."**—The debates on the first schema. "On Catholic doctrine against the errors stemming from rationalism," opened on Dec. 28, 1869. After lively and sometimes violent discussions, occupying 23 general congregations, the decree ***Dei** Filius* was unanimously voted on April 24. 1870. The first chapter treats of God. Who has of His goodness and by His almighty power created all things. Who foresees all things and Who by His providence protects and governs all things. The second chapter declares that God. the beginning and end of all things, can. from created things. be known with certainty by the natural light of reason; it then treats of the necessity and existence of supernatural revelation. The third chapter treats of faith! its reasonableness, supernaturalness and necessity. The fourth chapter treats of the relations of faith and reason: although faith is above reason. there can never be any real discrepancy between them since God. who reveals mysteries. is also author of reason.

Infallibility. — From the beginning of the council the question of papal infallibility had been an issue. No provision had been made for a discussion of this thorny question, but since the majority of the bishops desired the definition the matter could not he excluded from the agenda.

On Dec. 23. 1869. Archbishop Dechamps. Archbishop Manning and others launched a campaign to define papal infallibility. This initiative was successful, and soon more than joo of the Father? had subscribed to the plea. The petitions of the minority opposed could muster only 136 names. As a result a chapter on papal infallibility was added to the schema "The Church of Christ." On April 27, 1870, it was decided to take up immediately the discussion of this additional chapter, which was transformed into a separate decree. Under threat of interference from the powers. the council worked feverishly, holding betn-een May 13 and July 16. 1870, no fewer than 37 general congregations.

The minority alleged many arguments against the opportuneness of the definition and also against the doctrine itself. The majority defended papal infallibility n-ith great vigour, maintaining that the doctrine was clearly contained in both Scripture and tradition, that the historical difficulties alleged were not decisive and that the power of bishops and general councils would not be destroyed by the definition. After various alterations in the text oi the schema. the definitive ballot was taken in the 85th general congregation on July 13. 1870. Of 601 \\-ho were present, 451 voted in favour of the decree. which is known as *Pastor Aeternus*. Of the other 150. 62 accepted it on condition that certain alterations be made. and 88 rejected it. Of the 88. only 15 were opposed to the doctrine itself. On Monday, July 18. 1870. one day before the outbreak of the Franco-German War. 535 Fathers assembled in St. Peter's under the presidency of Pius IX and the last vote n-as taken: j33 Fathers voted *placet*, and only two, Bishop Aloisio Riccio of Cajazzo in Italy and Bishop Edward Fitzgerald of Little Rock. Ark., voted *non placct*. The pope immediately promulgated the dogma.

The decree *Pastor Aeternus* teaches that St. Peter had a true primacy of jurisdiction over the universal church and that this primacy passed to his successors. the bishops of the see of Rome; that accordingly the Roman pontiff enjoys full and supreme power of jurisdiction over the whole church; that he has the right of free communication with the pastors of the whole church and with their flocks; and that the primacy of the Roman pontifi includes the supreme teaching power to which Jesus Christ added the prerogative of infallibility:

> When, in the exercise of the office of pastor and teacher of all Christians, the Roman pontiff by virtue of his supreme apostolic authority teaches definitively that a doctrine concerning faith or morals is to be held by the universal church, he is, through the divine assistance promised to him in St. Peter. possessed of that infallibility with which the divine Redeemer willed his church to be endowed.

After the discussion on infallibility the Fathers n-ere permitted to Ieave Rome for a few months. Before they could return the Piedmontese troops occupied Rome. On Oct. 20. 1870. Pius IS prorogued the council indefinitely. It had completed only a small fraction of the work planned.

Results of the Decree "Pastor **Aeternus."**—Within a few years all the members of the episcopate who had opposed the definition signified their acceptance of the conciliar decision. In Germany.however, a number of priests and professors decided to resist the Vatican decrees.and their move was imitated in other countries. This led to the formation of the Old Catholic Church. which at one time numbered over 150,000 members in Germany, Switzerland. Austria. the Setherlands and other countries. These losses to the church were offset, however. by its gain in the council's clear and unequivocal statement on the nature of the papacy. The controversy that had arisen at the Council of Constance (1414–18) regarding the superiority of the council over the pope was now definitely settled. Gallicanism and Febronianism were finally banned, and the union of all Catholics with the Roman pontiff was greatly strengthened. Apart from the defection of the Old Catholics, the fear of losses to the church expressed at the council was not realized. Later popes have made little use of the defining power, the one certain instance being the definition by Pope Pius XII (1876–1958) on Nov. 1, 1950, of the dogma of the Assumption of the Blessed Virgin Mary into heaven. Furthermore, there is no indication that the power of the bishops has been diminished. Some, indeed, hold that practically it has increased.

See also COUNCIL; FEBRONIANISM; GALLICANISM; INFALLIBILITY; OLD CATHOLICS; PAPACY.

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VATICAN STATE: *see* VATICAN CITY STATE.

VATTEL, EMERICH DE (1714–1767), Swiss jurist whose reputation rests chiefly upon his treatise on international law, was born at Couvet, in the principality of Neuchâtel. April 25, 1714. The treatise he frankly confessed was not an original work but a popularization of a volume published in 1749 by the German philosopher Christian Wolff and entitled *Jus gentium.* Vattel's own work. published in 1758. bears the title *Le Droit des gens* ("Law of Nations"). with the subtitle "Principles of Natural Law Applied to the Conduct and Affairs of Nations and Sovereigns." Vattel died at Neuchâtel on Dec. 28, 1767.

Vattel's analysis of international law is elaborate and complex. He explicitly rejects Wolff's conception of a commonwealth of nations. a world state having authority over its component members; in its place he substitutes rights and obligations derived from the law of nature. which he holds to be binding upon nations as upon their individual citizens. Where the inference from the law of nature is clear, the rights and duties are absolute; where the inference is not clear, each state must be allowed to judge for itself the extent of its obligations, nith the result that many of Vattel's conclusions are no more than his personal interpretations of the proper conduct of sovereigns.

In spite of its logical weaknesses. Vattel's treatise exercised great influence over the development of' international law, especially in the United States. where it was quoted not only by secretaries of state but also by federal judges in cases involving international law. His wealth of illustrations came to serve as precedents, and his liberal and humanitarian principles were readily adaptable to the policy of a democratic state. The principles of liberty and equality that he had absorbed in his native country fitted well into the ideals of the Declaration of Independence. Particularly his defense of neutrality and his detailed rules upon commerce between neutrals and belligerents proved to be of service to U.S. statesmen.

Translations of Vattel's work appeared almost immediately after its publication, the translation by Joseph Chitty being perhaps the best known. In 1916 the Carnegie Endowment for International Peace published a photographic copy of the original text of 1758, with an introduction by Albert de Lapradelle and a new translation by C. G. Fenwick.

See Charles G. Fenwick, "The Authority of Vattel," *American Political Science Review,* 7:395 (1913), 8:375 (1914); Arthur Nussbaum, *Concise History of the Law of Nations,* rev. ed. (1956). (C. G. Fx.)

VAUBAN, SEBASTIEN LE PRESTRE DE (1633–1707), marshal of France, was born at Saint-Léger-Vauban (Yonne). At the age of ten he was left an orphan in poor circumstances, and his youth was spent amongst the peasantry of his native place. At the age of seventeen Vauban joined the regiment of Condé in the war of the Fronde. He was soon offered a commission which he declined. Condé then employed him in the fortification of Clermont-en-Argonne.

Soon afterwards he was taken prisoner by the royal troops, and was converted into a devoted servant of the king. He besieged and took his own.first fortress, Clermont; in May 16jj he became an *ingénieur du roi.*

After the peace of Aix-la-Chapelle Vauban improved or rebuilt various fortresses. Hitherto the characteristic features of his method of fortification had not been developed, and he followed the systems of preceding engineers. Colbert and Louvois were profoundly intcrcstcd in the work, and it was at the request of the latter that the engineer drew up in 1669 his *Mémoire pour servir à l'instruction dans la conduite des sikges* (this, with a memorandum on the defence of fortresses by another hand was published at Leiden, 1740).

On the renewal of war Vauban conducted the sieges of Rheinbergen and Nijmwegen 1672, Maestricht and Trier 1673, Besançon 1674.

Vauban's introduction of a systematic approach to strong places by parallels dates from the siege of Maestricht, and in principle remains to this day the standard method of attacking a fortress. Vauban became *commissaire-général des fortifications* on the death of De Clerville, and in 1681 rebuilt the fortress of Strasbourg.

At Saarlouis for the first time appeared Vauban's "first system" of fortification. He always retained what was of advantage in the methods of his predecessors. In 1682 his "second system," which introduced modifications designed to prolong the resistance of the iortress, began to appear.

In 1687 Vauban chose Landau as the chief place of arms in lower Alsace. But side by side with this development grew up the far more important scheme of attack. He instituted a company of miners, and the elaborate experiments carried out under his supervision resulted in the establishment of all the necessary formulas for military mining *(Trait6 des mines* [Paris, 1740, 1799; The Hague. 1744]); at the siege of Ath in 1697 he employed ricochet fire for the first time to break donn the defense. He had indeed already used it with effect at Philipsburg in 1688 and at Namur, but was hindered by the jealousy of the artillery. After the peace of Ryswick Vauban rebuilt or improved other fortresses, and finally New Breisach, fortified on his "third system," which he called *système de Landau perfectionné.* His last siege was that of Old Breisach in 1703, which he reduced in a fortnight. On Jan. 14 Vauban had been made a marshal of France, a rank too exalted for the technical direction of sieges, and his active career came to an end with his promotion. Soon afterward appeared his *Traite' de l'attaque des places.*

But Louis XIV was now on the defensive, and the War of the Spanish Succession saw the gradual wane of Vauban's influence, as his fortresses were taken and retaken. The various captures of Landau, his *chef-d'oeuvre,* caused him to be regarded with disfavour; he then turned his attention to the defense; but his work *De la défense des places* (ed. by General Valazé, Paris. 1829) is of far less worth than the *Attaque,* and his ideas on entrenched camps (*Traité des fortifications de campagne*) were coldly received. though they contained the elements of the "detached forts" system that came to be universal in Europe. He now devoted himself to the arrangement of the manuscripts (*Mes oisivetés*) which contained his reflections on war, administration, finance, agriculture and the like. In 1689 he made a representation to the king in favour of the republication of the Edict of Nantes, and in 1698 he wrote his *Projet d'une dixme royale* (see *Economistes financières du XVIII^e sikcle* [Paris, 1851]), a remarkable work foreshadowing the principles of the French Revolution.

Vauban was impressed with the deplorable condition of the peasantry, nhose labour he regarded as the main foundation of all wealth, and protested against unequal taxation and the exemptions of the upper classes. His *dixme royale,* a tax to be impartially applied to all classes, was a tenth of all agricultural produce payable in kind. and a tenth of money chargeable on manufacturers and merchants. This work was published in 1707 and instantly suppressed by order of the king. The marshal died heartbroken at the failure of his efforts a few days after the publication of the order (March 30. 1707). At the Revolution his remains were scattered, but in 1808 his heart was found and deposited by order of Napoleon in the church of the Invalides.

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VAUCLUSE, a *de'partement* of France, formed in 1793 out of the countship of Venaissin, the principality of Orange and a part of Provence. and bounded by Drôme on the north. Basses-Alpes on the east, Bouches-du-RhBne (from which it is separated by the Durance) on the south and Gard and Ardkche (from which it is separated by the RhBne) on the west. It has also an enclave, the canton of Valréas, in the *département* of Drôme. Pop. (1954) 268,318. Area, 1,382 sq.mi. In the *de'partement* east to west chains of the French Alps die down westward toward the RhBne; the northernmost includes the Montagne de Lure (5,994 ft.) and Mont Yentoux (6,273 ft.) and is separated from the next, the Plateau de St. Christol (4,075 ft.), by the Nesque river; the river Coulon separates this plateau from the Chaine du Léberon (3.691 ft.), which in turn is bounded on the south by the Durance. The very numerous streams feed irrigation canals. The climate is that of the Mediterranean region. The valley of the RhBne suffers from the mistral, a cold and violent wind from north-northwest. but the other valleys are sheltered by the mountains, and produce oleander, pomegranate, olive, jujube, fig and other southern trees and shrubs. The winter average temperature is about 41° and the summer average temperature 73°. Wheat and potatoes are the most important crops; sugar beets, sorghum, millet, ramie! early vegetables and fruits: notably the melons of Cavaillon, are cultivated, and also the vine, olive. mulberry and tobacco. The truffles of the regions of Apt and Carpentras and the fragrant herbs of the Ventoux range are renowned. Sheep are the principal livestock, and mules are also numerous. Lignite and sulphur are mined; rich deposits of gypsum, fire clay, ochre, etc., are worked. Beaumes-de-Venise and Montmirail have mineral springs. The industries include the spinning and weaving of silk, wool and hemp, metalworking, printing (Avignon), tanning and the making of paper, bricks, tiles, pottery, glassware and tobacco. The department is served by the P.L.M. railway, and the Rhône is navigable for 40 mi. within it. It is divided into three *arrondissements* (Avignon, Carpentras and Apt), 22 cantons and 151 communes. Avignon, the capital, is the seat of an archbishop. The department belongs to the region of the 15th army corps and to the *académie* (educational division) of Aix, and has its appeal court at Nimes.

The chief towns are Avignon, Apt, Carpentras, Cavaillon, Orange and Vaison-la-Romaine.

VAUD (Ger. WAADT), a canton of southwestern Switzerland, lying mainly between the Lake of Neuchâtel and the Lake of Geneva. It occupies 1,240 sq.mi., of which 85% is productive. Vaud. with 119.8 sq.mi. of water surface of the larger lakes, has more than one-quarter of the total for Switzerland. The largest lake in Yaud is de Joux (3.7 sq.mi.). There are more than 4 sq.mi. of glaciers; these and the loftiest summit in the canton (Diablerets, 10.528 ft.) occur in the western Bernese Oberland (S. Vaud). The canton includes most of the northern shore of the Lake of Geneva and stretches from slightly beyond Bex in the southeast to the Juras on the northwest. A long, narrow eastern tongue extends past Payerne to the Lake of Neuchâtel. Beyond its tip is the Avenches region, forming an enclave in Fribourg. Parts of Fribourg, in turn. form enclaves within Vaud along the shore of Neuchâtel. A strip of the right bank drainage of the RhBne (from above Bex to the Lake of Geneva) lies within the canton, but north and northeast of Lausanne the land is drained by the Broye and Thikle, of the Aar-Rhine basin.

Vaud, with plains near the lakes, is hilly rather than mountainous. Lausanne is a railway centre. and the canton has numerous small-gauge railways and mountain lines. In 1950 the population was 377.585. of whom 319.287 were French-speaking, 41.818 German-speaking, 10,925 talia an-speaking; 294.823 were Protestants, 75.142 Catholics, 1,814 Jews. In 1960 the population was 429.512.

The vineyards (15.4 sq.mi.), though showing a considerable decrease during the 20th century, are still the most extensive in Switzerland. White wines predominate; the best come from Yvorne (near Aigle), while the slopes of La Vaux (east of Lausanne) produce both red and white wine. Tobacco is grown in northeast Vaud, particularly near Payerne, and cigars are made at Grandson. Ste. Croix, in the Jura, is world-famed for watches, gramophones, musical boxes and jewelry. The Juras produce limestones and sandstones, and the canton-owned salt beds at Bex provide raw materials for a thriving chemical industry. Vaud is famed for its health resorts and for its educational establishments; visitors chiefly frequent Lausanne, Vevey, Montreux and Château d'Oex in the upper Saane valley. Lausanne academy (founded 1537) was raised to university rank in 1890; the 12th-century castle in Yverdon was the residence and school of Pestalozzi from 1806 to 1825. Lausanne (*q.v.*) is the political capital. The "agglomeration" known as Montreux in 1960 had 12,222, while Vevey had 16.269 and Yverdon 16,338. Other important small towns in 1960 were Ste. Croix (6,925), Payerne (6,024), Nyon (7,643), Morges (8,420), Aigle (4,381) and Château d'Oex (3.378). Among the historical spots are Avenches (the largest Roman colony in Helvetia), Grandson (scene of the first great victory of the Swiss against Charles the Bold in 1476), and the castle of Chillon (where Bonivard, lay prior of St. Victor, near Geneva, was imprisoned 1530–36 for defending the freedom of Geneva against the duke of Savoy).

The canton is divided into 19 administrative districts and contains 388 communes. Its constitution dates from 1885. The legislature consists of a *grand conseil* of 219 deputies (one member to every 450 electors) with an executive *conseil d'état* of seven members; both bodies hold office for four years. Six thousand citizens can compel the government to consider any project, whether legislative or constitutional; this initiative dates back to 1845. Since 1885 the referendum has existed in its "facultative" form for certain measures, and in its obligatory form for financial matters. The two members of the federal *standerat* are named by the *grand conseil,* while the 15 members of the federal *nationalrat* are chosen by a popular vote.

History. — The early history of the canton is that of southwest Switzerland. The Romans conquered (58 B.C.) the Celtic Helvetii and so thoroughly colonized the land that it has remained a Romance-speaking district. It formed part of the empire of Charlemagne, and of the kingdom of Transjurane Burgundy (888–1032). After the extinction of the house of Zahringen (1218) the counts of Savoy gradually won the larger part of it, especially in the days of Peter II, "le petit Charlemagne" (d. 1268). The bishop of Lausanne, however, still maintained the temporal power given to him by the king of Burgundy, and in 1125 had become a prince of the empire. (There is a distinction between the canton of Vaud and the old medieval Pays de Vaud: the districts forming the canton very nearly correspond to the Pays Romand.) In 1536, both Savoyard Vaud and the bishopric of Lausanne were annexed by Berne. Berne in 1526 sent Guillaume Farel, a preacher from Dauphiné, to carry out the Reformation at Aigle, and after 1536 the new religion was imposed by force of arms and the bishop's residence moved to Fribourg (permanently from 1663). Thus the whole land became Protestant, save the district of Échallens. Vaud was ruled harshly by bailiffs from Berne. Political feeling was therefore much excited by the outbreak of the

French Revolution. and a Vaudois, F. C. de La Harpe, an exile and a patriot, persuaded the Directory in Paris to march on Vaud in virtue of alleged rights conferred by a treaty of 1565. The French troops were received enthusiastically, and the "Lemanic republic" was proclaimed (Jan. 1798), succeeded by the short-lived Rhodanic republic, till in March 1798 the canton of Léman was formed as a district of the Helvetic republic. This corresponded precisely with the present canton minus Avenches and Payerne, which were given to the canton of Vaud (set up in 1803). The new canton was thus made up of the Bernese conquests of 1475, 1475–76, 1536 and 1555. The constitutions of 1803 and 1814 favoured the tonns and wealthy men, so that an agitation went on for a radical change, which nas effected in the constitution of 1831. Originally acting as a mediator, Vaud finally joined the anti-Jesuit movement (especially after the Radicals came into power in 1845). opposed the Sonderbund and accepted the new federal constitution of 1848, of which Druey of Vaud mas one of the two drafters. From 1539 to 1846 the canton was distracted by religious struggles, as a result of the attempt of the Radicals to turn the church into a simple department of state, a struggle which ended in the splitting off (1847) of the "free church." In 1882 the Radicals obtained a majority, and in 1885 the constitution of 1861 was revised. See SWITZERLAND: *History*.

VAUDEVILLE. The term vaudeville. which in modern popular usage in the United States and, to a lesser extent. in England, is synonymous with music hall and variety shows (see MUSIC HALL AND VARIETY), is of French origin. According to one derivation, it is a corruption of *vaux-de-vire,* satirical songs sung to popular airs in the 15th century in the Val (*Vau*)-de-Vire, Normandy. It is possible that the author of some of the songs was Olivier Basselin (*q.v.*). This derivation fits in with characteristics which remained constant in French vaudevzlle: the songs were in couplets, were political and satirical, and were sung to popular tunes. The term vaudeville was used to describe ballads of this type by Boileau in 1674.

The term passed into theatrical usage in the early 18th century as a device employed by professional actors and strolling players to circumvent the dramatic monopoly held by the state theatre. the Comédie Française. Forbidden to perform legitimate drama, they were forced to present their plays in pantomime, interpreting the action with lyrics and choruses set to popular tunes. The *comédie-en-vaudevilles* thus became an established part of the repertory of the theatres in street fairs (*théâtres* de la *foire*), and its success emboldened playwrights and producers to create a form of light musical drama, with spoken dialogue interspersed with songs. These *pièces* en vaudeville, as they were called, corresponded in kind to the English ballad opera (*q* v.) and developed into the specifically French *opéra comique;* their history also forms part of the development of opera.

Vaudeville continued to have its influence in the French theatre, and from the musical vaudevilles of C. S. Favart and M. J. Sedaine (*qq.v.*) developed the more literary comedies of Eugène Scribe and Eugène Labiche (*qq.v.*). It also spread to Austria. where vaudevilles were popular in Vienna in the 18th and 19th centuries, and to Denmark where it was introduced by J. L. Heiberg and imitated by Henrik Hertz (*qq.v.*).

In the United States the development of variety entertainment was encouraged from the beginning, although the word vaudeville was not used to describe it until late in the 19th century. The companies that toured between the widely separated urban centres of the colonies and the early states founded their popularity as much on the entr'acte specialties of the individual performers as upon their legitimate offerings. The scattered frontier settlements eagerly nelcomed strolling acrobats, singers and storytellers nhere formal companies could not afford to travel. In the larger cities so-called museums added freaks, trained animals and skits to their inanimate exhibits. Perhaps the best known of these uas Phineas T. Barnum's American museum in New York, established in 1841. In 1842 the Franklin theatre in New York advertised itself as the first variety theatre in that city; it nas at least the first New York theatre to maintain for a dozen years a program of what was later called vaudeville. It opened with J. Morris' Concert and Olio company of 20 persons. offering living models, magic lantern slides, comic lecturers and so on.

The olio seems to have originated as a feature of the minstrel show, a variety entertainment that came into popularity in the decades before the Civil War. The minstrel show. performed by a troupe of white men in blackface, consisted of a first part of songs and jokes, a second part or olio of skits and specialties, and a finale that usually was a legitimate play digested or parodied.

In the 1850s and '60s straight variety began to grow in popular favour until the "concert saloons" in which it was played outnumbered the regular theatres and spelled the death of the resident minstrel troupe. Many of these saloons were described as "dumps and slabs," the equivalent of the British "free and easies," beer parlours whose patrons were generally masculine and loner class and whose programs were always vulgar and sometimes downright obscene. But with the debut of Tony Pastor at the American theatre in the 1860s vaudeville became increasingly domesticated and respectable, with performance standards of narrow but incredible perfectionism. After a brief career as a singer of sentimental ballads. Pastor established on 14th street a small theatre dedicated in 1881 to the "straight. clean, variety show." His unexpected success encouraged other managers to elaborate on his code of prohibitions, until vaudeville achieved the innocuousness of a Sunday school picnic.

The vagabond life of the vaudeville performer (Fred Allen called him part gypsy and part suitcase) forced him to develop the qualities that made the vaudeville stage a training ground for the more serious theatres arts: precision, polish, timing and secure resources for producing gaiety or pathos on demand. The vaudeville actor was rarely allowed more than ten minutes for his turn, which meant that he must be able to establish himself without wasted motion, must display his talents with unvarying skill and move speedily to the climax, or "wow finish," knowing that he had no second chance. Under such conditions were developed the talents of Pat Rooney, the song-and-dance man; W. C. Fields, juggler and comic; and (Jim) MacIntyre and (Tom) Heath, whose "Ham Tree" nas perhaps the most famous of all blackface skits. Out of vaudeville and into the legitimate theatre went such stars as Sam Bernard, Lillian Russell, (Charles) Evans and (Bill) Hoey, May Irwin, Francis Wilson and Nat C. Goodwin. Through vaudeville such European stars as Harry Lauder, Albert Chevalier, Yvette Guilbert and Vesta Victoria first confronted United States audiences A typical bill might open with a song-and-dance team, followed by a singer, a comedy sketch, a monologuist, a character specialty (such as Will Rogers, with trick cowboy-style roping and comic patter), a musical act from the legitimate theatre, a dramatic skit (like the oft-performed *The* Valiant), a "headliner" (such as the singer Eva Tanguay. the "I Don't Care Girl"), concluding with an acrobatic troupe. From about 1895, a short program of motion-picture viens mas used to "clear the house."

In the days of Tony Pastor, vaudeville was an individual operation, the manager booking acts for his theatre alone, and the acts moving from theatre to theatre and town to town as bookings were offered them. By the end of the 19th century. however, the era of the vaudeville chain. a group of houses controlled by a single manager, mas firmly established. Among these managers were Percy C. Williams, who operated a dozen theatres in New York city, Sylvester Z. Poli in New England, Alexander Pantages on the west coast, Charles Kohl and George Castle in the midwest and Gus Sun in Ohio. Dominating all was Benjamin Franklin Keith, who had opened a museum in Boston in 1883. Two years later he joined forces with Edward Franklin Albee to establish the Boston Bijou as the home of "continuous vaudeville," playing from 10 A M. to 11 P M. Success led Keith and Albee to Providence to Philadelphia and finally in 1893 to New York. By 1920 Keith and Albee controlled nearly 400 theatres in the east and midwest, a chain governed by an iron financial and managerial hand and operated on puritanical principles. Through its United Booking office (1900) and its company union, the National Vaudeville Artists (1916), it achieved a near monopoly on both talent and production.

Keith and Albee's chief opposition came from the Orpheum circuit, whose manager, Martin Beck, controlled houses from Chicago to California. Beck built the Palace theatre in New York, from 1913 to 1932 the outstanding vaudeville house in America. Criticism too came from the trade paper *Variety,* founded by Sime Silverman in 1905 to report honestly and frankly on the conditions of the profession and to comment without fear or favour on the performers, performances and the managers. Final defeat for vaudeville came from mechanically reproduced theatre entertainment. Motion pictures, first introduced in 1893 by the former brewers John Koster and Adam Bial at their 31th Street Music hall in New Tork city as an added attraction, gradually consumed more and more of the performing time until. after the advent of the "talkies" about 1927, the customary bill featured a full-length motion picture with "added acts" of vaudeville. Circuits dwindled and playing time grew shorter. Keith-Xlbee absorbed Orpheum. but the combine was in turn absorbed by a film company. A great financial depression and the rapid growth of sponsored radio in the 1930s further restricted vaudeville to a few large population centres. After World War II the rapid development of television was another blow and vaudeville became almost a thing of the past. *See* also THEATRE.

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VAUGELAS, CLAUDE FAVRE, SEIGNEUR DE. BARON DE PÉROGES (1595–1650), French grammarian and man of letters. was born at Meximieu (Ain), on Jan. 6, 1595. Vaugelas was among the original Academicians. In his *Remarques sur la langue française* (1647), he maintained that words and expressions were to he judged by the current usage of the best society, of which, as an habitué of the Hôtel de Rambouillet, Vaugelas was a competent judge. He shares with Malherbe the credit of having purified French diction. His book fixed the current usage, and the classical writers of the 17th century regulated their practice by it. He died in Paris in Feb. 1650.

VAUGHAN, HENRY (1622–1695), British poet and mystic remarkable for the range and intensity of his spiritual intuitions, came of an ancient Welsh family and was born on April 17, 1622, at Llansantffraed. Breconshire, where he lived nearly all his life. He and his twin brother Thomas were privately educated by Matthew Herbert, a neighbouring rector, and went on to Jesus college, Oxford. Henry spent two years there from about 1638 and then went to London to study law, but he was summoned home in 1642 on the outbreak of the Great Rebellion, in which he seems to have taken some part on the royalist side. In 1646 he published *Poems, With the Tenth Satyre of Juvenal Englished* ("The Vanity of Human Wishes") and he had another volume of secular verse ready the next year; but between 1646 and 1650 he was profoundly impressed by George Herbert's poetry and, partly as a result of this, underwent a "conversion" which led him to repudiate all "idle verse." His *Silex Scintillans* (1650, enlarged 1655) and the prose *Mount of Olives or Solitary Devotions* (1652) show the depth of his religious convictions and the authenticity of his poetic genius. Of his secular poems, *Olor Iscanus* was puhlished in 1651 and *Thalia Rediviva* in 1678, both ostensibly without his sanction; but it is his religious poetry that has made his name live. He translated a number of short moral and religious works in prose, four included in *Olor Iscanus*, one in *The Mount of Olives* and four in *Flores Solitudinis* (1654). By that time he had become interested in medicine and, probably at his brother's instigation, he translated two medical works by Heinrich Nolle, under the titles *Hermetical Physick* (1655) and *The Chymists Key* (1657). When he began to practise medicine is not known, but he seems to have continued to do so with good results until shortly before he died in Llansantffraed on April 23, 1695. He was twice married. Little is known about his character except for Anthony à Wood's observation that he "was esteemed by scholars an ingenious person, but proud and humorous," and for what can be gathered from his letters (nine are extant) and his published works.

Vaughan learned a great deal from other writers and borrowed many phrases from George Herbert. He was nevertheless one of the most original poets of his day. His chief asset was a gift of spiritual vision or Imagination which enabled him to write of immaterial things more freshly and convincingly than any of his contemporaries except Milton; and this is illustrated not only in the famous lines beginning

> I saw Eternity the other night
> Like a great Ring of pure and endless light,

but when he plays the same light of eternity round things of common experience. He was a great lover of natural beauty and took easily to the old notion of a life in nature, making it his faith that every flower enjoys the air it breathes and that even sticks and stones share in the earnest expectation of the creature:

> I would I were a stone or tree
> Then should I (tied to one sure state)
> All day expect my date,

and

> Each Bush
> And Oak doth know I AM; canst thou not sing?

The often-pointed contrast between unfallen nature and degenerate man gained force with him from the political events of the 1640s; and these may also help to explain Vaughan's retrospection, his idealizations of the past and his readiness to admire all fresh, unspoiled, pristine existences, including childhood, the time of "white Celestial thought" and paradisal memories:

> When on some gilded Cloud, or flower,
> My gazing soul would dwell an hour,
> And in those weaker glories spy
> Some shadows of eternity.

The element of greatness in Vaughan's poetry owed much to his power of seeing all things *sub specie aeternitatis*, nourished in him not only by Christian theology but by Neoplatonist traditions and the sort of theosophical speculations favoured by his brother Thomas. Some features of Vaughan's poetry have analogies in that of Wordsworth (the similarities between "The Retreat" and the ode on "Intimations of Immortality" have often been appreciated); and it is possible that Wordsworth was influenced by Vaughan.

His technical accomplishments were of a higher order than has usually been recognized. He had not Herbert's sense of build and finish, but he knew how to make idiomatic usage serve the purposes of poetry, and he was a master of evocative phrasing and persuasive rhythm. His prose also deserves attention, not only for its molding and fluency but for the further light which it throws on his mind and imagination; for though most of it is translation he often interrupts his originals to insert his own self-revealing comments.

His poetry was largely disregarded in his own time and for over 100 years after his death. In the 19th century several editions appeared, of which those by H. F. Lyte, A. B. Grosart and E. K. Chambers were the chief. His *Works* were edited by L. C. Martin (2nd ed 1958).

See F. E. Hutchinson, *Henry Vaughan: a Life and Interpretation* (1947). (L. C. MN.)

VAUGHAN, HERBERT (1832–1903), cardinal and archbishop of Westminster, was born at Gloucester on April 15, 1832. He spent six years at Stonyhurst, and was then sent to study with the Benedictines at Downside, near Bath, and subsequently at the Jesuit school of Brugelette, Belgium, which was afterward removed to Paris. In 1851 he went to Rome. After two years of study at the Xccademia dei Nobili Ecclesiastici, where he became a friend and disciple of H. E. Manning, he took priest's orders at Lucca in 1854. On his return to England he became for a period vice-president of St. Edmund's college, Ware, at that time the chief seminary for candidates for the priesthood in the south of England. Since childhood he had been filled with zeal for foreign missions, and he conceived the determination to found a great English missionary college to fit young priests for the work of evangelizing the heathen. With this object he made a great begging expedition to America in 1863, from which he returned with £11,000. St. Joseph's Foreign Missionary college, Mill Hill Park, London, was opened in 1869. Vaughan also became proprietor of the *Tablet*, and used its columns vigorously for propagandist purposes. In 1872 he was consecrated bishop of Salford, and in 1892 succeeded

Manning as archbishop of U'estminster, receiving the cardinal's hat in 1893.

It was his most cherished ambition to see before he died an adequate Roman Catholic cathedral in Westminster, and he laboured untiringly to secure subscriptions. with the result that its foundation stone was laid in 1895, and that when he died, on June 19. 1903, the building was so far complete that a Requiem Mass was said there over his body.

See the *Life of Cardinal Vaughan,* by J. G. Snead Cox (2 vol., 1910).

VAUGHAN, THOMAS (1622–1666), British chemist and mystic whose writings, once notorious for their obscurity, are yet sometimes comparable with those of his elder twin brother Henry, the poet, was born on April 17, 1622, at Llansantffraed, Breconshire. Thomas was educated at Oxford and was ordained, for a time holding the living of his native parish; but he was evicted in 1650 on various charges including that of having borne arms for the king. Under the name of Eugenius Philalethes he published *Anthroposophia Theomagica* (1650), *Anima Magica Abscondita* (1650), *Magia Adamica* (1650), *Lumen de Lumine* (1651) and other works. After 1650 he worked in London as a chemist. He died in Albury, Oxfordshire. on Feb. 27, 1666.

Thomas Vaughan was at once an empirical scientist and a hierophant of theosophical mysteries. Rejecting scholastic science, and despising those who limited investigation to the material world, he hoped by analysis to isolate the "first matter:" a concept which he seems to understand both physically and spiritually, and which would bring the experimenter near to the Creative Spirit itself, and break down the imagined barriers between the material and the spiritual worlds. Much of his speculation was rooted in Neoplatonist and cabbalistic traditions, and seems to have been independent of his chemical researches. except in so far as these might throw light on the wider problems in which he was more deeply interested: the nature of the soul—"a seed or glance of light . . . descending from the first Father of Lights,"—the effects of this separation, the hope and the way of complete reunion with the divine spirit.

His esoteric language and fantastic symbols often baffled his readers and came in for some ridicule; and considering the abstract and elusive nature of his subjects his confident manner may seem less persuasive than he intended. He was nevertheless an honest seeker after truth, wayward and excitable, but intelligent and essentially modest. His works have moments of visionary power and luminous phrasing which recall his brother's writing; but he is likely to be remembered more for his eccentric contributions to mystical philosophy than as a man of letters.

The Works of Thomas Vaughan (1919), edited by E. A. Waite, includes his chief prose and verse in English; Henry Vaughan's *Thalia Rediviva: . . . With . . . Remains of Eugenius Philalethes* (1678) includes his Latin verse; as does *Complete Works* (of Henry Vaughan), edited by A. B. Grosart, 4 vol. (1870–71).

(L. C. Mn.)

VAUGHAN, WILLIAM (1577–1641), English author and colonial pioneer, was born at Golden Grove, Carmarthenshire, in 1577. William was educated at Jesus college, Oxford, and took the degree of LL.D. at Vienna. In 1616 he bought a grant of land in the south coast of Newfoundland, to which he sent two batches of settlers. In 1622 he visited the settlement, which he called Cambriol, and returned to England in 1625. Vaughan apparently paid another visit to his colony, but his plans for its prosperity were foiled by the severe winters. He died at his house of Torcoed, Carmarthenshire. in Aug. 1641.

His chief work is *The Golden Grove* (1600), a general guide to morals, politics and literature, in which the manners of the time are severely criticized, plays being denounced as folly and wickedness. The section in praise of poetry borrows much from earlier writers on the subject. *The Golden Fleece . . . transported from Cambriol Colchis . . . by Orpheus jun., alias Will Vaughan,* which contains information about Newfoundland, is the most interesting of his other works.

VAUGHAN WILLIAMS, RALPH (1872–1958), English composer, whose music derived from folk song and from medieval and Tudor polyphony. is in the great English tradition. He was born at Down Ampney, Gloucestershire. Oct. 12, 1872, and was educated at Charterhouse. Trinity college, Cambridge (D.Mus., 1901) and the Royal College of Music. He also studied with Max Bruch in Berlin. In 1904 he joined the newly founded English Folk Song society and his contacts with folk singers in Norfolk led him to write the three *Norfolk Rhapsodies* (1906). By studying folk music and the work of medieval and Tudor musicians. he evolved a musical language distinguished by vigorous melodic outlines, the free use of modal scales: a strong contrapuntal texture and a highhanded attitude toward harmony. His first two symphonies. *Sea Symphony* (1910) and *A London Synzphony* (1914), his *Fantasia on a Theme by Thomas Tallis* (1910) and his opera. *Hugh the Drover* (1911–14), were outstanding works of his early period. After serving in Macedonia and France during World War I. he became professor of composition at the Royal College of Music and from 1920 to 1928 conductor of the London Bach choir. His presidency of the English Folk Dance and Song society and his support for local music festivals are the signs of his belief expressed in his book *National Music* (1934) that the roots of art should be firmly planted in native soil. Vaughan Williams' principal works, in addition to those mentioned, are: *Toward the Unknown Region* (1907), *The Lark Ascending* (1921), *A Pastoral Symphony* (1922), *Mass in* G *Minor* (1923). the cantata *Flos Campi* (1925). the operas *Sir John in Love* (1929) and *The Pilgrim's Progress* (1951). *Symphony No.* 4 *in F Minor* (1935), *Symphony No.* 5 (1943). *Sixth Synzphony* (1948), *Sinfonia Antartica* (1953), *Eighth Synzphony* (1956) and *Ninth Symphony* (1958).

He has also set or arranged many songs. He was an-arded the Order of Merit in 1935. He died in London on Aug. 26. 1958.

VAULT, any covering for an enclosed room, formed of small pieces of material, generally wedge-shaped and arranged with the undersides forming a generally curved surface, in such a way that each separate unit is held in place by its neighbours on either side; a continuous arch: also, loosely, any curved ceiling or covering of a room, irrespective of its material *(see* ARCH AXD *VAULT)*. The word is also used for a room or series of rooms built for storing valuables and enclosed with heavy walls, doors and ceilings specially constructed to withstand the effect of fire or the attacks of burglars, and entered by a burglar-proof door *(see* SAFES. STRONG-ROOMS AND VAULTS); and, by a somewhat similar extension, to a masonry enclosure in a graveyard, intended either as a permanent tomb or to receive bodies until a final grave is made.

VAULTING: *see* POLE VAULTING.

VAUQUELIN, LOUIS NICOLAS (1763–1829). French chemist who discovered beryllium and chromium. was born at St. André des Berteaux in Normandy on May 16, 1763. A laboratory boy to an apothecary in Rouen (1777–79), after various vicissitudes he obtained an introduction to A. F. Fourcroy, in whose laboratory he was an assistant (1783 to 1791). At first his work appeared as that of his master and patron, then in their joint names; but in 1790 he began to publish on his own authority, and between that year and 1833 his name is associated with 376 papers. Most were simple records of patient and laborious analytical operations, in the course of which he detected two new elements—beryllium (1797) in beryl and chromium (1798) in a red lead ore from Siberia. In organic chemistry he is known as the discoverer of quinic acid, asparagine, camphoric acid and other naturally occurring compounds. He succeeded Fourcroy (1809) as professor of chemistry to the medical faculty in Paris. In 1827 he was elected to the chamber of deputies from Calvados. He died at his birthplace on Nov. 14, 1829. He published *Manuel de l'Essayeur* (1812).

See essay in G. Bugge, *Buck der grossen Chemiker (1955).*

VAUQUELIN *DE* LA FRESNAYE, JEAN (1536–1607), French poet, mas born at the château of La Fresnaye, near Falaise, in 1536. He studied the humanities at Paris and law at Poitiers and Bourges. He fought in the civil wars under Jacques de Matignon and was wounded at the siege of Saint L8 (1574). Most of his life mas spent at Caen, where he was president and where he died. La Fresnaye was a disciple of Pierre de Ronsard but laid stress on the continuity of French literary history. He was a student of the trouvbres and the old chroniclers and desired to see French poetry set on a national basis.

These views he expounded in an *Art poétique,* begun in 1574 and published in 1605.

Les Foresteries appeared in 1555, *Les Diverses Poe'sies* (including the *Aut poe'tique,* the *Satyves françoises* and the *Idylles,* with some epigrams and sonnets) in 1605. *Les Diverses Poe'sies* and *Oeuvres diverses* were edited *by* J. Travers (1869–73); there is also an edition of *Les Foresteries* prefaced by P. Blanchemain (1869) and an edition of the *Art poétique* by G. Pellissier (1884). Among Vauquelin's political writings may be noted *Pour la monarchie de ce royaume contre la division* (1570). *See* further A. P. Lemercier, *Etude littéraire et morale sur les poésies de Jean Vauquelin de La Fresnaye* (1887); C. Des Guerrois, *Études sur quelques-uns de nos vieux poètes* (1923); J. Boullé, *Trois Vauquelin* (1912).

VAUVENARGUES, LUC DE CLAPIERS, Marquis de (1 715-1747), French moralist and miscellaneous writer, was born at Aix in Provence on Aug. 6, 1715. His family was poor though noble; he was educated at the college of Aix, where he learned little — neither Latin nor Greek — but by means of a translation acquired a great admiration for Plutarch. He entered the army as sublieutenant in the king's regiment and served for more than ten years, taking part in the Italian campaign of Marshal Claude de Villars in 1733 and in the disastrous expedition to Bohemia in support of Frederick the Great's designs on Silesia, in which the French were abandoned by their ally (1741-42). In the course of Marshal Charles Belle-Isle's minter retreat from Prague. Vauvenargues' legs were frozen, and though he spent a long time in a hospital at Nancy he never completely recovered. He was present at the battle of Dettingen, and on his return to France was garrisoned at Arras. His military career was then at an end. He had long been urged by the marquis of Mirabeau (author of *L'Ami des hommes* and father of the statesman) to turn to literature, but poverty prevented his going to Paris as his friend wished.

He decided to enter the diplomatic service and made application to the ministers and to the king himself. These efforts were unsuccessful. but Vauvenargues was on the point of securing his appointment through the intervention of Voltaire when an attack of smallpox completed the ruin of his health and rendered diplomatic employment out of the question. Voltaire then asked him to submit to him his ideas of the difference between Jean Racine and Pierre Corneille. The acquaintance thus begun ripened into real and lasting friendship. Vauvenargues moved to Paris in 1745, and lived there in retirement, seeing but few friends, of whom Jean Marmontel and Voltaire were the chief. Among his correspondents was the archaeologist Fauris de Saint-Vincens. Vauvenargues published in 1746 his *Introduction à la connoissance de l'esprit humain, suivie de Réflexions et de Maximes.* He died in Paris on May 28, 1747.

The bulk of Vauvenargues' work is small, but its interest great. His real strength is in a department which the French have always cultivated with greater success than any other modern people — the expression in more or less epigrammatic language of the results of acute observation of human conduct and motives.

An edition of the *Oeuvres* of Vauvenargues, slightly enlarged, appeared in the year of his death. Later editions, containing correspondence, *Dialogues of the Dead* ("characters" in imitation of Thcopbrastus and La Bruyère) and numerous short pieces of criticism and moralizing, are those of D. L. Gilbert, 2 vol. (1857), and of P. Varillon, 3 vol. (1929). For the *Re'flexions et Maximes* see the edition with Eng. trans. by F. G. Stevens (1940). *See* also E. Gosse, *Three French Moralists* (1918). and P. Souchon, *Vauvenargues, philosophe de la gloire* (1947).

VAUXHALL, a district on the south bank of the Thames river. in London. Eng.. included in the metropolitan borough of Lambeth. The manor was held by Falkes de Breauté (whence the name. Falkes hall) in the time of John and Henry III. About 1661 public gardens were laid out. known as the New Spring garden (frequented by Pepys and Evelyn). and later as Spring garden\, but more familiarly as Vauxhall gardens. They soon became the favourite resort of the metropolis. In 1732. under the management of Jonathan Tyers (d. 1767) and his sons, they were greatly developed and became quite fashionable. As such they were described by Thackeray and Fanny Burney. In 1822, pith the approval of George IV. who frequented the gardens before his accession, the epithet Royal was added to their title. By mid-19th century, however, Vauxhall had lost its high reputation, and in 1859 the gardens were closed and the site was quickly built over.

VAUX OF HARROWDEN, THOMAS VAUX, 2nd Baron (1510–1556), one of the group of early Tudor courtier poets which included Sir Thomas Wyatt and the earl of Surrey. Born in 1510, he succeeded his father. Nicholas Vaux, in 1523. He accompanied Cardinal Wolsey on his embassy to France in 1527 and attended Henry VIII to Calais and Boulogne in 1532. Created a knight of the Bath at the coronation of Anne Boleyn (1533), he was captain of the isle of Jersey until 1536. He died in Oct. 1556.

Vaux's two best-known poems, included in Tottel's *Miscellany* (1557), are "The aged lover renounceth love" and "The assault of Cupide upon the fort where the lovers hart lay wounded." They exemplify the underlying melancholy of the early Tudor poets. and also their pleasure in neat antithesis. the development of a conceit and the handling of metre. The *Paradyse of daynty devises* (1576) contains 13 poems signed by him. "The aged lover renounceth love," also called in an early manuscript version "Dittye . . . representing the image of deathe," is misquoted by the gravedigger in *Hamlet*—a testimony to its contemporary popularity.

See A. B. Grosart, *Miscellanies of the Fuller Worthies Library,* vol. iv (1872), for the poems from the *Paradyse of Dainty Devices;* and H. E. Rollin's edition of Tottcl's *Miscellany* (1928–29).

VAVASSOR, in its most general sense a mediate vassal; *i.e.,* one holding a fief under a vassal. The word was. however. applied at various times to the most diverse ranks in the feudal hierarchy, being used practically as the synonym of vassal. Thus tenants-in-chief of the crown are described by the emperor Conrad as *valvassores majores* as distinguished from mediate tenants, *valvassores minores.* Gradually the term without qualification was found convenient for describing subvassals, tenants-in-chief being called *capitanei* or *barones.* Its implication, however, still varied in different places and times. Bracton ranks the *magnates seu valvassores* between barons and knights; for him they are "men of great dignity." and in this order they are found in a charter of Henry II (1166). But in the *regestum* of Philip Augustus one finds that five vavassors are reckoned as the equivalent of one knight. Finally, Du Cange quotes two charters, one of 1187. another of 1349, in which vavassors are clearly distinguished from nobles. The derivation of the word vavassor is obscure. Some would derive it from *vassi* tad *valvas* ("at the folding-doors." *valvae*), *i.e.,* servants of the royal antechamber. Du Cange, with more justice. regards it merely as an obscure variant of *vassus.*

VAVILOV, NIKOLAI IVANOVICH (1887–1943), Russian plant geneticist. was born in Moscow (?) on Dec. 6. 1887. He graduated at the Agricultural academy at Petrovsko-Razumovskoe near Moscow, and later studied under W. Bateson at Cambridge university and the John Innes Horticulture institution. London, in 1913–14. Returning to Russia. he became professor of botany at the University of Saratov (1917–21). and then head of what was finally called the Lenin -ill-Union Academy of Agricultural Sciences.

Vavilov made a comprehensive study of the origin of cultivated plants and proposed that there were several world centres of origin at which the greatest concentration of diversity in cultivated plant species occurred. He made expeditions to many parts of the world, including Persia, Afghanistan. Abyssinia. China. Central and South America. and amassed an immense collection of varieties of cultivated plants which was intended to be used for further study and the breeding of new varieties. However. in 1940 he was ousted from his positions by T. D. Lysenko, and is thought to have spent the years 1940–42 in prison, dying in Magadan, Sib.! in 1943. He was elected a member of the Academy of Sciences of the U.S.S.R. in 1929, and a foreign member of the Royal society of London in 1942.

Vavilov's The *Origin, Variation, Immunity and Breeding of Cultivated Plants,* selected and translated by K. S. Chester was published in an English edition in 1951.

See T. G. Dobzhansky, "N. I. Vavilov, a Martyr of Genetics," *J. Hered,* 38:227–232 (1947). (G. H. Be.)

VAZOV, IVAN MINCHEV (1850–1921), Bulgarian writer of poems, short stories, novels and plays inspired by patriotism and love of the Bulgarian countryside and reflecting all the main events in his country's history. He was born on June 27, 1850, at Sopot, and educated there and in Plovdiv. He then taught for a time in the provinces. His father sent him to Rumania to study commerce, but contact with the *émigré* leaders of the Bulgarian revolutionary, movement hastened his resolve to devote his life to literature and the national cause. After the Liberation, he was a civil servant and a district judge. In 1880 he settled in Plovdiv, where he edited several newspapers and periodicals. During the anti-Russian regime of Stefan Stambulov he went into exile in Odessa (1886–89), where he began his greatest novel, *Pod Igoto,* a chronicle of the trials of the Bulgarians under Ottoman rule (Eng. trans., *Under the Yoke,* 1894). After Stambulov's fall (1894) he was elected to the assembly and during 1898–99 served as minister of education. His works include the epic cycle of poems *Epopeya na zabravenite* ("Epic to the Forgotten." published in two collections of verse. 1881. 1884): the novella *Nemili-Nedragi* ("Unloved and Unwanted," 1883) ; the novels *Nova Zemya* ("New Land," 1896), *Kazalarskata Tsaritsa* (1903) and *Svetoslnv Terter* (1907); and the plays *Hashove* (1894); *Kam Propast* ("Towards the Abyss") and *Borislav* (both 1910). He died at Sofia on Sept. 22, 1921. Vazov's *Short Stories* were translated by Zhana Molkhova and Peter Tempest (1950). (L. By.)

VEBLEN, OSWALD (1880–1960), leading U.S. mathematician, was born in Decorah. Ia., June 24. 1880, and studied at the universities of Iowa, Harvard and Chicago. From 1905 to 1932 he taught mathematics at Princeton university: in 1932 he was appointed professor at the Institute of Advanced Study in Princeton. where he became professor emeritus in 1950. Veblen's first important research was in the field of topology and, in addition to his own work, he laid the foundations of the Princeton school of research in that subject. Soon after the discovery of general relativity he turned to differential geometry and took a leading part in the development of generalized affine and projective geometry. He also contributed to the mathematical theory of spinors, so-called because of their application to Paul Dirac's treatment of electron spin. He died in Brooklyn. Me., Aug. 10, 1960.

Veblen wrote the following: *Infinitesimal Analysis,* with N. J. Lennes (1907); *Projective Geometry,* vol. i, with J. W. Young (1910) and vol. ii (1918): *Analysis Situs* (1922); *Invariants of Quadratic Differential Forms* (1927): *Foundations of Differential Geometry,* with J. H. C. Whitehead (1932); *Projektive Relativitätstheorie* (1933); *Geometry of Complex Domains,* with W. Givens (1936). (J. H. C. W.)

VEBLEN, THORSTEIN BUNDE (1857–1929). U.S. economist. who was a leader in the development of modern dynamic analysis broadly conceived as concerned with growth and change. Born on a farm in Manitowoc county. Wis., on July 30. 1857, he received his B.A. from Carleton college in 1880. He pursued graduate studies at Johns Hopkins university for a semester (1881), then went to Yale (Ph.D. 1884) and Cornell (1891–92) universities. He taught at The University of Chicago (1892–1906), Stanford university (1906–1909), the University of Missouri (1911–1918) and the New School for Social' Research (1919–1926). He helped to launch *The Journal of Political Economy* in 1892, of which he served as managing editor until 1905; in 1918–19. he served as an editor along with John Dewey and Helen Marot of the section on postwar reconstruction of *The Dial.* He retired in 1927 and died near Rlenlo Park, Calif., on Aug. 3, 1929. Veblen was trained in philosophy and all branches of the social sciences in the period that witnessed the triumph of the Darwinian theory of evolution in the 1870s and 1880s. He played a decisive role in extending the impact of that movement in economics at the turn of the century. He attacked the Benthamite psychology and the narrow bounds of the neoclassical school of economics of his day. He thus became a powerful catalytic agent in the modernization of economic thought and policy.

His most important works are *The Theory of the Leisure Class* (1899), *Tlze Theory of Business Enterprise* (1901). *Tlze Instinct of Workmanship and the State of the Industrial Arts* (1914). *Imperial Germany and the Industrial Revolution* (1915), *An Inquiry info the Nature of Peace and the Terms of Its Perpetuation* (1917) and *The Place of Science in Modern Civilisation and Other Essays* (1919). These studies are analyses from different vantage points of the development and functioning of the modern economic order. Veblen's evolutionary approach focuses on two economic institutions: technology and business. In modern society, technology takes the form of the machine process, of which modern science is the purest embodiment; business takes the form of the massive corporation, which dominates the economic scene. To Veblen the modern corporation was a complex organism which if unrestrained would breed unmitigated pecuniary habits of thinking that might run counter to its proper function in the economy and lead to such phenomena as severe business cycles. Modern technology embodied imagination, playfulness, economical effort and taste. Veblen recognized that like all institutions it lent itself to passivity, habit and ugliness. Man's story, for Veblen, is one of constant attempts at a harmony between his interests and aspirations and the institutions he creates to give them expression. Veblen's influence extended beyond his own discipline of economics; his works interested, for example, such leaders in the biological and physical sciences as Jacques Loeb and .Alfred Einstein.

See Joseph Dorfman, *Thorstein Veblen and His America* (19.34); Wesley C. Mitchell (ed.), *What Veblen Taught* (1936). (J. Dn.)

VECTOR ANALYSIS. Some physical and geometrical entities, called scalars, can be fully described by specifying their magnitude in suitable units of measure. Thus, mass of a body can be described by the number of grams, temperature by degrees on some scale, volume by the number of cubic feet and time by hours. Scalars can be represented graphically by points on some kind of numerical scale as, for instance, on a clock or thermometer. There are also entities, called vectors, that require the specification of direction as well as magnitude. Velocity, force and displacement are examples of vectors. A vector quantity can be represented graphically by a directed line segment. symbolized by an arrow pointing in the direction of the vector quantity. with the length of the segment representing the magnitude of the vector. The study of operations on directed segments and generalizations resulting from such a study is the subject of vector analysis.

The origin of vector analysis was in the formulation. by Simon Stevin in 1586, of the "parallelogram law" of addition of forces. Vector analysis specifically adapted to the needs of mathematical physics was developed largely by Josiah Willard Gibbs and Oliver Heaviside in the last quarter of the 19th century, but it was antedated by the algebra of quaternions of Sir William Rowan Hamilton in 1843 (*see* NUMBER) and by *Die Ausdehnungslehre* ("theory of extended magnitudes") of Hermann Günther Grassmann in 1844. The needs of geometry and physics led to the generalization of the vector concept to spaces of higher dimensions by Georg Friedrich Bernhard Riemann and Elwin Bruno Christoffel in the second half of the 19th century. Their work culminated in the invention of tensor analysis (*q.v.*) which deals with a study of generalized vectors called tensors. Tensor analysis induced rapid developments in differential geometry and mathematical physics and made possible the creation of the general theory of relativity.

Vector Algebra.—A prototype of a vector is a directed line segment $\overrightarrow{AB}$ (*see* fig. 1) which can be thought to represent the displacement of a particle from its initial position *A* to a new position *B*. To distinguish vectors from scalars it is customary to denote vectors by single boldface letters. Thus the vector

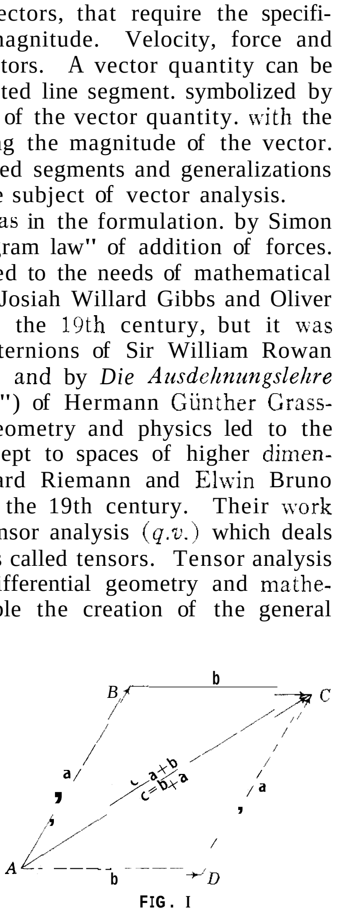

FIG. I

$\overrightarrow{AB}$ in fig 1 can be denoted by **a** and its length (or magnitude) AB by |**a**|. In many problems the location of the initial point *A* of a vector **a** is immaterial, so that two vectors are regarded as equai if they have the same length and the same direction.

The equality of two vectors $\boldsymbol{a}$ and $\mathbf{b}$ is denoted by the usual symbolic notation $\boldsymbol{a} = \boldsymbol{b}$, and useful definitions of the elementary algebraic operations on vectors are suggested by geometry. Thus, if $\overrightarrow{AB} = \boldsymbol{a}$ in fig. 1 represents a displacement of a particle from A to B and subsequently the particle is moved to a position C, so that $\overrightarrow{BC} = \mathbf{b}$, it is clear that the displacement from A to C can be accomplished by a single displacement $\overrightarrow{AC} = \mathbf{c}$. Thus, it is logical to write $\boldsymbol{a} + \mathbf{b} = \mathbf{c}$. This construction of the sum $\mathbf{c}$ of $\boldsymbol{a}$ and $\boldsymbol{b}$ yields the same result as the "parallelogram law" in which the resultant $\mathbf{c}$ is given by the diagonal $\overrightarrow{AC}$ of the parallelogram constructed on vectors $\overrightarrow{AB}$ and $\overrightarrow{AD}$ as sides. Since the location of the initial point B of the vector $\overrightarrow{BC} = \boldsymbol{b}$ is immaterial, it follows that $\overrightarrow{BC} = \overrightarrow{AD}$. Also, fig. 1 shows that $\overrightarrow{AD} + \overrightarrow{DC} = \overrightarrow{AC}$, so that the commutative law

$$\mathbf{a} + \mathbf{b} = \mathbf{b} + \mathbf{a} \tag{1}$$

holds true for vector addition. The extension of this commutative law to a larger number of vectors is immediate. Also, it is easy to show that the associative law

$$(\mathbf{a} + \mathbf{b}) + \mathbf{c} = \mathbf{a} + (\mathbf{b} + \mathbf{c}) \tag{2}$$

is valid. and hence the parentheses in *(2)* can be omitted without any ambiguities.

If s is a scalar, $s\boldsymbol{a}$ or $\boldsymbol{a}s$ is defined to be a vector whose length is $|s|$ $\boldsymbol{a}$ and whose direction is that of $\boldsymbol{a}$ when s is positive and opposite to that of a if s is negative. Thus, $\boldsymbol{a}$ and $-\boldsymbol{a}$ are vectors equal in magnitude and opposite in direction. This suggests defining $\boldsymbol{a} - \boldsymbol{b}$ by the formula $\boldsymbol{a} - \boldsymbol{b} = \boldsymbol{a} + (-\mathbf{b})$, and to define the zero vector. written $\mathbf{0}$, as a vector of zero length such that $\boldsymbol{a} + \mathbf{0} = \boldsymbol{a}$. The foregoing definitions and the well-known properties of scalar numbers show that

$$\begin{aligned} s(t\mathbf{a}) &= (st)\mathbf{a} \\ (s+t)\mathbf{a} &= s\mathbf{a} + t\mathbf{a} \\ s(\mathbf{a} + \mathbf{b}) &= s\mathbf{a} + s\mathbf{b} \end{aligned} \tag{3}$$

Inasmuch as the laws (1), (2) and *(3)* are identical with those encountered in ordinary algebra, it is quite proper to use familiar algebraic rules to solve systems of linear equations containing vectors This fact makes it possible to deduce by purely algebraic means many theorems of synthetic Euclidean geometry that require complicated geometrical constructions

Products of Vectors.—The algebraic operations introduced so far provide no means for dealing with metric properties of geometric configurations; that is, with the calculations of lengths and angles betneen vectors These are provided by two types of products of vectors. the dot product and the cross product

The dot or scalar product of two vectors $\boldsymbol{a}$ and $\boldsymbol{b}$, written $\boldsymbol{a} \cdot \boldsymbol{b}$, is a real number $|\mathbf{a}|\ |\mathbf{b}| \cos(\mathbf{a},\mathbf{b})$, where $(\mathbf{a},\mathbf{b})$ denotes the angle between the directions of $\boldsymbol{a}$ and $\boldsymbol{b}$. Geometrically,

$$\begin{aligned} \mathbf{a} \cdot \mathbf{b} &= |\mathbf{a}|\ |\mathbf{b}| \cos(\mathbf{a},\mathbf{b}) \\ &= |\mathbf{a}| \times \text{projection of } \boldsymbol{b} \text{ on a} \end{aligned} \tag{4}$$

If $\boldsymbol{a}$ and $\boldsymbol{b}$ are at right angles then $\boldsymbol{a} \cdot \boldsymbol{b} = 0$. and if neither $\boldsymbol{a}$ nor $\boldsymbol{b}$ is a zero vector then the vanishing of the dot product shows the vectors to be perpendicular. If $\boldsymbol{a} = \mathbf{b}$ then $\cos(\mathbf{a},\mathbf{b}) = 1$. and $\boldsymbol{a} \cdot \boldsymbol{a} = |\mathbf{a}|^2$ gives the square of the length of $\boldsymbol{a}$.

It is not difficult to show that the associative, commutative and distributive laws of elementary algebra remain valid for the dot multiplication of vectors. Thus

$$\begin{aligned} (s\mathbf{a}) \cdot (\boldsymbol{b}) &= s(\mathbf{a} \cdot \mathbf{b}) \\ \mathbf{a} \cdot \mathbf{b} &= \mathbf{b} \cdot \mathbf{a} \\ \mathbf{a} \cdot (\mathbf{b} + \mathbf{c}) &= \mathbf{a} \cdot \mathbf{b} + \mathbf{a} \cdot \mathbf{c} \end{aligned} \tag{5}$$

and hence it is permissible to employ the familiar rules of scalar algebra in calculations involving addition and scalar multiplication of vectors.

The cross or vector product of two vectors $\boldsymbol{a}$ and $\mathbf{b}$, written $\boldsymbol{a} \times \boldsymbol{b}$, is the vector

$$\mathbf{a} \times \boldsymbol{b} = \mathbf{n}|\mathbf{a}|\ |\mathbf{b}| \sin(\mathbf{a},\mathbf{b}) \tag{6}$$

where n is a vector of unit length perpendicular to the plane of $\boldsymbol{a}$ and $\boldsymbol{b}$ and so directed that a right-handed screw rotated from $\boldsymbol{a}$ toward $\boldsymbol{b}$ will advance in the direction of n (*see* fig. 2) If $\boldsymbol{a}$ and $\boldsymbol{b}$ are parallel, $\boldsymbol{a} \times \boldsymbol{b} = \mathbf{0}$. It follows from the definition (6) that the magnitude of $\boldsymbol{a} \times \boldsymbol{b}$ can be represented by the area of the parallelogram having $\boldsymbol{a}$ and $\boldsymbol{b}$ as adjacent sides. Also. since rotation from $\boldsymbol{b}$ to $\boldsymbol{a}$ is opposite to that from $\boldsymbol{a}$ to $\boldsymbol{b}$,

$$\mathbf{a} \times \mathbf{b} = -\mathbf{b} \times \mathbf{a}$$

This shows that the cross product is not commutative; but, it is true that the associative law $(s\mathbf{a}) \times \boldsymbol{b} = s(\mathbf{a} \times \boldsymbol{b})$ and the distributive law

$$\mathbf{a} \times (\mathbf{b} + \mathbf{c}) = \mathbf{a} \times \mathbf{b} + \mathbf{a} \times \mathbf{c} \tag{7}$$

are valid for cross products.

From definitions (4) and (6) it follows that when the scalar and vector products of $\boldsymbol{a}$ and $\mathbf{b}$ are known. then the angle between $\boldsymbol{a}$ and $\boldsymbol{b}$ is determined uniquely, since both $\cos(\mathbf{a},\mathbf{b})$ and $\sin(\mathbf{a},\mathbf{b})$ are determined by (4) and (6).

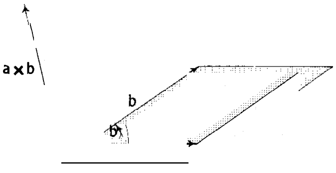

FIG 2

As an indication of the fundamental nature of the dot and cross products in mechanics. it should be noted that if $\boldsymbol{a}$ represents the force producing the displacement $\boldsymbol{b}$, then, as is clear from (4), $\mathbf{a} \cdot \boldsymbol{b}$ gives the work done by the force. If $\boldsymbol{b}$ is a position vector of some point P in a body and $\boldsymbol{a}$ is the force applied at P, then *(6)* shows that $\boldsymbol{a} \times \boldsymbol{b}$ is the torque or moment of force $\boldsymbol{a}$ about the initial point of $\mathbf{b}$.

Co-ordinate Systems.—The foregoing summary of operations on vectors makes no reference to any particular frame relative to which the vectors may be located Since natural laws of physics do not depend on special or accidental choices of reference frames selected to represent physical relations and geometric configurations, vector analysis forms an ideal tool for the study of the physical universe The introduction of a special reference frame or co-ordinate system establishes a correspondence between vectors and sets of numbers representing the components of vectors in that frame. and it induces definite rules of operation on these sets of numbers that follow from the rules for operations on the line segments.

If some particular set of three noncollinear vectors. $\boldsymbol{a}$,, $\boldsymbol{a}$,. $\mathbf{a}_3$, termed base vectors, is selected. then every vector $\boldsymbol{A}$ can be expressed uniquely in the form

$$\boldsymbol{A} = x_1\mathbf{a}_1 + x_2\mathbf{a}_2 + x_3\mathbf{a}_3 \tag{8}$$

where $\mathbf{A}$ is the diagonal of the parallelepiped (*see* fig. 3) nhose edges $x_1\mathbf{a}_1$, $x_2\mathbf{a}_2$, $x_3\mathbf{a}_3$ are the components of $\mathbf{A}$ in the directions of the base vectors. Since the base vectors are given. the triplet of numbers $(x_1\ x_2,x_3)$ completely determines $\boldsymbol{A}$, and hence the specification of three numbers x_1,x_2,x_3 is equivalent to specifying $\mathbf{A}$. The operations of addition of vectors, dot multiplication. etc can therefore be rephrased to yield the corresponding operations on the triplets of numbers determining vectors This is the procedure followed in a purely algebraic treatment of vector analysis

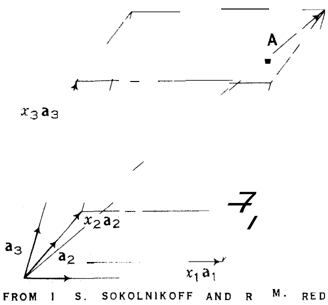

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FIG 3

A useful special set of base vectors in common use is a set of three mutually orthogonal unit vectors (*i.e.*, vectors of length 1) $\mathbf{i},\mathbf{j},\mathbf{k}$ directed along the axes of the familiar Cartesian reference frame (*see* fig. 4). In this system the representation (8) takes the form

$$\mathbf{A} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$$

where (x,y,z) are the projections of **A** in the directions of the co-ordinate axes. When two vectors **A**, and **A**, are represented as

$$\mathbf{A}_1 = x_1\mathbf{i} + x_2\mathbf{j} + x_3\mathbf{k}$$
$$\mathbf{A}_2 = y_1\mathbf{i} + y_2\mathbf{j} + y_3\mathbf{k}$$

then the use of laws (3) yields for their sum

$$\mathbf{A}_1 + \mathbf{A}_2 = (x_1 + y_1)\mathbf{i} + (x_2 + y_2)\mathbf{j} + (x_3 + y_3)\mathbf{k} \qquad (9)$$

Thus in a Cartesian frame, the sum of **A**, and **A**, is the vector determined by $(x_1 + y_1, x_2 + y_2, x_3 + y_3)$. Also, the use of laws (5) yields for the dot product

$$\mathbf{A}_1 \cdot \mathbf{A}_2 = x_1y_1 + x_2y_2 + x_3y_3 \qquad (10)$$

since

$$\mathbf{i}\cdot\mathbf{i} = \mathbf{j}\cdot\mathbf{j} = \mathbf{k}\cdot\mathbf{k} = 1, \mathbf{i}\cdot\mathbf{j} = \mathbf{j}\cdot\mathbf{k} = \mathbf{k}\cdot\mathbf{i} = 0$$

For

$$\mathbf{A}_1 = \mathbf{A}_2 = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$$

eq. (10) reduces to

$$\mathbf{A}\cdot\mathbf{A} = x^2 + y^2 + z^2 \qquad (11)$$

which is the square of the length of **A**. As is clear from fig. 4, the same result follows from the use of the Pythagorean theorem.

The use of the law (7) yields for

$$\mathbf{A}_1 \times \mathbf{A}_2 = (x_2y_3 - x_3y_2)\mathbf{i} + (x_3y_1 - x_1y_3)\mathbf{j} + (x_1y_2 - x_2y_1)\mathbf{k} \quad (12)$$

so that the cross product is the vector determined by the triplet of numbers appearing as the coefficients of **i**, **j** and **k** in (12).

The co-ordinates of the terminal points of the base vectors **i**, **j**, **k** in fig. 4 are those appearing in the rows of the 3×3 matrix

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \qquad (13)$$

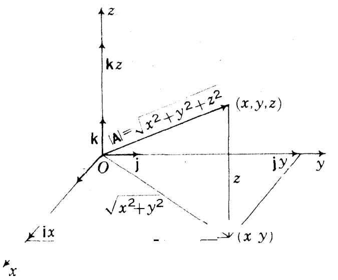

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FIG. 4

and if vectors are represented by 1×3 (or 3×1) matrices consisting of the components (x_1,x_2,x_3) of the vectors. it is possible to rephrase formulas (9) through (12) in the language of matrices. Such rephrasing suggests a generalization of the concept of a vector to spaces of dimensions higher than three. There is nothing mysterious about the notion of higher-dimensional spaces. In physics there are quantities that require more than three variables (or co-ordinates') for their representation. For example. the state of gas generally depends on the pressure p, volume v, temperature T and time t. A quadruplet of numbers (p,v,T,t) cannot be represented by a point in the three-dimensional reference frame. But since geometric visualization plays no role in algebraic calculations. the figurative language of geometry can still be used by introducing a four-dimensional reference frame determined by the set of base vectors $\mathbf{a}_1,\mathbf{a}_2,\mathbf{a}_3,\mathbf{a}_4$ with components determined by the rows of the matrix

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

as in (13). A vector **x** is then represented in the form

$$\mathbf{x} = x_1\mathbf{a}_1 + x_2\mathbf{a}_2 + x_3\mathbf{a}_3 + x_4\mathbf{a}_4$$

so that in a four-dimensional space, every vector is determined by the quadruple of the components (x_1,x_2,x_3,x_4). The sum of **x** and

$$\mathbf{y} = y_1\mathbf{a}_1 + y_2\mathbf{a}_2 + y_3\mathbf{a}_3 + y_4\mathbf{a}_4$$

is the vector determined by the quadruple $(x_1 + y_1, x_2 + y_2, x_3 + y_3, x_4 + y_4)$, the scalar product is

$$\mathbf{x} \cdot \mathbf{y} = x_1y_1 + x_2y_2 + x_3y_3 + x_4y_4$$

and the square of the "length" is

$$\mathbf{x}\cdot\mathbf{x} = x_1^2 + x_2^2 + x_3^2 + x_4^2$$

These are obvious extensions of formulas 19) through (11).

The extension of these ideas to spaces of arbitrary finite dimensionality is obvious. Such spaces occur in the study of dynamical systems with n degrees of freedom such as appear in the study of vibration of a flexible string carrying n beads. The needs of modern physics require the construction of vector theory in infinitely many dimensional spaces which arise. among other places. in the study of systems with infinitely many degrees of freedom, such as a vibrating piano string.

Calculus of Vectors.—A particle moving in three-dimensional space can be located at each instant of time t by a position vector **r** drawn from some fixed reference point O. Since the position of the terminal point of r depends on time, **r** is a vector function of t. Its components in the directions of Cartesian axes. introduced at O, are the coefficients of **i**, **j** and **k** in the representation

$$\mathbf{r} = x(t)\mathbf{i} + y(t)\mathbf{j} + z(t)\mathbf{k}$$

If these components are differentiable functions, the derivative of **r** with respect to t is defined by the formula

$$\frac{d\mathbf{r}}{dt} = \frac{dx}{dt}\mathbf{i} + \frac{dy}{dt}\mathbf{j} + \frac{dz}{dt}\mathbf{k} = \mathbf{v} \qquad (14)$$

which represents the velocity v of the particle. The Cartesian components of **v** appear as coefficients of **i**, **j** and **k** in (14). If these components are also differentiable, the acceleration $\mathbf{a} = d\mathbf{v}/dt$ is obtained by differentiating (14):

$$\frac{d^2\mathbf{r}}{dt^2} = \frac{d^2x}{dt^2}\mathbf{i} + \frac{d^2y}{dt^2}\mathbf{j} + \frac{d^2z}{dt^2}\mathbf{k} = \mathbf{a} \qquad (15)$$

It is easy to verify that the rules for differentiating products of scalar functions remain valid lor derivatives of the dot and cross products of vector functions. and suitable definitions of integrals of vector functions allow the construction of the calculus of vectors. Such calculus has become a basic analytic tool in physical sciences and technology.

Field Theory.—Applications of vector calculus to problems of continuum mechanics (fluid mechanics. elasticity, aerodynamics, heat conduction. electrodynamics, etc.) call for a consideration of scalar and vector functions specified at each point of some region. A region of space with each point of which a scalar function is associated is called a scalar field. while a region in which a vector function is determined is a vector field. Examples of scalar fields are regions at each point of which the temperature or density of a body can be determined. A region in the vicinity of a charged body in which the electric-intensity vector is determined is an example of a vector field. A scalar function $u(P)$ determined at each point P of a scalar field is called a scalar point-function, while a vector function $\mathbf{v}(P)$ specified in a vector field is a vector point-function.

Gradient of a Scalar Field.—If there is a scalar point-function $u(P)$ at a point P, and another scalar point-function $u(P')$ at a nearby point P', where

$$\overrightarrow{PP'} = \Delta\mathbf{r}$$

then

$$\frac{u(P') - u(P)}{|\Delta\mathbf{r}|}$$

represents the average space rate of change of $u(P)$ in the direction of $\Delta\mathbf{r}$. The limit of this ratio as $|\Delta\mathbf{r}| \to 0$, when this limit exists. represents the space rate of change of $u(P)$ in the direction of $\Delta\mathbf{r}$. The vector in that direction for which the space rate of change of $u(P)$ is a maximum is called the gradient of $u(P)$

and is denoted by grad u or ∇u. It can be shown that in Cartesian co-ordinates

$$\nabla u = \mathbf{i}\frac{\partial u}{\partial x} + \mathbf{j}\frac{\partial u}{\partial y} + \mathbf{k}\frac{\partial u}{\partial z}$$

Thus with each point of a scalar field, where ∇u exists, there can be associated a vector field. If $u(P)$ is the temperature, then ∇u gives the direction of the heat-flow vector in the field.

Divergence of a Vector Field.—On the other hand. two important fields can be associated with each continuously differentiable vector point-function $\mathbf{v}(P)$: one is a scalar field and the other a vector field. Let $\mathbf{v}(P)$ be defined in some region τ about the point P and let σ be the surface of τ. The component of $\mathbf{v}(P)$ (which for the sake of concreteness can be thought to represent velocity $\mathbf{v}$ of fluid particles moving in τ) in the direction of the exterior unit normal $\mathbf{n}$ to σ is $\mathbf{v}\cdot\mathbf{n}$. The amount of fluid issuing from a then is given by $\int \mathbf{v}\cdot\mathbf{n}\,d\sigma$, where the integration symbol represents the summation of $\mathbf{v}\cdot\mathbf{n}$ over the elements $d\sigma$ of the surface σ. The flux of fluid per unit volume τ is thus equal to

$$\frac{\int_\sigma \mathbf{v}\cdot\mathbf{n}\,d\sigma}{\tau}$$

and the limit of this ratio as $\tau \longrightarrow 0$, so that a shrinks toward P, is an important scalar called the divergence of $\mathbf{v}(P)$. Thus, the divergence of $\mathbf{v}(P)$, written div $\mathbf{v}(P)$, represents the rate of fluid flow from P. If div $\mathbf{v}(P)$ is positive at P, then P is a source of fluid: if it is negative. then P is a sink. If div $\mathbf{v}(P) = 0$, then no fluid issues from P.

In Cartesian co-ordinates div $\mathbf{v}(P)$ turns out to be given by the simple formula

$$\text{div } \mathbf{v} = \frac{\partial v_1}{\partial x} + \frac{\partial v_2}{\partial y} + \frac{\partial v_3}{\partial z}$$

where

$$\mathbf{v} = \mathbf{i}v_1 + \mathbf{j}v_2 + \mathbf{k}v_3$$

Curl of a *Vector* Field.—Also associated with $\mathbf{v}(P)$ is an important vector field in which the vector called curl of $\mathbf{v}(P)$ is defined by the formula

$$\text{curl } \mathbf{v}(P) = \lim_{\tau \longrightarrow 0} \frac{\int_\sigma \mathbf{n} \times \mathbf{v}\,d\sigma}{\tau}$$

This vector provides a measure of the angular velocity of the fluid at any point P in the field. In Cartesian co-ordinates curl $\mathbf{v}$ is given by the formula

$$\text{curl } \mathbf{v} = \mathbf{i}\left(\frac{\partial v_3}{\partial y} - \frac{\partial v_2}{\partial z}\right) + \mathbf{j}\left(\frac{\partial v_1}{\partial z} - \frac{dm)}{\text{ax}}\right) + \mathbf{k}\left(\frac{\partial v_2}{\partial x} - \frac{\partial v_1}{\partial x}\right)$$

When curl $\mathbf{v} = 0$ at every point of the region, the field is said to be irrotational, and when $\mathbf{v}(P)$ is such that div $\mathbf{v} = 0$, the field is solenoidal. The importance of these two special fields stems from the fact that every continuously differentiable vector function $\mathbf{v}(P)$ defined in a region τ (subject to mild restrictions) can be expressed as a sum of two vector functions $\mathbf{f}(P)$ and $\mathbf{g}(P)$ such that $f(P)$ is solenoidal and $\mathbf{g}(P)$ is irrotational. The possibility of such decomposition greatly simplifies the study of many velocity and force fields occurring in physics.

See VECTOR SPACES; see also references under "Vector Analysis" in the Index volume.

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VECTOR SPACES. Consider the totalitv of all forces in a plane acting on a particle. Such forces, *e.g.*, $\mathbf{F}_1$ and $\mathbf{F}_2$ of fig. 1, combine to make a resultant force $\mathbf{F}_3$ according to the "parallelogram of forces" law of mechanics. The resultant force $\mathbf{F}_3$ may be termed the sum of $\mathbf{F}_1$ and $\mathbf{F}_2$. The forces $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ may be represented in a diagram by pointed arrows, which indicate simultaneouslp direction and magnitude. Furthermore, each force $\mathbf{F}$ can be multiplied by a real constant c so as to yield a new force $c\mathbf{F}$ that is c times as large as F; $c\mathbf{F}$ points in the same direction as $\mathbf{F}$ if c is positive and in the opposite direction if c is negative. For each force $\mathbf{F}$ there is an opposite force, $-F$, such that their sum $\mathbf{F} + (-\mathbf{F})$ does not move the particle; that is, their resultant is the zero force, 0.

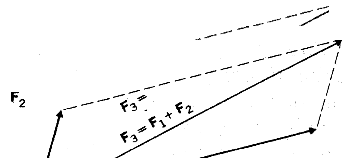

FIG. 1.—VECTOR ADDITION OF FORCES: $\mathbf{F}_3 = \mathbf{F}_1 + \mathbf{F}_2$

If the action of a planar force F is related to a Cartesian co-ordinate system located at the particle, then the force $\mathbf{F}$ is uniquely determined by a pair of real numbers x_1, x_2 (fig. 2). Thus $\mathbf{F}$ is the sum of the directed component forces x_1 and x_2 along the given axes of the Cartesian co-ordinate system. Note that x_1 and x_2 are the (perpendicular) projections of $\mathbf{F}$ on the co-ordinate system. Thus $\mathbf{F}$ can be identified with this fixed ordered pair of numbers (x_1, x_2). Then, if another force G is represented by the pair (y_1, y_2), their sum $F + G$ is represented by the pair $(x_1 + y_1, x_2 + y_2)$, while $c\mathbf{F}$ is represented by (cx_1, cx_2).

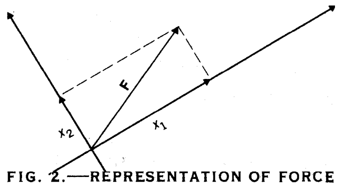

FIG. 2.—REPRESENTATION OF FORCE VECTOR IN CARTESIAN CO-ORDINATES

These elementary properties of forces can be summarized as follows: given any two forces F and G, there is a unique third force H, called their sum. The summation operation satisfies the following lams:

1. $(F + G) + \mathbf{H} = \mathbf{F} + (\mathbf{G} + H)$	"associativity"
2. $\mathbf{F} + \mathbf{G} = \mathbf{G} + \mathbf{F}$	"commutativity"
3. There is a iorce 0 such that $F + 0 = 0 + \mathbf{F} = \mathbf{F}$ for all $\mathbf{F}$	"existence of an additive identity force"
4. For each force $\mathbf{F}$ there is a iorce $-\mathbf{F}$ such that $\mathbf{F} + (-F) = 0$	"existence of an additive inverse"

Furthermore, for each force $\mathbf{F}$ and for each real number c there is a unique force $c\mathbf{F}$, such that

5. $c(\mathbf{F}_1 + \mathbf{F}_2) = c\mathbf{F}_1 + c\mathbf{F}_2$	"distributivity"
6. $(a + b)\mathbf{F} = aF + b\mathbf{F}$	
7. $(ab)\mathbf{F} = a(b\mathbf{F})$	
8. $1\,\mathbf{F} = \mathbf{F}$	

where a, b denote real numbers.

This summary would be an idle exercise if there were not other systems apart from the forces of mechanics that obey the same algebraic laws (1) to (8). Here are some examples:

A. All 12-tuples, *i.e.*, ordered systems of real numbers $x_1, \ldots,$ xi, $\ldots, x_n$ arranged as "rows": X = (xi, $\ldots, x_i, \ldots, x_n$). Here $X + Y$, where $Y = (y_1, \ldots, y_i, \ldots, y_n)$ is another ordered system of real numbers yi, is defined to be $(x_1 + y_1, \ldots, x_i + y_i, \ldots, x_n +$ y,). The scalar product cX, where c is a given real number, is defined as the n-tuple $(cx_1, \ldots, cx_i, \ldots, cx_n)$. The laws (1) to (8) are verified as consequences of appropriate properties of the component (real) numbers x_i and y_i. Note that $n = 2$ is the case of the pairs of component forces in the earlier discussion. If $n = 3$, then forces in three-dimensional space are described.

B. All polynomials $f(t) = x_1 + x_2t + \ldots + x_nt^{n-1}$ in an indeterminate (or variable) t which are of degree at most equal to $n - 1$, where n is a given positive integer. The sum and scalar product, $f(t) + g(t)$ and $cf(t)$, are defined in the customary fashion.

C. All sequences of real numbers $x_1, \ldots,$ xi, $\ldots$, for which $\sum_{i=1}^{\infty}$ xi is finite (convergent).

D. All sequences of complex numbers $x_1, \ldots, x_i, \ldots$, for which $\sum_{i=1}^{\infty} |x_i|^2$ is finite—a "Hilbert space."

E. All continuous functions $f(x)$ on the real line segment $-1 \leq x \leq 1$.

Note that verification of the laws (1) to (8) for the examples (C) to (E) requires recourse to basic facts of analysis; for example, why is $\sum_{i=1}^{\infty}(x_i + y_i)$ finite if both $\sum_{i=1}^{\infty} x_i$ and $\sum_{i=1}^{\infty} y_i$ are finite?

Many of the consequences which follow from laws (1) to (8), using in addition new definitions and concepts, do not depend on the nature of the scalars as real numbers. To illustrate this, call a mathematical system $K = \{a, b, c, \cdots, 0, 1\}$ a field if it has all those properties of addition, subtraction, multiplication and division of the real numbers, which do not involve the concept of order or magnitude. Such systems can be easily constructed. For example, take two symbols z and e and postulate for them $z + z = z$, $e + z = z + e = e$, $e + e = z$ and $zz = z$, $ez = ze = z$, $ee = e$. Note that z acts like the real number "zero" and that e acts like the real number "one" as far as the fundamental laws of algebra for addition and multiplication are concerned. Now replace the real numbers x_i in example (A) by the symbols e or z. It is easily verified that the new system has all the properties (1) to (8). Similarly, in place of the real numbers x_i the elements of any field K (for example, all rational numbers) may be used to obtain a system $V_n(K)$ which again satisfies (1) to (8) if the sum and scalar product are defined as in (A). In a similar fashion the "columns" $\begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix}$ of n elements $x_1, \cdots, x_n$ taken from a field K form a system $V_n(K)'$ in which sum and scalar product are defined by replacing the horizontal arrangements by a vertical arrangement (F). (See FIELDS.)

Basic Properties; Subspaces.—The general definition of a linear vector space is obtained by abstracting from the examples (A) to (E) the specific nature of the elements and scalars. Thus a linear vector space (for short, vector space) $V = (\mathbf{F}, \mathbf{G}, \mathbf{K}, \ldots)$ over a field $K = (c, \ldots)$ is a system in which are given (i) a concept of identity $\mathbf{F} = \mathbf{G}$ subject to the laws of reflexivity ($\mathbf{F} = \mathbf{F}$), symmetry ($\mathbf{F} = \mathbf{G}$ implies $\mathbf{G} = \mathbf{F}$) and transitivity (if $\mathbf{F} = \mathbf{G}$, $\mathbf{G} = \mathbf{K}$, then $\mathbf{F} = \mathbf{K}$); (ii) a concept of sum $\mathbf{F} + \mathbf{G}$; and (iii) a concept of scalar product $c\mathbf{F}$ such that the laws (1) to (8) hold as postulated axioms. The elements of V are called vectors and the elements of K are called scalars (*see* VECTOR ANALYSIS). Note that scalars are always given when vector spaces are considered.

If $\mathbf{F}_1, \ldots, \mathbf{F}_k$ are vectors and $c_1, \ldots, c_k$ are scalars, then the sum, which is defined inductively, $c_1\mathbf{F}_1 + \ldots + c_k\mathbf{F}_k = \sum_{i=1}^{k} c_i\mathbf{F}_i$ is called the linear combination of the k vectors $\mathbf{F}_i$ with the k scalars c_i. A subspace S of a vector space V/K is a collection of elements in V which contains all linear combinations of any finite set of its elements. In example (A), for $n = 3$ all triples of real numbers $x_1 = u + v$, $x_2 = u - 2v$, $x_3 = 2u - v$, where u and v denote arbitrary real numbers, form a subspace (example [G]). Note that $(x_1, x_2, x_3) = u(1, 1, 2) + v(1, -2, -1) = u\mathbf{G}_1 + v\mathbf{G}_2$ for every vector of this subspace. Similarly, all triples of real numbers with the restriction $x_2 = 0$ form a subspace. However, the triples $(x_1, 1, x_3)$, with arbitrary real numbers x_1 and x_3, do not form a subspace.

Let $S_1, \ldots, S_i, \ldots, S_k$ denote subspaces of $V = V/K$. Then all linear combinations $\sum_{i=1}^{K} c_i\mathbf{F}_i$ of vectors $\mathbf{F}_i$ in the subspaces S_i and coefficients c_i in the common field of scalars K determine a subspace $S = \cup_i S_i$, called the sum (union) of the given subspaces. The space S is the "smallest" subspace of V which contains $S_1, \ldots, S_k$; *i.e.*, if S_o is another subspace containing these subspaces, then S_o contains S. Furthermore, all vectors common to $S_1, \ldots, S_k$ form a subspace $\mathbf{I} = \cap_i S_i$, called the intersection (mean) of the given subspaces. The space $\mathbf{I}$ is the "largest" subspace which is contained in $S_1, \ldots, S_k$; *i.e.*, if S_{oo} is a subspace of these k spaces then S_{oo} is contained in $\mathbf{I}$.

If there are k vectors $\mathbf{F}_1, \ldots, \mathbf{F}_k$ in a linear space V such that V is the totality of all linear combinations $\sum_{i=1}^{K} c_i\mathbf{F}_i$, the elements c_i being arbitrarily selected in the field of scalars K, then V is said to be spanned by $\mathbf{F}_1, \cdots, \mathbf{F}_k$. If V can be spanned by a finite number of its vectors, it is called finite-dimensional. In example (A) the vectors $\mathbf{U}_i$ which have all components equal to 0 except the ith, $i = 1, \ldots, n$, span the space; similarly in example (B) $1, t, \ldots, t^{n-1}$ span the space; but in example (C) no finite collection of vectors spans the whole space. Therefore (C) is called an infinite-dimensional space.

A sum $c_1\mathbf{F}_1 + \ldots + c_k\mathbf{F}_k = 0$ is called a linear-dependence relation of the vectors $\mathbf{F}_1, \ldots, \mathbf{F}_k$. If $c_1 = \ldots = c_k = 0$ are the only constants for which the given vectors $\mathbf{F}_1, \ldots, \mathbf{F}_k$ are linearly dependent, then these constants are called linearly independent. Thus, the vectors $\mathbf{U}_1, \ldots, \mathbf{U}_n$ mentioned earlier are linearly independent. In the subspace S of example (G) the vectors $\mathbf{G}_1$ and $\mathbf{G}_2$ which are obtained by letting $u = 0$, $v = 1$ and $u = 1$, $v = 0$, respectively, are linearly independent. On the other hand, for vectors $\mathbf{F}_1, \ldots, \mathbf{F}_k$ to be linearly dependent there must be at least one set of scalars $c_1, \ldots, c_k$ all of which are not 0, such that $\sum_{i=1}^{k} c_i\mathbf{F}_i = 0$. Thus, in example (A) the vectors $\mathbf{U}_1 = (1, 0, 0)$, $\mathbf{U}_2 = (0, 1, 0)$, $\mathbf{U}_3 = (0, 0, 1)$ and $\mathbf{F}_4 = (1, 0, 3)$ are linearly dependent, because $(-1)\cdot\mathbf{U}_1 + 0\cdot\mathbf{U}_2 + (-3)\cdot\mathbf{U}_3 + 1\cdot\mathbf{F}_4 = (0, 0, 0) = 0$. Note also that in example (G) the vectors $\mathbf{G}_1$, $\mathbf{G}_2$ and $\mathbf{G}_3 = (-1, -6, -7)$ are linearly dependent; that is, $\mathbf{G}_3$ lies in the subspace S. However, the vectors $\mathbf{G}_1$, $\mathbf{G}_2$ and $(-1, -7, -7)$ of the linear space of all triples are linearly independent. The latter is true because there are no numbers a, b, c except 0 for which $a\mathbf{G}_1 + b\mathbf{G}_2 + c(1, -7, -7) = (0, 0, 0)$; that is, the system of linear equations $a + b + c = a - 2b - 7c = 2a - b - 7c = 0$ has no other solution except $a = b = c = 0$.

The elements $\mathbf{F}_1, \ldots, \mathbf{F}_n$ of a linear space $V = V/K$ are said to form a basis of V if they span V and are also linearly independent. Thus, in example (A) the vectors $\mathbf{U}_1 = (1, 0, 0)$, $\mathbf{U}_2 = (0, 1, 0)$, $\mathbf{U}_3 = (0, 0, 1)$ or $\mathbf{F}_1 = (1, 1, 1)$, $\mathbf{F}_2 = (3, -1, 4)$, $\mathbf{F}_3 = (5, 6, 9)$ form distinct bases for the space of triples of real numbers.

If a space is finite-dimensional and is spanned by k elements, then it has a basis of at most k elements. Actually, all bases of a linear space contain the same number of elements. This common number is called the dimension $m = \dim V$ of V, and V is called m-dimensional. (A) and (B) are examples of n-dimensional space, and the subspace S in example (G) is two-dimensional. This important fact of the uniqueness of the dimension of a linear space is a consequence of the so-called Steinitz exchange theorem. This theorem states that, given r linearly independent vectors $\mathbf{L}_1, \cdots, \mathbf{L}_r$ of a space V and k vectors $\mathbf{F}_1, \cdots, \mathbf{F}_k$ spanning V, then certain r vectors $\mathbf{F}_i$ can be replaced by the vectors $\mathbf{L}_j$, $j = 1, \cdots, r$, such that the resulting collection of vectors $\mathbf{L}_j$ and the remaining $k - r$ vectors $\mathbf{F}_i$ still span the space V. The theorem has important consequences. If S is a proper subspace of the n-dimensional space V, *i.e.*, if V contains vectors which do not lie in S, then $\dim S < n$. A basis of a subspace S can always be augmented by $n - \dim S$ vectors of V so as to obtain a basis of the whole space V. Starting with a nonzero vector of V whose multiples by all scalars from the field K form a one-dimensional space, the preceding statement implies that V has proper subspaces of dimensions $1, 2, \ldots, n-1$. Furthermore, $\dim S + \dim T = \dim (S \cup T) + \dim (S \cap T)$ for two subspaces S and T of V. This equation is of significance in the analytic treatment of projective geometry.

If $S \cap T = 0$, *i.e.*, if the subspaces have only the zero vector in common, the union $S \cup T$ is called the direct sum of S and T, frequently denoted by $S \dotplus T$. Every vector $\mathbf{F}$ of $S \dotplus T$ is the sum $\mathbf{F}_S + \mathbf{F}_T$ of uniquely determined vectors $\mathbf{F}_S$ and $\mathbf{F}_T$ in S and T, respectively. The vector $\mathbf{F}_S$ is called the component of $\mathbf{F}$ in the subspace S, or the projection of $\mathbf{F}$ on S along T. If $\mathbf{F}_1, \ldots, \mathbf{F}_n$ constitute a basis of V and $S_1, \ldots, S_n$ denote the one-dimensional subspaces spanned by them individually, then $V = S_1 \dotplus \ldots \dotplus S_k$. Given a subspace S of V, there is always at least one subspace T such that $V = S \dotplus T$. The space T is not uniquely determined by S; note, for example, that $V_2(K) = S \dotplus T = S \dotplus T_1$, where S, T and T_1, respectively, consist of all the multiples of (1, 0), (0, 1) and (1, 1).

Homomorphism. — An important concept in the discussion of linear spaces is that of homomorphism, or linear transformation, or linear mapping. There are given tn-o linear spaces V and W with the same field of scalars K. A one-valued function ϕ with argument in I' and value in W is called a homomorphism of V into W if $(a_1\mathbf{F}_1 + a_2\mathbf{F}_2)\phi = a_1(\mathbf{F}_1\phi) + a_2(\mathbf{F}_2\phi)$ for every pair of vectors $\mathbf{F}_1$, $\mathbf{F}_2$ in V and arbitrary scalars a_1, a_2 in K. For $\mathbf{F}$ in V the vector $\mathbf{F}\phi$ of W is called the value of ϕ at F, or the image (map) of F by ϕ. The defining equation above may be stated in words thus: the map of a linear combination $a_1\mathbf{F}_1 + a_2\mathbf{F}_2$ is the linear combination of the maps $\mathbf{F}_1\phi$ and $\mathbf{F}_2\phi$ with the same coefficients a_1 and a_2. The collection of all maps $\mathbf{F}\phi$ is a subspace $V\phi$ of W; $V\phi$ can be a proper subspace of W. In example (G) consider (u,v) to be a vector G in the two-dimensional space $V = V_2(K)$ and let $\mathbf{G}\phi = (u + v,\ u - 2v,\ 2u - a)$ in $W = V_3(K)$ (example [H]). Then $V\phi$ is a proper subspace of W. On the other hand, letting $V = V_2(K)$, $W = V_2(K)$ and setting (I) $(x_1, x_2)\phi = \mathbf{F}\phi = (x_1 + 3x_2,\ 2x_1 - x_2)$, the image space $V\phi$ coincides with W; or letting $V = V_3(K)$, $W = V_2(K)$ and setting (J) $(x_1, x_2, x_3)\phi = \mathbf{F}\phi = (x_1 + x_3,\ x_1 - 2x_2 + 4x_3)$, there is obtained a homomorphism of V on 14'—the image space of V equals W. Note that a homomorphism ϕ is completely determined if its effect on a set of basis vectors is known.

To each homomorphism ϕ there is associated its "kernel" N_ϕ, also called the inverse image $0\phi^{-1}$ of the zero vector in W. It is the set of all vectors $\mathbf{F}$ in V for which $\mathbf{F}\phi = 0$; N_ϕ is a subspace of V. If elements F and G in V have the same image in W, then their difference $\mathbf{F} - G$ lies in N_ϕ, and conversely. In examples (H), (I) and (J) the kernels are, respectively, the zero-dimensional subspaces (0, 0), (0, 0) and the subspace of all vectors $a(1, -\frac{3}{2}, -1)$, where a denotes an arbitrary element of K, taken here as the field of all rational numbers, Note that the problem of determining the kernel of a homomorphism is equivalent to that of solving a system of linear homogeneous equations. For example, in (J) it is $x_1 + x_3 = x_1 - 2x2 + 4x_3 = 0$.

Special homomorphisms ϕ_S are determined as follows: suppose that S is a subspace of V. and let $\mathbf{F}$ denote a typical vector of V. Then consider the totality $\underline{\mathbf{F}} = \mathbf{F}\phi_S$ of all sums $\mathbf{F} + G$ where, for fixed $\mathbf{F}$, the vector $\mathbf{G}$ varies over all vectors of S. The set $\underline{\mathbf{F}}$ is called the "coset of $\mathbf{F}$ modulo S," and an element H in $\underline{\mathbf{F}}$ is called a representative of $\underline{\mathbf{F}}$. Then $\mathbf{H}\phi_S = \underline{\mathbf{H}} = \underline{\mathbf{F}}$, and two cosets, when considered as collections of elements in V, are either coincident or they have no element in common. Now denote by $V/S = \underline{\mathbf{V}}$, "$V$ modulo S," the collection of all distinct cosets $\underline{\mathbf{F}}$ for vectors $\mathbf{F}$ in V. This collection can in turn be made into a vector space over K called the "factor" ("quotient" or "difference") space of V modulo S.. A nen- sum $\underline{\mathbf{F}} + \underline{H}$ is defined as the coset which is determined by the sum $\mathbf{F}_1 + \mathbf{H}_1$ of any two representatives $\mathbf{F}_1$, $\mathbf{H}_1$ of $\underline{\mathbf{F}}$, H, respectively: similarly, the scalar product $a\underline{\mathbf{F}}$ for a in the field of scalars K is defined as the coset modulo S of the vector $a\mathbf{F}_1$, where $\mathbf{F}_1$ is a representative of $\underline{\mathbf{F}}$. Then the mapping ϕ_S which associates to each vector $\mathbf{F}$ of V its coset $\underline{\mathbf{F}} = \mathbf{F}\phi_S$ in V/S is a homomorphism of V on V/S.

The isomorphisms, whose kernels N_ϕ consist of the zero vector, are special homomorphisms. For an isomorphism, distinct elements have distinct images. For example, if $(x_1, x_2)\phi = (x_1 + 3x2, 2x1 - x_2)$ for $V = W = V_2(K)$, where K is the field of all real numbers, then ϕ is an isomorphism of I onto itself. Note that the equations $x_1 + 3x_2 = 2x_1 - x_2 = 0$ have the solution $x_1 = x_2 = 0$ and no other; that is, the kernel N_ϕ is given by (0, 0).

The connection between homomorphisms and factor spaces is established by the important "isomorphism theorem," which states that, given a homomorphism ϕ of a vector space V/K into a vector space W/K with the kernel $N_\phi = S$, there is an isomorphism ψ between $V\phi$ and V/S. The mapping ψ may be constructed by picking in V any element G which maps on the given image vector $\mathbf{F}\phi$ and then taking its coset $\mathbf{G}\phi_S$, set $(\mathbf{F}\phi)\psi = \mathbf{G}\phi_S$.

This theorem has significant corollaries, such as the following ones:

a. There are bases $\mathbf{F}_1, \ldots, \mathbf{F}_m$ and $\mathbf{H}_1, \ldots, \mathbf{H}_n$ in the vector spaces V/K and W/K of respective dimensions m and n such that $\mathbf{F}_1\phi = \mathbf{H}_1, \ldots, \mathbf{F}_r\phi = \mathrm{H}_r$, $\mathbf{F}_{r+1}\phi = 0, \ldots, \mathbf{F}_m\phi = 0$ for a homomorphism ϕ on V into TY. The integer r, which is at most equal to the smalier of the integers m and n, is called the rank of ϕ.

b. $\dim V = \dim V\phi + \dim N_\phi$.

c. $\dim V\phi \leq \dim V$. If $\dim V\phi = \dim V$, then ϕ is an isomorphism of V into W. (All dimensions are assumed to be finite.)

An interesting isomorphism of an n-dimensional space V/K with $V_n(K)$ is obtained as follows: Suppose that $\mathbf{F}_1, \ldots, \mathrm{F}_n$ is a basis of V/K, let $\mathrm{F} = x_1\mathbf{F}_1 + \ldots + x_n\mathbf{F}_n$, and set $\mathbf{F}\phi = (x_1, \ldots, x_n)$. Then $V\phi = V_n(K)$. This means that all n-dimensional spaces over K are isomorphic. Note, however, that this does not mean that the spaces coincide. For example, the two-dimensional space of all pairs (u, v) is isomorphic to the set of all triples $(u + v,\ u - 2v,\ 2u - v)$ in V_3 (see example [H]). Also, the subspace in V_3 of all linear combinations of $\mathbf{F}_1 = (1, 2, 3)$ and $\mathbf{F}_2 = (0, 1, 6)$ has dimension 2, and in V_3 it is isomorphic to the subspace spanned by $\mathbf{M}_1 = (0, 6, 0)$ and $\mathbf{M}_2 = (1, 1, 1)$; however, the two subspaces do not coincide. Given two linear spaces V and W of respective dimensions m and n over the same field of scalars K, all homomorphisms ϕ, ψ, ... of I.' into W can be considered as vectors of a linear space $\mathrm{Hom}\,(V, W) = \mathrm{H}$ over K. Properties and laws of H are set up as follows: (iv) the mappings ϕ and ψ are called equal, $\phi = \psi$, provided $\mathbf{F}\phi = \mathbf{F}\psi$ for all'vectors $\mathbf{F}$ in V; (v) the mapping of F on the vector $\mathbf{F}\phi + \mathbf{F}\psi$ in W, which turns out to be a homomorphism of V into W, is termed the sum $\sigma = \phi + \psi$, and thus $\mathbf{F}\sigma = \mathbf{F}\phi + \mathbf{F}\psi$ for all F in V; and (vi) if a is a scalar then the mapping of F on $(a\mathbf{F})\phi$, being a homomorphism of V into W, is called the scalar product $a\phi$, $\mathbf{F}(a\phi) = a[\mathbf{F}\phi]$. It is easy to verify that this new sum σ and scalar product in H turn it into a linear space over K. It is found that $\dim \mathrm{H} = mn$. Thus, if $V = V_m(K)'$ and $W = V_n(K)'$ (see example [F]) a system of linear equations (vii)

$$\sum_{j=1}^{m} a_{ij}x_j = y_i,\ i = 1, \ldots, n,$$ with given constants a_{ij} in the field K, determines a homomorphism of the column vectors X $= (x_1, \ldots, x_m)'$ into the space of column vectors Y' $= (y_1 \ldots, y_n)'$.

An Important special case arises if W is assumed to be a one-dimensional space over K; *i.e.*, essentially the same as K. Then $\mathrm{Hom}\,(V, K)$ is the set of all "linear functionals" of V/K, or the so-called dual space V^*/K. The theorems on $\mathrm{Hom}\,(V, W)$ imply that V^* is a linear space over F and $\dim V^* = \dim V$ for finite-dimensional spaces; definitions (iv) to (vi) are carried over.

Annihilators. — To each linear subspace S of V there is associated its annihilator an (S);that is, the linear subspace of all linear functionals χ in V^* such that $\mathbf{F}\chi = 0$ for all vectors F of S. The dimension of an (S) equals n-dim S; it is called the codimension of S. The operations of union and intersection of linear subspaces S, T of V and the rule of associating to them their respective annihilators are connected by the following laws: (viii) if $S \subseteq T$ (*i.e.*, if all elements of S lie in T), then an $(T) \subseteq$ an (S); (ix) an $(S \cup T)$ = an (S) $\cap$ an (T): (x) an $(S \cap T)$ = an (S) $\cup$ an (T). Furthermore, an (an S) is essentially the same as S, which means in effect that the vectors $\mathbf{F}$ of S can be viewed as linear functionals $\kappa_{\mathbf{F}}$ on the subspace $\{\phi\}$ = an (S) of V^* for which $\phi\kappa_{\mathbf{F}} = 0$. (To achieve the latter relation, let $\phi\kappa_{\mathbf{F}} = F\phi$ and vary ϕ.) These results are the equivalent in algebra to the basic rules on duality in projective geometry.

An important concept used for the proofs of these facts is that of the dual basis $\phi_1, \ldots, \phi_n$ in V^* belonging uniquely to a basis $\mathbf{F}_1, \ldots, \mathbf{F}_n$ of V. The functionals ϕ_j and the vectors $\mathbf{F}_j$ are paired by the n^2 conditions $F_i\phi_j = 0$ for $i \neq j$ and $\mathbf{F}_i\phi_i = 1$, $1 \leq i,$

$j \leq n$. If the general vectors $F = \sum_{i=1}^{n} x_i\mathbf{F}_i$ and the general functional $\phi = \sum_{j=1}^{n} y_j\phi_j$ with co-ordinates x_i and y_j in the field of scalars K are given, then (xi) $\mathbf{F}\phi = \sum_{h=1}^{n} x_h y_h$. This means that the "row" vector $X = (x_1, \ldots, x_h, \ldots, x_n)$ of $V_n(K)$ is multiplied by the "column" vector $Y' = (y_1, \ldots, y_h, \ldots, y_n)'$ of $V_n(K)'$ (see example [F] according to the rules of matrix multiplication [see MATRIX]).

There is a close connection between the theory of linear functionals and that of linear equations. Take a system of m linear equations in n unknowns $x_1, \ldots, x_n$, *e.g.*, (xii) $a_{h1}x_1 + \ldots + a_{hi}x_i + \ldots + a_{hn}x_n = b_h$, with $1 \leq h \leq m$ and given numbers a_h, and b_h in the field K. If the row of elements $(a_{h1}, \ldots, a_{hn})$ is denoted by A_h and the column of unknowns $x_1, \ldots, x_n$ by X', then the equations (xii) take the form $A_h\mathbf{X}' = b_h$, $1 \leq h \leq m$. Therefore, recalling (xi), the problem of solving (xii) is the same as that of finding all linear functionals $\mathbf{X}'$ with $A_h X' = b_h$. Similarly, the annihilator an (A) of the subspace A of $V_n(K)$ which is spanned by the row vectors $\mathbf{A}_1, \ldots, \mathbf{A}_m$ is precisely the collection of all column vectors X' of the solutions of the system (xii) after all b_h have been set equal to 0. From the general results on annihilators, this is a linear space over K. Direct verification is easy; for, if $Y' = (y_1, \ldots, y_n)'$ is another solution, then $\sum_{i=1}^{n} a_{hi}(x_i + y_i) = \sum_{i=1}^{n} a_{hi}x_i + \sum_{i=1}^{n} a_{hi}y_i = 0 + 0$ and $\sum_{i=1}^{n} a_{hi}(cx_i) = c\sum_{i=1}^{n} a_{hi}x_i$ for the hth equation, thus $X' + Y'$ and $c\mathbf{X}'$ are also solutions.

Upon combining the properties of homomorphisms and annihilators, the useful result is found that the dimension of the annihilator of A equals the dimension of the kernel of the mapping given in (vii). The formula (xi) is "bilinear" in the two variables F and ϕ; $(a_1\mathbf{F}_1 + a_2\mathbf{F}_2)\phi = a_1(\mathbf{F}_1\phi) + a_2(\mathbf{F}_2\phi)$ and $\mathbf{F}(b_1\phi_1 + b_2\phi_2) = b_1(\mathbf{F}\phi_1) + b_2(\mathbf{F}\phi_2)$, where a_1, a_2, b_1, b_2 are constants, $\mathbf{F}_1$ and $\mathbf{F}_2$ are vectors, and ϕ_1 and ϕ_2 are linear functionals.

Euclidean Spaces.—A similar formula occurs in analytic geometry; it is obtained by expressing the angle α between two nonzero vectors $\mathbf{F} = (x_1, x_2)$ and $\mathbf{G} = (y_1, y_2)$ in terms of their co-ordinates relative to a Cartesian co-ordinate system (fig. 3). The law of cosines implies $\cos\alpha = \dfrac{x_1y_1 \quad x_2y_2}{\sqrt{x_1^2 + x_2^2}\sqrt{y_1^2 + y_2^2}}$, where the square roots are positive real numbers. This formula is a special case of an important result valid in Euclidean linear spaces.

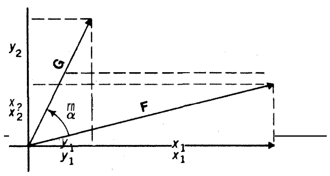

FIG. 3.— REPRESENTATION OF ANGLE α BETWEEN TWO VECTORS

Such a space E has the real numbers for scalars. Moreover, there is given a rule which associates to every pair of vectors F and G of E a real number (F, G) called their inner product such that (xiii) $(a_1\mathbf{F}_1 + a_2\mathbf{F}_2,\ b_1\mathbf{G}_1 + b_2\mathbf{G}_2) = a_1(\mathbf{F}_1, \mathbf{G}_1)b_1 + a_2(\mathbf{F}_2, \mathbf{G}_1)b_1 + a_1(\mathbf{F}_1, \mathbf{G}_2)b_2 + a_2(\mathbf{F}_2, \mathbf{G}_2)b_2$ ("bilinearity"); (xiv) (F, G) = (G, F) ("symmetry"); and (xv) (F, F) is always positive for a nonzero vector F, (0, 0) = 0 ("positiveness"). If, for example, the vectors $F = (x_1, \ldots, x_n)$ and $G = (y_1, \ldots, y_n)$ are given with real components, and (F, G) is defined as $\sum_{i=1}^{n} x_iy_i$, then $(\mathbf{F}, G)$ is an inner product defined on the linear space E_n of all n-tuples of real numbers. Properties (xiii) and (xiv) are implied by the algebra of real numbers, whereas property (xv) means that a sum of squares $\sum_{i=1}^{n} x_i^2$ of real numbers x_i can be zero if and only if $x_1 = \ldots = x_n = 0$.

General Euclidean spaces are important in geometry and analysis. For example, all continuous real-valued functions (or to be more restrictive, all polynomials) $f(x)$, $g(x)$ on the closed segment from -1 to $+1$ form a Euclidean space of infinite dimension, if the inner product $(f(x), g(x))$ is defined as the definite integral $\int_{-1}^{+1} f(x)g(x)dx$. Note that significant results of analysis are needed to verify the rules (xiii) to (xv). In every Euclidean space the important Schwarz inequality (xvi) $|(\mathbf{F}, G)| \leq |\mathbf{F}|\,|\mathbf{G}|$ is valid, where $|\mathbf{F}|$ denotes the positive square root of (F, F). This inequality expresses the simple geometric fact that the law of cosines is true in analytic geometry. Furthermore, (xvii) $|\mathbf{F} + \mathbf{G}| \leq |\mathbf{F}| + |\mathbf{G}|$. This inequality, the triangle inequality, describes in plane geometry the fundamental fact that in a triangle the length of a side never can exceed the sum of the lengths of the other two sides. Suppose that P and Q are the end points of the vectors $\mathbf{F}$ and G, and call $|\mathbf{F} - \mathbf{G}|$ the distance $d(P, Q)$ between P and Q (fig. 4). The properties of a Euclidean space simply imply that (xviii) $d(P, P) = 0$; (xix) $d(P, Q) = d(Q, P)$; and (xx) $d(Q, R) \leq d(P, Q) + d(P, R)$ as a consequence of (xvii). The inner product (F, G) with its defining properties (xiii) to (xv) can be recaptured from $|\mathbf{F}|$ and $|\mathbf{G}|$ by means of the formula $(\mathbf{F}, \mathbf{G}) = \frac{1}{2}[|\mathbf{F} + \mathbf{G}|^2 - |\mathbf{F}|^2 - |\mathbf{G}|^2]$, if the "length" $|\mathbf{F}|$ satisfies $|\mathbf{F}| > 0$ if $F \neq 0$, if $|a\mathbf{F}| = |a|\,|\mathbf{F}|$ for any real number a and if (xvii) holds; the space is called a metric linear space over the real field.

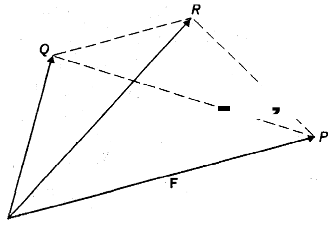

FIG. 4.— TRIANGLE INEQUALITY (*see* TEXT)

For a Euclidean space of dimension n, there is always a basis $\mathbf{H}_1, \ldots, \mathbf{H}_n$ such that $|\mathbf{H}_i| = 1$, $(H_i, H_j) = 0$ for $i \neq j$, $1 \leq i$, $j \leq n$ ("orthonormal basis"). If such a basis has been determined by the so-called Gram-Schmidt orthogonalization process (which involves nothing else but solving linear equations), then $(\mathbf{F}, \mathbf{G}) = \sum_{i=1}^{n} x_iy_i$, where $\mathbf{F} = \sum_{i=1}^{n} x_i\mathbf{H}_i$ and $G = \sum_{i=1}^{n} y_i\mathbf{H}_i$. Furthermore, the Bessel inequality $\sum_{i=1}^{k} (F, \mathbf{H}_i)^2 \leq |\mathbf{F}|^2$, $k \leq n$, holds. Many of the properties of finite-dimensional Euclidean spaces can be suitably extended to spaces of infinitely many dimensions.

Unitary Spaces.—Other linear spaces, this time over the field of all complex numbers, with a concept of length $|\mathbf{F}|$ and inner product (F, G), are the unitary spaces. For these, there are usually the postulates (xxi) $(a_1\mathbf{F}_1 + a_2\mathbf{F}_2, G) = a_1(\mathbf{F}_1, G) + a_2(\mathbf{F}_2, G)$ ("linearity in the first argument"); (xxii) $(F, G) = \overline{(G, F)}$, the bar denoting the conjugate complex number; and (xxiii) (F, F) > 0, except for the zero vector. Many of the results found for Euclidean spaces carry over to these unitary spaces; however, formal generalizations are not always true. Noteworthy instances of unitary spaces (and metric spaces) over the complex numbers are complex Hilbert spaces and Banach spaces. They are of extreme importance in analysis (Fourier analysis, differential equations, etc.) and in physics (quantum mechanics and relativity). See ANALYSIS, ABSTRACT; TOPOLOGY, GENERAL.

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(O. F. G. S.)

VEDANTA, one of the six schools of thought to which Indian philosophers adhered in the centuries following the Epic period. Its metaphysics attracted a number of western thinkers in the 20th century.

See INDIAN PHILOSOPHY: The Six *Systems*.

VEDDA, a primitive people of Ceylon, the original inhabitants prior to the Hindu invasion in the 6th century B.C. During the Dutch occupation (1644–1796) they were found as far north as Jaffna. but are now confined to the southeastern district. They have adopted Sinhalese and no longer use their own language.

Physically, they are allied to the Dravidian jungle peoples of southern India and to early populations in Southeast Asia and Indonesia; the term "Veddoid" is often applied to this assumed early physical type. The Vedda average a little over 5 ft. in stature, are dark-skinned and dolichocephalic, and have long wavy hair.

The aboriginal material culture and subsistence patterns were extremely simple. The Vedda lived in caves and rock shelters. wore barkcloth clothing. hunted game with bow and arrow and gathered wild plants and honey. Pottery vessels of a crude type were made, and a fire drill twirled by hand was used to make fire.

The Vedda are divided into maternal exogamous clans which probably were formerly territorial units. Marriage is strictly monogamous; cross-cousin marriage is common and divorce rare. The dead are abandoned in rock shelters and the location temporarily deserted.

Vedda religion is essentially a cult of the dead. Ancestral spirits enter the body of the shamans, or religious practitioners, and communicate with their descendants. Otherwise there seems to be no trace of supernatural beings or deities associated with natural phenomena. The arrow occupies an important role in the ceremonials, the ancestral spirits using it as a means of passing into the shaman. Most rituals are performed to achieve success in hunting or to divine the proper direction to hunt. Little trace of mythology has survived.

The Vedda have been largely absorbed into the modern Sinhalese population at present. both physically and in terms of culture and language.

See C. G. and B. Z. Seligmann, *The Veddas* (1911). (F. R. E.)

VEDDER, ELIHU (1836–1923). U.S. painter. whose work was typical of its period in its academic and literary character but at its best also possessed a unique imaginative quality, was born in New York city. Feb. 26. 1836. He studied under the genre and historical painter Tompkins H. Matteson (1813–84), at Sherburne, N.Y., later under François Édouard Picot, in Paris. and then. in 1857–61. in Florence. Italy. After 1867 he lived in Rome. making occasional visits to the U.S. He mas elected to full membership in the National Academy of Design. New Tork, in 1865. He devoted himself to the painting of genre pictures. which, however. attracted only modest attention until the publication, in 1884, of his illustrations to the *Rubaiyat* of Omar Khayyam; these immediately gave him a distinguished place in the art world. Important decorative work came at a later date. more particularly the painting symbolizing the art of the city of Rome. in the Walker art gallery of Bowdoin college at Brunswick, Me., and the five lunettes (1896: in the entrance hall) symbolical of government and the mosaic "Minerva" (1897) in the Library of Congress at Washington. D.C.

Vedder died in Rome on Jan. 29, 1923.

Shortly before his death, his book, *Doubt and Other Things*, was published.

VEDIC RELIGION, or the religion of the Veda, is the oldest stratum of religious activity known to have existed in India. It is the starting point of the religion variously called Brahmanism or Hinduism (*q.v.*), the first of these terms denoting chiefly the older aspects and learned forms of this religion. the second embracing all its manifestations. Most of the beliefs, practices and speculations born in India are derived more or less directly from Vedism.

The Vedic religion was brought to India by the Aryan invaders when they invaded the upper Indus basin sometime around 1500 B.C. Its basic beliefs go back to the period when the Aryans lived in Iran. and Iranian religion before the reforms of Zoroaster so closely resembles that of Vedic India that we can. with some reservation. talk about an Indo-Iranian religion. There is, on the one hand. a common belief in certain fundamental ideas—for example, that of a twofold divine hierarchy. the *daivas* (the Indo-Iranian form of *devas*) and the *asuras*—and. on the other, the same cults of fire, animal sacrifice and the sacrifice of Soma (see *Ritual,* below).

It seems likely that in yet more ancient times there was an Indo-European religion. though the basic elements that would permit its reconstruction are lacking. It is also probable that from the time of Indo-European unity onward, there was a network of fairly complex beliefs, notably at the mythological level, and that this mythology contained features that were at one and the same time naturalistic, ritualistic and social. Certain modern writers believe that Indo-European religious activity had a framework of three different types of functions: the religious function proper, with magical and juridical aspects; a warlike function, or one concerning itself with the temporal power; and an "economic" function. concerned with agriculture and, later, commerce and the activities of craftsmen.

However, this twin Indo-Iranian and Indo-European heritage offers only an inadequate explanation of Vedic religion. Either through contact with indigenous elements, or else as the result of internal evolution the ancient forms mere swamped by new accretions. It is impossible to say when Vedism gave way to Hinduism, but there was less literary activity among the Vedic schools from the 5th century B.C. onward, and about this time texts of Hindu character began to appear.

Vedic Texts.—The only extant Vedic material is the texts, great in length and very varied in content. They were written down over a period of about ten centuries, from approximately the 15th to the 5th century B.C., this being the period when Vedism was a living force. Out of the vast literary production of Vedism, only a part has survived, but this part is sufficient for understanding of the nature of the whole.

Religious activity tended to be concentrated within certain groups. or schools, stemming from subdivisions that had early occurred in the four main branches of Vedic literature—branches themselves determined by the adhesion of devotees to one or another of the four Vedas. and by the fourfold function of the chief officiants of the cult. The rise and duration of the schools cannot be dated precisely; tradition furnishes the names of several hundred. but nothing is known of them beyond those few whose supposed texts survive, for example the Xitareya and Shankhayana schools of the Rigveda and the Apastamba and the Baudhayana of the Yajurveda.

The most important texts are also the oldest. They are the four collections (Samhita) which, taking the word in its most restricted sense, we call the Veda or Vedas (*i.e.*, "Book[s] of Knowledge"). In a broader sense the term Veda(s) also includes all or part of the later literature! insofar as this is based on one or another of the four Samhitas.

The Rigveda. or "Veda of Verses." earliest of the Samhitas. is composed of about 1,000 hymns addressed to the deities. arranged for the most part to serve the needs of the priestly families who mere the custodians of this sacred literature. Most of the hymns refer directly or indirectly to the Soma cult. but in general they have only a distant connection with the ritual. The Yajurveda or "Veda of Sacrificial Formulas" contains prose formulas applicable to the different rites (*see* below), verses intended for a similar purpose and, finally, commentaries. or Brahmanas. The Samaveda or "Veda of Chants" is made up of a selection of verses (drawn almost wholly from the Rigveda), with musical notation, intended as an aid to the performance of sacred song. Finally. the Xtharvaveda is considered to be either of less worth than, or of similar content to, the three earlier collections.

Next in probable chronological order come the Brahmanas, or commentaries. These are prose texts. compiled separately for the various Vedas and serving to interpret either their formulas or their ritual. The Aranyakas. or "Forest Texts." composed c. 600 B.C., were intended to be studied in the iorest. away from the community, because of their esoteric or magical character. They contain mostly symbolic interpretations of ritual or of the *mantras* (sacred formulas). Finally, and most important, are the Upanishads (*c.* 600–300 B.C.), which touch the very quick of specula-. tion. These texts are generally very short and summarize a speculative teaching, often through parables or passages of dialogue. The so-called "Vedic" Cpanishads are 13 in number; the remainder (about 100) are probably post-Vedic, though many of them are influenced by the Vedas.

The Samhitas, Brahmanas, Aranyakas and Upanishads form what is known as the *shruti,* the "heard" or divinely revealed section of the literature. The remaining Vedic documents belong to the *smriti,* "traditional texts based on human memory," a term which also includes a whole assemblage of post-Vedic texts including the juridical *smritis* and the Bhagavad Gita (*q.v.*). They are essentially collections in the form of sutras, or aphorisms, which give a detailed description of the ceremonies or else condense certain teachings complementary to religion. for instance jurisprudence, astronomy, phonetics and metrics. Others among these ancillary texts are written either in a running prose or in didactic verse.

The Vedic corpus is written in an archaic Sanskrit whose morphological and syntactical singularities decrease with the age of the texts. The whole of this literature seems to have been preserved orally (although there must early have been manuscripts to assist memory); even today several of these works, notably the three oldest Vedas, are recited throughout India with subtleties of intonation that must have been handed down from their earliest days.

Mythology.—Although the earliest-known features of Vedic religion is its mythology, found in the Rigveda, this in no way means that there was a period when myths were recited to the exclusion of all other religious activity. The mythology in any case shows certain correlations with the ritual. Two of the greatest deities are at the same time material elements of the offering: on the one hand. Agni (*q.v.;* fire) is equally the fire of the sun. lightning the fire that is hidden in wood and in plants. and that which men light for the purposes of worship: on the other hand, Soma (*q.v.*) is simply the deified aspect of the liquid poured in oblation.

Important as Agni and Soma are, the highest rank is held by Indra (*q.v.*), a warlike god—one might say a typically Aryan god—who conquered innumerable human and demon enemies, vanquished the sun, killed the dragon Vritra who held up the flow of the waters and delivered the cows Vritra held captive (which partly represent the Dawns). Although there is no systematic mythological explanation of the creation of the universe in the Vedas, Indra is sometimes designated creator of parts of it; for instance, in the hymns to Indra he is addressed as the creator of light and of the oceans. Among his allies are the Maruts (q *v.*), young men who ride the clouds and who make rain; the Ashvins or Nasatyas, twin brothers famed for their powers of healing and analogous to the Dioscuri of Greek legend; and Vishnu. the giant who is said to cover the world in three strides and who later evolves into one of the three principal gods of Hinduism.

Among the other great deities, the chief is Varuna, the god-"sovereign." to be distinguished from Indra. the god-"king" and prototype of the warrior chief. Varuna is upholder of the cosmic and moral laws; he is associated with Mitra. who represents the more juridical side of sovereignty, while Varuna represents the magical and speculative aspects. Both are members of the Adityas. a group of gods who are supposed to have descended from Aditi. a somewhat shadowy mother-goddess. There are indications that Varuna was once the highest god but was deposed to the advantage of Indra; this event seems to coincide with the victory of the devas, or gods, over the asuras, who may be equated roughly with the Titans.

In the background is the Father of the Heavens, Dyaus or Dyauh Pitar, the equivalent (as his name alone shows) of the Roman Jupiter but generally coupled with the Earth goddess and forming with her a pair in which the feminine side dominates. The female deities are numerous but not clearly differentiated; the most distinctive is Ushas, or Dawn. Rudra stands somewhat apart: he is an ambivalent god, in part beneficent, in part a source of fear, and as such is a forerunner of the post-Vedic deity Shiva.

The cosmos is filled with living beings; apart from the individual gods there are the demigods or spirits of uncertain status (such as the Gandharvas and their female companions, the Apsarases), and there are the divine groups, the most extensive of which is the one that goes under the name of the Vishve Devas. "All-gods." There exist also demons or groups of demons (most numerous in the Atharvaveda), whose leader is Vritra, the warrior demon. But there is no dominant figure: Vedic India elaborated no principle of evil comparable to the principle of good embodied by the gods (who are often called vasu, an Indo-Iranian term meaning "good"). Evil is within, and numerous divine and normally favourable entities have another side which inspires fear and brings misfortune.

Finally, few roles are strictly defined. The qualities and exploits attributed to one god pass very easily to another, showing that in the midst of so many and varied images there was a tendency to blend the different elements. This indicates a move in the direction of monotheism and prepares the way for that weakening of mythology that takes place in the Vedic texts written after the Samhitas; Prajapati, the lord of living creatures, takes on the rank of supreme god, and, still later, the concept *brahman* replaces any specific personification.

Cosmology and Cosmogony.—Just as there is no stable principle of evil, there is no precise picture of an infernal region. Paradise. or the world of "the pious act," is scarcely more clearly described: it is situated in the third heaven and represented as a place of material felicity. Vedic man asks. in general, for nothing more than the life of the moment—riches. good fortune, male, progeny—and has no clear vision of a rebirth. Yama, who was the first of human beings and so the first of the dead, became king of the dead, sovereign sometimes of a subterranean world. sometimes of paradise. As for the creation of the world. it is at times conceived in nonfigurative terms; starting from abstract ideas, but the dominant image is that of a cosmic giant who initiates a primordial sacrifice in which he himself is the willing victim and from whose limbs are born the structural elements of the universe (see also HINDUISM: *Cosmology*).

Metaphysical Speculation.—Vedic thought became increasingly refined and subtle, but its foundations are all to be found in the Rigveda. All speculation was directed toward the search for harmony, equivalences and correspondences between macrocosm and microcosm: and its ultimate goal was a reduction to unity by way of successive equations. There was already a hint of this tendency in the mythico-religious complex of the earliest ages and in the setting in an order of human, atmospheric and celestial phenomena, designated by the old term *rita* (now sometimes translated by "truth"). Elements of natural philosophy. culled from a theory of fire, a theory of breath and a theory of the cycle of the waters, provided a concrete illustration of the Upanishadic *gnosis,* in which all images came together and where ancient myth was reduced to parable.

The crucial idea was that of *brahman;* this word, which is neuter in gender and originally denoted the sacred formula (or, to be more exact, the particular energy expended either in repeating the formula or in maintaining silence) tends to become a guiding principle, a sort of universal soul, in which is merged the individual soul: Atman. This is the central thesis of the Upanishads. but was already partially developed in the Brahmanas and even in the Atharvaveda.

Ritual.—There were three phases in the development of Vedic ritual. In the Rigveda the ritual seems to have been relatively simple; the hymns served as introductions to the most solemn ceremonies, which were also accompanied by chants and various activities, such as horse races, real or imagined raids and perhaps verse competitions. In the last stage, that of the Aranyakas and Upanishads. the ritual is smothered either by mental or symbolic forms or by pure speculation. Between the two is the whole range of the Vedic liturgy, which culminated in sacrifice. Homage to the divinity consists essentially of offerings to Fire, the aim being to enter into communication with the divine world and by so doing to obtain certain benefits, general or particular, collective or personal. There are fixed ceremonies, corresponding to' precise dates in the lunar calendar, and others, votive in intention, which accompany some particular occasion, sometimes of a national, sometimes of an individual character.

The shortest solemn rite is the Agnihotra or Oblation to Fire, which is simply an offering of milk, morning and evening, and calls for only one officiant. More complex is the Sacrifice of the Full and New Moons, which serves as the norm for a series of other liturgies and consists of offerings of plants. Animal sacrifice — the killing of a ram — existed either independently or as an integral part of the Sacrifice of Soma. a plant whose juice acts as a stimulant. In the basic form of this ritual the lay sacrificer is first consecrated and then the juice is three times pressed from the plant, part being offered to the fire and part consumed by the priests. Each of the three occasions is preceded and followed by recitations and chants. The longest rituals are the "sessions." for example the "way of the cows" *(gavam ayana)*, the crucial point of which is a festival of the winter solstice known as the "great observance." The *rajaszrya*, or sprinkling of the (newly elected) king, the *Vajapeya*, or "drink of victory" destined for the victorious prince, the *ashvamedha*, or horse sacrifice, are elaborate variants of the Soma sacrifice.

The patron who ordered the sacrifice took part in it with his spouse; he pronounced certain formulas and distributed the fees due to the professional priests. who numbered from 4 to 16 or 17 and mere theoretically under the orders of the *brahman*, who supervised in silence. The *hotar* poured the oblation and recited stanzas drawn from the Rigveda: the *udgatar*, or cantor. chanted the stanzas taken from the Samaveda; the *adhvaryu* performed numerous ritual gestures and recited the formulas emanating from the Yajurveda. There were no temples or images; the ceremony took place in an open space, consecrated afresh for every important ceremony, whose altar *(zedi)* was a quadrangle marked out by hollowing or slightly raising the ground. No prayer existed independent of the formulas used for sacrifice. At first the sacred formulas must have consisted principally of invitations to the gods to come to the earth and participate in human worship; later they became learned elaborations of this elementary pattern.

Private Rites. — All the rituals mentioned above were public, necessitating the participation of priests, and these are the true Vedic rituals. Mention must also be made. however, of the private or domestic rites, even though it is not clear whether they are really Hindu (or the precursors of Hindu) rites that have incorporated certain genuine Vedic patterns. They are carried out by the head of the household at the family hearth, and are brief ceremonies in which milk, butter or grain are offered either to the fire or to the winds. Some occur daily or monthly. others accompany a particular event and have votive or expiatory significance. The *sanzskaras* (sacraments) are consecration rites of various kinds marking the life of the Indian (of the first three castes) from the period as an unborn child up to time of death and nhat lies beyond it. The most elaborate ceremonies are those relating to marriage and death. Marriage rites. which include oblations to the gods, recited formularies and symbolic acts, are followed by a three-day period of abstinence from sexual intercourse.

The normal way of disposing of the dead is cremation. There too the rites include symbolic acts, particularly the custom, already attested in the Rigveda, of inviting the widow to lie down for a moment beside the dead body of her husband, then to get up and join her brother-in-law as a substitute for the dead man. Cremation is followed by purificatory rites; later a mound is set up. and commemorative rites *(shraddhas)* are performed on a fixed date. These rites have some social importance. for they confirm the authenticity and the limits of the family line and determine who is later to have the right of inheritance. On the religious plane they help to transform the dead man into a *pitr*, that is, a powerful and friendly ancestor.

The most important sacrament socially is *upanayana* or initiation, which confirms the admission of the child into the brahmanical community. The master of ceremonies gives a staff to the candidate. girds him and grasps him by the hand: after a short interchange of request and acceptance the child receives instructions and is commended to the gods. Thus he becomes "twice born " He is then eligible to consume the remains of the offerings and takes his place in the male brahmanical line.

Finally. there are the magical and ascetic practices. Magic was highly developed and even found a place in religious observances and the ancient hymnary. The magician made use of an extensive range of symbols, he was familiar with the mysteries of divination, and in the role of chaplain he put himself at the service of the king. It also seems that there already existed certain ascetic practices of the type which in later times was especially associated with the Yoga of Patanjali.

Conclusion. — The literature gives a relatively full account of certain aspects of religious life but leaves others unexplained. Very little is known about Vedic man: he is seen beseeching the gods with his petitions — what one is tempted to call faith *(shraddha)* is plainly rather the confidence that is felt in the efficacy of the ritual — and troubled by the fear of sinning. However. it is not known how this religion fitted into a precise political system nor how it manifested itself at the social level.

In spite of the fact that the religion seems to have had a very fixed and decisive nature, various aspects nevertheless managed to survive in later periods down to the present time. Hindu mythology inherits much from the mythology of the Rigveda; the ancient speculation gave birth to a number of systems of thought in classical India *(see* IXDIAX PHILOSOPHY). As for the ritual, if most of the spectacular ceremonies have been practised only on rare occasions. and perhaps inspired by antiquarian sentiment rather than religious feeling; the private rites on the other hand continued in use alongside the later developments of Hinduism in the Puranas and Tantras, and many of them have remained alive.

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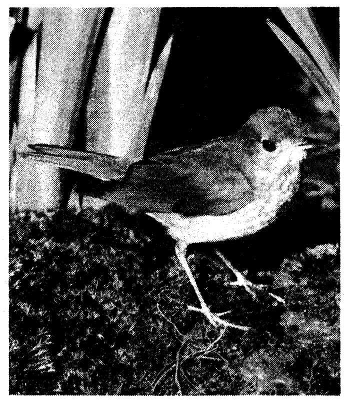
VEERY *(Hylocichla fuscescens)*, also called Wilson's thrush, a North American songbird of the thrush *(q.v.)* family (Turdidae). It breeds from Newfoundland to New Jersey (in the mountains as far south as Georgia) and ranges west to central Oregon and northern New Mexico, migrating to South America in the winter. About 7 in. long, the veery is an even tawny brown above and white below, the throat and upper breast being buff-marked with a few indistinct brownish spots. The young have upper parts spotted tawny olive. The veery is often seen in young hardwood thickets of willow or alder where it feeds on insects, berries and seeds. Its characteristic song is a vibrant series of downward-slurred notes having a ventriloquistic, faraway quality.



ALLAN D. CRUICKSHANK FROM NATIONAL AUDUBON SOCIETY

VEERY OR WILSON'S THRUSH (HYLOCICHLA FUSCESCENS)

See also SONGBIRD. (R. S. PR.)

VEGA, GARCILASO DE LA (1503–1536), Spanish soldier and poet. was born at Toledo. At the age of 17 he was attached to the bodyguard of Charles V. fought against the insurgent *communeros* and afterward gained great distinction by his bravery at the battle of Pavia (1525). In 1526 he married a lady-in-waiting to Queen Eleanor. He took part in the repulse of the Turks from Vienna in 1529, was present at the coronation of the emperor at Bologna in 1530 and was charged with a secret mission to Paris in the autumn of the same year. In 1531 he accompanied the duke of Alva to Vienna, where, for conniving at the clandestine marriage of his nephew to a maid-of-honour, he nas imprisoned on an island in the Danube. During this captivity he composed the fine cancion. "Con un manso ruido de agua corriente y clara." Released and restored to favour in June 1532, he nent to Naples on the staff of Don Pedro de Toledo, the newly appointed viceroy, by whom he was twice sent on public business of importance to Barcelona, in 1533 and 1534. After having accompanied the emperor on the expedition to Tunis (1535), he took part with him in the invasion of Provence and was mortally wounded while storming a fort at Muy, near Fréjus. His poems, which are among the finest in their language, include three pastorals, which rank among the finest in the Spanish language, 37 sonnets, five canciones, two elegies, and a blank verse epistle, all influenced by Italian models. An English translation was published by J. H. Wiffen in 1823. Garcilaso's delicate charm has survived all changes of taste, and by universal consent he ranks among the most accomplished and artistic of Spanish poets.

See H. Keniston, *Garcilaso* de la *Vega* (1922–25).

VEGA, GARCILASO DE LA, called "Inca" 150–1616), historian of Peru, was born at Cuzco. His father, Sebastiano Garcilaso (d. 1559), was a cadet of the illustrious family of La Vega, who had gone to Peru in the suite of Pedro de Alvarado, and his mother was of the Peruvian blood-royal, a circumstance of which he was very proud as giving him a right to the title which he claimed by invariably subscribing himself "Inca." About 1560 he removed to Spain, but failed to win the preferment for which he hoped. After long service in the army, he turned to literature, solacing himself in his rather meagre circumstances by depicting the riches of the new world. He died in Spain in 1616. He published in 1590 a translation of *Dialoghi* di *Amore* of Léon Hebro, but his fame depends upon La Florida del Ynca (1605) and his history of Peru (Pt. 1, *Commentarios Reales que tratan del origen* de *los Yncas,* Lisbon, 1608 or 1609; Pt. 2, Cordova, 1617). This latter work has been translated into English, French, German and Italian and has been utilized by Robertson, Prescott, Marmontel and Sheridan. The former work, a history of the De Soto expedition, was long regarded primarily as fiction. In spite of its exaggerations as to the numbers and wealth of the Indians, recent investigations have shown it to possess more ethnological value than had been hitherto supposed. Garcilaso de la Vega wrote before history was regarded as a science; by temperament and circumstances he was inclined to the romantic; nevertheless his work possesses permanent intrinsic interest and he will be remembered as the first South American in Spanish literature.

See monograph by J. Fitzmaurice-Kelly (1921) in Hispanic series, and Lima edition of the Peruvian history (1918–21) prepared by H. H. Urteaga with introduction by Don José de la Riva Agüero.

VEGA, the bright star in the constellation Lyra (*q.v.*), hence its Bayer equivalent, α Lyrae; it is one of the brightest stars in the sky. It is also one of the sun's nearer neighbours in space, being located at a distance of about 26 light years.

VEGA CARPIO, LOPE FELIX DE (1562–1635), Spanish dramatist and poet, was born in Madrid. His father and mother, Felices de Vega and Francisca Hernandez Flores, originally came from the valley of Carriedo in Asturias. Lope began his studies at the Theatine college in Madrid, and afterwards entered the service of Don Jerónimo Manrique, bishop of Avila, who sent him to the University of Alcalá de Henares, perhaps from 1577–81. He took part in the expedition to the Azores in 1582, and from 1583–87 was secretary to the marqués de las Navas. In Feb. 1588 he was banished for circulating criminal libels against his mistress. Elena Osorio, whom he has celebrated under the name of Fills. He defied the law by returning to Madrid soon afterwards and eloping with Isabel de Urbina, sister of Philip II.'s herald; he married her by proxy on May 10, 1588, and joined the Invincible Armada, losing his brother in one of the encounters in the Channel. He settled for a short while at Valencia, where he made acquaintance with a circle of young poets who were afterwards to be his ardent supporters in founding the new comedy. He joined the household of the duke of Alva, with whom he remained till 1595. Soon afterwards he lost his wife. He was prosecuted for criminal conversation in 1596, became secretary to the marquis de Malpica (afterwards count of Lemos), and in 1598 married a second wife, Juana de Guardo, by whom he had two children (Carlos, who died in 1612, and Feliciana Felix); but she died, shortly after giving birth to the latter, in 1613. Lope then sought a refuge in the church. After having been affiliated to a tertiary order, he took priest's orders.

At this juncture, about 1614, he was in the very zenith of his glory. A veritable dictator in the Spanish world of letters, he wielded over all the authors of his nation a power similar to that which was afterwards exercised in France by Voltaire. At this distance of time Lope is to us simply a great dramatic poet, the founder of the Spanish theatre; but to his contemporaries he was much more. His epics, his pastorals, his odes, his sonnets, now forgotten, all placed him in the front rank of authorship. Such was his prestige that he dealt with his noble patrons almost on a footing of equality. The duke of Sessa in particular, his Maecenas from 1605 onwards, was also his personal friend, and the tone of Lope's letters to him is one of frank familiarity, modified only by some forms of deference. Lope's fame, too, had travelled abroad; foreigners of distinction passing through Madrid made a point of visiting him; papal legates brought him the compliments of their master; in 1627 Urban VIII., a Barberini, sent him the diploma of doctor of theology in the Collegium Sapientiae and the cross of the order of St. John of Jerusalem (whence the poet's titles of "Doctor" and "Frey"). His last days were full of sadness; the death of his son Lope, the elopement of his daughter, Antonia Clara, wounded him to the soul. Montalban tells us that every Friday the poet scourged himself, so severely that the walls of his room were sprinkled with his blood. His death, on Aug. 27, 1635, was followed by national mourning.

For a rapid survey of the works of Lope, it is convenient to begin with those which the Spaniards include under the name of *Obras* Sueltas, the title of the large collection of the poet's non-dramatic works (1776–79). We shall enumerate the most important of these, as far as possible in the order of publication. The Arcadia (1598), a pastoral romance, inspired by Sannazaro, is one of the poet's most wearisome productions. La *Dragontea* (1598), is a fantastic history in verse of Sir Francis Drake's last expedition and death. *Isidro* (1599), a narrative of the life of Isidore, patron of Madrid, is called a Castilian poem on account of the rhythm in which it is composed—quintillas of octosyllabic verse. The *Hermosura* de *Angélica* (1602), in three books, is a sort of continuation of the Orlando *Furioso,* in octaves after the fashion of the original poem. Finally, the *Rimas* are a miscellany of short pieces. In 1604 was published the *Peregrino* en *su Patria,* a romance similar in kind to the Aethiopica of Heliodorus. Having imitated Ariosto, he proceeded to imitate Tasso; but his Jerusalem conquistada (1609) has preserved nothing of the art shown in its model and is an insipid performance. Next follows the *Pastores* de *Belen* (1612) a pious pastoral, dedicated to his son Carlos, which forms a pendant to his secular Arcadia; and incidental pieces published in connection with the solemnities of the beatification and canonization of St. Isidore in 1620 and 1622. It is enough to mention La *Filomena* (1621), La *Circe* (1624) and other poems published about the same date, as also the four prose novels, Las *Fortunas* de Diana, El Desdichado *por* la *Honra,* La *Más Prudente Venganza* and *Guzmán* el Bravo. The great success of the *Novelas exemplares* (1613) of Cervantes had stimulated Lope, but his novels have none of the grace, naturalness, or interest which characterize those of his rival. The last important work which has to be mentioned before we leave the narrative poetry of Lope is the Laurel de Apolo (1630). This piece describes the coronation of the poets of Spain on Helicon by Apollo, and it is more meritorious as a bibliographical manual of Spanish poetry at that time than as genuine poetry. One other obra *suelta,* closely akin to Lope's dramatic works, though not, properly speaking, a drama, is La Dorotea (1632). Lope describes it as an "action in prose," but it is rather a "romance in dialogue"; for, although divided into acts, the narrative is dramatic in form only. Of all Lope's productions Dorotea shows most observation and study; the style also is unusually simple and easy. Of all this mass of obras *sueltas,* filling more than 20 volumes, very little (leaving *Dorotea* out of account) holds its own in the judgment of posterity. The lyrical element alone retains some vitality. From the *Rimas* and other collections of detached pieces one could compile a pleasing anthology of sonnets, epistles, elegies and romances, to which it would be proper to add the *Gatomaquia,* a burlesque poem published along with other metrical pieces in 1634 by Lope under the pseudonym of Tomé de Burguillos.

It is, however, to his dramatic writings that Lope owes his eminent place in literary history. It is very curious to notice how he himself always treats the art of comedy-writing as one of the humblest of trades (*de pane lucrando*), and protests against the supposition that in writing for the stage his aim is glory and not money. The reason is not far to seek. The Spanish drama, which, if not literally the creation of Lope, at least owes to him its definitive form — the three-act comedy — was totally regardless of the precepts of the schooi, the pseudo-Aristotelianism of the doctors of the period. Lope accordingly, who stood in awe of the criticism of the *científicos,* felt bound to prove that, from the point of view of literary art, he attached no value to the "rustic fruits of his humble *vega.*" In his *Arte Nuevo de hacer comedias en este tiempo* (1609), Lope begins by showing that he knows as well as any one the established rules of poetry, and then excuses himself for his inability to follow them on the ground that the "vulgar" Spaniard cares nothing about them. "Let us then speak to him in the language of fools, since it is he who pays us." Another reason which made it necessary for him to speak deprecatingly of his dramatic works is the circumstance that the vast majority of them were written in haste and to order. The poet does not hestitate to confess that "more than a hundred of my comedies have taken only 24 hours to pass from my brain to the boards of the theatre." Nevertheless, Lope did write dramas in which the plan is more fully matured and the execution more carefully carried out; still, hurried composition and reckless production are after all among the distinctive marks of his theatrical works. Towards the close of his career Lope somewhat modified the severe and disdainful judgments he had formerly passed upon his dramatic performances; he seems to have had a presentiment that posterity, in spite of the grave defects of his work in that department, would nevertheless place it much higher than *La Dragontea* and *Jerusalem conquistada,* and other works of which he himself thought so much. We may certainly credit Lope with creative power, with the instinct which enabled him to reproduce the facts of history or those supplied by the imagination in a multitude of dramatic situations with an astonishing cleverness and flexibility of expression; but unfortunately, instead of concentrating his talent upon the production of a limited number of works which he might have brought to perfection, he dissipated it, so to say, and scattered it to the winds.

The classification of the enormous mass of Lope's plays (about 470 *comedias* and 50 *autos* are known to us) is a task of great difficulty, inasmuch as the terms usually employed, such as comedy, tragedy, and the like, do not apply here. There is not explicitness enough in the division current in Spain, which recognizes three categories: — (I) *comedias de capa y espada,* the subjects of which are drawn from everyday life and in which the persons appear as simple *caballeros;* (2) *comedias de ruido* or *de teatro,* in which kings and princes are the leading characters and the action is accompanied with a greater display of dramatic machinery; (3) *comedias divinas* or *de sarztos.* Some other arrangement must be attempted. In the first place, Lope's work belongs essentially to the drama of intrigue; be the subject what it may, it is always the plot that determines everything else. Lope in the whole range of his dramatic works has no piece comparable to *La Verdad Sospechosa* of Kuiz de Alarcon, the most finished example in Spanish literature of the comedy of character: and the comedy of manners is represented only by *El Galan Castrucho, El Anzuelo de Fenisa* and one or two others. It is from history. and particularly Spanish history. that Lope has borrowed more than from any other source. But it is to the class of *capa y espada* — also called *novelesco,* because the subjects are almost always love intrigues complicated with aifairs of honour — that Lope's most celebrated plays belong. In these he has most fully displayed his powers of imagination (the subjects being all invented) and his skill in elaborating a plot. Among the plays of this class which are those best known in Europe, and most frequently imitated and translated. may be specially mentioned *Los Ramilletes dr Madrid, Lrr Boba para los Otros y Discreta para si, El Perro del Hortelano, La Viuda de Valencia* and *El Maestro de Danzar.* In some of them Lope has sought to set forth some moral maxim. and illustrate its abuse by a living example. as in *Las Flores de Don Juan.* Such pieces are, however. rare in Lope's repertory; in common with all other writers of his order in Spain. with the occasional exception of Ruiz de Alarcon, his sole aim is to amuse and stir his public; not troubling himself about its instruction. The strong point of such writers is and always will be their management of the plot.

To sum up. Lope found a poorly organized drama, plays being composed sometimes in four acts. sometimes in three: and. though they were written in verse. the structure of the versification was leit far too much to the caprice of the individual writer. The style of drama then in vogue he adopted. because the Spanish public liked it. The narrow framework it afforded he enlarged to an extraordinary degree. introducing everything that could possibly furnish material for dramatic situations — the Bible. ancient mythology. the lives of the saints. ancient history. Spanish history, the legends of the middle ages. the writings of the Italian novelists, current events. Spanish life in the 17th century. Before him manners and the conditions of persons and characters had been barely sketched; with fuller observation and more careful description he created real types. and gave to each social order the language and drapery appropriate to it. The old comedy was awkward and poor in its versification; he introduced order into the use of all the forms of national poetry. from the old romance couplets to the rarest lyrical combinations borrowed from Italy. Hence he was justified in saying that those who should come after him had only to go on along the path which he had traced.

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VEGETABLE, in its broadest sense, refers to any kind of plant life or plant product; viz., "vegetable matter." However, in common. narrow usage "vegetable" usually refers to the fresh, edible portion of a herbaceous plant — roots. stems. leaves. flowers or fruit. These plant parts are either eaten fresh or prepared in a number of ways. (*See* VEGETABLE COOKERY.)

The edible portion may be a root — rutabaga,beet. turnip. radish. carrot. parsnip. celeriac, sweet potato. salsify, horse-radish; tuber (storage stem)—white (Irish) potato. yam. taro; stem—asparagus. kohlrabi: bud — Brussels sprouts: bulb — onion, garlic, shallot; petiole — celery. rhubarb. fennel, cardoon; leaf — cabbage, lettuce: kale, mustard. turnip (leaves). endive, chard, collard. parsley, spinach, chive; immature flower—cauliflower. sprouting broccoli, artichoke; seed — pea. southern (cow) pea. Lima bean; fruit (immature) — snap bean. chayote, okra. eggplant. summer squash (vegetable marrow). cucumber. sweet corn (maize); fruit (mature) — muskmelon, watermelon. squash (winter), pumpkin. tomato. pepper. The fruit-producing vegetables are all herbaceous annuals or, rarely, in temperate climates. perennials. The "fruit" crops, except strawberries. are produced on woody perennial vines or trees. A decision of the U.S. supreme court in 1893 held, in effect, that a plant or plant part is a vegetable if generally eaten as a part of the main course of a meal, but is a fruit if eaten as an appetizer, or as a dessert. or out of hand. Muskmelons and watermelons are, broadly speaking, vegetables, but they. and tomatoes also. are frequently commonly and botanically classed as fruits. (*See* FRUIT.)

The importance of vegetables in the human diet lies primarily in quantities of usable iron and calcium. the high vitamin C (ascorbic acid) content and. in the yellow or leniy vegetables, the large amount of vitamin A. Many vegetables contain appreciable quantities of the B-complex vitamins. niacin. riboflavin and thiamin, The iron and calcium in spinach and rhubarb are practically unavailable, because of their oxalic acid content. Most vegetables are low in protein and carbohydrate. Lima beans and peas are relatively high in protein, and Lima beans. sweet corn. peas, white potatoes and sweet potatoes have moderate amounts of carbohydrate (*see* DIET AND DIETETICS).

About 80 plant species and 18 families are represented in crops cultivated as food by Europeans alone. Nearly one-third of these are of economic value. Of the more important vegetahles. all except the rutabaga have been cultivated since ancient times and are contributions from early civilizations of both the new and old worlds. Some have been so changed by man that their wild ancestors can no longer be identified with certainty. Examples are the cucumber. muskmelon. white potato. sweet potato. pumpkin, squash, sweet corn and onion.

The diversity of origin and of the plant part utilized. aided by human selection through the centuries. has resulted in a variety of vegetables adapted to each climate. from the short summers of the arctic to the year-around gron·ing season of the tropics. The primary factor influencing vegetable growth is temperature. With a few exceptions, crops grown for vegetative parts require cool temperatures, and fruit-producing vegetables require warmer temperatures. A general classification based on average temperatures for satisfactory growth is:

1. Cool-season crops—adapted to 55°–70° F.:
   - (a) Tolerant of some frost: cabbage. Brussels sprouts. kale, sprouting broccoli, collards, kohlrabi, turnips, spinach, beets, parsnips. onions, asparagus.
   - (*b*) Intolerant of frost at maturity: lettuce, peas. cauliflower, celery, carrots, artichoke, white potatoes, endive.
2. Warm-season crops—readily damaged by frost:
   - (a) Adapted to 6;"–So° F.: muskmelon. cucumber, squash, pumpkin, beans (all), tomatoes. peppers, sweet corn.
   - (*h*) Require temperatures above 70° F. and long growing season : sweet potatoes, watermelon. eggplant, okra.

The time from planting to maturity also may vary—irom 26 to 28 days for radishes to five months for sweet potatoes. (*See* HORTICULTURE; CABBAGE: CORN; ONION; TOMATO; POTATO; etc.)

The photoperiod (length of light) interacts with temperature to influence bulb formation in onions. tuber development in potatoes and seed-stalk production in spinach. lettuce and endive. With cucunibers in the greenhouse. photoperiod may alter the ratio of male to female flowers (*see* PHOTOPERIODISM).

Some crops (white potatoes. sweet potatoes. onions. cabbage. carrots. beets, garlic. turnips. winter squash. pumpkin. winter radish, salsify. parsnip and horse-radish) may he stored for considerable periods under proper humidity and temperature. Others may not be stored longer than a few weeks.

Controlled storage temperatures permit long-term holding of storage crops and large-scale shipment of perishable crops to distant markets. The storage liie of cool-seasoit crops and sweet corn is maximum near 32° F.. except that potatoes below 38° F. develop undesirable sweetness. Warm-season crops may be damaged at temperatures below 45°–55° F., depending on the crop. A chemical. maleic hydrazide. is widely used to prevent sprouting of potatoes in storage. (*See* also FOOD PRESERVATION.)

There are no reliable estimates on world-wide acreage and production of most vegetables. However. it is known that locally grown vegetables provide a substantial. though unmeasured, part of the diet of the agricultural three-fifths of the world's population. as well as a portion of the food for nearby village and city dwellers. Among many peoples in underdeveloped areas of the world. native plants are often utilized. mostly in the form of tender young shoots and leaves. for cooked greens. Cooking not only renders the plants palatable but also, unintentionally, safe from serious soil- and water-borne disease organisms.

Vegetable Culture in the United **States.**—Many kinds of vegetables are grown throughout the U.S. in home and market gardens. Twenty-nine vegetahles are listed by the U.S. department of agriculture as having farm value in excess of $1,000,000. Total annual acreage for all vegetables approximates 6,250,000, with a value near $1,400,000,000. White potatoes alone equal nearly 40% of all other vegetables in value and acreage. Following white potatoes in descending order of production are: tomatoes, sweet corn, watermelons. lettuce, cabbage, sweet potatoes, onions, celery, muskmelons and carrots.

Commercial vegetable-growing has developed into two quite distinct types of enterprises: production for storage or processing, and production for immediate fresh-market sale.

Storage crops and processing crops (for canning or freezing) are grown mainly where good quality. high yield and low costs prevail. and where time of harvest is relatively unimportant. The major areas of such production are the Pacific coast states; a belt along the northern third of the country, from Minnesota eastward; southward along the Atlantic seaboard; and the Texas-Arkansas area.

Before World War I most fresh-market vegetables were grown near the areas of consumption. Since that time, however. development of modern refrigerated trucks and railroad cars has permitted a steady, orderly and large-scale expansion of off-season perishable fresh-vegetable production in the south and on the irrigated lands of the southwest and west. far from centres of population. Vegetables can now be produced in the areas best suited to their growth and shipped in great quantities over long distances to large urban centres. This. together with local greenhouse production and imports from Cuba and, in rapidly increasing volume, from Mexico, makes fresh vegetables of all kinds available to consumers throughout the year.

The primary areas for production of fresh-market vegetables lie near large temperature-moderating bodies of water (Great Lakes. Atlantic and Pacific oceans. Gulf of Mexico) and certain intermountain valleys of the western states. Nearly one-third of all vegetables produced in the United States are grown in California.

Consumption of fresh vegetables approximates 144 lb. per capita annually. From the beginning of World War II until the late 1950s consumption declined slightly while annual per-capita use of processed vegetahles rose substantially—canned vegetables by 30% to 72 lb. annually and frozen vegetables by more than 800% to 14 lb. (fresh equivalent') annually. During the same period. per-capita consumption of white potatoes declined 20% to 100 lb. annually and sweet potatoes declined 60% to 9 lb.

Modern developments include a marked increase in mechanization of cultural, harvesting and packing operations; greater use of chemical fertilizer; new herbicides, insecticides and pesticides; and the introduction of irrigation to supplement rainfall in the eastern Cnited States. Farm and marketing units have steadily increased in size. and farm management is increasingly conducted on a business basis, requiring large capital outlays for land: equipment and operation. The small market garden is steadily disappearing.

Vegetable Culture in Western Europe.—In the northern countries of western Europe only cool-season crops can be produced in quantity. Special methods of production. in the form of sashes, cloches and greenhouses, are extensively employed for warm-weather and off-season crops. More than 16.000 ac. of vegetables are grown under glass. mainly in the Netherlands and England. Western Germany, the United Kingdom and France import quantities of vegetables from the Netherlands. Italy, Spain, north Africa and the Canary Islands. Moderate climates around the Mediterranean permit the culture of most vegetables during much of the year and the production of warm-season crops for shipment to northern areas.

Throughout Europe the pattern of farming remains a family-sized unit. too small for extensive mechanization or volume merchandising. More economic farming units can develop only gradually if existing social and economic systems are not to be seriously disrupted. Agreements designed to remove trade barriers between certain western European countries. and improved refrigerated transport, may result in greater movement of perishable foods, as well as the development of areas for more specialized production of specific crops. particularly in the Mediterranean basin. About 14,500,000 ac. are used for vegetable production in western Europe, of which nearly 11.000,000 ac. are devoted to white potatoes.

In Great Britain the family-sized market-garden unit remains essentially unchanged. and the land is intensively cultivated. The use of machinery and other improved methods of production is increasing. as is irrigation to supplement rainfall. The present trend is to combine frame, cloche or greenhouse crop culture with market-garden production.

In the past vegetable-growing areas were located near large cities. which provided a ready market and a convenient source of needed animal manure. Although some market gardening remains near the cities, rail and truck transport and the disappearance of the horse from urban areas have permitted the movement of the vegetable industry into districts with climate and soil better suited to these crops. Primary production areas for vegetables other than potatoes. in the Midlands and south England, are: (1) the Fens (peat-soil areas) in parts of Norfolk, Isle of Ely and Holland district of Lincolnshire; (2) Vale of Evesham, Worcestershire; (3) Sandy district. Bedfordshire; (4) northwest Kent; (5) south Essex; (6) Middlesex plain; and (7) southeast Cornwall. In Scotland, vegetable-growing areas are close to Glasgow and the Lothian coastal plain, near Edinburgh. White-potato production is more widespread, with the Fens in England and the Angus-Perth-Fife area in Scotland being most important. Of the more than 3,000 ac. of greenhouses used for vegetables, more than two-thirds are devoted to tomato growing.

Crops of Great Britain, in descending order of importance, based on production, are: potatoes, cabbage, carrots, cauliflow-er and broccoli, peas, tomatoes, lettuce and beets. About 1,400,000 ac. are cultivated for vegetables. nearly three-fourths of which are used for white potatoes. Although nearly all tillable land is utilized. Great Britain must import large quantities of food. With the exception of white potatoes, about one-fifth of the vegetables (mainly onions and tomatoes) are imported. (P. G. S.)

VEGETABLE COOKERY. The term vegetables other than pulses and cereals (*q.v.*) covers those plants which have edible flowers, fruit or seed, stalks, roots or leaves. Green vegetables are valuable in the diet chiefly on account of their potassium salts and vitamins; cellulose, which supplies the body with bulk or "roughage," thus assisting digestion; and for their water content (average 90%–95%). Roots and tubers are heat- and energy-giving foods. The cellulose of vegetables is valuable as roughage in the intestinal tract.

Green Vegetables. — There are three distinct methods of cooking green vegetables. Steaming is one. In the second, only enough water is used to preven. the vegetables from sticking to the pan and getting burned, and the aim is to conserve the natural salts and flavours of the vegetables. The third and most common method of cooking ordinary "greens" is to boil the vegetable in a pan of fast-boiling salted water with the lid off. Soda is frequently added to soften the water and preserve the colour but it destroys the vitamins and is not recommended.

All these methods can be used for most green vegetables with the exception of sorrel and spinach, which have a very high water content and require very little water in cooking.

To cook cabbage first wash well in salt and water to get rid of any insects, trim off outside discoloured leaves and put into a kettle full of boiling water, with at least 1 teaspoon salt to each quart. To lessen odour of cooking, do not cover. Whole young cabbage, 25–30 min., old. 30 min.–1 hr. Quartered. 10–15 min. Leaves, 5–10 min. Drain, add 1 tablespoon butter ior each lh.

Cabbage may be stuffed with forcemeat or savoury rice (cooked rice and grated cheese, chopped onion and seasoning) by separating the leaves from a parboiled cabbage and rolling each leaf round the forcemeat, or the stuffing may be placed in the centre of the cabbage. If the cabbage is rolled, stem in a thickened gravy.

Brussels sprouts may be dipped in batter and fried. Single leaf vegetables, *e.g.*, spinach, beet tops, etc., may be cooked until tender, drained and passed through a sieve, then mixed with butter, cream, seasoning, and formed into a purée which can be garnished with hard-boiled eggs or served on toast. Green purée soups are made from green vegetables. It is, of course, of essential importance in the cooking of vegetables to avoid any overcooking.

White Vegetables. — To prepare white vegetables for cooking, wash, scrub or scrape. Celery should be cut up in thin strips lengthwise to facilitate cooking. Have ready a pan of salted boiling water, squeeze into it a little lemon juice to keep the vegetables a good colour. In cooking certain blanched vegetables, *e.g.*, asparagus, leeks, etc., it is best to tie the vegetables in bundles. Overcooking of all white vegetables should be avoided. As a rule, 15–30 min. (according to the age and type of vegetable being boiled) is sufficient time to allow.

Jerusalem artichokes, salsify (oyster plant), etc., may be passed through a sieve and creamed, sprinkled with grated cheese and sauce and then baked au gratin. They may also be fried in batter as fritters. Celery can be stewed in milk or brown sauce, or served au gratin. Sea kale and asparagus are usually served with melted butter but may be served with sauces, mayonnaise, etc. All white vegetables may be made into soup by passing through a sieve, thickening and mixing with milk.

Potatoes. — There are innumerable ways of cooking potatoes but for most potato dishes they must be first plain boiled. To boil in their skins, clean thoroughly and place in boiling salted water. Simmer until tender (about 30–40 min.; but see note in FOOD PREPARATION on boiling at high altitudes) ; drain off the water and allow them to steam in the pan for five minutes with the lid on. Remove the lid, allow the steam to escape for a few seconds and use as required.

To bake potatoes bake them in their skins or peel and put in a baking dish with sufficient fat to keep them from burning and place under a piece of roasting meat so that the fat from the meat can drip onto them and so keep them moist while cooking.

Mashed potatoes are plain boiled or steamed, mashed with butter and milk, and then beaten with a wooden spoon until creamy. Potatoes may be fried either in a frying pan or in a pan of deep fat. Before frying thoroughly dry; then after slicing cut into strips or fancy shapes. To cream potatoes for vegetarian dishes add eggs, cream or sauce to mashed potatoes and bake or steam as a soufflé.

VEGETABLE MARROW, a form of Cucurbita *pepo*, the fruit of which is popular, in the immature state, as a vegetable in Europe and the United States. Related to the pumpkin, this form of C. *pepo* is called summer squash in the U.S. *See* SQUASH. (V. R. B.)

VEGETARIANISM. The word vegetarian comes from the Latin *vegetus*, meaning "whole. sound, fresh, lively" and was formed in 1842 with the meaning: "one who abstains frorn the use as food of flesh, fish and fowl. with or without the addition of eggs and dairy produce."

The practice of vegetarianism is old and has been a religious precept in the east for thousands of years among Jains, some Hindu sects. Zoroastrians. Buddhists and others. Among those who in the past have advocated a fleshless diet were Buddha. Asoka. Pythagoras. Plato, Plutarch, Ovid, Seneca. Diogenes. Origen. Tertullian. John Chrysostom, Clement of Alexandria, Milton, Pope, Shelley, Voltaire, Rousseau, Thoreau. Tolstoy, Wesley. Swedenborg, Isaac Newton. William Booth. F. B. Kellogg. Gandhi and G. B. Shaw. Some religious and philosophical groups still advocate vegetarianism. They include the Order of the Cross. Mazdaznans, Seventh-day Adventists and some Catholic orders (*e.g.*, Trappists).

The vegetarian movement in Britain started in 1809, near Manchester. when members of the Bible Christian Church, Salford, pledged themselves to abstain from flesh-foods. In 1871 41 members emigrated to the United States and founded a similar religious group at Philadelphia, Pa. The first secular organization was established at Manchester in 1847 (mainly bv members of the Bible Christian Church) and was named the Vegetarian society, and it is irom this parent society that all others owe their inception. The London Vegetarian society assumed independence in 1888 and operates as a second national society with the Vegetarian society, which in 1956 had 4j affiliated societies in Britain. During World War II 120,000 persons in Great Britain registered with the ministry of food as vegetarians. The International Vegetarian union was founded in 1908 and. with its 30 affiliated national societies, holds biannual congresses in different countries. The Vegan society was formed in 1944 by a small minority of vegetarian purists, known as Vegans, who believed that no animal products should be included in the diet, but that it should consist solely of fruit. nuts, grains and vegetables.

The early pioneers of vegetarianism based their way of life on ethical principles, though the accumulation of supporting medical and scientific data concerning nutrition. metabolism, vitamins. etc., has tentlrd to shift the emphasis toward the attainment and maintenance of health. The main arguments used in favour of vegetarianism are:

1. Ethical. — It is held that life is sacred, not necessarily in a religious sense? hut that all living creatures should have the right to enjoy life without exploitation and unnecessary pain and fear. If it is accepted that the purpose of human life is spiritual development, then, it is argued, the same should apply to all living creatures and their life span should not be deliberately cut short.

2. Physiological. — Certain characteristics common to all carnivores are absent in man, such as a short bowel for rapid expulsion of highly toxic substances, the lack of sweat pores, specially developed teeth and claws for bringing down living prey.

3. Aesthetic. — The processes of slaughter and of eating flesh on the way to decomposition are considered revolting and barbaric. The eating of flesh causes certain individuals to follow degrading trades in the slaughterhouse and butcher's shop since, it is claimed, the killing of animals and handling of meat can only breed callousness and irreverence for life.

4. Nutrition. — Protein obtained from dead animals has certain disadvantages. Toxic wastes, including uric acid, are present from blood and tissue, as also are dead and virulent bacteria, not only from putreiactory processes, but from animal diseases such as tuberculosis, foot and mouth, contagious abortion, swine fever, cancer tumours, etc. Similarly, meat contains serums and vaccines injected into cattle and meat animals against prevalent diseases. Protein obtained from nuts, pulses, grains and dairy produce is claimed to be relatively pure as compared with beef with a 56% impure water content. It is pointed out that the vegetable kingdom is the richest source of all necessary elements, minerals, carbohydrates and vitamins; and is the source from which herbivorous animals of immense strength and endurance obtain their food.

5. Health. — Vegetarians believe that a meatless diet is more health-

giving than one which includes deleterious substances. Flesh, an end product, breaks down by putrefaction whereas vegetarian food is digested by processes of fermentation involving quite different types of intestinal flora. Failure of eliminatory organs to deal with excess toxic material leads to ill-health and disease; irritants may cause cancer, which is unknown in, for example, the vegetarian Hunza tribe. Vegetarian athletes have achieved distinction out of all proportion to their numbers. "Nature cure" treatments are based on the remedial qualities of a raw food diet preceded by a short fast.

6. Economics.—There is in the world about one acre to each person of land that is capable of producing food, and a meat eater requires two acres Therefore, it is alleged, he takes more than his fair share A vegetarian requires only three-quarters of an acre for his food; thus vegetarianism is put forward as a solution to food problems caused by rapidly increasing populations

Vegetarians have led the demand for wholesome food. This includes the growing of fruit and vegetables by organic methods (composting) and not by havina recourse to chemical fertilizers and poisonous sprays and systemic insecticides. Whole-grain bread without toxic "improvers" and unprocessed foods are preferred to those demineralized and devitalized by milling, refining, canning, preserving and colouring with chemicals.

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(G. L. R.)

VEGETATIVE REPRODUCTION: see Plant Propagation.

VEGETIUS (Flavius Vegetius Renatus) (4th century A.D.), military writer. His treatise. commonly called De re *Militari* or *The Military Institutions of the Romans*, was a compilation from ancient sources. Vegetius was not a practical soldier and did not realize that the military reform and revival of the ancient organization of the legion he proposed had become impossible because of the evolution of warfare. By one of the strange mutations of history, when later the crossbow and gunpowder deprived cavalry of its shock power, the tactics of Vegetius became ideal for armies, and his work became a military bible for European soldiers for hundreds of years.

In manuscript. Vegetius' work had a great vogue. In the middle ages his rules of siegecraft were much studied. and during and after the Renaissance the sections dealing with training and tactics were indispensable. His work was translated into English, French and Bulgarian before the invention of printing. An English version was published by Caxton in 1489, and *The Military Institutions of the Romans* was included in T. R. Phillips' Roots of Strategy (1940), with brief critical introduction.

VEII, an ancient town of Etruria. Italy, situated about 10 mi. N. by W. of Rome by road. It is mentioned in the earliest history of Rome as a constant enemy, being the nearest Etruscan city to Rome, but the site was occupied in the Villanovan period, remains of huts having been found on the acropolis as well as numerous tombs. The story of the slaughter of the Fabii. who had encamped in the territory of Veii (perhaps in an effort to cut the communications of Veii with Fidenaej and of whom but one boy escaped, is well known (Livy, ii, 50). After constant warfare, the last war (the 14th, according to the annalists) broke out in 406 B.C. The Romans laid siege to the city, and after a ten years' siege, M. Furius Camillus took it by storm in 396, by means, so we are told, of a tunnel leading into the citadel. According to the legend, the emissarium of the Alban lake was constructed in obedience to the Delphic oracle, which declared that, until it was drained, Veii could not be taken. The captured territory was made into four new rustic tribes. Tradition says that after the defeat of the Romans at the Allia in 390 B.C., a project was broached for abandoning Rome for Veii, which was successfully opposed by Camillus. Veii is spoken of by Propertius as almost deserted, but Augustus founded a municipality there, inscriptions of which have been found down to the time of Constantius.

Veii was reached by branch roads from the Via Clodia. The site is characteristic — a plateau, the highest point of which is 407 ft. above sea level, divided from the surrounding country by deep ravines and accessible only on the west, where it was defended by a wall and fosse. Remains of the city walls, built of blocks of tufa 2 ft. high, may be traced at various points in the circuit. The area covered measures about 1 sq.mi. and it was thus only second to Rome in size among the cities in the neighbourhood.

Etruscan houses and temples (one dating from the 6th century B.C., with three cellae) have been discovered at Veii. The most famous of the Etruscan tombs is the Grotta Campana, which contains paintings on the walls with representations of animals, among the earliest in Etruria. One of the numerous Etruscan inscriptions confirms the existence in Veii of the gens Tolumnia, which gave a king to the city *c.* 430 B.C. Toward the end of the 6th century B.C. a sculptor from Veii, Vulca, provided statues for the temple of Jupiter Capitolinus in Rome; a terra-cotta statuette of Apollo discovered at Veii in 1916 and other important fragments of archaic sculpture may have come from his atelier. The forum of the Roman municipium stood on the west side of the plateau; a statue of Tiberius (now in the Vatican) and the 12 Ionic columns now decorating the western side of the Piazza Colonna in Rome were found there. (T. A.; X.)

VEIN. A vein (geological) is a deposit of mineral matter sheetlike in form and usually following a zone of fracturing in the rocks. It may consist of one or of many minerals, either valuable or worthless. Veins carrying the metals or their 'compounds are of great industrial importance.

Veins were deposited from underground solutions that easily circulated along the fractures and penetrated the pores of the rocks. Deposition of the vein minerals was often accompanied by a dissolving of rock minerals. Valuable mineral veins are commonly several thousand feet in length and a few feet to a few yards in width. (E. S. Ba.)

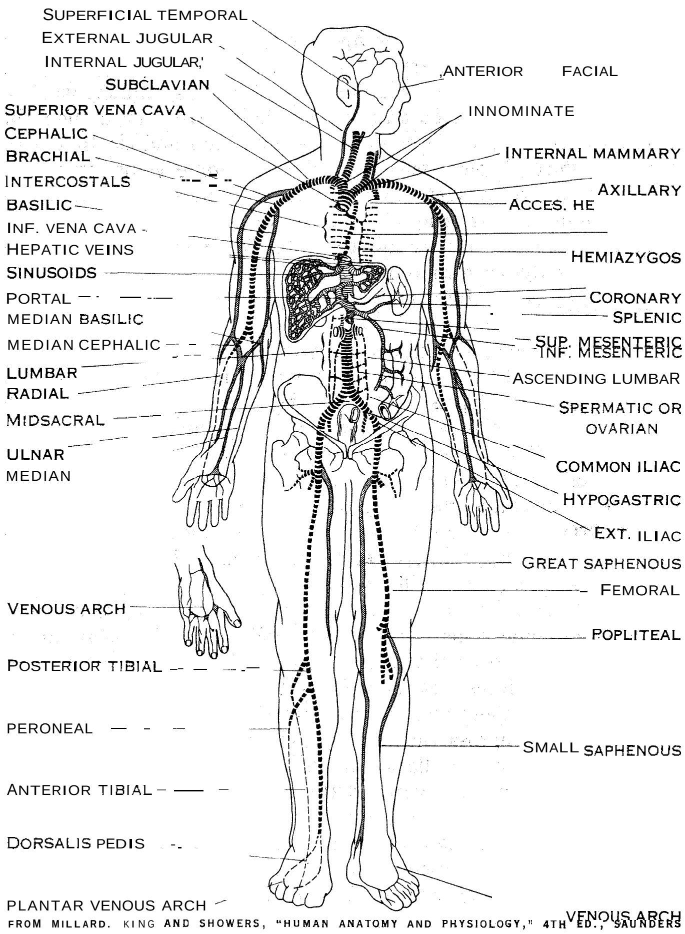
VEINS, in the anatomy of animals, are blood vessels that return the blood from the capillaries toward the heart. They begin as tiny venules, which join together to form larger and larger trunks as they approach the heart. In man and other mammals three venous systems are recognized: (1) the general venous system; (2) the pulmonary system; and (3) the hepatic portal system.

Apart from vessels related to specific internal organs, there are superficial and deep veins. The former lie in the superficial fascia and are often visible through the skin. They are usually accompanied by lymphatic vessels though not as a rule by arteries, and, sooner or later, they empty their blood into the deep veins, often passing through special openings in the deep fascia to do so. The deep veins usually accompany arteries, and are often enclosed in a common sheath; they are therefore known as companion veins (venae comites). With small and medium-sized arteries there are two of these companion veins, one on each side: connected by occasional cross communications; large arteries have only one companion vein.

The following account refers to the vessels as they occur in man (fig. 1).

Veins of the Head and Neck.—In the scalp and face the superficial veins follow the very tortuous route of their corresponding arteries more or less closely in order to drain effectively the areas served by the arteries. The deep veins run a comparatively straight course. Frontal, superficial temporal, posterior auricular and occipital veins are found in the scalp, their names indicating the areas they drain. Like all other superficial veins, they anastomose freely and also at certain places communicate, through foramina (openings) in the skull! with the intracranial blood sinuses; these communications are known as emissary veins, and act as safety valves to the sinuses. The frontal vein on the forehead passes down on the inner side of the eyelids, where it is known as the angular, and then becomes the facial vein, which runs down to an inch in front of the angle of the jaw, whence it passes into the neck to join the common facial. In the greater part of its course it lies some distance behind the facial artery itself.

The superficial temporal vein runs down in front of the ear, where it joins the maxillary vein from the pterygoid plexus and so forms a common trunk that passes down, embedded in the parotid gland, to about the angle of the jaw. Here it divides into



FROM MILLARD. KING AND SHOWERS, "HUMAN ANATOMY AND PHYSIOLOGY," 4TH ED., SAUNDERS (1956)

FIG. I. — DIAGRAM OF THE HUMAN VENOUS SYSTEM
(Solid lines indicate superficial veins)

an anterior branch. which joins the facial vein to form a common stem. and a posterior branch. which receives the posterior auricular vein and becomes the external jugular.

The external jugular vein is easily recognized through the skin on the side of the neck; it eventually pierces the deep fascia above the middle of the clavicle to join the subclavian vein. The occipital vein sinks deeply into the back of the neck and so forms the beginning of the vertebral vein.

The intracranial venous sinuses lie betneen two layers of the dura mater (see MENINGES AND CEREBROSPINAL FLUID) and differ from the veins in having fibrous walls that do not contract or expand. The superior sagittal sinus runs along the upper margin of the falx cerebri (*see* BRAIN), nhile the inferior sagittal sinus runs along the loner margin; these drain the surface of the brain. and the blood passes backward in both. Where the falx meets the tentorium cerebelli. the inferior sagittal sinus receives the great cerebral veins from the interior of the brain and then passes backward as the straight sinus to join the superior sagittal sinus at the internal occipital protuberance.

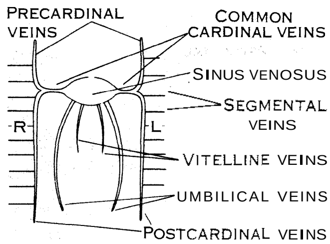


FIG. 2.—DIAGRAM OF THE FORMATION OF THE VENOUS SYSTEM IN THE FIRST STAGE

The meeting place here is known as the confluence of the sinuses, and from it the blood passes outward and downward through the right and left transverse sinuses, nhich groove the cranium, until they reach the posterior lacerated foramina, through which they pass to form the beginning of the internal jugular veins.

Most of the blood from the base of the brain passes into the cavernous sinuses, which lie in the middle cranial fossa. one on each side of the hypophyseal fossa. These receive the ophthalmic veins from the orbit in front and, after running backward for about an inch, divide into the superior and inferior petrosal sinuses, the former of which joins the transverse sinus within the cranium; the latter runs to the posterior lacerated foramen, after passing through which it joins the transverse sinus, which is now becoming the internal jugular vein.

The internal jugular vein thus formed runs down at first behind and then to the outer side of the internal and common carotid arteries and at the root of the neck joins the subclavian vein of its own side to form the innominate (or brachiocephalic j vein. In its course down the neck it receives the common vein from the face and tributaries from the tongue, pharynx, larynx and thyroid body. The deep veins of the head and face tend to form plexuses rather than venae comites; among these. pterygoid, pharyngeal and basilar plexuses are recognized.

Veins of the **Upper** Extremity. — On the back of the hand and in front of the wrist, superficial venous plexuses are easily seen through the skin. From these and others on the palmar surface the blood passes up the forearm chiefly on its flexor surface by the basilic and cephalic veins and their tributaries. Just below the bend of the elbow the cephalic vein communicates with the deep veins and then gives off the median cubital vein, which passes across and joins the basilic; it is the vein from which patients are usually bled. After this junction the common vessel is continued up the inner side of the arm as the basilic, which pierces the deep fascia about the middle of the arm and in the axilla becomes the axillary vein. which lies on the inner side of its artery. Continuing above the level of the elbow. the cephalic vein runs up the outer side of the arm and, a little below the clavicle. passes through the clavipectoral fascia to enter the upper part of the axillary vein. At the outer border of the first rib the axillary vein becomes the subclavian. which lies in front of and below its artery and is separated from it by the anterior scalene muscle. The arrangement of the superficial veins, especially in front of the elbow, is liable to great variation.

Veins of the Lower Extremity. — The superficial veins of the lower extremity begin in a venous arch on the dorsum (the word dorsum means "back." and hence any part corresponding to the back or upper side) of the foot.

From the inner extremity of this the great saphenous vein runs up, in front of the inner ankle, along the inner side of the leg, and. passing behind the inner side of the knee. continues up the thigh. gradually working forward until it reaches the saphenous opening in the deep fascia of the thigh a little below the spine of the pubis. Here it pierces the deep fascia (fascia lata) to enter the femoral vein. In this long course it has many valves and receives numerous tributaries. From the inner end of the dorsal arch of the foot the small saphenous vein runs up behind the outer ankle along the midline of the calf to pierce the deep fascia in the popliteal space behind the knee and open into the popliteal vein. Among the deep veins, venae comites occur as tibial vessels; they unite to produce the popliteal in the region of the knee and then the femoral of the rest of the thigh and groin.

Veins of the Abdomen. — The femoral vein. after passing deep to the inguinal ligament, becomes the external iliac. which runs along the brim of the true pelvis and, after a course of some three inches, joins the internal iliac (or hypogastric). which drains the pelvis, and so forms the common iliac vein. In front of the body of the fifth lumbar vertebra the common iliac veins of the two sides unite to form the inferior vena cava, a very large trunk which runs up on the right of the abdominal aorta to an opening in the diaphragm (*q.v.*). On its way it receives lumbar veins from the body wall. testicular or ovarian veins from the genital glands. renal veins from the kidneys and vessels from the right adrenal gland and the diaphragm. Before reaching the diaphragm it lies in a groove in the back of the liver and receives the hepatic veins from that organ. The hepatic portal system which lies in the abdomen is discussed below,

Veins of the Thorax. — The inferior vena cava. after piercing the diaphragm. has a very short thoracic course and opens into the lower and back part of the right atrium of the heart. The right and left innominate veins are formed behind the sternal end of the clavicle by the union of the subclavian and internal jugulars of their own side. The left vein is much longer than the right. and runs nearly horizontally behind the upper half of the manubrium sterni to join its fellow on the right side of that bone just below the first rib. By the junction of these the superior vena cava is formed, which runs down to the right atrium of the heart. The chief tributaries of the innominate veins are the vertebral, the internal thoracic (or internal mammary) and the inferior thyroid.

The intercostal veins open into the azygos system of veins, which begins in the abdomen by (1) a continuation of the ascending lumbar, a vertical trunk which joins together the lumbar veins, or (2) sometimes on the right side by a communication with the inferior vena cava. The right azygos vessel is known as the vena azygos and passes through the aortic opening of the diaphragm. Entering the thorax, it runs up in front of the thoracic vertebrae, and to the right of the aorta and thoracic duct, and receives the intercostal veins of the right side. At the level of the fourth thoracic vertebra it arches forward to open into the posterior surface of the superior vena cava.

On the left side, the upper intercostal veins join to form the left highest intercostal vein, which commonly opens into the left innominate. Lower down the intercostal veins, from the fourth to the seventh spaces, form the accessory hemiazygos vein, which runs down on the left of the spinal column and, crossing it about the level of the eighth or ninth thoracic vertebra, opens into the vena azygos. The lower intercostal veins on the left side join the hemiazygos vein, which runs up and opens either into the accessory hemiazygos or into the azygos proper, below the opening of that vein.

Pulmonary Venous System.—The pulmonary veins emerging from the lungs bring back the oxygenated blood from those organs to the left atrium and ventricle of the heart, and also the greater part of the blood carried by the bronchial arteries to nourish the lungs. Bronchial veins return blood from the larger bronchi and drain it into the azygos system. There are three pulmonary veins coming out of the right lung, while on the left there are only two. On the right side, however, two of the three veins usually unite in the root of the lung, so that there are, as a rule, two pulmonary veins entering the left atrium of the heart on each side, but it is not uncommon to find three on the right side or one on the left. The pulmonary veins have no valves.

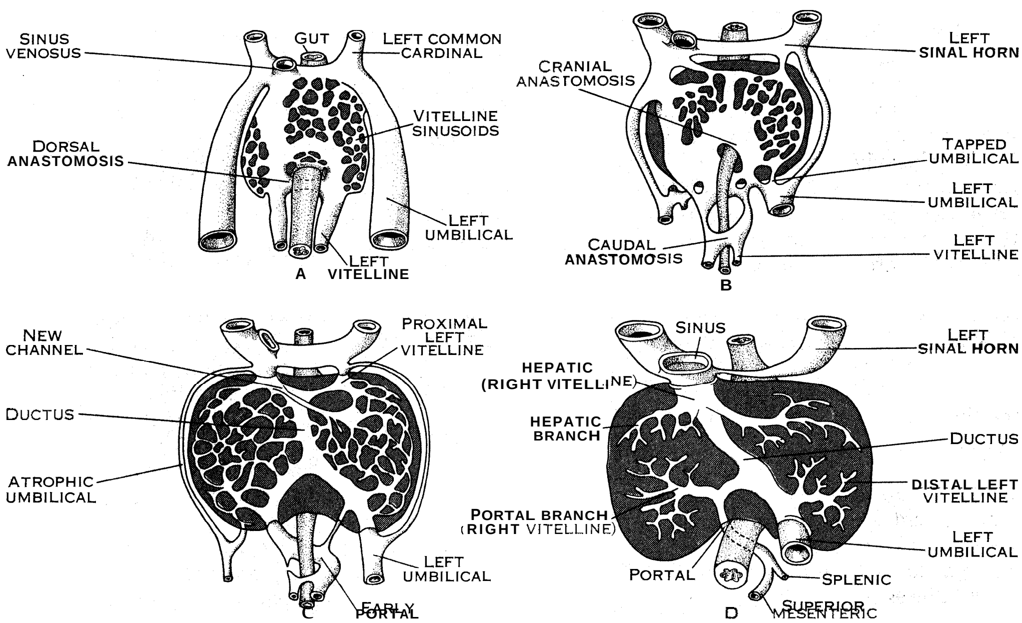
Hepatic Portal System.—The veins that drain the blood from the stomach, intestines, spleen and pancreas unite to form a large vein that begins behind the head of the pancreas and ends by dividing into right and left branches in the porta of the liver. This is the portal vein. which lies in front of the inferior vena cava and is about three inches long. Its chief iormative tributaries- are the superior and inferior mesenteric and the splenic veins. There are two marked characteristics of the portal system; one is that it has no valves and the other that it begins and ends in capillaries, since the two terminal branches of the portal vein branch and rebranch in a complex manner as described in the article LIVER. In the lower part of the rectum the veins discharge partly into the portal and partly into the general system, and in this dependent position they are liable to become varicose and to form hemorrhoids.

Structure of Veins.—The histology of veins follows the same general plan as that for arteries (see ARTERIES). The wall of the tube is composed of three similar coats. but it is thinner, weaker, more loosely constructed and more variable from type than the corresponding artery. It contains less muscular and elastic tissue, whereas white fibrous tissue is in excess. Some veins. especially those of the appendages, bear valves, and these are commonest where tributaries come in. The lining of a vein is folded to produce such pockets, usually in pairs. Their cavity, so formed, fills with blood only when there is backflom.

Embryology.— Human embryos three millimetres long possess three sets of paired veins (fig. 2). These are: (1) umbilical veins, from the chorionic sac (future placenta); (2) vitelline veins, from the yolk sac; and (3) cardinal veins, from the body of the embryo itself. The last comprise two sets. the precardinals, which drain blood from the head region, and the postcardinals, which return blood from levels caudal (the word cauda means "tail"; hence caudal, "tailward") to the heart; both pairs unite into short, common stems, known as the common cardinals (or ducts of Cuvier). Hence three pairs of vessels open into the sinus venosus, or caudalmost portion of the primitive heart. As the heart is at first situated in the region that later will be the neck of the embryo, the precardinals receive few segmental veins and the postcardinals many.

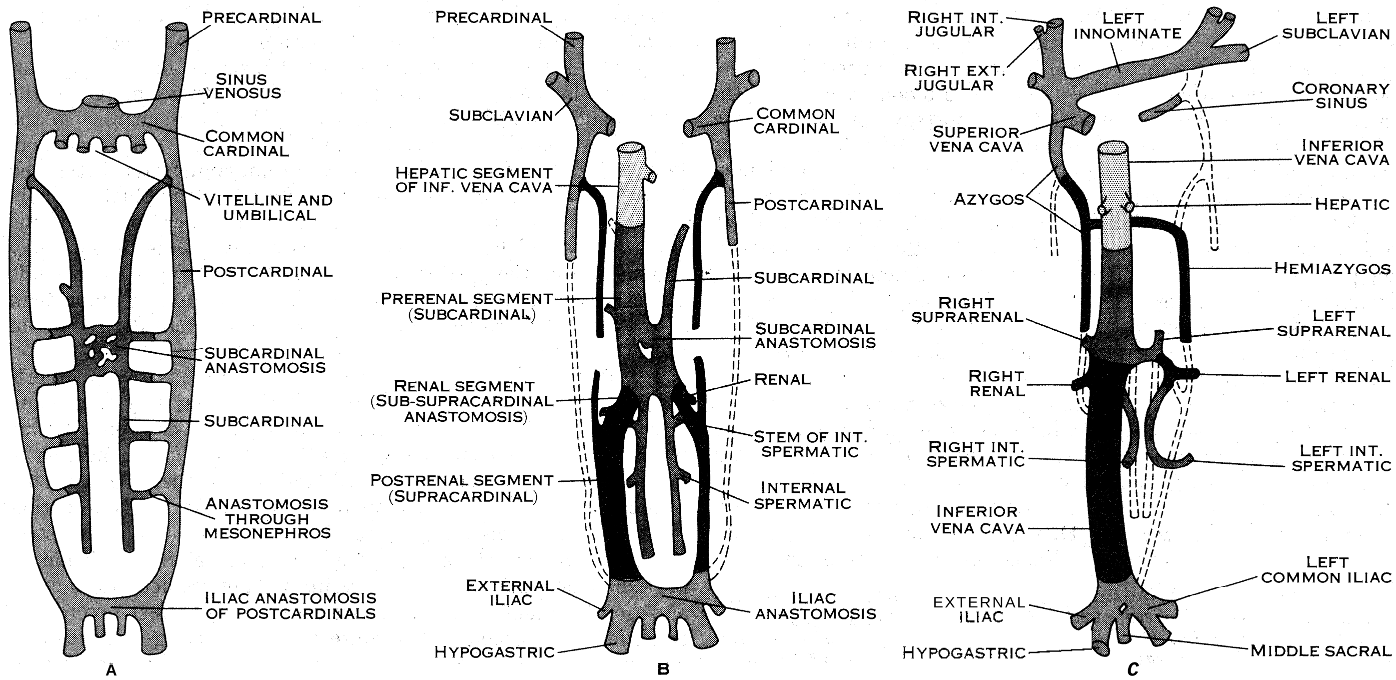
As the vitelline veins run from the yolk sac to the heart along each side of the primitive foregut, they pick up the mesenteric veins from the intestines as well as the splenic and pancreatic veins as soon as these viscera are formed. The liver, however, is developed right across their path, and the vitelline veins break up into a mass of capillaries in it, leaving that part of them which lies between the liver and the heart to form the primitive hepatic veins (fig. 3). While the vitelline veins are still lying on each side of the foregut (future duodenum) they are connected by three transverse channels. the anterior and posterior of which appear on the ventral side of the gut, the middle on the dorsal side (fig. 3 [A], [B]). This figure of eight does not persist. however, because the cephalic part of it on the left and the caudal part on the right become obliterated, and what is left forms the portal vein (fig. 3 [C]).

The two umbilical veins unite between the placenta and the umbilicus, and soon all the blood from the placenta passes through the left one aithin the body, the right becoming rudimentary. The left umbilical vein on reaching the liver now joins the left branch of the portal vein and establishes a new communication



FROM AREY, "DEVELOPMENTAL ANATOMY," SAUNDERS (1954)

FIG. 3.—TRANSFORMATION OF THE HUMAN VITELLINE AND UMBILICAL VEINS IN THE REGION OF THE LIVER. SEEN IN VENTRAL VIEW (A, B AND C AT ABOUT FOUR WEEKS: D AT FIVE WEEKS)



FROM AREY, 'DEVELOPMENTAL ANATOMY," SAUNDERS (1954)

FIG. 4.— DIAGRAMS OF THE TRANSFORMATION OF THE PRINCIPAL HUMAN VEINS FROM THE EARLY EMBRYONIC CONDITION (A AT SIX WEEKS; B AT EIGHT WEEKS; C, ADULT)

with the left hepatic vein. This is the ductus venosus (fig. 3 [B], [C]), and, as soon as it is formed, most of the blood returning from the placenta bypasses the liver capillaries. After birth the pulmonary circulation becomes established and the ductus venosus and umbilical vein convert into ligamentous cords (ligamentum venosum; ligamentum teres).

As the heart moves from the neck into the thorax the precardinal veins elongate and become the internal jugulars in the greater part of their extent. When the arms begin to bud out, subclavian veins are developed (fig. 4 [B]) and an oblique connecting vein (fig. 4 [C]) is established between the point of junction of the left subclavian with the left precardinal and the caudal part of the precardinal of the right side. This connection becomes the left innominate vein. while the caudal part of the left precardinal persists as the highest intercostal vein (fig. 4 [B]). On the right side that part of the precardinal between the subclavian and the junction with the left innominate becomes the right innominate, while the caudal part of the right precardinal and the right common cardinal become the superior vena cava (fig. 4 [B]). The external jugulars are later, secondary formations.

The right and left postcardinal veins receive the intercostal and lumbar segmental veins and are continued into the lower limbs as the common iliac veins (fig. 4), the primitive blood path from the thighs. The veins from the primitive kidneys open into the segmental veins. and when the permanent kidney (metanephros) is formed a large renal vein on each side is established (fig. 4 [B, C]).

Little of this postcardinal set of veins is retained when the unpaired inferior vena cava becomes dominant. The origin of the inferior vena cava is multiple (fig. 4 [B. C]). Its components are as follows: (1) a hepatic segment, derived from the hepatic vein and a caudal extension from it; (2) a prerenal segment, derived from the right member of a pair of secondary (subcardinal) vessels; (3) a postrenal segment, derived from the right member of a still different pair of vessels (supracardinals) that replace the postcardinals. The inferior vena cava, when formed, receives from both sides of the body most of the blood that previously drained into the postcardinals and subcardinals. Above the level of the kidneys, the supracardinal vessels become the azygos system of drainage.

Comparative Anatomy. — The venous system of vertebrates is much less standardized than is the arterial system, and variations are marked even among placental mammals. Vessels that become functionless. through elimination of the structures they originally supplied, either modify and adapt to the new conditions or disappear. The venous system of fishes is a primitive arrangement, with paired and symmetrical sets of veins. In the higher groups there is a progressive shift toward the right side, and hence an asymmetrical plan. The veins can be considered in four regional sets: (1) systemic veins. returning blood from most parts of the body directly to the heart; (2) a hepatic portal system, conveying blood from the digestive tract to the liver; (3) a renal portal system. carrying blood from the tail and caudal trunk to the kidneys; and (4) pulmonary veins, returning blood from the lungs to the heart. The two portal systems arose when the liver and kidneys interrupted a portion of the primitive venous return; they are characterized by vessels that arise from a capillary bed and again break down into capillaries in the liver or kidneys.

Systemic *Veins*.—In fishes, paired precardinal and postcardinal veins, respectively, serve regions headward and tailward of the heart; they reach the sinus venosus of that organ by common cardinal veins (or ducts of Cuvier). Subclavian and iliac veins return blood from the pectoral and pelvic fins, respectively. The Dipnoi (lungfishes) add a postcava (or inferior vena cava), a hich carries most of the blood directly from the caudal body and kidneys to the heart; also the vein of each lateral line in lower fishes is represented by a single, median abdominal vein. The plan in amphibians is little changed, yet subcardinal veins, beneath the kidneys, have united to produce the lower portion of a prominent postcava. In amniotes (reptiles. birds and mammals) the postcava becomes an increasingly dominant collecting vein, below the level of the heart, as the postcardinals disappear or give place to other vessels such as the azygos set. The abdominal veins of fishes, amphibians and reptiles become important during the development of reptiles birds and mammals. since they bring blood from the allantois or placenta. In placental mammals they receive the name umbilical veins; only the left one persists throughout fetal life, and it makes a short cut through the liver known as the ductus venosus. After birth the outmoded vessel fibroses into a ligamentous cord. The precardinal veins give rise to the internal and external jugular veins. In reptiles, birds and some mammals both common cardinal veins persist as precaval stems, but in other mammals, including man, all the blood for the head and forelimbs passes into the right precava, the common vessel then being known as the superior vena cava.

Hepatic *Portal System* —All vertebrates possess a hepatic portal system of veins. Vessels from the stomach-intestine and associated organs converge into a hepatic portal vein. which discharges blood into the sinusoids of the liver. The blood then leaves the liver in hepatic veins. which pass to the postcava or to the heart.

Renal Portal System. — Blood from the tail of fishes and from the tail and caudal trunk of amphibians is shunted to the kidneys (mesonephroi) by paired vessels, formed by the forking of the caudal vein and then knonn as renal portal veins. The capillary bed of the kidneys, in turn, connects with the postcardinals or the postcava, as the case may be, so that the detoured blood eventually reaches the heart. This system is incompletely represented in reptiles. whereas in birds and mammals it is wholly lacking: this abandonment is correlated nith the development of a different kind of kidney (metanephros).

Pulmonary Veins — Lungs and pulmonary veins occur first in dipnoid fishes and are constant features of all higher groups. In every instance the blood reaches either the left atrium or the left side of a single or partly partitioned atrium. See ARTERIES; BLOOD VESSELS. SURGERY OF: CIRCULATION OF BLOOD; CIRCULATORY SYSTEM; HEART, ANATOMY OF; HEART, COMPARATIVE PHYSIOLOGY OF. See also references under "Veins" in the Index volume.

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VEINS, DISEASES OF. The veins of the body can be affected by a number of different conditions, including inflammatory, obstructive and degenerative abnormalities. The clinical manifestations of these disorders depend upon the location of the involved vessel and its role in returning blood to the heart.

In inflammation of a vein, called phlebitis (*q.v.*), the process affects all layers of the mall of the vessel. If it continues for some time, there mill usually be enough irritation of the inner lining (intima) of the vein to result in the deposition of various elements in the blood and subsequently the production of a clot locally (thrombus). The condition is then called a thrombophlebitis. If the initial change is a clot, there generally follows an inflammatory response in the vessel wall at the point of contact.

Thrombophlebitis in the extremities is a relatively common occurrence. If the process is located in a vessel under the skin (superficial vein), the condition is relatively innocuous and the clinical course and complications are of minor consequence. The reason for this is that there are many superficial veins, and obstruction of one or even several does not interfere with drainage of blood from the limb and into the main veins emptying into the right side of the heart. Therefore, the only untoward effects in such a condition are noted locally in the site of involvement.

The patient first notices a tender, red and warm area on the limb, which becomes painful on walking or on stretching the inflamed tissues. Examination reveals an elevated temperature in the site and a tender cordlike mass under the skin. As the condition subsides, the signs of inflammation disappear and the hard mass generally becomes smaller. At times, however, it may remain for months and even years in an unchanged state.

When the clot is situated in the small veins in the muscles of the calf and foot or in the main deep venous channels through which the blood from the extremity must pass in order to reach the heart, the outlook may be entirely different. In the case of involvement of the small deep venous channels in the muscles, the clot may be poorly attached to the interior of the vessel; as a result. portions of it may break off and become liberated in the blood stream, eventually reaching the blood vessels in the lungs and obstructing them. This complication (pulmonary embolism) may be very serious since it can produce death of lung tissues (pulmonary infarction), a condition typified by cough, expectoration of bloody sputum and pain in the chest, exaggerated on taking a deep breath (pleuritic type). Since the veins involved in this type of process are not particularly important in the removal of blood. the local findings in the limb are minimal and the diagnosis frequently is not made until after the changes in the lungs appear.

If the clot continues to grow upward and then enlarge to the point that it completely obstructs a main venous channel in the thigh, obvious clinical changes will be noted. This condition, known as milk-leg (deep iliofemoral thrombophlebitis). is typified by the appearance of smelling of the foot, leg and thigh. pain in the groin on the involved side and along the inner portion of the thigh, fever and loss of appetite. Although pieces of clot may break off from the portion obstructing the main vein (to occlude vessels in the lungs), this complication is much less common than in the case in which the clot originates in the small deep veins in the leg and foot.

In the early stage of thromboangiitis obliterans, or Buerger's disease (*q.v.*), primarily a disorder of the arterial system. clots may be noted in small portions of superficial veins on all four limbs, more marked on the lower extremities. This condition is typified by the presence of small, red and tender masses, surrounded by an area of inflammation of the skin Examination over the site reveals the presence of short, firm, cordlike masses.

The inflammatory condition appears to travel from portion to portion of the same and different veins in an unpredictable manner. and from one limb to another. At times it may affect several extremities simultaneously. Because of these fleeting qualities and because the disorder is noted only in those veins on the surface oi the extremity, it has been called superficial migratory thrombophlebitis.

Relatively rarely veins show degenerative changes. Among these is deposition of calcium, usually in the middle or muscle coat of the vein. The process may be present throughout the length of the vessel or may be localized in the form of small beady masses (phleboliths). This type of change can be seen on X-ray examination. It has no clinical significance with regard to the efficiency of the venous circulation. Veins may also show signs of increased deposition of fibrous tissue in the muscle coat. As a result, the vessels become much firmer to touch but are not dilated. See also ARTERIES, DISEASES OF; THROMBOSIS AND EMBOLISM. (D. I. A.)

VEIOVIS, a Roman god of uncertain attributes. His name is connected with that of Jupiter (Iovis), but there is little agreement as to its meaning: he may be a "little Jupiter" or a "sinister Jupiter" or "the opposite of Jupiter", *i.e.,* a chthonian god. The last seems most likely from the offering of a goat *humano* ritu (*i.e.,* either on behalf of the dead or in place of a human sacrifice). (R. B. LD.)

VELÁZQUEZ (VELÁSQUEZ), **DIEGO RODRÍGUEZ DE SILVA** (1599–1660), the most important of Spanish painters and one of the world's greatest artists. was born in Seville and baptized on June 6, 1599.

The principal source of information about Velázquez' early career is a treatise by his master and father-in-law Francisco Pacheco (Arte de la *pintura*, 1647). The first complete biography of Velázquez appeared in El Parnaso *español* by Antonio Palomino (*Museo pictórico*, vol. iii, 1724), based on notes by the artist's pupil Juan de Alfaro. The number of personal documents is very small; the official ones relating to his paintings are relatively few and as he seldom signed or dated his works their identification and chronology has often to be based on stylistic evidence alone. Though many copies of his portraits were evidently made in his studio by assistants, his own production was not large and his surviving autograph paintings probably number less than 1jo. He is knonn to have norked slowly, and during his later years much of his time was occupied by his duties as court official in Madrid.

Velazquez' European fame dates from the beginning of the 19th century. when many of his early Sevillian paintings were acquired by foreign (chiefly English) collectors and most of his later official works, which had remained in the royal collection, were incorporated in the Prado museum, Madrid.

Seville: Training and Early Production. — According to Palomino. Velizquez' first master was for a short time Francisco de Herrera the Elder. In 1611 he was formally apprenticed to

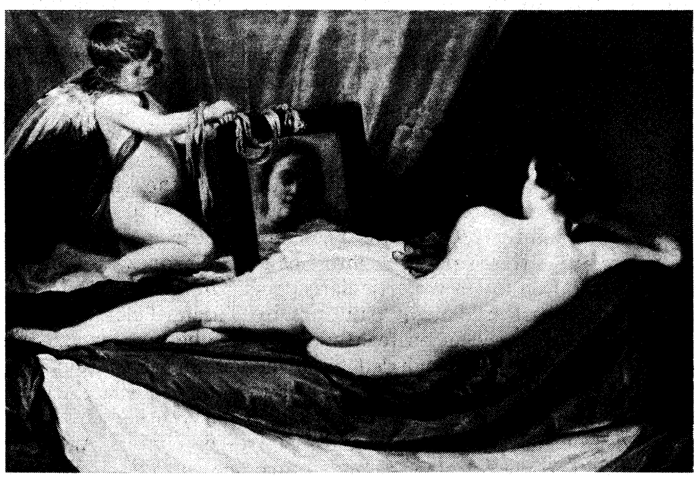
Francisco Pacheco, whose daughter he married in 1618. "After five years of education and training." Pacheco writes, "I married him to my daughter, moved by his virtue. integrity and good parts and by the expectations of his disposition and great talent." Although Pacheco was himself a mediocre mannerist painter, it was through his teaching that Velázquez developed his early naturalistic style. "He worked from life." writes Pacheco. "making numerous studies of his model in various poses and thereby he gained certainty in his portraiture." The strong modeling and sharp contrasts of light and shade of Velázquez' early illusionistic style closely resemble those of Caravaggio, and it is reasonable to assume that he had seen paintings by Caravaggio or his followers. Velázquez' early subjects were mostly religious or genre and he popularized a new type of composition in Spanish painting, the *bodegón* (a kitchen scene with prominent still life). based on northern prototypes, sometimes with religious scenes in the background, as in "Christ in the House of Martha" (National gallery, London) and "Christ at Emmaus" (Sir Alfred Beit collection, Russborough, Ire.). The "Adoration of the Magi" (Prado), dated 1617 or 1619, is one of the few Sevillian paintings of Velázquez that have remained in Spain.

Madrid: **Appointment** as Court Painter. — In 1622, a year after Philip IV came to the throne, Velizquez visited Madrid for the first time, "desirous of seeing the Escorial," according to Pacheco. and also in the hope of obtaining royal patronage. He painted a portrait of the poet Luis de Góngora (Museum of Fine Arts, Boston), but there was no opportunity of portraying the king or queen. In the following year he was recalled to Madrid by the prime minister Count Olivares. a fellow townsman of Velázquez and a future patron, and soon after his arrival he painted a portrait of Philip IV which won him immediate success. He was appointed court painter with a promise that no one else should portray the king. Pacheco describes an equestrian portrait of Philip (lost) painted soon afterward. "all taken from life, even the landscape"; the portrait was exhibited publicly "to the admiration of all the Court and the envy of members of the profession." The envy of fellow artists who accused Velázquez of only being able to paint heads is said by his friend Jusepe Martinez to have been the occasion of the king ordering him to paint a historical subject, the "Expulsion of the Moriscos" (lost), in competition with other court painters. Velázquez was awarded the prize and the appointment of gentleman usher (1627). Though he continued to paint other subjects, as court painter he was chiefly occupied in portraying members of the royal family and their entourage, and he painted numerous portraits of Philip IV during the course of his life. "The liberality and affability with which he is treated by such a great monarch is unbelievable!" writes Pacheco; "he has a workshop in his gallery and His Majesty has a key to it and a chair in order to watch him painting at leisure, nearly every day."

Velázquez' position at the court gave him access to the royal collections, rich in paintings by Titian. who was to have more influence than any other artist on the development of his style. The full-length portraits of Philip and his brother the Infante Don Carlos (Prado) are in the tradition of Spanish royal portraits established by Titian and are to some extent influenced by his style. The detailed description and dramatic tenebrism of Velázquez' Sevillian paintings has become modified; only the faces and hands are accentuated and the dark figures stand out against a light background. In his later court portraits Velázquez was to adopt something of the more elaborate décor and richer colouring of Rubens, whom he met during the latter's second visit to the Spanish court in 1628. Pacheco tells how Rubens praised Velázquez' works very highly because of their simplicity. Velázquez' painting of Bacchus, known as "Los Borrachos" ("the Topers"; Prado), seems to have been inspired by Titian and Rubens, but his realistic approach to the subject is characteristically Spanish and one that Velázquez was to preserve throughout his life.

Italy: First **Journey.**—Velázquez' visit with Rubens to the Escorial is said by Palomino to have aroused his desire to go to Italy. Having obtained leave and two years' salary from the king, and money and letters of recommendation from Olivares, he sailed from Barcelona to Genoa in Aug. 1629. In letters from Italian ambassadors in Madrid he is referred to as a young portrait painter, favourite of the king and Olivares. who was going to Italy to study and to improve his painting, and the visit was in fact to have an important effect on his artistic evolution. He stopped in Venice. where Palomino says he made drawings after Tintoretto and then hurried on to Rome Pacheco relates that he was given rooms in the Vatican palace, nhich he found very isolated. Having obtained facilities to return to the Vatican to make drawings after Michelangelo's "Last Judgment" and the paintings of Raphael, he therefore moved to the Villa Medici, which was "high and airy" and had "antique sculptures to copy." An attack of fever obliged him later to move nearer to the Spanish ambassador and after a year in Rome he returned to Spain, stopping on the nay in Naples. He arrived back in Madrid at the beginning of 1631

None of Velázquez' Italian drawings appear to have survived. Of the few paintings that he made in Italy, a "famous portrait of himself" made in Rome. mentioned by Pacheco, has probably survived only in replicas (Uffizi, Florence; Valencia museum; etc.); the portrait of Philip's sister Mary of Hungary painted in Naples is identified with an unfinished bust (Prado). The chief fruits of his Italian visit are the two "celebrated pictures" painted in Rome. which he took back to Spain and offered to the king (recorded by Palomino): "Joseph's Coat" (Chapter house. Escorial) and the "Forge of Vulcan" (Prado). These two monumental figure compositions are far removed from the limited realism in which he had been trained. As a result of his Italian studies, particularly of Venetian painting, his development in the treatment of space. perspective, light and colour and the freer technique mark the beginning of a new phase in his life-long pursuance of the truthful rendering of visual appearance.



BY COURTESY OF NATIONAL GALLERY, LONDON

"ROKEBY VENUS" BY DIEGO VELAZQUEZ. IN THE NATIONAL GALLERY, LONDON

Middle Years. — After his return to Madrid Velizquez entered upon the most productive period of his artistic career. He took up again his chief official task of portraiture, and was occasionally called upon to paint historical, religious and mythological subjects. For the decoration of the throne room of the new Buen Retiro palace. completed in 1635, Velazquez painted a series of royal equestrian portraits (now in the Prado), following a tradition that goes back in Spain to Titian's "Charles V at Mühlberg" and was continued by Rubens. Velizquez' equestrian groups have a balance and poise closer to Titian's than to Rubens' baroque compositions. and after his return from Italy he achieved a three-dimensional effect without detailed drawing or strong contrasts of light and shade. but with a broad technique and natural outdoor lighting. The "Surrender of Breda." Velázquez' famous contribution to the series of military triumphs painted for the same throne room, is his only surviving historical subject. Though the elaborate composition was based on a pictorial formula of Rubens, he creates a vivid impression of actuality and of human drama by means of accurate topographical details and the lifelike portraiture of the principal figures.

Though Velázquez frequently followed traditional compositions, particularly for his royal portraits. it was from no lack of ability to compose or invent. With his portraits of Philip IV, the Infante Ferdinand and Prince Baltasar Carlos as huntsmen (Prado), painted for the king's new hunting lodge, he created a new type of royal portrait. For the same place he painted hunting scenes of which "Philip IV Hunting Wild Boar" (National gallery, London) is possibly an example, and some mythological subjects, including probably the portraitlike figures of "Aesop" and "Menippus" (Prado). The "Coronation of the Virgin" (Prado), one of his rare religious subjects after he became court painter, was painted for the queen's oratory, about 1641–42. The series of "Court Dwarfs" (Prado), painted during the next few years, are seen with the same impartial and discerning eye as are his royal and noble sitters. while the character of their deformities is revealed through their awkward, unconventional poses, their individual expressions and by the exceptionally free and bold technique. The "Lady With a Fan" (Wallace collection, London), one of the few informal portraits of women, is, on the other hand, remarkable for the subtle and delicate painting and for the sensitive portrayal of personal charm.

Italy: Second Journey.— At the beginning of 1649 Velázquez left Spain on a second visit to Italy, this time on official business as gentleman of the bedchamber, and was given a carriage for pictures, possibly gifts from Philip to Pope Innocent X, who was to celebrate a jubilee in the following year. The chief purpose of the journey was to buy paintings and antiques for the king for the decoration of new apartments in the royal palace and also to engage fresco painters to decorate the ceilings of the apartments and to reintroduce fresco painting into Spain. Velázquez also found fresh inspiration in Italy. particularly from Titian. First he went to Venice, where he bought paintings by Titian, Tintoretto and Veronese; then he went on to Modena, where he saw the famous ducal collection which included his own portrait of the duke of Modena. painted in Madrid in 1638 (now in the Modena gallery). According to Palomino he also stopped in many other cities, including Bologna. where he visited the fresco painters Agostino Mitelli and Michelangelo Colonna to arrange to take them back to Spain, though they did not go there until 1658. Palomino recounts that on reaching Rome Velizquez was befriended by eminent prelates and artists, including Nicolas Poussin and G. L. Bernini. He gives a list of the antiques selected by Velázquez, from which it seems that he followed the tradition of great collectors since the 16th century and rather than inferior originals chose casts of the most famous statues in Rome. "Without neglecting his other business he also did many paintings" in addition to the portrait of Innocent X. Palomino relates that before portraying the pope, as an exercise in painting a head from life, Velázquez made the portrait of his mulatto assistant Juan de Pareja (earl of Radnor's collection. Longford castle, Wiltshire), an exceptional unofficial portrait, unusually boldly painted, which creates a powerful effect of familiar and living likeness.

For the portrait of Innocent X (Doria gallery, Rome), one of his most important official works. Velázquez followed a tradition for papal portraits created by Raphael and used by Titian. The powerful head: the brilliant combinations of curtain. chair and cope. the dazzling white surplice. are painted with a fluent technique and almost imperceptible brush strokes that go far beyond the late manner of Titian and announce the last stage in Velázquez' development in the direction of Impressionism. This portrait, which has always been Velázquez' most famous painting outside Spain, was copied innumerable times and won him immediate and lasting renown in Italy. In 1650 he was made a member of the Accademia di San Luca and of the Congregazione dei Virtuosi in Rome. The portrait earned for him the pope's support for his application for membership of a Spanish military order, though the difficulties arising from the fact that he was not of noble birth were so great that it was not until 1659 that he received the habit of the Order of Santiago. *(See* also PORTRAIT PAINTING: *Baroque* and *Ro-*

The two small "Views of the Villa Medici" (Prado), where Velázquez stayed during his first visit to Rome, must, for stylistic reasons, have been painted during his second visit. They are unique examples of pure landscape in his surviving work and among those of his achievements which foreshadow 19th-century Impressionist landscapes. The "Rokeby Venus" (National gallery, London) was also probably painted in Italy and is one of the few representations of the female nude in Spanish painting. The theme of the Toilet of Venus, the rich colouring and warm flesh tones are inspired mainly by Titian and other Venetian painters, though Velázquez has characteristically made no attempt to disguise or idealize his model and his Venus is exceptional for his time as a portrayal of a living nude model.

Last **Years.**—Velázquez arrived back in Madrid in the summer of 1651 with some of his purchases and was warmly welcomed by the king who, in the following year, appointed him chamberlain of the palace, an office that entailed the arrangement of the royal apartments and of the king's journeys. During his absence Philip had remarried, and the young Queen Mariana of Austria with her children provided new subjects for him to portray. For his portraits of the queen (Prado) and of the king's oldest daughter, the Infanta Maria Teresa (Kunsthistorisches Museum, Vienna), who had reached marriageable age, he used identical formulas; and numerous studio replicas of them were made. The royal ladies appear as doll-like figures with their enormous coiffures and farthingales, and the effect of form. texture and ornament is achieved in Velázquez' late manner without any definition of detail, in a free, "sketchy" technique. The portraits of the young Infanta Margarita and Prince Philip Prosper (Kunsthistorisches Museum. Vienna). similar in composition and manner, are among the most colourful of his works, and he most sensitively reveals the childlike character of his sitters behind the façade of royal dignity. Velázquez' late bust portraits of Philip IV (Prado and National gallery, London), of which many studio versions exist, are very different in character and are exceptional as royal portraits for their informal appearance. These last close-up views of the sad and aging monarch are among the most intimate of all Velázquez' characterizations.

In addition to his many royal portraits, Velázquez painted during his last years two of his most original figure compositions and greatest masterpieces, which epitomize his whole artistic achievement. The "Spinners" (Prado), a genre scene in a tapestry factory. is at the same time an illustration of the fable of Pallas and Arachne. the mythological subject—like the religious scenes in his early *bodegones*—being represented in the background. But in his late work there is no barrier between the world of myth and reality; they are united in an ingenious composition by formal and aerial perspective. In the "Meninas" ("Maids of Honour"; Prado) (1656), a more natural subject, he has created the effect of a momentary glance at a casual scene in the artist's studio while he is painting the king and queen, whose reflection only is seen in the mirror in the background, accompanied by the Infanta Margarita with her ladies-in-waiting and other attendants. In this complex composition, the nearly life-size figures are painted in more or less detail according to their relation to the central figure of the Infanta and to the source of light. creating a remarkable illusion of reality never surpassed by Velázquez or any other artist of his age.

Velázquez' last activity was to accompany the king and court to the Isle of Pheasants in the summer of 1660 to arrange the decoration of the Spanish pavilion for the marriage of the Inianta Maria Teresa with Louis XIV. Shortly after his return to Madrid he fell ill and died on Aug. 6. 1660. Though he must have had many assistants, he left few pupils or immediate followers. The naturalistic tradition in which he was trained was one of the bases of 17th-century Spanish painting, but Velázquez' later achievements go beyond those of any Spanish or other artist of his century and make him a forerunner of modern painting. The first artist in Spain on whom they had a profound influence was Francisco de Goya, and they provided an important stimulus to Edouard Manet and the French Impressionists. *Ser* also PAINTING: *Spain.*

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(1888; 2nd rev. ed. 1903; Eng. trans., *Velazquez and His Times*, 1889); A. L. Mayer, *Veldzquez: a Catalogue Raisonné of the Pictures and Drawings* (1936); E. Lafuente Ferrari, *Veldzquez* (1944); E. du G. Trapier, *Velázquez* (1948). (E. Hs.)

VELÁZQUEZ (DE CUÉLLAR), DIEGO (1465–1524), first lieutenant governor of Cuba, was born at Cuéllar, province of Segovia, Spain, in the year 1465. He arrived in Espafiola with Christopher Columbus in 1493 and became the lieutenant of Gov. Nicolas de Ovando. He was reputed to be the wealthiest man in the island, of graceful presence with fair face and blond hair, amiable in disposition and a close friend of the treasurer, Miguel de Pasamonte. Through him, Velazquez established direct connection with the crown. Under Diego Colón's order, Velizquez headed an expedition to Cuba in 1511, establishing on that island a base at Baracoa. Natives of Espafiola, escaping to Cuba, had already warned of the Spaniards and the Cubeños, bravely resisted the incursion, but the discovery of gold made the Spaniards the more eager and valiant. Early in 1513 Velázquez was married to Doña Maria, the daughter of Cristóbal de Cuéllar, but she died within a week of the nuptials. Upon teceipt of news of Velázquez' activities in Cuba, the crown made him *repartidor*, thus authorizing the encomienda system in the new colony. By Aug. 1515, the *repartidor* had founded seven cities, built warehouses, and had stocked Cuba with cattle in addition to the agricultural plantings. In 1517 he sent Fernandez Chrdova, his nephew Juan de Grijalva, and Cristóbal de Olid to Yucatan in separate expeditions to investigate the possibilities of plundering that area. The reports led him to commission Hernando Cortés, his secretary, to attempt the conquest which was begun in 1519. Velazquez had spent the greater part of his fortune in the equipment of the flotilla but before Cortés had left Cuba had lost confidence in his choice of commander. He tried in vain to halt Cortés and although he importuned the Spanish courts for aid, he lost not only the original investment but also the fleet and equipment under command of Pánfilo de Narváez with which he sought to retrieve his loss. His misfortunes were increased by his temporary removal from office as lieutenant governor of Cuba in 1521. The office of *repartidor* remained to him, however, and through it he was able to recoup his fortune. Shortly after the loss of his title of *adelantado* of Mexico he died and was buried in Santiago de Cuba, June 11, 1524.

The story of Velázquez rests largely on Bartolomé de Las Casas' *Historia de las Indias* (1875–76). In English, *see* I. A. Wright, *The Early History of Cuba 1492–1586* (1916). (R. G. RR.)

VELDE, VAN DE, a family of Dutch artists.

ESAIAS I VAN DE VELDE (*c.* 1590–1630), chiefly a landscape painter, draftsman and etcher, who was born in Amsterdam about 1590 and died at The Hague in 1630. He was among the first who changed from the romantic Flemish style to a colourful realistic vision. Also his genre pieces of elegant garden parties, etc., belong to the most modern of this type in Holland.

WILLEM II VAN DE VELDE (1633–1707), a marine painter who was born in Leiden in 1633. With his father, Willem I, also a marine painter, he settled in England in 1672. He made numerous drawings of sea fights (collection in the National Maritime museum, Greenwich)! first from the Dutch and later from the English side. Some of his paintings are exact renderings of actual sea history; others are freely composed, carefully executed calm and stormy seas. His influence on the development of English sea painting was strong. He died in London in 1707.

ADRIAEN VAN DE VELDE (1636–1672), a brilliant landscape painter, also sought after to paint figures in other artists' landscapes, was born in Amsterdam in 1636 and died there in 1672. He specialized in Italian landscapes (although it is not known whether he really visited Italy), delicately executed in brilliant colours. The figure drawings are sensitive and academic.

See K. Zoege von Manteuffel, *Die Künstlerfamilie van de Velde* (1927); C. Hofstede de Groot, *Catalogue of Dutch Painters*, vol. iv (1912) and vii (1923). (H. K. GN.)

VELDE, HENRY CLEMENS, VAN DE (1863–1957), Belgian architect and teacher, who ranks with his compatriot Victor Horta as an originator of the *art nouveau* (*q.v.*) style, was born at Antwerp on April 3, 1863. By designing furniture and interiors for the Paris art galleries of Samuel Bing in 1896, he was responsible for bringing the *art nouveau* style to Paris. However, he was not interested in the style as such, but rather in the philosophy of William Morris and the arts and crafts movement (*q.v.*) in England; and although he had studied in Paris as a painter under Carolus Duran his most vital contributions to modern design were made as a teacher in Germany, where his name became known through the exhibition of furnished interiors at Dresden in 1897.

In 1902 he went to Weimar as artistic adviser to the grand duke of Saxe-Weimar, reorganized the Kunstgewerbliches (Arts and Crafts) Institut and the Academy of Fine Art, and thus laid the foundations for Walter Gropius' amalgamation of the two bodies into the Bauhaus in 1919. Like all progressive German designers at the time van de Velde was connected with the Deutscher Werkbund, designing the theatre for the Werkbund exhibition in Cologne in 1914, but at the same time he was involved in the disputed designs for the Théâtre des Champs Elysées in Paris, later completed by Auguste Perret. In spite of his long life, and numerous official appointments in Belgium after 1918, he made no further live contributions to the progress of architecture or design, but remained, even in his last years of retirement in Switzerland, an admired and venerated living memorial to the creative vitality of the early years of the 20th century.

The extract from van de Velde's *Memoirs, 1891–1901*, published in the *Architectural Review*, 112:143–148 (Sept. 1952), gives a valuable firsthand account of his ideas and intentions.

See S. Giedion, *Space, Time and Architecture* (1949). (R. BM.)

VELEZ DE GUEVARA, LUIS (1579–1644), Spanish dramatist and novelist, was the author of more than 400 plays, of which the best known are *Reinar despues de morir* and *Más pesa el rey que la sangre*. He won considerable fame as the author of *El Diablo cojuelo* (1641), a fantastic novel which suggested to Alain Rene Le Sage the idea of his *Diable boiteux*.

VÉLEZ-MÁLAGA, a town of southern Spain, in the province of Malaga, finely situated in a fertile valley at the southern base of the lofty Sierra de Alhama, and on the left bank of the small river Vélez, 1 mi. from its mouth and 27 mi. E.N.E. by road of Málaga. Pop. (1950) 31,948 (mun). Vélez-Málaga was taken from the Moors in-1487 by Ferdinand of Castile. Under Moorish rule the citadel was built and the town became an important trading station and fortress.

VELIA, an ancient town of Lucania (Gr. *Yele*, later *Elea*), Italy, on the hill now crowned by the medieval castle of Castellammare della Bruca, 440 ft. above sea level, on the southwest coast, $1\frac{3}{4}$ mi. N.W. of the modern railway station of Ascéa, 25 mi. S.E. of Paestum. Remains of the city walls, with traces of one gate and several towers, of a total length of more than 3 mi. still exist. It is celebrated for the philosophers who bore its name. (*See* ELEATIC SCHOOL.) About 530 B.C. the Phocaeans, driven from Corsica, seized it from the Oenotrians. Its coins were widely diffused in southern Italy, and it kept its independence till 78 B.C.

VELIKA KIKINDA, a town in the Vojvodina, Serbia, Yugos. Pop. (1953) 29,570. It is one of the centres of production of the famous wheat of the Banat.

VELLEIUS PATERCULUS, GAIUS (*c.* 19 B.C.–after A.D. 30), Roman historian whose work is an important source for the principates of Augustus and Tiberius. His father was of equestrian status and his mother belonged to a distinguished Campanian family. He served as military tribune in Thrace, Macedonia, Greece and the east, and in A.D. 2 was present at the interview on the Euphrates between Gaius Caesar. grandson of Augustus, and the Parthian king, Phraataces (Phraates V). Later, as prefect of cavalry and legatus, he served for eight years (from A.D. 4) in Germany and Pannonia under Tiberius. He was quaestor in A.D. 7, praetor in 15, and was still alive in 30, for he dedicated his work to M. Vinicius as consul of that year. He wrote a compendium of Roman history from the origins to A.D. 29. The period from the death of Caesar to that of Augustus is treated most fully, and the achievements of Tiberius are described in eulogistic terms. He enlarges on Roman colonization, the Roman provinces and literary topics. He applies biographical methods in his account of historical figures. His style shows distinct characteristics of the Silver Age: antithesis, epigram and rhetorical embellishment.

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(A. H. McD.)

VELLETRI (anc. Velitrae), a town and episcopal see of the province of Roma, Lazio, Italy, at the southeast foot of the outer ring wall of the Alban crater. 26 mi. S.E. of Rome by rail and 24 by electric streetcar line, 1,155 ft. above sea level. Pop. (1951) 15,329. It is the seat of the bishop of Ostia. Good wine is made in the vineyards and there is a government experimental station for viticulture. Velletri is the junction of the Terracina line and a branch to Segni. on the main line to .Naples. At the highest point is the municipal palace. The internal façade of the Palazzo Ginetti is finely decorated with stucco, and has a curious detached baroque staircase by Martino Lunghi the younger. The lofty campanile of S. Maria del Trivio. erected in 1353, is in the style of contemporary brick campaniles in Rome. but built mainly of black selce (lava), with white marble columns at the windows. The cathedral, reconstructed in 1660, contains traces of the 13th century structure.

The ancient city of Velitrae was Volscian in Republican times, and it is the only Volscian town of which an inscription in that language is preserved (4th century B.C.). It mentions the two principal magistrates as *medix*. Velitrae was important as commanding the approach to the valley between the Alban and Volscian mountains. Interesting terra-cotta reliefs from a Volscian temple have been found (especially 5th century B.C.) belonging to the period when it had regained its freedom after its first capture by Rome. It was only reduced in 338 and was punished by the destruction of its walls and the banishment of its town councilors to Etruria, while their lands were handed over, to Roman colonists. It was the home of the gens Octavia, to which the emperor Augustus belonged. (T. A.)

VELLORE, headquarters city of North Arcot district, Madras state, India, on the Palar river and 5 mi. from a station on the Southern railway, 80 mi. W. of Madras city. Pop. (1951) 106,024. It has a fortress, famous in the wars of the Carnatic, dating probably from the 17th century. It is a good example of Indian military architecture, and contains a finely sculptured temple of Siva. In 1780 it withstood a siege for two years by Hyder Ali. After the fall of Seringapatam (1799) Vellore was the residence of the sons of Tipu Sahib, and to them has been attributed the mutiny of the sepoys there in 1806. The town contains an arts college and a medical school connected with Madras university.

VELLUM: see **PARCHMENT.**

VELOCITY OF LIGHT. The history of the measurement of the velocity of light, perhaps the most important of all the constants fixed by nature, may be said to have started in 1676 when Ole Roemer observed certain significant fluctuations in the time of arrival of the eclipses of Io, Jupiter's first satellite. A series of earlier observations of eclipse periods, T, by the Italian astronomer Giovanni Domenico Cassini had yielded an accurate evaluation of the average eclipse period, T_0, for this satellite. (A modern determination gives this average period as 42 hr., 28 min., 16 sec.) The distance between Jupiter and the earth varies because of the different orbital periods of these two bodies, the difference between the maximum and minimum distances being the diameter of the earth's orbit. Roemer found a slow variation in the period with an amplitude of approximately 20 sec. and a period of 13 mo.; the latter is just the time required for the earth to move in its orbit from one closest approach to Jupiter to the next. Starting at a time when the earth was closest to Jupiter, and trying to predict on the basis of the mean eclipse period the time of occurrence of an eclipse six and one-half months later (when the earth was its full orbital diameter more distant), Roemer found that the actual eclipse occurred with a delay, relative to this prediction, which he estimated to be of the order of 22 min. He drew the correct inference from this that light travels with a finite velocity, the delay of 22 min. representing its transit time across the diameter of the earth's orbit. More recent measurement shows this delay to be nearer 16 min. This interpretation did not receive acceptance, however, until the English astronomer James Bradley in 1727 found entirely independent evidence for the finite propagation velocity of light. He found it in his observation of the phenomenon known as the aberration of light, a displacement of the apparent position of the stars in the direction of the earth's orbital velocity.

An elementary explanation of this effect is usually offered by likening the situation of the astronomer with his telescope to a man walking through a shower of vertically falling raindrops and carrying a straight vertical pipe. If the man were stationary he would have to hold the pipe vertically in order that the raindrops fall straight down the pipe without striking its walls, but if he were walking with horizontal speed, v, then he would have to incline the tube forward at an angle whose tangent is v/c to the vertical (where c is the velocity of the falling raindrops) in order that each raindrop traverse the length of the pipe in a direction parallel to its axis. The analogy to the aberration of light is only valid when v/c is an extremely small ratio.

In 1849 the French physicist A. H. L. Fizeau was the first to succeed in measuring c, the velocity of light, by a method not involving astronomical observations. He measured the time of transit of light flashes between two hills about 8.6 kilometres (km.) apart, near Paris. The beam of light was chopped into flashes by means of a rotating wheel aith 720 teeth, and Fizeau measured the successive critical speeds of rotation at which the returning flash of light (from a mirror on one of the hills) was just eclipsed by rotation of succeeding teeth into the path. The experimental conditions were later improved upon by M. A. Cornu and by T. Young and G. Forbes with more accurate results. A drawback to this method is that the exact speed at which complete eclipse occurs is ill-defined.

Rotating-Mirror Method.—The French astronomer D. F. J. Arago was the first to suggest the famous rotating-mirror method which permits considerably higher accuracy than the toothed wheel. It was first successfully applied by Fizeau and by J. L. Foucault working independently in 1850. In these experiments a pencil of light from a point source was reflected from a rapidly rotating plane mirror and, after traversing a path to a stationary mirror about 20 m. distant, returned to the rotating mirror. During the time of transit this mirror was found to have rotated sufficiently to displace the focused image of the light source by a distance of 0.7 mm. Foucault's result for the velocity of light was roughly 298,000 km. per second. This method was greatly improved by Cornu, by Simon Newcomb and by A. A. Michelson. They increased the path distance and utilized rotating polygonal mirrors of glass and steel with very accurately polished optically plane faces and with optically accurate mutual orientations between faces. The dihedral angles between adjacent faces were equalized by interferometry to better than $\frac{1}{20}$ sec. of arc. In a series of experiments performed in California and published in 1927, Michelson used a light path of 44 mi., from Mt. Wilson to Mt. San Antonio and return. His zoo determinations varied between extremes of 299,756 and 299,803 km. per second. The average value, after correction for the group velocity refractive index of air to obtain the vacuum value, yielded

$$c = 299{,}798 \pm 4 \text{ km. per second} \qquad (1)$$

The length of the light path for Michelson's Mt. Wilson determinations was measured by the U.S. coast and geodetic survey in a remarkably accurate triangulation from a 40-km. base line. The length of this base was determined to an estimated error of 1 part in 11,000,000. The result (1), within its estimated error range, is in accord with the results of the best modern measurements.

Group Velocity and Phase Velocity.—All methods in which a light beam is modulated or chopped into signals whose transit times are then measured, such as the toothed-wheel, rotating-mirror or Kerr-cell modulation methods, yield values of the group velocity

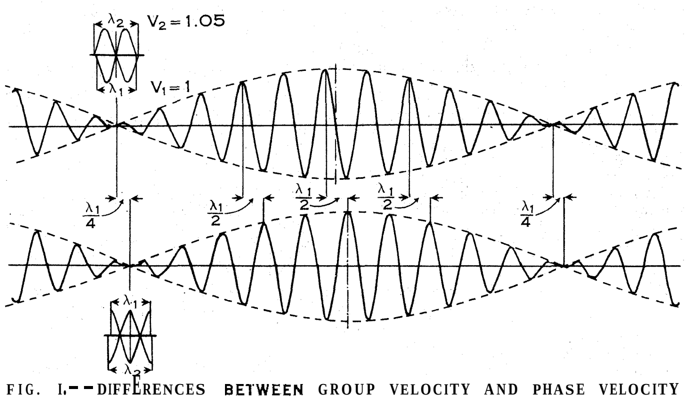


FIG. 1.—DIFFERENCES BETWEEN GROUP VELOCITY AND PHASE VELOCITY IN A DISPERSIVE MEDIUM

The velocity with which the nodes and loops propagate is called the group velocity. The figure illustrates an exaggerated case in which $\Delta\lambda/\lambda = 0.1$ and the corresponding $\Delta V/V = 0.05$, so that the group velocity is only half the phase velocity

of light in the medium employed. The group velocity is to be distinguished from the phase velocity; the latter is the velocity of propagation of each wave crest of an infinitely long, pure, sinusoidal plane wave train. In a dispersive medium (one in which different wave lengths propagate at different phase velocities), the group velocity and phase velocity are, however, not identical and therefore the group refractive index of air is the one which must be used in correcting the results (of a measurement in air) to find the vacuum value of c, the fundamental natural constant. Fourier analysis shows that the effect of modulating or chopping an infinite wave train originally consisting of a pure sine wave into identifiable groups always introduces other frequencies in addition to the original one. The simplest way to illustrate the difference between phase velocity and group velocity is, therefore, to consider two superposed pure wave trains of equal amplitude and nearly equal wave length, λ and $\lambda +$ AX, propagating in the same direction, say from left to right. Because of the slight difference in the two wave lengths the train will be modulated with nodes and loops as shown in fig. 1, the nodes being separated by a number, $\lambda/\Delta\lambda$, of the original wave lengths, λ. If the longer of the two wave lengths propagates at slightly higher phase velocity it will be noted that the crests of the wavelets in each group will be moving forward slightly faster than the group as a whole, the wavelets continually dying at the front of the group and new wavelets apparently being born at the rear. The relationship of group velocity, V', to wave velocity, V, is then given by the equation

$$V' = V[1 - (\lambda/V)dV/d\lambda] \tag{2}$$

Actually Michelson had incorrectly used the phase velocity refractive index in reducing his 1926 results from air to vacuum. R. T. Birge detected this error, and for this reason made a correction upward of 2 km. per second in Michelson's value, obtaining the result (1) above. As Table I below shows, this point was overlooked by several other workers also. Birge refers to this oversight on Michelson's part as "one of the most inexplicable errors" he ever encountered since Michelson had: in earlier work, shown himself to be completely familiar with the distinction between group and phase velocity indices.

Irvine Ranch Experiment.—A rotating-mirror experiment, begun in 1929 by Michelson, F. G. Pease and F. Pearson but not completed until after Michelson's death in 1931, was conducted over a light path in an evacuated pipe one mile long on the Irvine ranch near Laguna beach in California. Successive to-and-fro reflections between plane mirrors were employed to yield a total light path of some 10 mi. A plot of the statistical frequency distribution of the results of nearly 3,000 measurements with this equipment showed a distribution with a strong symmetrical peak centred at the mean value

$$c = 299{,}774 \text{ km. per second} \tag{3}$$

The distribution exhibited, however, rather widely spreading and more or less symmetrical wings or plateaus on either side of the central peak which were decidedly of non-Gaussian character and which, in the late 1950s, were still, unexplained. The computed "probable error" of this array of results was ± 0.2 km. per second, but this apparently overestimates the true accuracy considerably, and in the light of knowledge available by the late 1950s the mean result (3) is almost certainly 18 or 19 km. per second too low. It may be significant that the value strongly indicated as correct by modern and very accurate methods, namely 299,793 km. per second, or even Michelson's slightly higher value (1), falls well inside the above-mentioned non-Gaussian plateau on the Irvine ranch statistical distribution curve. A posteriori reasons to account for the systematic errors in the Irvine ranch work are not hard to find. The base line was on very unstable alluvial soil. A correlation between fluctuations in the results and the tides on the sea coast was reported by Pease and Pearson. A far greater number of time-of-transit measurements with the rotating mirror than with length measurements of the admittedly fluctuating base length were made. Base-length measurements, it appears, were all made in the daytime. whereas a great majority of the rotating-mirror measurements were made at night.

The Kerr-Cell Method.—The Kerr cell or electrooptical shutter furnishes a method of modulating a light beam much more rapidly than the mechanical methods just described. In 1875 the Scottish physicist John Kerr discovered that when a plate of glass is subjected to a strong electric field it becomes doubly refracting, a phenomenon which appears also in liquids. In the electrooptical-shutter method the Kerr cell, consisting usually of two electrical condenser plates immersed in a liquid such as nitrobenzene, is placed between a polarizer and an analyzer "crossed" so as to give complete extinction when the cell is not active. The light beam passes through the cell in a direction parallel to the condenser plates. When a considerable difference of potential is established between the condenser plates. the electric field causes the liquid to behave optically like a uniaxial crystal with its optical axis parallel to the field direction. With the cell oriented at 45° to the plane of polarization of the polarizer, the incident plane vibrations from the polarizer are broken up into two equal components that are parallel and perpendicular to the electric field. These travel through the cell with different speeds so that a phase difference is introduced and the light emerges from the cell as elliptically polarized light. The horizontal component of this light is then transmitted by the analyzer. Thus in the absence of the electrical field no light is transmitted, but with application of the field the light is able to pass.

A. Karolus and O. Mittelstaedt in 1925 were the first to develop this Kerr-cell method, and W. C. Anderson in 1937 and in 1941 improved upon it. Nearly 3,000 observations in 1941 by Anderson yielded the mean value

$$299{,}776 \pm \text{g km. per second} \tag{4}$$

which agrees very well with the Michelson, Pease and Pearson value, but is the one which is regarded as almost certainly 19 km. per second too low. The different transit times of the electrons in the tube used for detecting the modulated light pulses in Anderson's work constituted a possible source of systematic error which he recognized clearly himself. This latter objection is avoided in the Kerr-cell method of E. Bergstrand described below.

The two measurements (3) and (4), with their impressively large number of replicated observations and their excellent (but apparently fortuitous) agreement, misled physicists, including Birge, for about a decade. Not until 1949 was suspicion cast on the value $c = 299{,}776$ km. per second. In that year C. I. Aslakson, using Shoran, a radar method of measuring the distance of an airplane from a ground station by the time of flight of a radio signal, reported a higher value of c. When signals were measured using Shoran, as the airplane approached a position of exact alignment between ground stations separated by a known distance, Aslakson obtained limiting results indicating a value, $c = 299{,}792 \pm 3.5$ km. per second. Since then all other measurements of the constant c for electromagnetic radiation made by many observers and by much more accurate methods support the higher value $c = 299{,}793$ km. per second.

The Bergstrand Geodimeter.—E. Bergstrand developed equipment for an improved Kerr-cell modulation method of measuring the transit time of light over long outdoor light paths of several kilometres. He gave the equipment the name "geodimeter" because it was developed with the idea of using the method in high-precision geodetic surveying. A frequency of 8.33 megacycles (mc.) per second with amplitude of 2.000 v. is used to modulate the light source by means of a Kerr cell, and the same high-frequency oscillator also modulates the detecting photomultiplier tube which receives the returning light from the distant mirror. A jo-cycle-per-second (c.p.s.) alternating bias voltage of 5,000 v. with a square wave form is also applied to the Kerr cell so that the 8.33-mc.-per-second oscillations swing to and fro over the steepest and most linear region of the Kerr cell's characteristic curve of light intensity v. applied voltage. Thus one set of alternate half waves of the 8.33-mc.-per-second oscillator give high light transmission during one entire half cycle of the 50-c.p.s. square-wave bias voltage. while the other half cycles of the high frequency give low light transmission so as to yield a nearly pure sinusoidal variation of light intensity at 8.33 mc. per second. During the next half cycle of the 50-c.p.s. square wave the reversed bias causes the oscillations of light intensity to occur with the high light-transmission maxima 180° (of the 8.33-mc.-per-second frequency) out of phase with respect to their phase during the preceding half cycle of the low frequency. If the oscillations of intensity of the returning light are in suitable phase coincidence with the electrical high frequency which modulates the plate voltage of the photomultiplier tube, the latter will supply 50-c.p.s. rectified pulses of a maximum amplitude during one set of alternate half cycles, and these are arranged to furnish a rectified pulsating signal to an amplifier. During the other set of alternate half cycles oi the 50-c.p.s. square-wave biasing voltage practically no rectified signal will be available from the photomultiplier tube because the 8.33-mc.-per-second modulating voltage applied to its plate is in the wrong phase. Clearly. however, a shift in phase of the sinusoidal light intensity can modify this condition of extreme unbalance between the rectified signals from the two sets of alternate jo-cycle half waves. Two vacuum tuhes, controlled from the 50-c.p.s. square-wave supply. serve to switch alternate phases of this amplified signal from the photomultiplier through a D.C. meter of long period. Reversing switches permit the operator to reverse the phases of the 50 c.p.s. which the switching tubes select and also to reverse the phase of the 8.33-mc. voltage applied to the photomultiplier tube plate. There will be *some* distance for the remote mirror such that the phase delay of the returning oscillations of light intensity will just yield a zero reading on the D.C. meter, and for the selected frequency of 8.33 mc. per second there will occur another such zero for every increase or decrease in distance of the remote mirror of about nine metres.

Uergstrand used great care in guarding against all possible sources of systematic error. For example, he explains in his published articles the means provided to correct a systematic error resulting from the fact that different parts of the image of the light source at the distant mirror have different phases, depending on the part from which light is emanating in the space between the Kerr-cell condenser plates.

Summary of Significant Determinations.— In Table I is given a list of all the significant determinations of the velocity of light of optical frequencies. The first 12 are taken from the 1941 review of this subject by Birge. Bergstrand's geodimeter measurements are seen in this table to yield a value of c about 19 km. per second higher than the Michelson, Pease and Pearson or the Anderson values. The geodimeter has also been independently used by I. C. C. Mackenzie in Scotland with results which do not differ significantly from Bergstrand's. This higher value of c also, as will be seen. receives further support from high-precision work with microwaves. For purposes of comparison, an indirect determination of c by E. B. Rosa and N. E. Dorsey, obtained by measuring the ratio of an electrical charge in absolute electrostatic units (e.s.u.) to the same charge in electromagnetic units (e.m.u.), is included in 'Table I. This experiment, carefully carried out at the U.S. national bureau of standards, has been characterized by

TABLE I.— Determinations of the Velocity of Optical Light

Author	Method†	Year	Corrected result (km. per second)	Standard deviation‡ (km. per second)	Corrected by	Corrected for
Cornu-Hélmert	TW	1875	299,990	± 300		
Michelson	RM	1879	299,910	± 75		
Newcomb	RM	1883	299,860	± 45		
Michelson	RM	1883	299,853	± 90		
Perrotin	TW	1902	299,901	± 104		
Rosa-Dorsey*	REU	1906	299,784	± 15	R. T. Birge, 1941	Electrical conversion factor
Xfichelson	RM	1927	299,798	± 22	R. T. Birge, 1941	Group-velocity refractive index of air
Mittelstaedt	KC	1928	299,786	± 15	R. T. Birge, 1941	Group-velocity indices of optical path
Michelson, Pease and Pearson	RM	1933	299,774	± 6		
Anderson	KC	1937	299,771	± 15	R. T. Birge, 1941	Group-velocity indices oi optical path
Hüttel	KC	1937	299,771	± 15	R. T. Birge, 1941	Group-velocity refractive index of air
Anderson	KC	1941	299,776	+ 9		
Bergstrand	KC	1951	299,793.1	± 0.32		
Mackenzie	KC	1953	299,792.4	± 0.5		

*The Rosa-Dorsey determination is listed here for purposes oi comparison. It is not a determination of the velocity oi optical light but of the constant, c, in Maxwell's equations (*see* LIGHT: *Tie Electromagnetic Equations*).There is no reason to believe that the two should differ in value, however.

†TW = toothed wheel; RM = rotating mirror; REU = ratio electrical units: KC = Kerr cell.

‡The root-mean-srjuare or "standard" error is adopted as the index of precision in this article in accord with the best modern error-statistical usage. Wherever "probable errors" were those originally given they have been converted to standard errors by dividing each probable error by o 6745.

Birge as "one of the most beautifully executed pieces of precision research in the entire history of science." (R. T. Birge. "The General Physical Constants as of August 1941 With Details on the Velocity of Light Only." The Physical Society. *Reports on Progress in Physics*, vol. 8 [London, 1941].) The Rosa and Dorsey value, c = 299.784 ± 15 km. per second. is about at the mid-point of the above-mentioned 19-km.-per-second discrepancy interval and its precision is insufficient to discriminate clearly in favour of either the old 299,774 value or the modern 299,793 value, but it is worth noting that this careful piece of work is not inconsistent with the modern high value since the difference, 9 km. per second, has an expected standard deviation of ±1j km. per second. In fact. if the Michelson, Pease and Pearson and the Anderson values are excluded. the remaining data of Table I, including the work of Rosa and Dorsey and the Mt. Wilson work of Michelson, are not at all inconsistent with the newer. much more accurate. high value.

VELOCITY DETERMINATIONS OF RADIO-FREQUENCY WAVES

The question of whether the speed of light in vacuum varies with wave length or frequency seems to have been clearly settled long ago by observationsof variable stars. Some of these are so distant that their light must take many centuries to reach the earth. Were there any difference in the propagation velocity of the light of different colours, even to so small an extent as one part per million, the apparent colour of the star would change as it waxed and waned, and no evidence whatever for such an effect has been observed.

An even more conclusive test of the absence of any dispersion, in the propagation of radiation of very different wave lengths across intergalactic space has been obtained as a by-product of radio-astronomy. In 1951 F. G. Smith of Cambridge university succeeded in locating within an area of less than one square minute of arc an already well-known. exceedingly intense source of extra-galactic radio waves in the constellation Cygnus. Walter Baade thereupon took a picture of the object with the zoo-in. Palomar telescope and discovered that at this point two very distant galaxies gave every evidence of being in close collision. The Doppler shift toward the red of the optical spectral lines emitted from this object show it to be 270,000,000 light years distant from the earth. and the 21-cm. radio line of hydrogen (discovered in the laboratory by Willis Lamb, Jr., and R. C. Retherford in 1950) as emitted from this radio object was found to have exactly the same red shift. One is forced to the conclusion that the radio waves and the light waves have been propagated over this huge distance with exactly the same velocity. Recent experiments measuring the propagation velocities of radio waves on the one hand and of very short wave-length gamma rays on the other give complete support to the hypothesis that all wave lengths propagate with the same speed in vacuum.

The principal high-precision radio-frequency measurements of c up to 1955 may be listed as (1) W. W. Hansen and K. Bol at Stanford university, Stanford, Calif., using microwave cavity resonance with a cavity of fixed length; (2) L. Essen at the National Physical laboratory, Teddington, Eng., using cavity resonance in a cavity of variable length; (3) K. D. Froome, also at the National Physical laboratory, using a free-space microwave interferometer; (4) Aslakson, using the above-mentioned Shoran radar method originally devised for determining the distance of an airplane from a ground station; (5) E. K. Plyler. L. R. Blaine and W. S. Connor, and D. H. Rank et al., using infrared spectroscopic measurements of the molecular constants of carbon monoxide; (6) E. F. Florman, using a large-scale radio interferometer at 172.8 mc. per second. set up on a dry lake bed in Arizona.

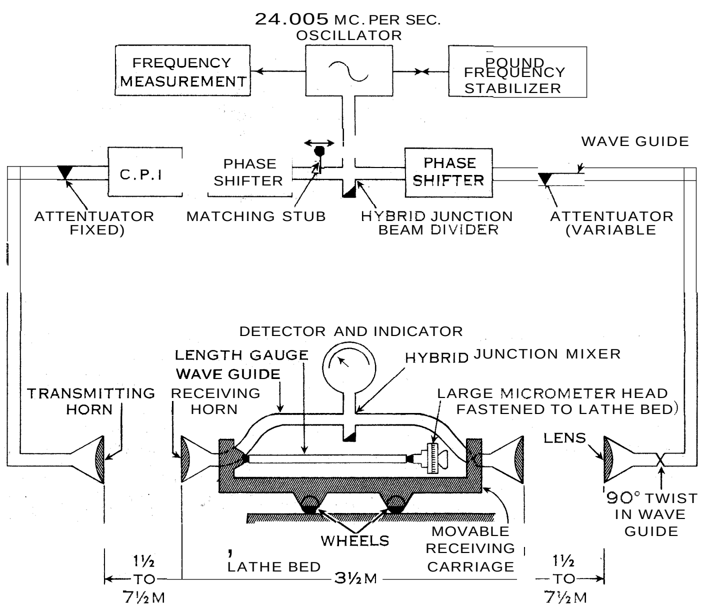
All these radio-frequency methods depend in principle on determining independently a frequency, ν, and a wave length, λ, associated with some electromagnetic wave phenomenon. If ν and λ were the frequency and wave length of a train of infinite plane waves in free space (vacuum), then the velocity of light, c, would be simply given by the product, $\nu\lambda = c$. If the waves are confined in cavities or interact with material objects, or if they are neither plane nor infinite (as is usually the case), then complicated corrections are required.

The results of all these methods (see Table II) indicate clearly that the earlier-weighted average value arrived at by R. T. Birge, based chiefly on the Michelson, Pease and Pearson rotating-mirror and evacuated-tube determination and on the Anderson Kerr-cell determination, *i.e.,* 299,776 km. per second, was too low by about 16 or 17 km. per second. The values after 1948 are far from being of equal reliability or accuracy, nor are they all completely in agreement to within the accuracy estimated by their authors. The Hansen and Bol result in particular disagrees with the others by being about 3 km. per second lower—a disagreement which, though small judged by earlier standards, is uncomfortably large relative to the claimed precision measures.

The Hansen and Bol Method (Fixed-Length Cavity Resonance).—In the Hansen and Bol measurement a cavity resonator was employed which was an accurately machined right circular metal cylinder with optically flat removable metal ends. To reduce losses and to insure a "high-Q" resonance, the machined cast-iron cavity surfaces were plated with silver. Three spacer rods, located in longitudinal holes in the cylinder wall, were used to space the silver-plated surfaces of the cast-iron optical flats which formed the end faces of the microwave cavity. These spacer rods had convex spherical ends which on each rod were zones of a common sphere. All three rods were carefully equalized so that as long as contact was with the ends, the distance between two parallel planes (one contacting each convex surface) was independent of the orientation of the rod axis. The three rods were intercompared in a temperature-controlled oil bath by an ingenious spring-feeler multiplying gauge and were lapped to uniform length. The distance between plane end faces of the cavity was determined interferometrically by replacing the silver-plated cast-iron flats with glass flats. A source of some uncertainty entered here because of the possible difference in elastic or plastic yield at the points of contact between spacer rods and the two different kinds of flats. A study of this effect was made by varying the loading. The diameter of the cylindrical cavity could not be measured accurately by direct means, but the ratio of length to diameter could be determined by a calculation from the ratio of the observed resonant frequencies for two modes of electrical vibration (the TE_{012} and TE_{021} modes) since one of these depends primarily on the length of the cylinder and the other primarily on its diameter. The ratio of length to diameter had been chosen purposely so as to put the frequencies of the two modes only a few megacycles apart out of 3,000 mc. A correction to the resonant frequencies was required because of the perturbation produced by the probe hole through which the electromagnetic energy is introduced into the cavity. The shift in resonant frequency produced by this hole was theoretically predicted to vary as the cube of the diameter, and this was experimentally verified. This finding permitted extrapolation to find the frequency for a vanishingly small hole. An insulating gap was purposely allowed between the plane ends and the cylindrical walls to suppress those certain unwanted modes of electrical vibration for which currents would otherwise be required to flow across this gap. Correction for the gap was small and easily made.

The high-frequency currents in the conducting walls of the cavity, which must necessarily accompany the electromagnetic waves, only penetrate into the conductor to a certain very shallow depth (the shallower the higher the frequency of the particular mode of oscillation), known as the "skin depth." The skin depth and current distribution depend also on the resistivity and dielectric constant in this shallow region. In this experiment the true electrical dimensions of the cavity are greater than the mechanical dimensions by an amount of the order of magnitude of the skin depth. The possible presence of a thin film of silver sulfides of unknown thickness with a resistivity and a dielectric constant differing from the values for bulk silver will affect the observed resonant frequency of the cavity. Correction for this should increase the Hansen and Bol value of the velocity slightly. It has been also suggested by E. S. Dayhoff that the mechanical effect of polishing the silver-plated surface may cold-work the metal and thus greatly decrease its conductivity in an extremely shallow layer. It is unfortunate that Hansen and Bol only made measurements at just enough frequencies to determine *c* in the absence of such anomalous skin effects. In any precision measurement it is always a better policy to overdetermine the measurements in an effort to uncover unsuspected systematic errors.

The Froome Method (Free-Space Microwave Interferometer). — The four-horn Fraunhofer diffraction microwave interferometer of Froome is shown schematically in fig. 2. A Pound stabilized reflex klystron oscillator is used as the source of 24,005-mc.-per-second microwaves corresponding to a wave length of about 1.25 cm. The accuracy of the frequency measurement is about 1 part in 100,000,000. The microwave energy from the oscillator passes to a hybrid junction ("magic T") which serves as a beam divider, from which it passes through two long wave-guide arms to the pair of transmitting horns. The matching stub and phase shifter (see fig. 2) to the left of the beam divider, together with a "constant phase auxiliary interferometer" (c.p.i.), constitute a device for altering the amplitude of the waves transmitted



ADAPTED FROM FROOME, OF THE NATIONAL PHYSICAL LABORATORY, "PROCEEDINGS OF THE ROYAL SOCIETY," LONDON (1952)

FIG 2 — THE FREE-SPACE MICROWAVE INTERFEROMETER OF K. D. FROOME AT THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON. ENG.

down this arm without introducing any change of phase. In this c.p.i. the input wave is split into two components of equal amplitude in two different paths. These components are subsequently recombined after a change in their relative phases brought about by an increase in path length for one path and an exactly corresponding decrease in path length for the other. The two equal vectors representing the phases of the two components are thus rotated in opposite directions through the same angle so that the direction (phase) of their resultant is unchanged while its amplitude is reduced. The phase shifter to the right of the beam divider, together with the variable attenuator, is required in order to adjust and balance the position of the first interference minimum.

A pair of receiving horns mounted on a movable carriage constructed almost entirely of silica tubes (for thermal stability) is arranged to travel on ways through a path of about one metre length. The pair of receiving horns is centred on a straight line, the central axis running betueen the two stationary transmitting horns. The tuo received signals are "mixed" to produce interference, and are detected by means of a simple superheterodyne arrangement; the output is rectified and indicated on a milliammeter. An interference minimum is then indicated by minimum current through the meter and the carriage can be set on a minimum to better than one micron. Lenses were introduced into the horns to render the waves more nearly plane-parallel. Of course diffraction effects coming from the finite dimensions of the horns relative to the wave length tend to distort the wave fronts so that the simple relationship $\lambda\nu = c$ is invalidated and requires a correction. The seriousness of errors of this sort diminishes the farther. in terms of wave lengths, the two transmitting horns are placed from the receiving horns, and by varying this distance it was possible therefore for Froome to arrive at an estimate for the correction to be applied.

A wave-length measurement then consists of determining the exact displacement of the carriage corresponding to 81 wave lengths (162 minima) measured to $\frac{1}{4}$ micron by means of end-contact gauges. Froome states that this 24,005-mc.-per-second equipment is merely a. prototype constructed for the investigation of sources of inherent error. The conditions were, therefore, deliberately chosen to cause errors. as. for example, the random effects arising from reflections in the rather small room. Nevertheless the apparatus was found to yield an accuracy of 1 part in 10^6 for the velocity measurements. Much better results are anticipated from the final equipment which is to operate at 70,000 mc. per second ($\lambda = 4$ mm.) over a path difference of 1,000 minima in a much larger room. Ten observations with the present prototype have been reduced to yield a preliminary value for the free-space velocity of electromagnetic waves in *vacuo* of

$$c = 299{,}793.0 - 0.3 \text{ km. per second} \qquad (5)$$

The original papers of Essen and of Froome give many details and refinements which are omitted here, and contain a particularly careful study of correctioris for the refractive index of air and water vapour.

Table II lists the experimental values of c obtained for radio, microwaves and infrared radiation since 1949 and, for comparison with these, the results of Bergstrand's, Mackenzie's and Schöldstrom's determinations with optical light by means of the geodimeter. Although the other methods are somewhat less precise than those of Froome and of Bergstrand, it will be noted that all of the modern determinations strongly support the higher value. $c = 299{,}793.0 \pm 0.3$ km. per second. upon which the quite independent methods of Froome and of Bergstrand are in excellent agreement as contrasted with the value some 17 km. per second lower which was thought in 1941 to be correct. The reader will find cited in the bibliography an excellent review by J. F. Mulligan and D. F. McDonald in which all methods listed in Table II are described and discussed. See also ELECTRICITY; LIGHT.

TABLE II.—*Experimental Values of the Velocity of Electromagnetic Radiation in Vacuum*

Author	Date of publication	Method†	velocity	(Km. per second)
Aslakson	1949	Shoran	299,792	± 3.5
Hansen and Bol	1950	FLCR	299,789.3	± 1.2
Essen	1950	VLCR	299,792.5	± 1.0
Bergstrand*	1951	Geodimeter	299,793.1	± 0.32
Aslakson	1951	Shoran	299,794.2	± 1.9
Froome	1952	FSMWI	299,792.6	± 0.7
Mackenzie*	1953	Geodimeter	299,792.4	± 0.5
Froome	1954	FSMWI	299,793.0	± 0.3
Plyler, Blaine and Connor	1955	Infrared Spectroscopy	299,792	± 6.0
Florman	1955	FSMWI	299,795.1	± 1.9
Rank, Bennett and Bennett	1956	Infrared Spectroscopy	299,791.9	± 2.2
Schöldström*	1956	Geodimeter	299,792.4	± 0.4

*The measurements of Bergstrand. Mackenzie and Schöldström are at optical frequencies; all the others are for radio waves.

†FLCR = fixed-length cavity resonance; VLCR = variable-length cavity resonance; FSMWI = free-space microwave inlerferometer.

BIBLIOGRAPHY.—Joseph F. Mulligan and Daniel F. McDonald, "Some Recent Determinations of the Velocity of Light, II," *American Journal of Physics* 25:180 (1957). This article contains a complete bibliographical list of references to all the original papers describing determinations made between 1949 and 1956. E. R. Cohen, K. M. Crowe and J. W. M. DuMond, *The Fundamental Constants of Physics* (1957); T. Preston, *The Theory of Light*, 5th ed., p. 534 (1928); R. T. Birge, "The General Physical Constants as of August 1941 With Details on the Velocity of Light Only," The Physical Society, *Reports on Progress in Physics*, 8:90 (1941). (J. W. M. D.)

VELOUR. The term velour (French for velvet) refers in particular to a large variety of woolen textures, and in general to several varieties both of woolen and cotton textures, and also to union fabrics, that are formed with a short furry nap or fur on either one side only or on both sides of the fabric, and developed. subsequent to weaving, by operations of milling and raising. Velour fabrics are characterized by a soft and full "handle" or "feel" and used as dress and costume fabrics, suitings. coatings and dressing gowns according to the texture. Velour is also applied as a general description of many other varieties of fabrics produced from a mixture both of wool and cotton, and to some varieties of all-cotton fabrics on which there is developed the characteristic "velour finish." after weaving.

The nap or pile surface of a velour fabric. produced by milling and raising, is not analogous to the velvet or plush pile of true velvet or plush, nor of velveteen (cotton velvet) in which the pile is produced by a series of tufts, that stand erect from a foundation texture. and are developed by severing the pile warp threads, in velvet and plush (*q.v.*) fabrics, and the pile picks of weft in velveteen or cotton velvet.

VELSEN, a town of the Setherlands, in the province of North Holland, close to Ymuiden. with which it forms a single municipal administration. Pop. (1957 est.) 59.938 (mun.). It is on the North sea canal. and forms the port of entrance for Amsterdam.

VELVET. The term "velvet" applies strictly to the true type of the plain silk velvet of the lighter textures. constructed with a short "velvet!' or plush pile surface, which is developed during weaving by severing certain warp threads of silk, thereby causing the severed threads to stand erect in the form of short tufts from a substantial foundation texture of silk. cotton or other textile material. Velvet has been greatly in the popular favour for many centuries as a dress material. also for garments for use on such occasions as state: social and religious ceremonies and an infinite variety of uses such as curtain drapery. hangings and furniture upholstery and many other purposes. The richest velvet fabrics are those of Dutch (Utrecht) and Genoese manufacture. and that variety known as "collar velvet" for use specially in making the collars of men's overcoats. The velvet pile warp consists of pure silk yarn, though the foundation texture may be woven from a silk warp and cotton weft. or all cotton for both warp and weft.

One of the oldest examples of velvet is that forming part of a 14th-century embroidered cape in the College of Mount St. Mary, Chesterfield, Eng. In the earliest of the inventories relating to church vestments. there is a reference, in St. Paul's. London. A.D. 1295. to the use of "velvet" nith its kindred web "fustian," for "chasubles"; while in that of Exeter cathedral, in 1327, velvet. for the first time is mentioned as being "in two pieces not made up. of which some yards had been then sold for vestment making "

Velvet Weaving.— Velvet fabrics of the lighter textures are woven on hand looms and produced from two distinct series of warp threads and one series of weft threads, viz., "ground" threads to form the foundation texture. and "pile" threads to form the pile, arranged in the fabric in the order of two ground threads and one pile thread, uniformly. Also. each system of warp threads is contained on a separate warp beam or roller in order to permit the tension and rate of delivery of each system to be adjusted and controlled independently. This provision is essential by reason of the two warps contracting at different rates during weaving; that of the pile warp being considerably greater than that of the ground warp, and in the ratio of about six or eight to one, respectively, according to the length or depth of the pile.

During weaving, the pile is developed by raising all the pile warp threads while the ground threads remain down, and then insetting through the warp shed thus formed, a long, thin steel wire, having a narrow groove formed in the upper edge, and extending for its entire length. This wire, termed a "pile wire" is then beaten-up by the reed right up to the "fell" of the cloth, just as an ordinary pick of weft, after which (in one velvet structure), three picks of weft are inserted in succession. These interweave with the ground warp threads on the plain calico principle to produce a firm foundation texture for the tufts of pile. Also, for the first and third of these picks, all pile warp threads are left down, but are raised on the second or intermediate pick, thereby interweaving these threads on the principle known as "fast" or "lashed" pile which binds them very securely to the foundation texture, with less risk of their accidental withdrawal, when the fabric is in use. After these three picks of weft are inserted, another pile wire is inserted in the warp shed, formed, as before, by raising all pile warp threads only and leaving down all ground threads. Then follow the next three ground picks in succession, and so on, in the same regular sequence, uniformly.

Producing the Pile.—From this brief description, it will be apparent that all the pile warp threads simply bend over the grooved pile wires and thus form a horizontal row of loops extending across the entire widrh of the fabric, between the two selvedges, while those wires virtually constitute thick picks of weft which, along with the three fine picks, are all beaten up close together, by the reed, in the usual manner. After the second pile wire has been inserted, and followed by the three ground picks, the weaver releases the first wire by severing, with a knife specially adapted for that purpose, all the pile threads that pass over it. This wire is then removed and inserted in the next pile warp shed to be followed by three more ground picks, after which the second wire is also released, and removed to be again inserted in the next following pile warp shed, and so on, continuously. The severing of the loops formed by the pile warp threads causes these to stand erect as short tufts and thus produce the pile surface.

The instrument employed by a velvet weaver, for cutting the pile warp threads, consists of a special form of knife blade, bent at an angle and fixed adjustably in a frame described as a "trevette." This frame serves both as a handle and guide for the blade, of which the thin and sharp edge is inserted by the weaver into the narrow groove of the pile wires, and drawn quickly, by the right hand, from the left selvedge to the right, with the rear side of the "trevette" bearing against the pile wire last inserted, to serve as a guide, while the knife edge passes along the groove of the pile wire nearest the weaver.

Types of Velvet.—Velvet fabrics also comprise many other varieties ranging from the light, plain textures employed for personal adornment, to the heavier and stronger figured textures for furniture upholstery, curtain drapery, mats, rugs, and similar articles of a more durable character. These comprise such types as Utrecht velvet, "frieze" velvet, "moquette" velvet, and others of a similar kind. Many of these varieties of figured velvets, with the pile produced from mohair and uool, are woven in pouer looms furnished with a special mechanism adapted to insert the "pile wires" into the warp sheds and afterward withdraw them from the cloth, automatically.

Figured velvet fabrics are also sometimes embellished with both a cut or "velvet" pile and an uncut (*i.e.*, looped or "terry") pile, with very pleasing effect owing to the lighter and darker tones of colour resulting from the difference in the reflection of light from the velvet and terry pile surfaces, which appear to be of darker and lighter tones, respectively, although produced from warp threads of exactly the same material, colour and counts of yarn.

Very beautiful varieties of figured, plush pile fabrics are those so-called "embossed" plush or velvet pile fabrics.

(H. N.)

VELVETEEN. One of the most important varieties of the type of fabrics comprised under the general description of "fustian" (*q.v.*). Such fabrics are virtually "cotton velvets" constructed with a short weft pile surface and bear a very close resemblance to the true velvets (*q.v.*) constructed with a warp pile of silk.

Although "velveteen" and "velvet" have a similar general appearance, they are each constructed on distinctly different principles of fabric structure.

Before being submitted to the operation of fustian cutting, all velveteen fabrics have a smooth and even weft surface very similar to that of ordinary cotton weft-face satin textures known as "sateen," and may be made to assume, during that operation, either a plain pile surface uniformly, or else a ribbed or corded surface with the ribs extending lengthwise of the fabric, *i.e.*, in the direction of the warp threads. Although they comprise several different modifications in respect of their structural details, they all embody the same essential features in their construction.

This consists of the development of a series of short tufts of weft pile on a foundation of the plain calico, a simple twill or other elementary weave structure of a suitable character. They consist essentially of one series of warp threads and two series of weft threads, viz., "face" or pile picks and "back" picks, respectively, of the same kind of weft from a single shuttle. The warp threads and back picks are interwoven on some elementary principle to constitute the foundation texture, while the face or pile picks are allowed to "float" somewhat freely on the face, as in a sateen fabric, to be afterward severed by the fustian knife, in order to develop the tufts of pile.

Face and back picks may be employed in any suitable ratio ranging from two to as many as nine pile picks for each ground pick, and with the face picks floating loosely over from 3 to 11 warp threads chiefly according to the character of texture as regards the length (or depth) and density of the pile and the weight and quality of the fabric and its particular use.

Forming the Pile.—During the operation of fustian cutting, all the floating pile weft is severed by the fustian knife, thereby causing that weft to stand erect, and thus form the short tufts of pile which lie in close formation. This operation develops the characteristic velvet or plush pile over the entire surface of the fabric.

The picks are cut by the fustian knife. This knife blade is formed with a very fine and sharp cutting edge at the extreme end of a long, square, steel shank inserted in a wooden haft to be held by the fustian cutter.

After the velveteen fabric has been prepared in a suitable manner for cutting and stretched taut in a frame for that purpose, the fustian cutter, commencing at one selvedge, proceeds to cut that stretch of cloth one "race" or "run" at a time, taking each "race" in succession.

Varieties of Velveteen.—There are three principal varieties of velveteen, distinguished chiefly by the particular weave structure on which the foundation texture is based. Hence, they are described as "plain" or "tabby-back"; "jean" or "jeanette-back"; and "Genoa-back" velveteens.

The tabby-back variety signifies a foundation texture based on the plain calico weave; while jean-back signifies those based on the three-end $(\frac{2}{1})$ regular twill weave; and Genoa-back those based on the four-end two-and-two $(\frac{2}{2})$ regular twill weave; while there are many other weaves employed in their construction. In addition to these variations, some velveteens are also constructed as "fast" or "lashed" pile velveteen, a name derived from the method of interweaving the picks of pile weft with the warp threads in such a manner that the tufts of pile are thereby interlocked or "lashed" more securely in the foundation texture. Thus, instead of each tuft of pile being looped underneath only one warp thread by the usual method, each tuft in a lashed-pile velveteen intersects with three warp threads in succession.

See H. Nisbet, Grammar of Textile Design (1927). (H. N)

VELVETLEAF (*Abutilon theophrasti*), an annual velvety-hairy plant of the mallow family (Malvaceae; *q.v.*), known also as Indian mallow, native to southern Asia and widely naturalized in the warmer parts of the United States, where it grows as a weed.

It grows from two feet to eight feet high, with heart-shaped leaves and clusters of beaked seed pods with very long-lived seeds. In China it is grown for a fine fibre called chingma, derived from the stem.

VENAISSIN, formerly a province of France, bounded on the north and northeast by Dauphiné, on the south by the Durance, on the east by Provence and on the west by the Rhône. It comprises the present de'partement of Vaucluse. Its capital is Carpentras.

Venaissin is a picturesque territory, varying in scenery between the foothills of the Alps and magnificent plains, which are irrigated by canals supplied by the Rhône, the Durance and the Sorgue

The Comtat-Venaissin (*Comitatus Venassinus*), the territory of the Gallic people, the Cavares, belonged first to the counts of Provence and then to the counts of Toulouse. Ceded to the pope in 1218 by Raymond VII, count of Toulouse, and again in 1274 by Philip the Bold, it was only united to France in 1791.

The town of Avignon (*q.v.*), anciently distinct from the Comtat-Venaissin, was incorporated in it by Pope Clement VI at the beginning of the 14th century. Avignon, a bishopric since the 1st century, became an archbishopric in 1475. Carpentras was a bishopric from 483 till 1805.

For history see L. Loubet, Carpentras et *le Comtat-Venaissin* avant *et après l'annexion* (1891).

VENDACE (*Coregonus vandesius*), a small fish of the salmon family, from the lakes of Lochmaben, in Dumfriesshire, Scotland; the name is also given to an allied form (C. *gracilior*), from Derwentwater and Bassenthwaite. These differ from other British species in having the lower jaw prominent; the scales are larger than in related species from the Arctic ocean and the countries round the Baltic. (See WHITEFISH; SALMON AND SALMONIDAE.)

VENDÉE, a maritime de'partement of western France, formed in 1790 out of Bas-Poitou, and taking its name from an unimportant tributary of the Sèvre Niortaise. It is bounded by Loire-Inférieure and Maine-et-Loire on the north, by Deux-Silvres on the east, by Charente-Inférieure on the south and by the Atlantic ocean on the west for 93 mi. Pop. (1954) 395,641. Area, 2,709 square miles. The islands of Yeu (area, 9 sq.mi.) and Noirmoutier are included. The de'partement stretches from the Hauteurs de la Gâtine (935 ft.) in the northeast doun the wooded slopes of the Bocage Vendéen to the plain, bordered toward the sea by the Marais, largely salt marshes reclaimed during the last four centuries. The Gdtine is a southeast to northwest axial line of the Armorican system, and the Bocage on its flank is formed mainly of Palaeozoic rocks, but the plain on the edge of the Marais is of Jurassic limestone. The three chief rivers are the Sèvre Nantaise, draining the Gdtine longitudinally, the Lay, and, in the south, the Silvre Niortaise. The climate is that of the Girondine region, mild and damp, the temperature rarely rising above 77° or falling below 18° F.; 120 to 150 days of rain give an average annual rainfall of 25 in. The woodland is colder than the plain, and the marsh is unhealthy.

Vendée is served by the Ouest-État railway and has 81 mi of navigable rivers and canals. The *département* forms the diocese of Luqon, has its court of appeal and educational centre at Poitiers, and is in the district of the 11th army corps (Nantes). There are three arrondissements (La Roche-sur-Yon, Fontenay-le-Comte and Sables-d'Olonne), 30 cantons and 306 communes. The chief towns are La Roche-sur-Yon, the capital, Les Sables-d'Olonne, Fontenay-le-Comte and Luqon (*q.v.*). Foussais, Nieul-sur-l'Autise and Vouvant have Romanesque churches; Pouzauges has a stronghold of the 13th century; Maillezais has the ruins of a 12th century cathedral; Talmont and Tiffauges possess ruined castles; and Le Bernard, and Noirmoutier have dolmens.

VENDEE, WARS OF THE, a counterrevolutionary insurrection which took place during the French Revolution (*q.v.*), not only in Vendte proper but also in Lower Poitou, Anjou, Lower Maine and Brittany. The district was mainly inhabited by peasants; it contained few important towns, and the *bourgeois* were but a feeble minority. The ideas of the revolution were slow in penetrating to this Ignorant peasant population, which had always been less civilized than the majority of Frenchmen, and in 1789 the events which roused enthusiasm throughout the rest of France left the Vendéans indifferent. Presently, too, signs of discontent appeared. The priests who had refused to submit to the Civil Constitution of the Clergy perambulated these retired districts, and stigmatized the revolutionists as heretics. In 1791 two "representatives on mission" informed the convention of the disquieting condition of Vendée, and this news was quickly followed by the exposure of a royalist plot organized by the marquis de La Rouerie.

The signal for a widespread rising was the introduction of conscription acts for the recruiting of the depleted armies on the eastern frontiers In Feb. 1793 the convention decreed a levy on the whole of France, and on the eve of the ballot the Vendée, rather than comply with this requisition, broke out in insurrection. In the month of March 1793 the officer commanding at Cholet was killed, and republicans were massacred at Machecoul and St. Florent. Giving rein to their ancient antipathy, the revolting peasantry attacked the towns, which were liberal in ideas and republican in sympathies.

These first successes of the Vendéans coincided with grave republican reverses on the frontier—war with England, Holland and Spain, the defeat of Neerwinden and the defection of Charles Dumouriez. The *émigrés* then began to throw in their lot with the Vendéans. Royalist nobles like the marquis de Bonchamp, Charette de la Contrie, Gigot d'Elbée, Henri de la Rochejaquelein and the marquis de Lescure placed themselves at the head of the peasants. Although several of these leaders were Voltairians, they held up Louis XVI, who had been executed in Jan. 1793, as a martyr to Catholicism, and the Vendtans, who had hitherto styled themselves the Christian army, adopted the name of the Catholic and Royal army.

The Convention took measures against the *émigrés* and the refractory priests. By a decree of March 19, 1793, every person accused of taking part in the counterrevolutionary revolts, or of wearing the white cockade (the royalist emblem), was declared an outlaw. The prisoners were to be tried by military commissions, and the sole penalty was death with confiscation of property. The convention also sent representatives on mission into Vendée to effect the purging of the municipalities, the reorganization of the national guards in the republican towns and the active prosecution of the revolutionary propaganda. These measures proving insufficient, a decree was promulgated on April 30, 1793, for the despatch of regular troops; but, in spite of their failure to capture Nantes, the successes of the Vendéans continued.

At the end of Aug. 1793, the republicans had three armies in the Vendée—the army of Rochelle, the army of Brest and the *Mayençais;* but their generals were either ciphers, like Charles Philippe Ronsin, or divided among themselves, like Jean Antoine Rossignol and Count J. B. Camille Canclaux. They were uncertain whether to cut off the Vendéans from the sea or to drive them west ard; and moreover, their men were undisciplined. Although the peasants had to leave their chiefs and work on the land, the Vendéans still remained formidable opponents. They were equipped partly with arms supplied by England, and partly with fowling pieces, which at that period were superior to the small arms used by the regular troops, and their intimate knowledge of the country gave them an immense advantage.

The dissensions of the republican leaders and the demoralizing tactics of the Vendéans resulted in republican defeats at Chant",,~, Torfou, Coron, St. Lambert, Montaigu and St. Fulgent. The convention resolved to bring the war to an end before October, and placed the troops under the undivided command, first of Jean Léchelle and then of Louis Turreau, who had as subordinates such men as Francois Marceau, Jean Kléber and Francois Joseph Westermann. On Oct. 7 the various divisions concentrated at Bressuire, took Châtillon after two bloodv engagements, and defeated the Vendéans at Cholet, Beaupréau and La Tremblaye. After this repulse, the royalists, under Jean Nicolas Stofflet and Henri Louis Auguste, Marquis de la Rochejacquelein, attempted to rouse the Cotentin and crossed the Loire. Beaten back at Granville, they tried to re-enter the Vendée, but were repulsed at Angers. They re-formed at Le Mans, where they were defeated by Westermann, and the same officer annihilated the main body of the insurgents at Savenay (Dec. 1793).

Regular warfare mas now at an end, although Turreau and his "infernal columns" still continued to scour the disaffected districts. After the 9th Thermidor attempts were made to pacify the country. The convention issued conciliatory proclamations allowing the Vendéans liberty of worship and guaranteeing their property. Gen. Lazare Hoche applied these measures with great success. He restored their cattle to the peasants who submitted, "let the priests have a few crowns," and on July 20, 1795, annihilated an *émigré* expedition which had been equipped in England and had seized Fort Penthièvre and Quiberon. Treaties were concluded at La Jaunaie (Feb. 1j, 1795) and at La Mabillaie, and were fairly well observed by the Vendéans; and nothing remained but to cope with the feeble and scattered remnant of the Vendéans still under arms, and with the Chouans (*q v.*). On July *30,* 1796, the state of siege was raised in the western departments.

During the Hundred Days there was a revival of the Vendéan war, the suppression of which occupied a large corps of Napoleon's army, and in a measure weakened him in the northern theatre of war. (*See* WATERLOO CAMPAIGN, 1815.)

In 1832 again an abortive insurrection broke out in support of the Bourbons, at the instigation of the duchess of Berry; the Vendéan hero on this occasion was the Baron de Charette.

There are numerous articles on the Vendéan insurrection of 1793 in the *Revue du Bas-Poztou, Revue hzstorzque de l'Anjou, Revue de Bretagne de Vendée et d'Anjou, Revue historique de l'Ouest, Revue hzstorzque et arche'ologique du Maine* and *La Vendte hzstorzque. See* also R Bittard des Portes, "Bibliographie historique et critique des guerres de Vendée et de la Chouannerie" in the *Revue du Bas-Poitou* (1903 *et seq.*); C. L Chassin, *Etudes sur la Vendte et la Chouannerie (La Préparation de la guerre—La Vende'e patriote—Les Pacifications de l'Ouest)* (Paris, 1892 *et seq*), 11 vols (the best general work on the subject); C. Port, *Les Origznes de la Vende'e* (Paris, 1888); *C.* Leroux-Cesbron, "Correspondance des représentants en mission à l'armée de l'ouest (1794–95)" in the *Nouvelle Revue rétrospective* (1898); Blachez, *Bonchamps et l'insurrection vendéenne* (Paris, 1902); P. Mautouchet, *Le Conventzonnel Philippeaux* (Paris, 1901). On 1815 B Lasserre *Les Cent Jours en Vende'e; le général Lamarque* (Paris, 1907); on 1832 see Vicomte *A.* de Courson, *La Vende'e* (1909). (R. AN.)

VENDETTA (Ital. from Lat. *vindicta,* "revenge," *vindicare,* "to defend oneself"), the term applied to the custom of the family feud, by which the nearest kinsman of a murdered man was obliged to take up the quarrel and avenge his death. From being an obligation upon the nearest, it grew to be an obligation on all the relatives, involving families in bitter private wars among themselves.

It was common to many primitive communities that an injury done was held to be more than personal—a wrong done to the whole gens. The term originated in Corsica, where the vendetta long played an important part in the social life.

If the murderer could not be found, members of his family were liable to fall victims to the vendetta. The feud was sometimes complicated by the *vendetta transversale,* when each of two branches of a family had a murder to revenge on the other. In Corsica it was regarded as the most sacred family duty. Mediators (*parolanti*) sometimes intervened successfully to end the feuds, and extort an oath to forgo vengeance.

See also LAW (PRIMITIVE).

VENDÔME, LOUIS JOSEPH, DUC DE (1654–1712), marshal of France, was the son of Louis, 2nd duke of Vendôme, and the great-grandson of Henry IV and Gabrielle d'Estrées. Entering the army he distinguished himself in the Dutch wars, and by 1688 had risen to the rank of lieutenant-general. In the War of the Grand Alliance he rendered conspicuous service and in 1695, in command of the army operating in Catalonia, he took Barcelona.

Soon afterward he received the marshalate. In 1702, after the first unsuccessful campaign of Catinat and Villeroi, he was placed in command of the Franco-Spanish army in Italy. (*See* SPANISH SUCCESSION, WAR OF THE.) During three campaigns in that country he proved a worthy antagonist to Prince Eugene, whom at last he defeated at Cassano.

Next year he was sent to Flanders to repair the disaster of Ramillies with the result that his successors Marsin and Philip of Orleans were totally defeated, while in the new sphere Vendôme was merely the mentor of the pious and unenterprising duke of Burgundy, and was unable to prevent the defeat of Oudenarde. He retired in disgust to his estates, but was soon summoned to take command of the army of Philip in Spain. There he won his last victories, crowning his work with the battle of Villaviciosa. Before the end of the war he died suddenly at Vinaros on June 11, 1712.

VENEER, a thin sheet of superior wood, covering the surface of inferior wood. Veneers may be sliced with a knife (knife-cut) or cut with a saw (saw-cut) from a section of a tree (flitch).

The art of producing and using veneers dates back to the earliest days of civilization, and it may be looked upon even as a standard of human development, since efficient veneering has always followed the wake of human progress. (*See* Wilkinson's *Manners and Customs of the Ancient Egyptians*, Perrot and Chipiez' *History of Art in Chaldea and Assyria,* etc.) Intarsia and marquetry work are closely allied to and interdependent upon the art of veneering.

In the usual process of manufacture, the flitches are steamed before being cut, and the sheet of veneer thus obtained is carefully dried. Veneers may be cut along the grain, through the log, or from cross sections of the log; the figure and design of the veneer obtained from the different methods employed vary widely and the art of veneering consists as much in the most effective utilization of the log as in the careful and suitable application and matching of the veneers afterward. Veneers are also produced by means of the rotary cutting process as a raw material for plywood. A part of a log is inserted lengthwise between two pins on a rotating lathe, and a knife, pressed against it, peels off an endless ribbon of veneer. (*See* PLYWOOD)

See Sidney J. Duly, *Timber and Timber Products* (1924); E. Vernon Knight and Meinrad Vulpi, *Veneers and plywood* (1927); E. Brocard, *L'Art de découper le bois comprenant également la Marquêterie et la Sculpture Simple* (Paris, 1873). (A. MOR.)

VENER (VÄNERN), the largest lake in Sweden and the third largest in Europe. The area is 2,141 sq mi., the maximum length, 87 mi., the maximum breadth, 47 mi. and the maximum depth, 322 ft. The surface of the lake is normally 144 ft. above the sea but may rise 10 ft. or more higher, for the lake receives numerous streams, the largest being the Klar, which drains the forests of Varmland and Kopparberg to the north. It is drained by the Gota (*q.v.*) river to the Cattegat.

The Vener is divided into two basins by two peninsulas and a group of islands. the western half being Lake Dalbo. The northern shores are high. rocky and in part wooded; the southern shores are open and low. though isolated hills occur such as the Kinnekulle (1,007 ft.).

By means of the Dalsland canal from Kopmannabro, midway on the west shore of Dalbo. communication between the lake. which has an extensive traffic in timber. iron and agricultural produce, and Halden in Norway nas established. The lake is traversed from Vanersborg on the south to Sjotorp on the east by the Gota canal route

The principal lake ports are. on the north shore, Karlstad and Kristinehamn. nith ironworks and tobacco factory; on the east, Mariestad, chief town of the district of Skaraborg; on the south, Lidkoping and Vanersborg with its iron foundries, tanneries and match and paper factories.

VENERABLE, worthy of honour, respect and reverence, especially a term applied to dignified or honourable age (from the Latin *venerabilis,* "worthy of reverence"). *See* CANONIZATION.

VENERABLE BEDE: *see* BEDE.

VENEREAL DISEASES comprise a number of contagious diseases that are most commonly acquired in sexual intercourse.

Included in this group are both a destroyer of life (syphilis) and a preventer of life (gonorrhea). The group includes at least three other diseases: chancroid, lymphogranuloma venereum and granuloma inguinale. These five are linked not because of similarity of causative agents, tissue reactions or symptoms produced, but because the principal means of spread of each disease is by sexual intercourse, especially promiscuous sexual intercourse, as implied by their group name, "venereal." Not only are the causative organisms different morphologically but they also represent five distinct classes of microorganisms: spirochetes, cocci. bacilli, viruses and the Donovan body (perhaps a bacterium).

Although much progress has been made in the control of venereal diseases, especially syphilis, and although the decline of syphilis in the United States has been outstanding, there is no evidence that gonorrhea is declining, nor do available world statistics indicate an over-all decline in the venereal diseases. Even in those countries where incidence has been reduced to a lon level, these diseases still represent a potential danger because the means of transmission is dependent upon intimate personal relationships that rarely, if ever, change.

This article is organized as follows:

I. SYPHILIS

A. History and Occurrence

Syphilis is a generalized systemic discasc initiated by infection with a microorganism known as *Spirochaeta pallida* or Treponema pellidurn. Two distinct forms of syphilis are recognized. The form that is spread venereally is of world-wide occurrence. The other, often referred to as endemic syphilis and bejel, is of nonvenereal spread and confined to parts of the world where economic, social and climatic conditions favour its development; it is not seen in the United States. Endemic syphilis and bejel are acute diseases of limited geographical distribution, predominantly household occurrence, and characterized clinically by an eruption of skin and mucous membranes, usually without evident initial primary sore. Early skin and mouth lesions are indistinguishable from those of venereal syphilis. In endemic syphilis, unlike venereal syphilis, the nervous and cardiovascular systems seem rarely to be involved and fatality is negligible. Serologic tests for syphilis are reactive in the early stages and remain so for many years of latency, gradually tending toward nonreactivity; response to treatment is as in venereal syphilis (see Bejel).

1. Causative Organism. — The causative organism of syphilis is a delicate corkscrew-shaped microbe with clear-cut, regular, tightly wound coils. It varies in length from 5 to 25 microns, usually two to three times the diameter of a red blood cell. It can be seen in the living state only under the dark-field microscope. It has a characteristic motion made up of three components: (1) slow undulation; (2) rotation on its own long axis like a corkscrew; and (3) slow propulsion backward or foraard.

The virulent organism has probably never been cultured on artificial mediums. It has one important biologic characteristic that appears to be solely responsible for the classification of syphilis as a venereal disease, namely, its requirement of moisture for life and transmission. The organism is killed by many chemicals, including soap, and by heat but not by cold. In the tissues it remains alive often for the lifetime of the infected person unless destroyed by treatment.

Endemic syphilis and bejel are initiated by a microorganism morphologically indistinguishable from the treponemes of venereal syphilis and those of yaws and pinta (*qq.v.*). These five disorders are closely related both from a historical viewpoint and from the viewpoint of control activities. This latter importance is emphasized by the fact that both the activities and the title of this control section of the World Health organization (WHO) is "Venereal Disease and Treponematoses."

2. Historical Background. — A historical review by E. Herndon Hudson (*Treponematosis,* 1946) gives the potential development of treponematosis and the social and environmental conditions that led to the different disease processes' being initiated venereally and nonvenereally by microorganisms indistinguishable from each other. The actual historical origin of syphilis is still obscure. There is no indisputable reference to this disease in European literature prior to the return of Christopher Columbus from the new world, but evidence of treponematosis has been found in the skeletal bones of pre-Columbian American Indians. These facts, coupled with its appearance in epidemic form in Europe shortly after Columbus returned. lend some support to the theory of the American origin of syphilis.

Hudson presents evidence against the theory of American origin. In view of the fact that leprosy prior to the time of Columbus was considered highly contagious. mas associated with sexual contact, had hereditary features and was said to respond to mercury therapy. it is likely that the so-called leprosy of that period was actually syphilis, since these are the characteristics of syphilis and not leprosy. In the 300 years following the post-Columbus outburst much was learned about syphilis: signs and symptoms were recognized; its infectiousness was proved; means of transmission were clarified; the duality of syphilis and gonorrhea was reaffirmed; the lesions of congenital syphilis were described; and treatment with mercury was widely used. In 1834 potassium iodide was introduced into the treatment of syphilis. Chancroid was differentiated from syphilis in 1852. In 1905 F. Schaudinn discovered *Treponerna pallidum,* thus making diagnosis more certain. In 1906 A. Wassermann, A. Neisser and A. Bruck introduced the Wassermann reaction. In 1909 Paul Ehrlich gave to the world Salvarsan (606) (*q.v.*). The history of drug treatment for syphilis may be divided into three periods: (1) that of mercury ending 1909 with the discovery of 606 by Ehrlich; (2) that of arsphenamines. 1910–43; and (3) that of the antibiotics beginning with the discovery of J. F. Mahoney and others.

3. Occurrence, Distribution and Trends. — Information of this kind, which defines the extent and significance of disease problems, requires the reporting of cases of the disease to a central agency, usually a department of health. Laws requiring compulsory notification vary throughout the world. and requirements may vary from year to year. Thus data on occurrence, distribution and trends may be very difficult to analyze on a comparative basis.

International.—It was estimated in the mid-1950s that 20,000,000 cases of syphilis existed in the world. There appeared to be a downward trend in the Scandinavian countries, Canada, Finland, France, Italy, Poland, the United Kingdom, the United States and several other countries, although according to a World Health organization study it aas difficult to appraise the statistical information accurately. Despite these apparent trends for each country as a whole, there was evidence of continuing problems in smaller local areas. From the international point of view there are extensive reservoirs of syphilis infection, both venereal and nonvenereal, in several vast regions of the world that are potential hazards to the remainder of the world if they are not brought under control. Occurrence is usually higher in ports than in inland cities. In the Americas in the mid-1950s there were rising syphilis rates in 11 countries out of 25 for which data were available. In 5 of 20 countries death rates from syphilis had risen.

United States. —The true incidence of syphilis (*i.e.,* the number of new cases occurring within a specified time) is not known because not all cases are detected in the early stages and also because many of those detected in the early stages are not reported to the health departments. When questioned, 31 state health officers stated they believed the numbers of reported cases mere not accurate indexes of the size of the syphilis problem in their states.

All states require that syphilis be reported, and each state submits to the U.S. public health service a quarterly summary of the cases reported to it. All cases not previously reported are included. Cases and rates for the country as a whole conceal what is happening in individual states. For example, rises in syphilis rates were reported in 17 states in 1953; in 20 states in 1954; in 13 states in 1955; and in 19 states in 1956—however, it was not until 1956 that these rises were reflected in the rates for the U.S. as a whole. In 1958 there was a national decline, but there were increases in 18 states and in 24 major cities.

Incidence of Syphilis in the U.S.

Year	No. of cases reported	Rate per 100,000 pop.
1945	359,114	282.3
1955	122,075	76.0
1958	125,542	82.02
	126,072	74.0

In 1953 the highest rates for early syphilis were in ages 20 to 24 (primary and secondary 24.46, early latent 88.83 per 100,000) and the next highest in ages 15 to 19 (primary and secondary 16.26, and early latent 45.89 per 100,000). In 1958, 22 states and 13 major cities reported increases in the 15–19 age group and 12 states and 13 cities reported increases in the 10–14 group.

Great Britain.—In England and Wales there was a steady decline in reported infectious syphilis from 1946, the year of highest postwar incidence, to 1955, when there was a slight rise. In 1957 Ambrose King made a critical review of the venereal disease problem and stated, "Thus, though at present there is no reliable evidence of a tendency to rise, it does seem that the progressive fall has come to an end." (Ambrose King, "These Dying Diseases: Venereology in Decline?", Lancet, 1958, i, 651–657.) Late and latent syphilis declined consistently from 1952 until 1955. Rises occurred in 1955 and again in 1956, when there were 4,297 reported cases, about the same number as in the mid-1940s. Congenital syphilis showed a steady decline after 1949, with no rise in 1955 or 1956. Cardiovascular syphilis, however, remained a serious problem, according to King. As a result of his survey King made a final statement, which shows the similarity of the problem in the United States and Great Britain and. indeed, in many parts of the world: "The postwar decline in incidence, and the introduction of new remedies, have inspired a false confidence and a move to dismantle some of the organization which has served the public well in the control of these diseases." (Ambrose King, "These Dying Diseases: Venereology in Decline?", Lancet, 1958, i, 651–657.)

Reported Mortality and Insanity Caused *by Syphilis*.—Mortality statistics are generally admitted to be inadequate, but the data compiled by the National Office of Vital Statistics (U.S.) from duplicates of death certificates filed with state and local registrars show a decline in syphilis mortality from a high of 10.7 per 100,000 in 1940 to 2.1 in 1958. Infant mortality has declined from 0.53 per 1,000 live births in 1940 to 0.006 in 1956. First admissions to mental hospitals due to syphilis declined from 6.1 per 100,000 population in 1940 to 0.8 in 1956. These are encouraging data, but a remaining serious problem is obvious when the losses due to uncontrolled syphilis are estimated: for example, in the United States the estimated man-years of disability due to insanity from syphilis were 32,000; losses due to syphilitic heart disease were 7,000; and those due to syphilitic blindness were 26,000. Loss of life expectancy is estimated at 68,850 man-years per year and loss of income to age 6j (based on 1956 income rates) $80,618,000. Other estimated economic costs are: maintenance of patients with syphilitic psychoses $47.555,000 yearly; maintenance of syphilitic blind $12,500,000. These are very conservative cost estimates, since they are based on maintenance costs in state institutions.

In England and Wales mortality from general paresis and tabes dorsalis declined steadily from 1940 to 1954, but after 1954 there was very little change in general paresis and only a slight decline for tabes dorsalis. Deaths from syphilitic aneurysm did not decline for males and rose for females after 1942.

There is no doubt that many persons receive no treatment for their syphilitic infections. Based upon a sound study of untreated syphilis in Norway, the following outcomes might be expected to occur among the untreated: heart disease, males 14.9%, females 8%; neurosyphilis, males 9.4%, females 5%; and deaths from syphilis, males 15.1%, females 8.3%.

B. The Disease Process

Before infection with syphilis takes place there are several factors that determine the transmission of the disease. The spirochete requires moisture to exist, so continuous moisture is a necessity for a transfer of the organism from one person to another. The social and economic environment in which people live plays a part in transmission. There is definitely more syphilis and greater hazard of infection in low social-economic groups and in communities where adequate venereal disease control measures have not been instituted. Organisms may be abundant in an area but no transmission takes place unless habits, customs. attitudes, sex education, etc., of people permit them to have sexual relations with infected persons.

1. Primary Syphilis.—After the germ (the spirochete) has gained admission to the body, usually through sexual intercourse, it reproduces itself at the admission site and within a matter of hours begins to spread by means of the blood stream throughout the body; it does not produce symptoms until after about 21 days (range of incubation ten days to ten weeks). The first manifestation is the primary sore (chancre). which appears at the site of the entrance of the germ. This highly infectious primary sore may be a typical chancre (painless, ulcerated. firm, with enlarged neighbouring lymph nodes), or it may be so slight as to go unnoticed. There are at least 13 diseases that primary genital syphilis may resemble and at least 12 from which the extragenital primary lesions must be distinguished. Any lesion of the genitalia of male or female should be regarded as possible primary syphilis until it is proved to be something else, and any chronic lesion anywhere on the body, particularly lips, tonsils or fingers, that fails to heal may be a primary syphilis lesion. Blood tests are usually not positive when the primary lesion first appears but become positive after several days. Even without treatment this sore heals and usually leaves no scar, but the disease is still present in the body.

2. Secondary Syphilis.—The spread of the spirochete throughout the body before the primary sore appears paves the way for secondary syphilis in the skin, mucous membranes, eye and nervous system. The organism multiplies in these areas of the body, and in about six weeks (or even months) after the appearance of the chancre the secondary signs and symptoms appear. In about one-half of the infected persons there are mild constitutional symptoms such as headache, vague pains in bones and joints, and sore throat. The skin rash is usually but not always symmetrical, generalized, does not itch, does not contain blisters and is often difficult to see. The palms and soles are often affected. The only visible lesions of secondary syphilis may appear on the mucous membranes of mouth or genitalia. the skin being entirely spared.

Other more or less common manifestations of secondary syphilis are a moth-eaten type of loss of hair from the scalp, external or internal inflammation of the eye, pain from bone involvement, jaundice from liver involvement, edema (swelling) and albumin in the urine from kidney involvement, and syphilitic meningitis with severe headache, convulsions, deafness, partial paralysis and sometimes coma.

The great variety of potential signs and symptoms in all stages of syphilis is the reason why the disease has been called "the great imitator." There are at least 40 skin diseases that secondary syphilis may resemble; 23 diseases that the mouth lesions may resemble; and at least 16 diseases that genital lesions may resemble.

The manifestations of secondary syphilis persist for a variable period of time, ranging from a few days to several months. and then disappear spontaneously. These early lesions of syphilis are characterized by a mild tissue reaction and the presence of large numbers of T. *pallidum*, the infectious agent. They are superficial, nondestructive, highly infectious lesions and usually heal without scarring. With healing the treponemes usually disappear from the skin and mucous surfaces.

During the first few years of untreated syphilis there may be a series of recurring infectious lesions of skin or mucous membranes (secondary relapse). According to the Norwegian study, this occurs in about one out of every four untreated syphilitics. It is from the often trivial-appearing and usually painless but highly infectious lesions of primary and secondary syphilis that infection of other persons occurs.

The diagnosis of early syphilis is a laboratory procedure, but careful physical examination suggests the diagnosis. Proof of the presence of early syphilis is obtained by demonstrating the causative microorganism in serum from a suspected lesion by a special attachment to the microscope known as the dark-field condenser. In ordinary light this micoorganism is invisible.

The failure to discover the organism by repeated dark-field examinations does not rule out syphilis. Repeated tests of the blood must also be made. These serologic tests are frequently negative during the first ten days after the appearance of the chancre and should be repeated at frequent intervals. By the fifth week the blood test is almost always positive.

In secondary syphilis it is strongly positive in more than 99% of the cases. In most instances one positive blood test should be confirmed by another before treatment is begun.

3. Latent Syphilis. — Following the spontaneous healing of the early lesions a period ensues, ranging in length from a few months to a lifetime, during which no outward sign of syphilis is recognizable. Syphilis recognizable only by means of routine serologic tests of the blood is known as latent syphilis. Unfortunately, it is in this noninfectious period that most cases of the disease are brought to medical attention. The majority of patients with latent syphilis do not progress to the development of late symptomatic manifestations, even if untreated. According to the Oslo study, at least 72 out of 100 untreated persons go through life without symptoms of late syphilis, but 28 out of 100 were known to have developed serious outcomes and there is no way to predict what will happen to an untreated infected person.

Women with latent syphilis, if untreated, frequently give birth to congenitally syphilitic children.

During this long latent period the disease loses some of its infectiousness. After the first few years the organism is rarely transmitted through sexual intercourse, but a syphilitic expectant mother can still transmit it to her unborn child.

4. Late Symptomatic Syphilis. — Of every 100 persons acquiring syphilis, at least 15 may be expected to develop, if untreated, a late (tertiary) manifestation that will incapacitate or kill, and 13 may be expected to develop a more benign late manifestation that may appear from 3 to 30 or more years after infection; almost any part of the body may be affected. Of the former group, the most important manifestations are cardiovascular syphilis (heart and blood-vessel involvement), neurosyphilis (brain and spinal-cord involvement) and ocular syphilis (eye involvement). The latter group of manifestations is called gummatous syphilis or benign late syphilis (skin, mucous membrane and bone involvement).

Cardiovascular Syphilis. — The fundamental lesion in most cardiovascular syphilis is located in the thoracic aorta, the largest blood vessel, directly adjacent to the heart. The elastic tissue is destroyed and the aorta dilates. **A** localized saccular dilatation (aneurysm) may occur, or the process may involve the aortic valve and a leakage may develop. The symptoms differ in no recognizable way from the symptoms of heart and vascular disorders of other origins. The diagnosis depends upon the findings on physical examination, fluoroscopy, X-rays, electrocardiography and blood serologic tests. The prognosis of cardiovascular syphilis is poor, and sudden death is not uncommon.

Neurosyphilis.—This may mimic any other neurologic disorder. It is responsible for many deaths and much invalidism. The presence of neurosyphilis may be detected by routine spinal fluid examination years before the appearance of obvious clinical damage in the nervous system. For this reason spinal punctures are an essential part of the examination in all syphilitics.

Paresis (general paralysis of the insane), the most dreaded late manifestation of syphilis, may strike down its victims in the prime of life. The symptoms are due to widespread destruction of the brain by large numbers of T. pallidurn. The mental changes are varied, perhaps the commonest being a gradual change in personality. First noted frequently is a decreased ability to work and impairment of concentration and judgment. The commoner signs of abnormal behaviour include delusions, loss of memory, lack of insight, apathy or violent rages, disorientation and incontinence. Convulsions are not uncommon. Temporary remissions may occur, but the course, unless arrested by treatment, is inevitably downhill to eventual death. The diagnosis is based upon neurologic, psychiatric and spinal fluid examinations.

Tabes dorsalis (locomotor ataxia) is the commonest manifestation of syphilis in the spinal cord, typically a degeneration of the posterior columns. Similar degeneration of the optic and other cranial nerves is common. The disease, though commonly progressive, may undergo arrest in any stage. The commoner symptoms include flashes of shooting, shifting pain, usually in the legs, difficulty in urination, numbness in hands or feet, a sense of constriction about the waist, unsteadiness on the feet with a wobbly broad-based gait, constipation, blurred or dim vision from atrophy of the optic nerve, double vision, drooping of the eyelids, loss of sexual power, loss of weight, deafness, severe sudden attacks of intense abdominal pain and vomiting and disintegration of one or more joints. Tabes is often confused with ulcerated stomach, gall-bladder disease, kidney stone and appendicitis. Differential diagnosis requires careful neurological and laboratory examinations.

Benign Late Syphilis. — The characteristic lesion of late syphilis of skin, mucous membranes or bone is the gumma. Gummata are noninfectious, and the name benign late is used because in most instances life is not endangered. Various organs may be involved, particularly the liver, testes or brain. The gummatous structure consists of granuiation tissue characterized by dense plasma and round cell infiltration, especially around the blood vessels, with impairment of blood supply and usually tissue breakdown. The symptoms depend upon the site involved. On the skin and mucous membranes gummata appear as chronic, usually painless, often ulcerated lesions, which may result in extensive disfigurement if treatment is delayed and particularly if the patient, because of incorrect diagnosis, is subjected only to surgery or X-ray therapy.

When bone is involved, deep-seated aching pain is usually, but not always, present. If the skull bones are involved, there is severe headache. There is tenderness to pressure over the involved bones, and often an obvious swelling with local heat. The diagnosis of gumma is based upon the appearance of the lesion, the positive blood serologic test and, often, upon the results of X-ray examination.

5. Syphilis in Pregnancy and Congenital **Syphilis.**—Prenatal paternal transmission of syphilis to infants does not occur directly but only through maternal infection. Untreated syphilis can have very serious effects on the outcome of pregnancy. Infection of the child may occur at any time from about the third month to the day of delivery.

Recognition of the existence of syphilis during pregnancy is usually possible only by a routine blood serologic test, which should be performed on all pregnant women.

If the mother's infection is untreated, the probability of premature stillbirth is increased fourfold over the normal, the probability of infantile death is almost doubled, and almost 20% of surviving children suffer from congenital syphilis. Adequate treatment of the syphilitic pregnant woman reduces syphilis as a cause of fetal death to a relatively minor role.

A congenitally syphilitic infant may show lesions at birth; may appear normal at birth and develop lesions within a few months; or may remain asymptomatic until adolescence, when late manifestations usually appear.

In general, the clinical manifestations of congenital syphilis parallel those of the acquired infection. The lesions of infantile congenital infection are comparable with, and as infectious as, the secondary lesions of acquired syphilis. Congenital syphilis passes through a latent stage and produces late lesions analogous to those of acquired syphilis.

The infant with clinically apparent congenital syphilis is usually malnourished, has lesions on the skin and mucous membranes, "snuffles" and bone lesions. The latter are often detectable only by X-ray, but sometimes there is loss of function of the affected extremity. Clinically manifest infantile congenital syphilis is usually easily diagnosed. Blood serologic tests are not diagnostic before three to four months of age because of the possible presence of maternal antibody in the infant's blood.

With adequate treatment, the prognosis in early congenital syphilis is, on the whole, favourable, although less so than in early acquired syphilis. Without treatment. a majority of congenital syphilitics ultimately develop some late manifestations in childhood, adolescence or early adult life. In order of decreasing frequency the common lesions are ocular, particularly involvement of the cornea, which exceeds in frequency all other manifestations combined; neurosyphilis, including juvenile tabes and juvenile paresis; nerve deafness; bone and joint lesions; and gummata of skin and mucous membranes.

The late congenital syphilitic usually bears some evidence of antecedent infection. Such changes are known as stigmata. The more important ones are extremely high brow; corneal scarring; flattened (saddle) nose; notched, widely spaced, peg-shaped upper central incisor (Hutchinsonian) permanent teeth; mulberry-shaped first molar teeth; deafness; radiating scars about the mouth (rhagades); a dish-shaped face; and anterior bowing of the tibia known as sabre shin. These stigmata do not mean that active infection exists. The diagnosis in late congenital syphilis is based upon the clinical picture and the positive blood serologic test. The prognosis in late congenital syphilis, with the exception of juvenile paresis, is good, although blindness is not uncommon and deafness occasionally occurs. Third-generation syphilis, barring reinfection in the second generation, is of doubtiul occurrence.

C. Diagnosis

Syphilis, "the great imitator," requires physical examinations and laboratory tests for diagnosis. Laboratory tests are made of serum taken from early lesions (dark-field examination) and of blood (serologic tests) and spinal fluid.

1. Dark-field Examinations. — These examinations are performed in an attempt to find the microorganism of syphilis in serum from a suspected lesion. In primary and secondary syphilis the organism is abundant in the tissues, lymph glands and skin lesions. Serum obtained from these lesions by excoriating the surface of the lesion or by puncture and aspiration from the glands is examined under a microscope with a special dark-field condenser attached.

2. Blood Serologic Tests. — The diagnostic (Wassermann, flocculation) tests for syphilis are highly specific and sensitive, but many factors other than syphilis may cause a false positive reaction. Technical error is by no means uncommon. In the absence of clinical findings, a single positive report should never be accepted at face value. Quantitative serologic tests for syphilis are helpful in certain circumstances.

In a few apparently healthy persons (1:3,000 to 1:5,000) and in many others under the influence of various infections and other nonsyphilitic conditions, false positive serologic tests occur that may disappear within a few days or months or may persist for many years. False positive reactions are common in leprosy, acute malaria, infectious mononucleosis, smallpox vaccination, ratbite fever, disseminated lupus erythematosus, upper respiratory infections and virus pneumonia. They occur with less frequency in a number of other conditions. Yaws, pinta and nonvenereal syphilis uniformly produce positive serologic tests for syphilis.

The physician should diagnose syphilis not from the blood serologic tests alone but only after careful consideration of the entire clinical picture, including a physical examination, often supplemented by spinal fluid examination, epidemiologic investigation of the family and sexual contacts, and by special procedures such as the *Treponema pallidum* immobilization (T.P.I.) test.

3. Spinal Fluid Examinations. — Examinations of the spinal fluid obtained by lumbar puncture is an essential part of the examination of all syphilitic patients. This permits the detection of central nervous system involvement years before the appearance of neurologic signs or symptoms.

D. Treatment

The purpose of treatment is to kill all remaining spirochetes, to initiate the healing of existing lesions and to prevent further damage and spread of the pathologic process. Treatment of early syphilis also serves to prevent spread of the disease to others. The earlier treatment is started, the more effective it is in accomplishing these purposes.

In the mid-1940s penicillin began to replace the arsenical products (arsphenamine, neoarsphenamine, oxyarsphenamine) and bismuth preparations in the treatment of syphilis. The arsenicals and bismuth were used either alternately or concurrently and were generally administered in weekly injections over a period of many months or years. The results of this type of treatment, when complete, were good, but the side effects were many and the course was long, so that a large percentage of patients did not complete their treatment.

Penicillin, with relatively few side effects and with equally good but more rapid results, has proved most etiective in the treatment, control and prevention of this disease. At first some medical authorities advocated combining penicillin with the arsenicals or bismuth or both, but experience has shown this to be unnecessary. The use of penicillin alone in the treatment of syphilis is practically universal. The widespread use of penicillin for treatment of a variety of other disorders has frequently added some difficulties in the diagnosis and subsequent management of syphilis because under these circumstances the syphilitic infection may be masked completely or its course changed.

Several types of penicillin have been used effectively in treatment, and a number of schedules of injections has been recommended. The primary consideration is not the exact schedule of injections but rather the maintenance of a penicillin level in blood and tissues for a minimum duration, depending on the stage of the disease; *e.g.*, in early syphilis the minimum is seven to ten days, while in some forms of late syphilis blood and tissue levels must be maintained for several weeks. To obtain these levels over the required periods, the frequency of injections and dosage depend upon the type of penicillin used. Research workers continued their efforts to find a penicillin product that will maintain these levels with a minimum number of injections.

The first type of penicillin used required an injection every two or three hours to maintain the required level; then with penicillin in peanut oil and beeswax it was necessary for it to be given only every 12–24 hours. The next product was procaine penicillin with aluminum monostearate (PAM), which could be given every two to four days. In the mid-1950s benzathine penicillin became available. For primary and secondary syphilis it is relatively easy to maintain the required level for seven to ten days with a single dose of benzathine penicillin; for later stages the required blood levels must be maintained for several weeks.

After the completion of treatment the patient should be periodically examined and have periodic blood tests performed so that further treatment may be given if necessary. Retreatment usually is given only for clinical relapse, serologic relapse, seroresistance at a high level or an abnormal spinal fluid. On the average, after successful treatment the blood test becomes negative from four to seven months later. Patients who are treated adequately for early syphilis are susceptible to reinfection by the usual routes.

If the pretreatment spinal fluid has been negative it is unnecessary to repeat this examination. Further treatment usually is given only in case of clinical relapse or progression. In all forms of late syphilis, a persistently positive blood test is the rule rather than the exception. This persistence does not usually mean a poorer prognosis. In some instances the tests become negative after a number of years, but this change is not necessarily hastened by additional treatment.

Cardiovascular syphilis (aortic insufficiency and aneurysm) is the most frequent basic cause of death from acquired syphilis. It can be prevented by the adequate treatment of early syphilis, and in most instances prevented even by treatment first given in the latent stage. Once overt cardiovascular involvement has developed, life may still be prolonged by a judicious combination of cardiac care and penicillin therapy and careful observation after treatment.

The various forms of neurosyphilis respond well to penicillin. Some authorities continued to recommend fever therapy in an occasional case. After treatment, periodic re-examination of the spinal fluid and neurologic and psychiatric examinations are essential as guides to the necessity for further therapy. Retreatment is given usually only in case of inadequate spinal fluid response.

Since destroyed nerve cells and tissues cannot be rebuilt, multiple courses of therapy given because of incomplete clinical response usually accomplish little. Best results are obtained when treatment is given early, before irreparable damage has been done. Thus early diagnosis is very important.

Congenital syphilis can be prevented almost completely by the routine serologic testing of all pregnant women and prompt treatment if syphilis is found. Penicillin is very effective. No infant should be treated for congenital syphilis until the diagnosis is proved. Best results are secured when treatment is given before the sixth month of age.

II. GONORRHEA

Gonorrhea (clap, "a dose," gleet, morning drop, running range) is an acute, self-limiting venereal disease that frequently progresses into a chronic state. It is initiated by a microorganism with a predilection for the type of mucous membranes found in the genitourinary tract and adjacent areas. This microorganism is known as the gonococcus (Neisseria gonorrhoeae).

All gonococcal infections except eye infections in newborn infants (ophthalmia neonatorum), some instances of vulvovaginitis of young girls living in institutions, and occasional accidental eye infections in adults are the result of direct sexual contact.

A. History and Occurrence

1. Historical Background. — Gonorrhea has apparently existed since prehistoric times. It was familiar to the Chinese more than 5,000 years ago, and was known to the ancient Arabs, Greeks, Hindus, Romans and other peoples of ancient times. It ranks among the oldest diseases. Hippocrates in 460 B.C. was aware of the existence of the disease, and Galen in A.D. 200 introduced the name by which it is known today. The name is based upon the belief that the discharge was an involuntary flow of semen (*gonos,* "seed"; *rhoia,* "flow"). The relation to sexual exposure was not understood until many years after this. It was not until 1790, however, that it was considered to be distinct from syphilis, and not until 1831 that the difference was proved. The isolation of the gonoroccus was made by Neisser in 1879.

2. Occurrence, Distribution and Trend. — Gonorrhea is an extremely common disease, present in all parts of the world. Its incidence is unknown because of self-treatment, undiagnosed cases (mainly in females) and very defective case reporting. According to statistical data of the World Health organization, there is no evidence that gonorrhea is declining in the world at large. In the mid-1950s there were increases in gonorrhea in one-third of the countries from which data were available. In the U.S. it was estimated in the mid-1950s that more than 1,000,000 cases occurred each year, about one-fourth of which were reported. During the decade 1948–57 the reported cases showed a downward trend, the significance of which was dubious (1948, 363,014 reported cases; 1957, 216,476). The mortality from gonorrhea is negligible, but its indirect effects on the population by its not infrequent sterilization of both sexes, particularly women, are incalculable.

B. The Disease Process

The same preinfection causative factors are important in gonorrhea as in syphilis. The gonococcus is sensitive to conditions outside the human body. Infection, therefore, usually requires direct deposit of the organism on or about the susceptible tissues of the genitalia, rectum and occasionally about the eyes either accidentally by deposit from hand to eye or in the eye of the newborn as a result of its passage through an infected birth canal (ophthalmia neonatorum). Gonococcal vulvovaginitis of children occurs as a result of intimate direct contact of children with infected adults, and as a result of the insertion of contaminated instruments and foreign bodies into the vagina and rectum.

The incubation period of gonorrhea is usually three to five, but occasionally two to ten, days. The signs, symptoms and outcome in male and female differ.

1. Male Gonorrhea. — The first symptoms are burning on urination and a purulent urethral discharge that may be severe or so mild as to go unnoticed. In the absence of treatment, the infection usually extends deeper to involve the posterior part of the urethra, the neck of the bladder and the prostate gland. Urgency and frequency of urination and, occasionally, hematuria (bloody urine) may follow. Complications are influenced by sexual excitement, alcohol and heavy lifting with a full bladder. Spontaneous recovery may occur within a few months to a year. Possible local complications are abscess of the prostate gland or seminal vesicles and inflammation of the spermatic cord and epididymis (which lies next to the testicle in the scrotal sac).

2. Female Gonorrhea. — The initial symptoms in most instances are so mild as to go unnoticed. Slight vaginal discharge and burning may be present. The disease is not usually suspected by either patient or physician until complications occur or a sexual partner is infected. Abscess of a vulvovaginal (Bartholin) gland occurs rarely as an early complication. Many women recover spontaneously from gonorrheal infections that extend no farther than the cervix (mouth of the womb). In many, however, there is extension through the uterus (womb) to involve the Fallopian tubes and ovaries. Fever usually accompanies these extensions to the pelvic organs, and lower abdominal pain is a prominent symptom. Pelvic abscess or peritonitis may result. The clinical picture is not infrequently confused with appendicitis. Eventual healing occurs without resort to surgery in most cases, often with some physical disability and sterility. In immature girls the infection is usually confined to the vagina.

In both male and female, arthritis is the commonest extragenital manifestation of gonorrhea. The process usually settles in one or two joints and may result in permanent disability in the absence of treatment. Involvement of the tendon sheaths in the region of the affected joint or joints is not uncommon.

3. Gonococcal Ophthalmia Neonatorum. — This condition (conjunctivitis in newborn infants) is one of several acute inflammatory conditions of the eye occurring within the first three weeks of life. The external eye and the eyelids become very red and swollen, and there is a profuse discharge. In the absence of treatment, complete blindness is the usual outcome. Its occurrence has been greatly reduced through the routine use of 1% to 2% silver nitrate (or equivalent preparation) in the eyes of infants at birth, a measure almost universally required.

4. Other Complications. — A few other very rare complications of gonorrhea are iritis, endocarditis (involvement of the heart valves), meningitis and skin lesions.

C. Diagnosis and Treatment

There is a nongonococcal urethritis that resembles gonorrhea, and its widespread occurrence seriously complicates the clinical diagnosis in the male. In addition to searching with a microscope for the double bean-shaped gonococcus in Gram-stained smears, it is frequently necessary, particularly in females, to isolate the suspected organism and try to culture it in an incubator.

Penicillin is the drug of choice for treatment, one injection usually being sufficient to cure uncomplicated gonorrhea. Gonorrhea with complications (eye involvement, prostatitis, arthritis, etc.) requires treatment over longer periods depending on the extent of damage and duration of signs and symptoms. Evidence of the success of prophylactic treatment of all persons exposed sexually to an infected person is rapidly accumulating, and many experts insist on immediate treatment of exposed persons with penicillin before diagnostic measures are undertaken. Furthermore, it is futile to treat one member of a sexual alliance for gonorrhea and neglect the treatment of the other, because reinfection of the treated person will surely occur. Patients sensitive to penicillin may be effectively treated with several other antibiotics. The sulfonamide drugs are far inferior to penicillin in the treatment of gonorrhea.

The administration of the small amount of penicillin necessary to cure gonorrhea may mask the early manifestations of coexisting syphilis and delay its diagnosis. An integral part of the treatment of gonorrhea, therefore, is the so-called serologic follow-up—a blood test for syphilis at least once a month for four months,

III. OTHER VENEREAL DISEASES

A. Chancroid

Chancroid (soft chancre, ulcus molle, chancre mou, soft sore) is an acute. specific, localized, self-limiting, autoinoculable infectious disease usually acquired through sexual contact. It is initiated by a microorganism known as the Streptobacillus of Ducrey (*Hemophilus* ***ducreyi***).

1. History.—In medieval times the distinction of chancroid from the initial lesion of syphilis was not made. Gonorrhea and syphilis were differentiated about 1831, but it was not until after 1850 that a soft chancre was distinguished from the initial lesion of syphilis and later designated chancroid. In 1889 Ducrey identified the microorganism that later was accepted as the causative agent. The genital ulcerations are variable in appearance and even now are occasionally confused with those of other venereal diseases unless all available diagnostic measures are utilized.

2. Occurrence, Distribution and Trend.—Chancroid occurs endemically throughout almost the entire world, being especially common in tropical and subtropical countries and commoner in seaports and urban areas than in rural areas. It is primarily a disease of the underprivileged and the unclean. In many countries it is not a reportable disease. Exact data as to its occurrence, distribution and trends are not available, but it is known to be common and universally distributed. In 1945, 5,515 cases were reported in the continental United States. In 1947 there were 9,039 and, in 1956, 2,322 reported cases. The trend of reported cases has been continuously downward, but these represent only a small fraction of actual cases because reporting is not required in all states. In British and U.S. armed forces stationed in tropical zones the incidence of chancroid was sometimes vastly greater than that of syphilis.

3. The Disease Process.—The same preinfection causative factors are important in chancroid as in syphilis, but chancroid can be definitely prevented by the proper use of soap and water immediately after exposure. About three to five days after exposure (sometimes later) there appears a small red area at the infection site; this enlarges into a papule, which soon breaks down. forming an ulcer with ragged edges exuding pus. The ulcers are painful and bleed easily. In about one-half of the cases there develops within a few days to two weeks a swelling in local lymph glands (buboes). These are acutely inflammatory, usually contain pus and may rupture spontaneously. Usually the disease is self-limited, but in particularly dirty persons, especially when the lesion is under the foreskin or about the clitoris where it cannot be properly exposed, relatively prolonged disability and tissue destruction may ensue. Extragenital chancroid is a rarity but it does occur.

4. Diagnosis.—The diagnosis is usually based on the clinical picture of the disease, provided syphilis has been adequately ruled out. The organism may occasionally be seen in stained smears from the ulcers and may sometimes be cultured. The intradermal test (Ito test) uith bacillary vaccine is of value.

5. Treatment.—The sulfonamides (sulfanilamide, sulfathiazole or sulfadiazine) are specific in therapy. As a rule, their administration need not be continued longer than one week. Penicillin has not been helpful, but the tetracycline antibiotics and chloramphenicol have been widely and successfully used. The bubo may be aspirated if necessary.

Local cleanliness is of great importance, with generous use of soap and water, supplemented often by the use of powdered sulfonamide locally and soaks of permanganate of potash. Local therapy is avoided until repeated dark-field examinations for syphilis have been performed. In any event, an integral part of the therapy of chancroid is prolonged follow-up with blood serologic tests to rule out syphilis.

B. Lymphogranuloma Venereum

Lymphogranuloma venereum is a venereally acquired virus infection of lymph channels and lymph nodes manifesting itself by swollen lymph nodes, ulcerations, enlargement of genital organs and rectal stricture. It is also known as lymphogranuloma inguinale, climatic bubo, poradenitis, lymphopathia venereum and Nicolas-Favre disease.

The microorganism is known as the virus of lymphogranuloma venereum. It is a so-called filtrable virus immunologically related to the virus of psittacosis (*q.v.*).

1. History.—Lymphogranuloma venereum was first described as a clinical entity in 1913, and detailed information became available in 1922 as a result of a study by Joseph Nicolas and M. Favre. It was proved to be a virus disease in 1930.

2. Occurrence, Distribution and Trend.—Exact data are not available. It is a relatively common disease, occurring throughout most of the world, especially in tropical and subtropical areas. In the mid-1950s the World Health organization published the reported cases since 1946 in 16 countries located in Africa, America, Asia, Europe and Oceania. It is endemic in the southern part of the United States, particularly among lower socioeconomic groups. The age incidence is that of greatest sexual activity. Sex differences are not great, and all races are affected. In the decade 1947–56 the number of cases reported in the U.S. fell from 2,688 to 602.

3. The Disease Process.—The primary lesion, usually on the genitalia, appears from 5 to 21 days after infection takes place. This lesion is often so transitory as to escape notice, and the first manifestation of the disease may be a swollen, hot, tender group of glands (buboes) in the inguinal region, appearing from 10 to 30 days after exposure. In the female, the inguinal bubo is frequently absent and the initial symptoms are referable to the rectum.

Fever, chills, headache and joint pains may be present. Abscess formation with drainage of pus from the inguinal lymph nodes is usual. Later manifestations of the disease include secondary ulceration and elephantiasis (great enlargement) of the genitalia in both sexes, polypoid growths about the anus, inflammation, ulceration and stricture of the rectum and, rarely, arthritis, conjunctivitis and nervous-system involvement. Extragenital infection is rare. The course of the disease varies from asymptomatic infection to extreme debilitation with chronic invalidism as the result of chronic late manifestations.

4. Diagnosis.—The diagnosis of lymphogranuloma venereum is usually made on a clinical basis, but a skin test known as the Frei test and a blood (complement-fixation) test are of considerable value. Microscopic examination of a bit of removed tissue from a lesion is sometimes indicated.

5. Treatment.—This varies with the stage of the disease: Chlortetracycline, along with sulfadiazine, is used in the bubo phase with moderate success; for the rectal lesions and other ulcerations, tetracycline antibiotics with chloramphenicol or sulfadiazine may be effective if administered for as long as 30 days after symptoms improve. Penicillin is not effective. Aspiration of pus from the bubo gives symptomatic relief. At times surgery or repeated dilatation is of value in stricture of the rectum. Plastic surgery may be indicated in elephantiasis.

Periodic follow-up blood tests for syphilis are essential.

C. Granuloma Inguinale

Granuloma inguinale is a chronic, mildly contagious, progressively autoinoculable venereal disease that usually but not always occupies the genital and inguinal regions. It is initiated by a microorganism known as the Donovan body (Donovania granulomatis), probably a bacterium. Among the other names given this disease are ulcerating granuloma, granuloma pudendi tropicum, granuloma contagiosa, chronic venereal sore and granuloma venereum.

1. History.—The first description mas made in 1882. In 1905 C. Donovan mentioned a "body" found in the diseased tissues, and about 1945 the Donovan body was cultivated in the yolk sac of the chick embryo.

2. Occurrence, Distribution and Trends.—Exact data on its incidence and prevalence are not available, but it seems to be the least common of the venereal diseases. It is commonest in the tropics but has been reported from all countries. In the United

States it is endemic in the south, particularly among the lower socioeconomic groups. In the decade from 1947 to 1956 in the United States the number of reported cases fell from 2,403 to 419.

3. The Disease Process. — Little is known about the incubation period because reports state it to be from 8 days to 12 weeks and sometimes more than 100 days. The process begins on the genitalia and slowly spreads to involve the inguinal regions and perineum. It takes the form of an extremely chronic, usually deep beefy red ulceration, with little tendency to heal. If secondary infection occurs, there may appear pain, fever and general symptoms. Ultimately, in some untreated cases, severe debility develops, ending in death. Lesions in other than the genital region are seen in about 6% of the cases, and on rare occasions the disease may become generalized.

4. Diagnosis. — The clinical picture may permit diagnosis, which should be confirmed, however, by the demonstration of the Donovan body in stained smears or sections from the lesion. Typically the microorganisms appear as small encapsulated bodies about one micron in length, lying within mononuclear cells. In all cases of diagnosed or suspected granuloma inguinale, syphilis should be ruled out by repeated serologic tests, performed monthly for at least four months.

5. Treatment. — Treatment with antimony compounds has been entirely replaced by antibiotic therapy. Streptomycin over a period of 5 to 10 days and chlortetracycline, chloramphenicol and oxytetracycline over a period of 15 to 20 days have been used successfully.

IV. CONTROL MEASURES

Although available world statistics do not indicate an over-all decline in the venereal diseases, much progress has been made in some areas. In order to continue this progress and to initiate progressive control measures throughout the world, constant vigilance must be maintained. . All areas of high venereal disease occurrence are potential hazards to the remainder of the world. Furthermore, the relationship of venereal and nonvenereal syphilis and other forms of treponematosis (yaws, pinta) make it essential that control measures be applied effectively to all forms of treponematosis in order to assure future protection of the world from these diseases that resemble syphilis in signs, symptoms and occasionally in outcome. This is the objective of the Division of Venereal Disease and Treponematoses of the United Nations World Health organization, which stimulates and assists national health administrations in the control of these diseases. By the late 1950s such treponematosis control projects had been carried out in Yugoslavia, Haiti, Indonesia, Thailand and the Philippines, and smaller programs had been conducted in Ceylon, Afghanistan, Iraq, Egypt, Burma, Ecuador and Venezuela. The Venereal Disease and Treponematoses division is in constant communication with venereal disease and treponematoses control programs all over the world.

In the United States, control of venereal diseases is carried out on a local basis with some state and federal support. Federal appropriations for venereal disease control decreased annually from a peak of $17,000,000 in 1948 to a low of $3,000,000 in 1954. It was soon realized that reductions had taken place too rapidly, so in the years after 1955 annual changes in appropriation in keeping with estimated needs were made.

Control of the venereal diseases and of nonvenereal treponematosis depends on both community and individual action. The community or mass measures comprise such health promotional measures as health and sex education, preparation for marriage, premarital and prenatal blood testing and improvement of social and economic conditions. Specific protection is rendered by attempts to suppress clandestine sexual promiscuity and by teaching methods of personal prophylaxis. All these control measures are accomplished by co-operative activities of the citizens in the community and the local health organizations. The citizens participate both individually and through such organizations as (in the U.S.) the American Social Hygiene association, a voluntary agency that devotes its time to collecting pertinent information and making it available to all who need it.

Mechanical prophylaxis by means of the condom is a practical prophylactic method. Local chemical prophylaxis has been used with decreasing frequency, and soap and water, while desirable for general hygienic purposes, is of dubious etiectiveness except in chancroid. Administration of penicillin after exposure has been extremely effective in the prevention of both syphilis and gonorrhea.

Additional community measures include the provision of facilities for case finding through contact investigation and selective serologic testing, as well as facilities for early diagnosis and treatment.

Control of infected individuals involves adequate diagnosis, investigation of contacts and sources of infection, proper treatment and notification of cases to health authorities. Investigation of contacts by interviewing patients and tracing their contacts in the family and the community is a basic *sine qua* non for venereal disease control. Notification of cases is essential if dependable data on occurrence, distribution and trends are to be available.

Control measures for nonvenereal syphilis are the same as those for yaws and pinta. Community activities include health education, improved sanitation and social-economic conditions, and provision for early mass diagnosis and treatment. It is recommended that all familial contacts of persons with any type of treponematosis be treated with penicillin as a community and family control measure.

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VENETI, name of two ancient European tribes.

1. **A** Celtic people in the northwest of Gallia Celtica. They were the most powerful maritime people on the Atlantic and carried on a considerable trade with Britain. In the winter of 57 B.C., they took up arms against the Romans, and in 56 were decisively defeated in a naval engagement.

2. The inhabitants of a district in the north of Italy. It was at first included in Cisalpine Gaul, but under Augustus was the tenth region of Italy. The Veneti were a peaceful people, chiefly engaged in commercial pursuits. They carried on a trade in amber, which reached them overland from the shores of the Baltic.

They were famous for their skill in the training and breeding of horses. Homer (*Il.* ii. 85) speaks of the Paphlagonian *Henetoi* as breeders of "wild mules," and their fondness for horses is regarded as a proof of their descent from the "horse-taming" Trojans. Dionysius, tyrant of Syracuse, who assisted them in repelling the attacks of the Liburnian pirates, is said to have kept a stud in their country.

Herodotus mentions a curious marriage custom. Once a year the marriageable maidens of a village were collected together. Each young man chose a bride, for whom he had to pay a sum of money in proportion to her beauty., The sums thus obtained were used by the public officials to dower the less beautiful and thus afford them the chance of obtaining husbands.

The first historical mention of the Veneti occurs in connection with the capture of Rome by the Gauls. whose retreat is said to have been caused by an irruption of the Veneti into their territory. Sometime during the Second Punic War they passed under Roman rule. At first, they possessed complete autonomy in internal administration; in 89 B.C. Gnaeus Pompeius Strabo bestowed upon them the *ius Latinum*.

Under the empire Venetia and Istria were included in the tenth region of Italy with capital Aquileia. Down to the time of the Antonines the country enjoyed great prosperity, which was interrupted by the invasion of the Quadi and Marcomanni and a destructive plague. It was devastated at intervals in later times by the barbarians — by the Alamanni, Franks and Juthungi in 286; by the Goths under Alaric (beginning of the 5th century); by the I-Iuns under Attila (452), who utterly destroyed Aquileia and several other cities.

Under Theodoric the Great (ruler of Italy from 493 to 526) the land had rest, and in j68 was occupied by the Lombards.

See also VENETIA; VENETIC LANGUAGE.

VENETIA, a comprehensive name for the eastern half of northern Italy. The Latin name Venetia, from which the English is derived, meant simply the country of the Veneti (*q.v.*). In Italian, however, the etymologically equivalent form Venezia is the proper name of Venice itself and requires some qualifying epithet wherever it is used to denote anything beyond that city. Venetia, then, in the extended English sense, is the area bounded on the west by the Italian *regione* of Lombardy, on the northwest by the Swiss Grisons, on the north by the Austrian Tirol and by Carinthia, on the east by Slovenia and on the south by the Adriatic gulfs of Trieste and of Venice and by the vegione of Emilia-Romagna. It thus comprises three *regioni,* as follows: (1) the Veneto, or Venezia Euganea; (2) Friuli-Venezia Giulia; and (3) Trentino-Alto Adige. or Venezia Tridentina. The size and composition of the aggregate have varied in the course of history.

The mediaeval history of Venetia is inseparable from that of the republic of Venice (see VENICE). Further details are to be found under FRIULI, PADUA, VERONA, VICENZA and, for a territory that resisted the republic's encroachment, TRENTO. The comnion danger of Turkish expansion, from the end of the 15th century onward. led to a settlement of the long-standing dispute between Venice and the Habsburgs for the possession of the eastern territories, whereby Venice secured Friuli (with western Istria also). After the overthrow of the republic, however. France and Austria redistributed Venetia under the treaties of Campo Formio (1797) and Pressburg (1805). Next, on the downfall of Xapoleon. the whole territory was occupied by the Austrians.

In 1866. as a consequence of the Seven Weeks' War, the kingdom of Italy, unsuccessful though it had been in its own aggression against Austria: acquired those parts of Venetia that had belonged to the republic of Venice ('including Friuli but not Istria). lifter World War I, however. Italian Venetia was greatly expanded. acquiring not only Trieste and its hinterland. Istria and Fiume (as well as Zara on the Dalmatian coastj but also: under the treaty of St. Germain (1919), the Trentino and the southern Tirol.

These new frontiers remained unchanged until World War II. By 1944 control over most of the mountainous area in the east of Venezia Giulia had passed to Yugoslav partisans; and in the negotiations for a treaty of peace with Italy the Yugoslavs showed themselves most reluctant to abandon Istria and certain districts in the north to the west of the Isonzo. The treaty of 1947 eventually gave them the Istrian peninsula except Trieste and its immediate neighbourhood and advanced their northerly frontier west of the Isonzo. thus transferring to them Plezzo, Sonzia. Caporetto. Tolmino and some other formerly Italian towns. For the final partition of the Free Territory of Trieste in 1954 see TRIESTE.

The Trentino and the southern Tirol were retained by Italy after World War II. For the policy adopted with regard to the large German-speaking population, which had withstood Italianization since the 1920s, see TIROL.

In 1955, then, the total area of Venetia was about 15,390 sq.mi., with a population of 6,200,000.

For the geographical description of the country, it is most convenient to treat the three regioni separately. as follows:

Venezia **Tridentina.**—This area comprises the provinces of Bolzano and Trento and covers about 5,252 sq.mi. It includes the mountainous area of the Venoste, Brenner, Aurine and Pusteria Alps on the frontier. the Ortles Alps in the west, the Dolomites in the east and the high plateaus of the interior. The chief rivers draining the mountain masses are the Etsch (upper Adige), the Isarco. the Noce and the Avisio, tributaries of the Xdige (*q.v.*), which flows down the principal valley from north to south through Bolzano and Trento to Verona in the plain of Lombardy. The valleys of the larger rivers (particularly that of the Xdige) are well populated and fertile, especially in the Trentino. Some peaks of the border Alps are among the highest in Europe: Palla Bianca (Weisskugel) (12.257 ft.), l'Altissima (11,414) and Punto Lago Bianco (11,588) in the Venoste Alps in the west; Pan di Zucchero (Zuckerhutl) (11,519) and Tribulaun (10,1j7) in the Brenner Alps; and Gran Pilastro (Hochfeiler) (11,j16) and Monte Lavello (11,083) in the Aurine Alps. Passes breaching these Alps are the Stelvio (9,048 ft.) into Switzerland; the Resia (4,944) and the Brenner (4,511) into the Austrian Tirol; and the Dobbiaco (4,232) into Carinthia. South of the Alpine massifs, a large part of the province of Bolzano consists of a roughly rectangular area between the Adige, Passirio and Isarco valleys, much of it a plateau averaging from 4,300 to 5,600 ft. This province is inhabited mostly by German-speaking Austrians.

Much of the regione is forested (particularly Bolzano) but the valleys are quite thickly populated and intensively cultivated. Vines are grown extensively on the hillsides, and fruit trees flourish even up to 4,000 ft. North of Bolzano rye is more common than maize and wheat. Farther south the main cereal is maize and then wheat, oats and barley. Cattle raising and dairy farming are found on the lower hills and slopes in the valleys. Forestry has been particularly developed.

In addition the area contains certain mineral deposits, chiefly of zinc, lead, copper and iron ore, which the Italians have attempted to exploit. Some mechanical industries sprang up, and hydroelectric power stations were built to utilize the power of the rivers (principally the Adige and Noce). By 1954 there were about 100 small undertakings engaged in mining (with a labour force of around 900). Manufacturing concerns (most of them very small) numbered 11,274, employing about 34,000. A labour force of 10,300 was engaged in construction; and enterprises concerned with electricity, power gas and water employed 12,000 workers.

The tourist trade provides a large item of income. In the mid-1950s tourists numbered around 150,000 annually. The most famous resorts are Merano. Bressanone, Vipiteno, Dobbiaco and Brunico in Bolzano; and Madonna di Campiglio. Canazei. Levico and Roncegno in the province of Trento. From the Lombard plain several roads and railway lines converge on Trento (from Brescia, Verona. Vicenza and Padua). Road and railway follow the main valley (Val di Adige) to Bolzano. From there the Val Venosta strikes west (road and railway) toward Switzerland. and at Merano a road branches to the Brenner. A second road and railway goes north from Bolzano along the Val d'Isarco to the Brenner, throwing off a route (road and railway) eastward via Brunico into Carinthia. (See also TRENTINO.)

Venezia **Euganea.**—This is the original core of Venetia. It comprises the seven provinces of Venice, Padua, Rovigo. Verona, Vicenza, Treviso and Belluno, an area of 7,100 sq.mi., with a population of around 4,000,000 (1955). The territory comprises mountainous country to the northwest, where it is bordered by the Dolomites, and to the north, where the Carnic Alps form the frontier with Austria. Within its own northern area there are the Venetian Alps. Passes through the Carnic Alps into Carinthia are the Monte Croce (4,258 ft.) and, with both road and railway, the Camporossa. The southern part is an extension of the Lombard plain, through which run the Po, the Adige and the rivers draining the Dolomites and Venetian Alps (Brenta, Piave). These rivers (and particularly the Po) form an extensive delta area stretching along the Gulf of Venice, whose shore lagoons are kept healthful by the fairly considerable tides of the Adriatic.

The sunny slopes of the mountainous area are cultivated, vines and various fruit trees being the chief produce. The valleys provide good meadowland and arable soil in many places. Like Venezia Tridentina, the mountainous parts of the region are well known to tourists. The low-lying area of Venezia Euganea with its coastal fringe of lagoons and deltas is extremely fertile, and much use of irrigation has been made, together with a considerable effort to reclaim land. The population is largely agricultural; the principal crops are wheat and maize, with beans, sugar beet, potatoes and vines also important.

As in many other parts of Italy after World War II, a number of large estates were expropriated and divided among small holders and peasants.

The larger towns of the plain have various industries: textiles. silk, lace, hemp, paper, iron founding, shipbuilding, etc. Many are well supplied with hydroelectric power. Venice, population (1951) 174.632, is not only a city of historical. architectural and cultural fame. but also a considerable port and possesses a large industrial zone at Marghera. The traditional occupations of glass, lace and tapestry making are still carried on. Though the largest vessels can only be berthed nearby, Mediterranean trade is important. Adjacent are the small islands of Murano and Burano, specializing in glassware and in laces respectively. Verona (134,-636), below the southern spurs of the Dolomites. is also famous for its architecture and for its cultural and historical associations. It also does a considerable trade in silk, wool, leather and textiles. Padua (138,951), an equally ancient city, is likewise an agricultural centre of importance and has engineering, silk and textile and chemical industries. Vicenza (61,207) is another agricultural market and manufactures textiles, fertilizers and luxury goods. Treviso (53,165) has textile mills and industrial plants. Rovigo (17,588) is the agricultural centre for the Po delta. Valdagno is a centre of the textile industry. Apart from Venice, only Chioggia, an important fishing port and centre of the lace industry, is noteworthy.

Friuli-Venezia **Giulia.**—This division. to the east of Venezia Euganea, comprises the provinces of Udine and Gorizia, with the rump of Trieste.* The whole has an area of 3,033 sq mi. with a population of 1,226,121.

The Italian part of the Julian Alps (some reaching around 9,000 ft.) is a barren area. Farming of a limited nature is carried on, but there is little cattle raising. Friuli, lying between the Carnic Alps to the north, the Venetian Alps and the eastern Venetian plain to the west and the Julian Alps and the Isonzo to the east is partly hilly and partly plain; the plain is fertile and fairly thickly populated. The capital of Friuli is Udine (65.199 inhabitants), chiefly an agricultural centre. The hilly Carnia area to the north resembles the Dolomites in scenery and is economically of little value. The Carso (Karst) area, bordering on Yugoslavia, is a barren and arid stretch of limestone. There are small farms where sheep and goats are reared. The produce of the land is composed largely of vines, some root crops and a little maize. Nearer the coast fruit is also grown. On its coastal strip are the historic and decayed cities of Aquileia and Grado. Monfalcone, with its shipyards. is important. Most of the population on the coast live by fishing. Inland is Gorizia (1951) 34,607, principally an agricultural centre.

Trieste (259,167), the sole possession of Italy in the Istrian peninsula, is a beautiful and important metropolis. It was once the chief port of Austria-Hungary, from which it derived its prosperity. It has considerable maritime traffic; shipbuilding yards (with an output of 16% of Italy's total in this sphere) ; and an engineering industry, with metallurgical foundries and refineries.

(J. D. L.)

VENETIC LANGUAGE. The language of the Veneti (*q.v.*) is recorded in almost 200 short inscriptions, which have been dated to the last five centuries before Christ. It was spoken in northeastern Italy, in the plains around the head of the Adriatic and in the mountains to the north. The inscriptions are for the most part inscribed either as epitaphs or on objects dedicated to one or another deity. The principal sites which yielded the linguistic evidence are Este, Padua, Vicenza, Trieste, Pieve di Cadore and the Gurina plateau in Austrian Carinthia. These inscriptions are written in an alphabet characteristic of them, but which was obviously borrowed from the Etruscans who had established settlements in the Po valley toward the end of the sixth century B.C. It is preserved on several bronze tablets from Este, and in the transliteration here used runs as follows: *a e v d h 0 k 1 m n p ś r s t u b g o*. The symbols here transcribed *d b g* correspond graphically to the Etruscan and Greek letters *z* ϕ χ; but that the sounds indicated by them were voiced stops is clear from such correspondences as that of *triφus-* in the native alphabet, with *TRIBUS-* in the Latin. The digraph *vh* was used with the value of f, as in Etruscan; *t* and *0* were both employed for the sound *t*, as were *ś* and *s* for *s;* a letter *i* occurs in the texts but not in the alphabets; and a *k* of distinct form is found in the northern inscriptions. A remarkable feature of Venetic writing is the punctuation system: vowels not preceded by consonants, and consonants not followed by vowels (excepting those followed by *r, n, 1)* are regularly written with a point on either side of the letter. This system, apparently devised for a syllabary, is also found in a few Etruscan inscriptions.

In the inflectional system of Venetic at least four cases for the noun can be identified. Such nominative forms as *ve·r·ko·n·darna* (a feminine name), *va·n·t·s·*, and *e·kupeθari·s·* ("charioteer"?) are found. A certain instance of a genitive is *enoni,* and probable occurrences appear in *re·i·tii* and *makkno·s·* (all masculine names). Dative forms are recognized in *re·i·tiia·i·* and *lo·u·dera·i·* (both feminine divine names) and in *rako·i·*, *pupone·i·*, *ve·i·gno·i·* and *·o·stiiare·i·* (all names of men); *vda·n·*, *dono·m·* ("gift") and *e·kvo·n·* ("horse") are examples of accusatives. Among the few surely identified noun plural forms are the datives *lo·u·derobo·s·* ("children"?) and *andeticobos*. The following are verbs: *doto* and *dona·s·to* (both are third person singular preterite and are translated "gave"); *vhag·s·θo* ("made"); *tula·r·* (also *tole·r·*, *tola·r·*) ("offers"); and *·e·s·t·* ("is"). As pronouns *·e·go* ("I"), *mego* ("me"). and *sselboisselboi* ("for himself") are found. Other parts of speech are represented by the conjunction *ke* "and" and the prepositions *pe·r·* and *·o·p*.

The following texts are typical examples of Venetic inscriptions:

1. On a bronze pin found at Este: *mego dona·s·to vhugiia vho·u·-go·n·tiiaka śa·i·nate·i· re·itiia·i·* ("Fugiia Fougontiiaka dedicated me to Śainatis Reitiia").
2. On a vase from Padua: *voθo kluθiiari·s· vhag·s·θo* ("Voto Klutiiaris made [it *or* me]").
3. On a cinerary urn from Este: *va·n·te·i· vho·u·go·n·tio·i· ·e·go* ("I am for Vants, son of Fougonts").
4. On a bronze pin from Làgole di Calalzo, near Pieve di Cadore: *o·l·lo·s· aliisiko·s· doto dono·m· trumus katei* ("Ollos Aliisikos gave [this as a] gift to Katus Trumus[iiatis]").

It is clear that Venetic was an Indo-European language. Carl Pauli, the first scholar who discussed the question of its position within the family *(Die Veneter und ihre Schriftdenknzaler,* 1891), related it most closely to the scantily known idiom of ancient Illyria *(see* ILLYRIAN LANGUAGE), and for almost 60 years Venetic was regularly classified as an Illyrian tongue. This view, however, has now been abandoned by most students of the subject; some regard the language as closely related to Latin and to the other members of the Italic branch, while others classify it as a wholly independent member of the family. The evidence is not sufficient to afford a completely unambiguous answer to the problem.

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VENETO, BARTOLOMMEO (c. 1480–1530), Venetian painter, whose portraits combine brilliant show of wealth with pensive or poetic mood to present notable embodiments of Renaissance man. The slightly rigid simplicity of style in Bartolommeo's portraits adds to the effect of objectivity and contrasts with Titian's treatment of the same people. The only extant documents pertaining to his life tell of his stay as court painter at Ferrara (1505–08). Ownership and signatures of paintings indicate an early career in Venice and a later one in Milan; his hypothetical stay at Bergamo has been refuted. One curious signature of 1502, to which he adds the phrase "half Venetian half Cremonese." doubtless refers to family origin and not to stylistic influence as is sometimes inferred. In a more important but less noted signature of 1509, he called himself a pupil of Gentile Bellini.

Bartolommeo's earliest works (1502–05), Madonnas of the Bellini type, are of little interest. His early, somewhat fanciful portraits (1505–08), of which the best known is at Frankfurt, were considered to have been painted under German influence. The famous portraits (c. 1512) were followed by his Milanese works such as the "Lute Player" (Gardner museum, Boston) in which poetic fancy dress has given way to Leonardo da Vinci's influence.

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VENETTE, JEAN DE (c. 1307–*c.* 1370), French chronicler, born at Venette, near Compiègne, became prior of the Carmelite convent in the Place Maubert, Paris, in 1339, and was provincial of France from 1341 to 1366. In 1368 he was still living, but probably died within a year or two of that date. His Latin Chronicle, covering the years 1340 to 1368, was published by Achery (*Spicilegium,* vol. iii). Jean de Venette's sympathies were entirely with the peasants. Jean de Venette also wrote a long French poem, La Vie *des trois* Maries, about 1347.

VENEZIANO, DOMENICO: see Domenico Veneziano.

VENEZUELA, a republic of South America on the Caribbean coast, is approximately four times the size of the United Kingdom or one and one-third the size of the state of Texas. Venezuelans are predominantly of mixed ancestry. Indian, Negro and European strains are all present in significant quantities. Petroleum and iron ore have, in the 20th century, made Venezuela a treasure-trove of the modern world. The republic has derived relatively little from the exploitation of its natural resources, as officials have channeled a large share of fiscal revenues into the pockets of a few individuals rather than into the development of the national economy or social and cultural institutions. The gap separating the elite groups*from the masses has broadened noticeably since the large-scale development of the petroleum industry in the 1920s. Political and cultural lags have been at least as pronounced as that in the economic area. From 1899 to Jan. 1958, except for three years (1945–48), Venezuela was controlled by force through a military leadership from the Andean state of Táchira. This ruling element neglected basic education while it provided funds for a few institutions which could attract international recognition.

Many of the attitudes found in Venezuela in the second half of the 20th century can be traced back through the 19th century to the colonial period. After gaining its independence from Spain between 1810 and 1821, through the efforts of its most illustrious son, Simón Bolivar (*q.v.*), Venezuela for the remainder of the 19th century had a dilatory existence, punctuated by power struggles among those who constituted the narrow social and ruling class. The republic during this era had little to offer the world and was largely immune to impulses emanating from Europe and the United States. Still earlier, as a Spanish colony, the European settlers, after a brief but stormy period of searching for sudden wealth had accepted a prosaic way of life, based upon agriculture, in which they held sway over native Indians and imported Negroes.

Venezuela means "little Venice" and is a modification of the name Venecia (Venice) originally bestowed by Alonso de Ojeda in 1499 on an Indian village of pile dwellings on the shores of the Gulf of Maracaibo (called by him the Gulf of Venecia).

(J. J. J.)

I. PHYSICAL GEOGRAPHY

Geology and Structure.—In the basement complex of the Guiana highlands and in the axis of the Cordilleran and Maritime ranges of Venezuela are found some of the oldest rocks in northern South America. In the Venezuelan part of the Guianas these consist of a great mass of Archaean granite, gneiss and other crystalline rocks with overlying nearly horizontal bands of sandstone and shale. The core of granites and schists which forms the axis of the Cordilleran and Maritime chain is in large part flanked by sedimentary beds folded in anticlinal structure. Most of these latter are of early Cretaceous Age and are locally much altered. At places they are overlain by Pleistocene or Recent deposits into some of which are intruded dikes and masses of igneous rocks.

The llanos (plains) between these mountain systems are largely covered with broad Terciary and Quaternary deposits of gravel, sand and clay loam. In the delta region at the mouths of the Orinoco these deposits are thick and are accumulating rapidly. The depression in which lie Lake Maracaibo and adjoining lakes and lagoons is to some extent outlined by faults and has a surface deposit of Quaternary alluvium underlain by folded Cretaceous and Terciary beds. These beds are of particular importance because from them rise the petroleum seepages which led to the discovery of enormous quantities of oil. The sedimentary deposits of the northeastern llanos also are underlain in places by oil-bearing materials.

Physiography (or Relief and Drainage).—Venezuela's drainage system consists mainly of one large river, the Orinoco. Probably not less than four-fifths of the country's territory belongs to the Orinoco system. This river has several hundred tributaries, gathering the interior runoff from the northern mountains, draining most of the eastern slope of the Colombian Andes and collecting most of the water that runs northward and westward from the Guiana highlands, in addition to carrying off the water supplied by heavy seasonal rains over most of the llanos and some of the heavy all-year rainfall of the forests southward from these great plains. The Orinoco was long believed to head in the Guiana highlands but it was only in 1951 that its true head was discovered in the Cordillera Maigualida of the western Guiana plateau at lat. 2° 19′ 05″ N., long. 63° 21′ 43″ W., 3,523 ft. above sea level. From this point, after flowing for about 1,700 mi., the river makes an almost complete circle before heading eastward to the Atlantic. A unique feature of the upper Orinoco near its head is its bifurcation as it leaves the Guiana highlands, a part of its flow continuing northwest to form the lower river, while a branch, the Casiquiare, turns southwest and carries a large volume of water into the Rio Negro which, in turn, joins the Amazon. Among the larger tributaries of the Orinoco are the Caroni, Aro, Caura, Cuchivero and Ventuari which have their sources in the Guiana highlands; the Apure, Arauca, Capanaparo, Meta, Vichada and Guaviare (the last three being Colombian rivers) running across the llanos from the Andes; the Manapire, Suata, Pao and Caris from the central plains.

Apart from the Orinoco and its tributaries the rivers of Venezuela are short and comparatively small, and, except for those of the Maracaibo basin, are rarely navigable. The San Juan, the Guanipa and the Guarapiche flow from the eastern llanos to the Gulf of Paria; the Aragua. Unare and Tuy flow to the Caribbean coast east of Caracas; the Yaracuy, Aroa and Tocuyo reach the same coast west of Caracas; and the Motatán, Chama, Escalante, Catatumbo, Santa Ana, Apón and Palmar discharge their waters into Lake Maracaibo.

Lake Maracaibo (*q.v.*) is the largest body of inland water in Venezuela, being 133 mi. long and 72 mi wide. Though shallow along its margins, it is deep enough over much of its surface for ocean-going vessels. It is connected with the Gulf of Venezuela through a strait 40 mi. long and varying in width from 3 to 10 mi., being narrowest where the city of Maracaibo is situated. In the outlet there are about 13 channels, their number and depth varying from time to time, being partially obstructed by banks of sand and mud. The normal depth of the main channel at low tide is about 7 ft., and at high tide about 12 ft. The channel has been dredged by the Venezuelan government. This *makes the lake accessible for the first time to deep draft ships and allows oil to be exported without transferring from shallow draft lake vessels.*

Another important lake is Valencia. near which the city of the same name is located. in the Maritime Andes 1,339 ft. above sea level. There are also numerous small lakes both in the llanos and in the mountainous section of the country. One of the most unusual lakes is that called Bermúdez Lake or Lago hsfalto, about 25 mi. up the San Juan river from the Gulf of Paria. It has an area of 1,100 ac. and its surface is made up of asphalt in a layer about 3 ft. deep. Shipments of asphalt from the lake have been made to many parts of the world.

The delta of the Orinoco is even more complicated than the Lake Maracaibo depression. It is crisscrossed by a multitude of channels, locally called caños. The main outlet is the Boca Grande at the mouth of the Corosimi channel. but one of the central channels, the Caño Macareo, leads more directly to the Gulf of Paria, the Island of Trinidad and the Caribbean sea. This caño has been deepened sufficiently to allow the passage of ocean-going vessels. Since the lower Orinoco itself has been dredged for vessels of 23 ft. draft, this opens a deep draft water route through the delta and up to the newly constructed Puerto Ordaz, thus facilitating the development of the lower Orinoco region.

Coast Line.— *Venezuela fronts on the Caribbean sea for about 1,500 mi. and for 300 mi. on the Atlantic ocean. There are a number of indentations, particularly on the Caribbean coast and some of these provide the country with serviceable harbours. On the far northwest the spacious Gulf of Venezuela, sometimes locally called the Saco de Venezuela, with its enclosed Gulf of Coro and its much greater landward extension in Lake Maracaibo, offers good protection behind the peninsula of Paraguaná on the east and the peninsula of Guajira on the west. In the far northeast of the country the Gulf of Paria lies well sheltered between the peninsula of that name and the off-shore British possession of Trinidad. The Gulf of Cariaco, lying behind the peninsula of Araya, offers excellent shelter. The Golfo Triste is a rather open indentation in the coast, on a part of which is situated Puerto Cabello. The Gulf of Santa Fe is a small inlet lying behind a narrow strip of land on the northern coast of the state of Sucre. The shipping of the country uses a number of estuaries and open roadsteads, such as those of La Guaira and Carupano.*

Curiously enough, the country's principal port, La Guaira, is not situated in a protected natural harbour, but on an open roadstead, with mountains rising picturesquely but formidably out of the sea. The city is strung along the base of the hills, as are also its airport Maiquetía, and suburban settlements. Puerto Cabello, though on a nearly open coast, has the protection of shoals offshore, and a small. low-lying spur of land into which dredging has opened passages sheltered from heavy seas.

Islands.— *There are 71 islands, with an aggregate area of 14,633 sq.mi., according to official calculations. The largest of these is the Island of Margarita (q.v.), 23 mi. off the coast of the state of Sucre.*

Climate.— *The climate of Venezuela is everywhere tropical in that winter never comes there and the seasons are periods of rainfall rather than of temperature. The year is divided into two seasons, the rainy and the dry (locally known as winter and summer), the former extending from April to October or November, the latter most marked from November through March or April. Vegetation growth, therefore is timed in harmony with these two seasons. The wet and dry seasons also regulate agricultural activities, affect travel and transportation, determine vacation periods, and, to a degree, influence even aviation. Temperature differences, on the other hand, are slight throughout the year. Average temperature, for example, at Caracas is 67° F., and no month averages more than 69° or less than 64°. Altitude, however, affects temperatures in marked fashion. For example, Maracaibo-at sea level averages just over 82° for the year, and Mérida at 5,325 ft. averages just over 65°. On some of the higher mountain peaks temperatures are low enough to permit fields of permanent snow. Whatever the average temperature there is little difference from month to month. The only marked variation in temperature is from day to night, this difference being greater than that from month to month.*

Rainfall varies much from district to district within the country. The northeast trade winds blow across the low coastal districts without leaving much precipitation, in places less than 20 in. per year. La Guaira, for example, has only 11 in. Most of the coastal lands, consequently, have scant, dry vegetation. Areas lying behind topographic barriers also get little rain. Windward slopes, on the contrary. are generally well watered. In places enough rain falls to support a lush jungle growth, in places a true selva (rain forest). Most of the well-populated part of the country is dry rather than humid, but everywhere there is a marked seasonal variation. The llanos suffer severely from want of rain from about January to April and then suffer equally from an over-abundance that floods whole countrysides from June to October.

Vegetation.— *About half of Venezuela is covered with forests of some kind. A little less than half is still in native grass, though much of this is used for at least occasional grazing. Only about 2%, mostly in the valleys of the Andes and the coast ranges, is under permanent cultivation. The vast llanos of the Orinoco basin, much of the lofty tablelands of the Guiana highlands, and numerous smaller areas in the Andean paramos (high bleak plateaus), have little in the way of trees. In the better-watered places the grass is compact and tall, in drier areas, such as high Andean districts and parts of the Guiana tablelands it is sparse and hard. True selva covers a relatively small area but is found in the lower Orinoco basin and delta, in some of the far southern Orinoco drainage basin bordering on Colombia and Brazil, and in smaller extensions about the windward lower and middle slopes of the northern highlands.*

Most of the plant life of Venezuela is tropical in that it is non-deciduous, retaining its foliage through the year, or shedding its foliage little by little, never becoming entirely leafless. Even in the arid regions where the vegetation is sparse and the foliage scant, there is little change from season to season.

Both native and introduced plants cover a wide range because of the altitudinal climatic zones. The true tropical vegetation, whether moist or dry, extends to an altitude of about 1,500 ft., above which it gives way (except in the moister districts) to what map be called semitropical with tree ferns and orchids. which reaches up to about 5,000 ft. From this point, up to from 7.000 to 8,000 ft. there is a transition into a mountain type. and above 8,000 or 9,000 ft. the characteristic paramo vegetation begins, with plants of an alpine character dominating from this altitude upward. Whatever the altitude, native plants remain non-deciduous.

The principal plants of economic value grown in Venezuela are coffee, cacao, tonka beans, sisal and bananas, raised in part at least for export; while corn, beans, wheat, rice, potatoes, sugar cane, cotton. tobacco. sweet potatoes. and below about 5,000 ft., oranges, lemons, coconut palms, papayas, avocados, mangos, cashews. guavas, breadfruit, zapotes, granadillas, cassava (both bitter and sweet), are commonly grown for local consumption. With the rapid growth of population and the demand for labour in the oil fields and related business enterprises since the 1920s, little of any of these crops, except bananas. has been exported. In fact, wheat flour, potatoes and some other vegetable food products have had to be imported.

Animal Life.— *The fauna of Venezuela is quite similar to that of the neighbouring regions of Colombia. Brazil and the Guianas, the open llanos of the Orinoco being something of a neutral district between the great forested regions on the east, south and west. There are no effective natural barriers serving to isolate the country. Among the animals indigenous to the country are seven species of the cat family, including the puma. the jaguar and the ocelot; the wild dog (Canis azarae); representatives of the marten family, including two species of Galactis, two of the otters (Lutra braziliensis and L. pteronura) and one of the skunk; two species of bear (Ursus ornatus and O'. nasutus); and the kinkajou, a carnivorous. arboreal, prehensile-tailed quadruped about the size of a cat. There are 6 species of monkeys corresponding to those of Guiana and the Amazon valley; the sloth and anteater; 12* known genera of rodents, including many species of *Mures;* the cavy, the capybara, the paca, the nutria, the agouti, the tree porcupine (*Loncheres* cristnta), spiny rats (*Echimys cayen*) and the Brazilian hare. Among the pachyderms the tapir is found in the forests of the Orinoco. There are two species of the peccary (Dicotyles *torquatus* and D. *labiatus*). There are also two species of deer (*Cervus rufus* and C. *simplicornis*). There are three species of opossum. On the coast and in the Orinoco there may be found the manatee and the dolphin. The Reptilia include 11 species of the crocodile. alligator and lizard. including the savage jacare of the Amazon, several species of the turtle, 4 species of batrachians and 29 species of serpents. including the striped rattlesnake (*Crotalus durissus*), the bushmaster (Lachesis *mutus*) and a rather rare species of *Cophias.* Among the nonvenomous species of the last. the commonest are the boa constrictor, the anaconda (*Eunectes murinus*) and the Coluber *variabilis.* Bird life is represented chiefly by migratory species. particularly the genera that inhabit the shores of streams and lagoons. In the *garzeros* ("heron rendezvous") are to be found nearly every kind of crane, heron, stork and ibis, together with an incredible number of Grallatores. Ducks are also numerous, including a small one called the *guiriri,* in imitation of its cry. Birds of prey are numerous. One species, the guacharo (*Steatornis caripensis*), or oilbird, is commonly said to occur only in Venezuela, though it is found on the Island of Trinidad, in Colombia and Ecuador also. These birds live in caves, especially in Caripe, and are caught for the oil extracted from them. The bellbird (*Chasmorhynchus niveus*) is common in the forests of the Orinoco. In the 14 orders of insects there are no fewer than 98 families. There are 8 families of Coleoptera, 6 of Orthoptera, 23 of Hymenoptera, 14 of Lepidoptera and 7 of Diptera. Locusts are common in the interior, though seldom constituting a plague. Molluscs, including the pearl oyster, are common on the coasts and in the fresh-water streams and lakes.

Domestic animals common to other parts of the continent are found in Venezuela. The number of cattle is estimated at 6,700,000 and most of these are found in the great herds that pasture on the unfenced llanos. There also are about 920,000 goats, 176,000 sheep and 2,360,000 swine. Oxen and horses and a few mules are used as draft animals on some farms: farmyard poultry is as common as elsewhere. There is no sharp altitudinal zoning of domestic stock,,but in the extreme highlands some animals, notably horses and cattle! suffer from the altitude more than others. All animals taken from the lowlands to highlands require a short period of acclimatization, as does man, though not to the same extent as in the higher regions of the Andes in Colombia, Ecuador, Peru and Bolivia.

II. GEOGRAPHICAL REGIONS

The surface of Venezuela is broken into three major irregular divisions: (1) the mountainous area of the northwest and north; (2) the extensive, nearly level basin of the Orinoco river; and (3) the Venezuelan section of the Guiana highlands. A branch of the Cordillera Oriental (eastern range) of the northern Andes enters Venezuela in the west at about lat. 7° 30′ N. and proceeds northeastward and then eastward toward the Gulf of Paria and the Island of Trinidad. with gradually diminishing elevation. This branch consists of more or less parallel chains of mountains. bordered by numerous paramos in the far west and enclosing a number of valleys elevated well above sea level, but not so high as the great valleys of the Andes in Colombia. Ecuador, Peru and Bolivia. The western, higher section of the Venezuelan Andes is known as the Sierra Nevada de Mérida and contains five peaks reaching 16,000 ft. or more. The highest of these. Bolivar peak (16,411 ft.) is followed by several other snow-capped peaks of almost equal height (La Columna, Monte Humboldt, La Concha). The bordering paramos range from 8.000 to 10.000 ft. Numerous basins and valleys here lie at elevations of 4,000 or 5,000 ft., the city of Mérida in a valley of the same name being 5,325 ft One mountain pass, however, only 4.600 ft. high, runs from the Orinoco plains to the Caribbean lowlands of Lake Maracaibo, and through it has been laid the Venezuela-Colombia boundary line. Eastward from a 13,500 ft. pass near Mucuchies the enclosed valleys are much lower. That of Trujillo is less than 3,000 ft. high, that of Barquisimeto is 1,800 ft.. the Valencia basin, 1,500 ft., that of Caracas, 3,000 ft. Few of the mountains in this region rise more than 5,000 ft. above sea level. Farther to the east the mountain ranges, knonn as the Maritime Andes, become lower and almost disappear over a 100-mi. stretch. to reappear and continue as parallel low ranges to the Gulf of Paria. A number of spurs from 3.000 to 5,000 ft. high extend northward from the main range of the Venezuelan Andes, enclosing the Maracaibo depression on the east and constituting a wide region of broken terrain, low mountain ridges alternating with valleys that lie, in general, less than 1.000 ft. above sea level. The western part of this region, known as the Segovia highlands, contains a rather sparse population. because it is rather arid but, together with the better-natered region just east of it. constitutes the real Venezuela, historically the dominant part of the country. the other parts of the national territory forming mere appendages to this true heartland.

Bordering this mountain and valley country on the south lies the vast basin of the Orinoco, consisting mostly of an extensive, almost featureless alluvial plain, the llanos. This plain slopes gently southnard from the foot of the Andean country of central Venezuela for over 250 mi. to the river, and south of the river rises gently at first, then more abruptly into the Guiana highlands. From the foot of the Colombian Andes it extends eastward for over 600 mi. to the Atlantic coast where it merges into the ocean in the broad, many channeled delta of the Orinoco which, of itself, covers about 10,000 sq.mi. In all of this expanse there are no mountains and few small hills to break the monotony of the landscape. Numerous tributary streams cross the plains but they run in shallow channels and the flat-topped interfluves rise little above the water in the streams. Around the margins of the llanos the land lies about 600 to 800 ft. above the general level, but most of the plain does not rise more than 300 or 400 ft. above the sea. So uniform is the level over a great part of the area that, in the rainy season, many hundreds of square miles are inundated. North of the lower Orinoco, however, there is a series of low gravel-capped mesas of 1.000 ft. that form a divide and shunt a number of small rivers northward to the Caribbean and others eastward as independent streams to the delta.

South and southeast of the llanos the land rises, gradually at first then abruptly into a great upland, the Venezuelan section of the Guiana highlands, generally called the Gran Sabana (great plain) because of the high, flat-topped mesas that make up much of the region. Though comprising nearly half of the country's area, it contains less than 3% of the population, and is one of the least developed and least known parts of the nation, and, indeed, of all South America. The general level probably does not exceed 4,000 or 5,000 ft., but some of the broad plateaus. or mesas, are several thousand feet higher. Toward the Brazilian and British Guiana border the land rises still higher, the giant table mountain of Roraima having an elevation of 9,219 ft. Much of the Guiana highland is intricately dissected by streams that flow in deep, steep-sided canyons, thus creating a labyrinth of strikingly varied topography. At the brink of one of these great tablelands about 8,000 ft. high. about 160 mi. from Ciudad Bolivar was discovered in 1935 nhat is believed to be the highest waterfall in the world, Angel Falls, 3,280 ft. high and some 500 ft. wide at the base. This cataract is located on the Carrao river, an upper tributary of the Caroni. It was named for the U.S. adventurer, James Angel (d. Dec. 8, 1956), who first reported its existence.

Many spectacular falls of almost equal height, and a number of smaller ones are known to exist among the deep canyons of the Gran Sabana. Local maps mark many "saltos," as these falls are called. By mid-20th century the region attracted tourists, who follow poor roads from Orinoco river points or fly to little towns near the base of the cliffs. Northward these highlands drop off' gradually from their base toward the Orinoco river, low hills reaching the river's channel where Ciudad Bolivar is located. Together with corresponding low hills on the other side of the river they confine the channel to a width of only ½ mi. The city founded there in early colonial times bore the name La Angostura ("the Narrows") until 1849 when it was changed to honour the great

Liberator. Simón Bolivar.

The highlands of the Venezuelan Guianas descend toward the northeast into a depression which drains southward through the numerous tributaries of the Cuyuni river, into British Guiana, while between this depression and the delta of the Orinoco rises another chain of low mountains. the Sierra Imataca and the Altiplanicie de Nuria, a granite tableland, averaging 2,000 ft. in height. On the west the Guiana highlands of Venezuela are bordered by a series of lower ranges and uplands nhich extend northward and westward to the plains country of the upper Orinoco and upper Amazon tributaries. The southern margin of the highlands coincides approximately nith the Venezuelan boundary. The highest ridge in this extensive upland, generally called the Sierra Pacaraima and the Parima sierras, constitutes the watershed between the middle Orinoco and the Rio Negro tributaries of the Amazon and has been adopted as the boundary between Venezuela and Brazil for about 500 mi Because of the favourable climate, soil and natural vegetation of this great highland area and the enormous water power available in its many streams and the rich mineral deposits being discovered in places about its border. it gives promise of becoming a very important section of Venezuela.

III. THE PEOPLE

Racial Types. — Racially the bulk of the population is of mixed (mestizo) ancestry, the European element predominating. Between 1% and 2% of the people of Venezuela are purely indigenous, living mainly in the Orinoco-Amazon forests of the extreme south and in the extreme west along the lower slopes of the Colombian-Venezuelan Andes, not far from Lake Maracaibo settlements. Few remain from the relatively civilized Indians that had occupied the higher Andean regions near Mérida dnd Táchira. The number of those of unmixed African ancestry is also small, and settled mainly along the Caribbean coast in such centres as La Guaira, Puerto Cabello and Cumana. The number of those of unmixed European descent is larger, without, however, constituting the largest ethnic group. There are small groups of foreigners living in the more progressive parts of the country. After World War II the largest single group (about 100,000) came from Italy, the next from Spain (about 75,000) and the third a fluctuating population. mainly from North America, and largely associated with the oil industry, numbering normally from 30,000 to 40,000.

Languages. — Spanish, the official language of Venezuela, is spoken by 97% or 98% of the population. Members of the intellectual middle class and the upper class customarily speak at least one foreign language. Formerly German and French predominated, but English has become the principal second language. Indian languages are spoken by 2% or 3% of the population. For a detailed listing of the Indian languages of Venezuela, see INDIAN, LATIN-AMERICAN.

Religion. — Church-state relations are maintained under the terms of a law of July 28, 1824, which made Roman Catholicism the official religion. Freedom of worship, however, is guaranteed. Until about mid-20th century, the church ordinarily co-operated closely with the military. This situation has been changing, as increasingly church policy calls for closer association with labour circles and greater interest in the activities of the labouring classes. Almost the entire population is nominally Roman Catholic, although Jewish, Moslem and Protestant congregations are present. There are two archbishoprics, those at Caracas and at Mérida, and eight episcopal sees. A seminary for the secular clergy is maintained at Caracas, though the regular (cloistered) clergy are nearly all educated abroad in Spain and Italy.

(G. M. McB.; R. E. Ct.)

Customs and Culture. — A façade of modernization dating from the 1920s conceals a generally backward country in which 75% of the population is agricultural and pastoral and 70% of the land is held by 3% of the population. A rigidly stratified social structure based primarily upon ethnic background and economic status persists. The aristocracy is of Spanish origin and is largely concentrated in the Andean area, and in and around Valencia and Caracas. The mestizos, found most often in the lower middle income groups and working classes, predominate in the northern highlands and the adjacent plains. Negroes and Negro-mixtures are found in greatest numbers along the coast and in the city of Caracas. Few Negroes and Afro-Europeans have thus far been able to rise above the working-class level.

The middle classes — artisans, craftsmen. shopkeepers. professionals — are numerically weak but are improving their economic status and at the same time are becoming more politically alert. They have been strengthened by post-World War II European immigration, by improvements in educational facilities. and by the general prosperity within the business and professional communities due to oil.

The military caste, whose leaders come largely from the state of Tachira. has been a dominant political force (see History). The military leadership identifies itself with the aristocracy socially and like that group traditionally has been of European origins.

(J. J. J.)

IV. HISTORY

The coast of Venezuela was the first part of the American mainland sighted by Columbus in 1498 during his third voyage to the new world. Within a few years an intimate knowledge of the Venezuelan coast was gained, through the efforts of such explorers as Alonso de Ojeda, Juan de la Cosa, Amerigo Vespucci. Pedro Alonso Niño, Vicente Yáñez Pinzón and Rodrigo de Bastidas. No permanent settlements were made on the mainland of Venezuela before 1520 but earlier Margarita Island, Cubagua, Cumaná region had become the centre of an active trade in pearls, and slave hunters periodically raided the territory in search of Indians who could be captured and sold.

Gonzalo de Ocampo founded Nueva Toledo, later to be known as Cumana, in 1520. The permanent occupation of Cumaná dates from 1523 and was the work of Diego Castellon. Father Bartolomé de las Casas, "The Apostle of the Indians," was in the Cumaná region at the same time as was Ocampo. In 1527 Juan de Ampués founded Santa Ana de Coriana, generally referred to as Coro, on the Paraguaná peninsula, in western Venezuela. Charles V, in partial payment of a loan, turned the western portion of Venezuela over to the Welsers of Augsburg in 1528 and the German occupation continued until 1546. The representatives of the Welsers — Ambrosio Alfinger. Nikolaus Federmann and Jorge Espira among others — with headquarters at Coro, devoted themselves to the search for precious metals, and in this connection a number of expeditions were made into the interior. The most successful was that of Federmann, whose group arrived on the central plateau of Colombia in 1538, about the same time that Gonzalo Jiménez de Quesada and Sebastián de Belalcázar reached that region. Meanwhile, Diego de Ordaz, in the name of Charles V, in 1531 had explored the Orinoco area.

Venezuela did not prove to be a land of great wealth during the colonial period. Before the end of the 16th century the European conquerors had settled down to an agricultural existence based upon Indian and African slave labour. Further exploration and discovery was left largely to various religious orders. These "Crusaders of the Jungle" concentrated their efforts on the natives of the Orinoco drainage system.

French interlopers were on the Venezuelan coast by the 1520s, and as early as 1565 the Englishman John Hawkins was selling Negro slaves to Venezuelan planters. Thereafter Venezuelan settlements were quite regularly threatened by pirates, buccaneers and "sea dogs." English pirates raided and plundered Caracas in 1595. About the same time Sir Walter Raleigh sought unsuccessfully to occupy the Orinoco region in the name of England. Much later, in 1669, the notorious Henry Morgan raided the Lake Maracaibo area. Venezuela also became a focus of attention for smugglers, particularly English and Dutch. The Dutch, operating from the Island of Curacao, commanded an important share of the trade during the late 17th and early 18th centuries. The primary Venezuelan products to enter the illicit trade were cocoa, tobacco and hides.

Smuggling and the growing tendency for European wars to be fought in part in the Americas had a profound effect upon Venezuela during the 18th century. In 1728 the Caracas company, a

Basque controlled trading concern, was given a monopoly over much of the region in return for defending it and suppressing smuggling. Venezuela, which had been subordinate to the *audiencia* of Santo Domingo. mas made a captaincy general, subject to the viceroyalty of New Granada after 1741. It was freed from that connection in 1778.

The Caracas company was cordially disliked by many of the inhabitants because of its price fixing and its success in limiting smuggling. Despite the complaints of the residents, the company brought a degree of prosperity which continued after its trade monopoly was withdrawn in 1780. The Venezuelans were enjoying an era of rising prosperity when the Wars of Independence came.

Throughout the colonial period Venezuela was run first for the Spanish crown and second for the residents of the colony who could claim pure European lineage. This latter group owned most of the land and benefited from a system which gave them preference to the social and cultural institutions of the colony. "People of colour"; *i.e.,* Indians. Negroes and progeny of racially mixed marriage, were ostracized and left on the outskirts of society.

The Independence Movement. — On April 19, 1810. the *cabildo* of Caracas ousted the Spanish captain general and organized a junta to rule in the name of Ferdinand VII. who had been forced by Napoleon Bonaparte to abdicate as king of Spain. On July 5, 1811, the rights of Ferdinand VII were abandoned and the independence of the territory proclaimed. The Venezuelan people aere launched upon a prolonged and bloody conflict in which civil strife often competed with the independence struggle for the attention of the leadership. For a decade Venezuela felt the brunt of the Spanish fury. Large sections of the region were laid waste and Caracas changed hands on a number of occasions. So many thousands of Venezuelans lost their lives that the population level of 1810 was not again attained until 1850. Bolivar, who suffered repeated military defeats between 1810 and 1819, is generally credited with having kept the resistance movement alive. M'ith the assistance of such able Venezuelan lieutenants as Antonio José de Sucre and José Antonio Páez, Bolivar carried the war to the Spaniards in all of northern South America.

Independence for Venezuela, which was not recognized by Spain until 1845, was followed by several decades of turbulence during which bullets, not ballots, in effect ordinarily resolved political differences. The social and economic patterns, meanwhile, remained essentially unchanged, although the wars and subsequent commercial development added to the ruling elite persons who were unburdened by colonial tradition. Shortly after the battle of Carabobo (June 24, 1821) which broke the power of Spain in the area. I'enezuela became a part of Gran Colombia, which also comprised Colombia and Ecuador. After a brief period, regionalism gained the upper hand and by 1829 General Páez was able to lead Venezuela out of the union without serious opposition from nithin Venezuela or from Colombia. Venezuela at that time became a sovereign and independent state and has so remained.

Páez, who was representative of the new elements brought to the surface by the independence movement, in 1831 became the first president of the republic. As president and the maker of presidents he ruled until 1846 with considerable restraint. The press was allowed some freedom. A few public schools were constructed. Agriculture was promoted on a limited scale. Coffee grew important as an export commodity. Relations with the Roman Catholic Church were circumspect. The clergy was given national support but tithes u-ere abolished as were special ecclesiastical courts.

José Tadeo Monagas, sponsored by Páez won the presidency in an election in which only 60.000 voted out of a total population of about 1,275,000. Monagas promptly won the support of the army and then turned upon his patron, who was driven into exile. For more than a decade Monagas dominated the country amid civil war. Slavery as a legal institution was abolished in 1854. Paez returned to Venezuela in 1861 raised an army of hard-riding plainsmen. known as *llaneros,* and fought his way back into the presidency. He ruled as a stern dictator for two years (1861–63). Gen. Juan Crisóstomo Falcón established himself as chief executive in 1863.and exercised a precarious hold over the republic until 1868. Supported by young liberals under the influence of European revolutionary thinking, he made Venezuela a federalist republic against the wishes of those who would have preferred a strong central government. A revolt by Monagas. who still had political ambitions, forced Falcón to flee the country and to resign the presidency.

Out of the turmoil and confusion of the 1860s one figure loomed large, Antonio Guzmán Blanco. the son of a newspaper publisher. He assumed the presidency in 1870 and for 18 years, either as president or through puppets, dominated the nation. The new president. who was an anticlerical dealt the church some severe reversals. Monastic orders were closed, church property was confiscated and civil marriage laws and state control over registration of births and deaths were decreed. But the president brought a degree of order to Venezuela and gave a strong impetus to economic development. Foreign loans were contracted, railways and highways were constructed and public buildings were raised. Coffee became the principal item of export. International trade was increased. Some attention was paid to public education. Guzmán Blanco demanded discipline and efficiency from the bureaucracy, and tolerated little open criticism from his political opposition.

Guzmán Blanco's overthrow in 1888 paved the way for another decade of unrest and violence. Joaquin Crespo, who controlled provisionally before being elected to a regular presidential term, ran the country from 1894 to 1898. Foreign economic influence in Venezuela expanded significantly during Crespo's administration. His regime is remembered particularly for the I'enezuelan-British Guiana boundary controversy. which Pres. Grover Cleveland successfully insisted must be arbitrated.

Cipriano Castro controlled the republic from 1899 to 1908. Rough and unschooled. he fought in many civil wars before raising an army of his own and capturing Caracas and the presidency. As president his truculence incurred the ill-will of several foreign governments. In 1902 British. German and Italian naval units blockaded Venezuela in order to press demands for settlements of the claims of their nationals. Again the United States used its influence to force arbitration. Castro viewed the republic as a huge personal estate and before he left for Europe for medical treatment he had plundered the nation of much wealth and had made a mockery of responsible government.

When he sailed for Europe. Castro left his trusted lieutenant, Juan Vicente Gómez in charge. The lure of wealth and power was too great and Gomez struck out on his own. He soon consolidated his position and for 27 years ruled the republic with a mixture of stern discipline and paternal pride. The opposition was silenced by the threat of spies, political dungeons and devices for torture reminiscent of the Inquisition. Gómez built at public expense a tremendous fortune in farms, palaces. businesses, industries and bank balances abroad. But he was careful not to neglect the military upon whom his power rested. He encouraged the foreign exploitation of the nation's fabulously rich petroleum deposits. and by the early 1920s revenues were pouring into the public coffers at an unprecedented rate. Relatively little of the revenue went toward technological or cultural development. but the nation's entire external debt was liquidated. The death of "The Tyrant of the Andes" in 1935, released the pent-up resentments of the populace, who sacked and fired the homes of the Gómez family and those of the dictator's henchmen.

Gen. Eleazar López Contreras was named provisionally to succeed Gómez and was later elected to a five-year term. He gave Venezuela its first enlightened administration in generations. Education was promoted and public works were pushed. Civil liberties for a time were respected, but the abuse of newly non privileges in the form of strikes and disorders among workers, apparently incited by political radicals, gave López Contreras an excuse to take harsh measures against advocates of communism and anarchy.

Isaias Medina Angarita was selected by the Venezuelan congress. in April 1941, to succeed López Contreras, uho, in turn, was made chief of the army. During Medina's regime. which coincided with World War II, oil production was curtailed because of shipping difficulties. The oil companies were held responsible, and a new petroleum law more favourable to Venezuela was approved in 1943.

Medina drew much of his support from urban workers, and they were given political importance for the first time in Venezuelan history. Yet it was a combination of radical elements, represented by Acción Democrática, with military officers which effected a successful coup in Oct. 1945, and drove Medina into exile

Romulo Betancourt, leader of Accion Democrática, was named provisional president by a junta that had assumed control upon Medina's expulsion. He was subsequently elected president in an election in which women voted for the first time. Betancourt and his advisors were civilian and middle class and his election was looked upon as a victory of the people. Politically the regime was leftist. Betancourt approved a constitution which contained advanced social legislation and a provision that legalized the expropriation of oil properties.

In Dec. 1947, Rómulo Gallegos, recognized novelist and the candidate of Accion Democritica, was chosen president in a popular and honest election. Gallegos took office in Feb. 1948 Plans were made for land reform, larger royalties from petroleum and greater participation of the popular masses in public affairs. But before the decisions could be implemented, the military elements who had put Acción Democrbtica in power became restive and in Sovember ousted Gallegos, ending Venezuela's brief foray into democracy.

A junta of three military officers took over control of the republic in the name of the military and conservative civilian elements. The junta retained control through 1952.

On Dec. 2, 1952, Marcos Pérez Jiménez was declared president following an election in which he was clearly defeated in the voting. He assumed office in early 1953 and promptly imposed one of the most rigid and cruel dictatorships that Latin America had ever known. The bountiful wealth of the republic made possible large-scale, and at times wasteful, modernization and the development of basic sectors of the economy, including agriculture, and also the enrichment of a favoured few who enjoyed the blessing of the dictator and those close to him. The Venezuelan people refused to accept the fraud of a plebiscite held on Dec. 1j, 1957, in nhich Pérez Jiménez ran for a second term without opposition. Sustained public discontent had by the end of the year won converts within the military and on Jan. 23, 1958, the dictator was ousted and took refuge first in the Dominican Republic and then in the United States. Adm. Wolfgang Larrazabal headed a junta composed of military personnel and civilians which promised early elections. They were held in Dec. 1958 and Romulo Betancourt was elected president. (J. J. J.)

V. POPULATION

Venezuela ranks sixth among the South American countries in population as it does in area. The population rose from 2,890,000 in 1926 to 7,361,703 in 1961. In 1961 the capital, Caracas, had a population of 739,255. Maracaibo, the next largest city, had 432,902, and the third city, Barquisimeto, 196,557. The Federal District and the Lake Maracaibo region showed the greatest gains, but other parts of the country also increased their population decidedly. Most of Venezuela is sparsely inhabited, the great majority living in one-quarter or one-fifth of its territory, the hill and valley districts of the northern highlands and the adjoining coastal lands. About 150 mi. from the coast of the Caribbean or Lake Maracaibo, there is what may be called a frontier country.

Over most of this frontier, comprised chiefly of the vast llanos and the Guiana highlands, not only are there few inhabitants but the material advances that mark modern life are almost entirely lacking. Most of this country is not new. The llanos have been occupied for several hundred years, but, because of the nature of these great grasslands, the human population has remained far smaller than the animal population, and the inhabitants, living remote from the settled parts of the country—and from each other—have failed to keep pace with modern ways of life. The Guiana highlands have lagged still more and have remained almost unknown. Only since the 1930s has attention been directed toward this latter region, though a few places in it had been occupied, such as El Dorado, about 90 mi. in from the Orinoco river where a rich gold deposit had been worked for some years but then abandoned. A line of small settlements had been extended up the Orinoco even in colonial times. but they were far apart, farther still from the populous sections of the country and with no feasible means of contact. The river. their only easy highway, led away from rather than toward civilization. As a result of this situation. Venezuela remained for many years one of the minor, less significant countries of South America, with a small population and few known resources that interested the outside world, resulting in meager national income and little opportunity to improve its lot or expand its population into the sparsely inhabited regions.

VI. ADMINISTRATION AND SOCIAL CONDITIONS

Government.—The country's official name, since 1953, has been La República de Venezuela. During most of its history, it had been Los Estados Unidos de Venezuela. The change implied greater centralization of authority in the national government. Theoretically the individual 20 states were autonomous, however, each electing its legislative assembly, its governor, its two senators and its proportionate number of representatives in the national congress. This congress consists of 42 senators and 130 representatives (*diputados*), all elected for a five-year term. The suffrage is extended to both men and women and voting was compulsory. Illiterates voted by the use of differently coloured ballots. The fate of the constitution of 1953, in force under a provisional government with provisions for elections of president and national congress in 1958, was left undecided after the ouster of Jiménez and the rise to power of the new junta of early 1958. The national president administers the government of the Federal District and the two territories. Advanced social legislation, dating from 1947, governs relations of labour and capital and controls working conditions for women and children. Public health regulations reduced the incidence of malaria. tuberculosis, hookworm, dysentery and yellow fever in the vicinity of the larger population centres, but have not yet reached many of the rural regions.

(G. M. McB.; R. E. Ct.; J. J. J.)

Taxation.—As late as 1939 customs revenues accounted for 50% or more of Venezuela's budget receipts. Although collections from that source grew during the 1940s, by 1951, customs dropped to third place as a source of revenue—after taxes on minerals, chiefly petroleum, and income and other direct taxes. During the early 1950s indirect consumption taxes yielded only about 10% of federal receipts annually, a very low figure for Latin America. Petroleum royalties and taxes, despite some fluctuations, followed a steeply rising trend. The increase resulted from a sharp rise in petroleum production and generally higher world prices and increased royalties and taxes under the Hydrocarbon law of 1943. The first income taxes were collected in 1942–43 under Venezuela's Income Tax law enacted in 1942 (amended in 1944, 1946 and 1948). Of the indirect taxes on consumption, the most important are those on alcoholic beverages and cigarettes. Smaller amounts of income are derived from taxes on matches. Among miscellaneous revenues the principal item after World War II has been foreign exchange profits. (J. J. J.)

Living Conditions.—It is difficult to generalize on living conditions in Venezuela because since its great development by mid-20th century the petroleum industry exerted so great an influence on the total economy of the nation (more than $500,000,000 annually in royalties alone), and the impression was general therefore that the entire populace benefits. Sixty-five per cent of the government's revenues came from tax payments by the oil industry. Nonetheless, fewer than 75,000 persons were employed by the petroleum industry. Also there was the difference between urban and rural living and the vast chasm existing between the very rich (a thin veneer) and the very poor (the great mass of the population). Finally. both the official statistics and the general literature were unreliable and confusing.

Drawing conclusions from the decade of the Marcos Pérez Jiménez dictatorship. it would seem accurate to say that the rich became richer and the poor poorer. About one-half of the population eked out a bare living. These were largely rural dwellers. The Pérez

BY COURTESY OF HAMILTON WRIGHT

LOW-RENTAL HOUSING UNITS, CARACAS

Jiménez regime concentrated on the development of cities. stimulating the growth of an urban middle class. Yet so great was the movement from farm to city that. despite government construction of fine apartments for large numbers of people, thousands of citizens lived in misery in rude shacks under slum conditions. Yet the nation boasted the highest per capita income among the Central and South American countries. The cost of living, however. was higher than anywhere else in Central and South America and for Caracas possibly double that in New York city. In the 1950s few governments were working more assiduously to break the shackles of a one-product economy that contributed so much to the low level of living. as the same situation did throughout all of Latin America.

In the rural areas at least 40% of the farmers lived on small pieces of eroded land incapable of yielding an adequate diet. Not enough rice was grown domestically to feed the population, and the consumption of milk and meat was low. Rut even where fertile land was tilled. scarcity of labour and machinery, along with backward methods. limited output. The government claimed that 85% of the food required was produced within the country. This figure undoubtedly was too high. The level of living would not rise appreciably until agriculture was improved, for it was basic. Also the level of living was tied to the world market for oil: anything that affected exports affected the living conditions of the people, for Venezuela utilizes only about 5% of its oil production. (L. WE.)

Welfare Services. — Given the relatively vast economic resources of the Venezuelan nation. its achievements in welfare services up to the overthrow of Pérez Jimenez in early 1958 were insignificant. Although the military governments after 1948 felt it expedient to accede to some extent to social pressures. they showed a decided preference for public works over social welfare. However. nutritional programs, including workers' restaurants, which were first established during the Medina administration (1941–45) were continued. as were most of the provisions of the Labour law enacted in 1936 and amended in 194j and 1947. Repeated promises were made that the social and economic gains achieved by Venezuelan labour would he honoured. Nevertheless, the National Federation of Labour and many labour federations and unions were dissolved for purely political reasons. Under Pérez Jiménez, workers' housing in Caracas received much publicity and considerable was accomplished. Achievement, however, fell somewhat short of what propagandists for the regime would have had the public believe was accomplished. Outside of Caracas and a few other larger centres, welfare services, including medical care. were kept to a minimum.

Justice. — The supreme tribunal of Venezuela is the federal and cassation courts seated in Caracas. Its seven members, one from each of seven groups of states into which Venezuela is divided for this purpose, are elected by congress for five-year terms. The members of the courts choose their own president, vice-president and chancellor. A federal procurator-general is appointed for five years. There are lower federal courts.

The states each have a supreme court with three members in addition to a superior tribunal, courts of first instance, district courts and municipal courts. The territories are served by military and civil judges of first instance. (J. J. J.)

Education. — By law all children are required to attend school until the age of 14. Primary schools exist in nearly all communities. Secondary schools are maintained in most of the important centres. The Central University at Caracas (founded 172j) began elaborately rebuilding in 1953 on a new site. the Ciudad Universitaria. Some 25 buildings including a large open-air auditorium were already constructed by the mid-1950s and more were being added. The university has about 2,000 students and a full complement of faculties and special schools. The University hospital is one of the largest in South America. Two other government institutions. the University of the Andes at Mérida and the National University of Zulia at Maracaibo. have several faculties and full power to confer degrees. The three universities mentioned are supported by the federal government. There is a workers university in Caracas, and there are also two private universities in operation. the Universidad Catolica Andrés Bello and the Universidad de Santa Maria. A new university was created by government decree at Valencia in 1956. The Venezuelan Institute for Neurology and Brain Research, a federal government agency. was founded in 1954 near Caracas. Four national parks exist, partly for recreation, partly for natural history study. The most notable park, named for the Venezuelan botanist Henri Pittier. straddles the mountain range from the dry Caribbean coastal district through the cloud forests on the slopes and down to the interior valley about Lake Valencia. thus offering a great variety of climate, vegetation and animal life. The latest national park to be created (1958) is located in the Guatopo forest about 50 mi. S.E. of Caracas and is intended mainly to provide a better water supply to the capital.

Defense. — I'enezuela has compulsory military service for all adult males. In 1956, the active army numbered 10,000 men. The navy had three large destroyers and three light ones, four patrol launches. four frigates and several service vessels, There were an elaborate new military academy at Caracas, a naval school and several other institutes for the training of army and navy officers and an expanded air force academy at Maracay.

VII. THE ECONOMY

A. PRODUCTION

Agriculture. — As the result of confiscation, during years of political turmoil, many of the haciendas belong to the government. Cities and towns also own rural community property (ejidosj. Government legislation, beginning in 1949. effected some reforms in ownership, created a number of farm colonies, introduced new methods of cultivation, provided hetter seed and improved rural housing. Some of the revenue from oil was being utilized for the benefit of the farming population.

Stock raising is carried on in a relatively small scale over most of the 11-ell-settled rural regions but the number of those engaged in stock raising alone in these areas is small. On the extensive grasslsnds of the llanos the cattle business overshadows everything else. However, there, too, the number of men employed is not large. The number. both of herdsmen and of cattle, fluctuates with favourable and unfavourable weather and also with the demand for meat and hides. When the cattle business is good a considerable number of men are employed driving the herds to the fattening pastures in the central valleys or to the markets in the principal consuming centres.

Forestry. — Lumbering is a minor but still important occupation. Woodcutting is carried on most actively within and on the fringes of the more populous parts of the country, particularly on the foothills of the Andes and the Maritime ranges. Wood is in demand for charcoal, furniture making, fence posts, telephone and telegraph poles, doors. window frames and some flooring. Cement, brick, stone and adobe are the commoner building materials as in most of Central and South America. About 30,000 or 40,000 persons are normally engaged in lumbering and related occupations.

Mining. — Mining was never an important occupation in Venezuela until the mid-20th century. The variety of mineral products is great. Less than $\frac{1}{2}$ of 1% of the actively employed population is regularly engaged in mining or related occupations. Developments in iron mining on the lower Orinoco in the late 1940s and the stimulus given to gold mining in the same region increased the number of those employed in mining.

Iron became important, mainly in two rich fields a short distance from the mouth of the Orinoco. Existence of iron had been known in the region south of the Orinoco at the base of the Guiana highlands, but only in 1947 was the famous Cerro Bolivar, a mountain capped with iron, sometimes called "the century's greatest ore find," discovered. This field. with the smaller field at El Pao, jo mi. east, and several other nearby newly discovered deposits, assure the country of a fabulous wealth from iron ore mining for many years to come. Cerro Bolivar was estimated to contain from 400,000,000 to 500,000,000 metric tons of ore having 65% iron content. El Pao was estimated to have about 65,000,000 metric tons of equal grade. The total iron ore reserves of this general district were calculated to reach 2,000,000,000 tons. Shipments from El Pao began in 1951 and from Cerro Bolivar in 1954. In 1955 iron ore shipments from Venezuela to the United States amounted to 8,400,000 metric tons. The making of steel had just begun. One small plant operated near the Cerro Bolivar mines and in 1956 an Italian consortium was awarded the contract for construction of a plant expected to produce over 421,000 tons annually by 1959, primarily to supply the needs of the country. As with all other minerals, subsurface iron resources in Venezuela belonged to the state and most of the remaining lands thought to contain iron ore were subject to concessions by the government.

Gold has been at times an important product. The mines at El Callao. about 90 mi. south of the iron fields mentioned above, produced fabulously for several years but declined greatly after 1885, were revived in 1946 and became the largest producers in the country. They again encountered vicissitudes, however, mainly from labour troubles and the flooding of some workings. The government nationalized them in 1952. They continued to operate and in 1954, together with other mines in the vicinity, produced 1,744,088 g.

Diamonds have been found for many years in the streams (mainly the Caroni and its tributaries) descending from the Gran Sabana in the Guiana highlands and in some other adjacent areas. Indians and adventurers of European background had long collected them in small amounts. In 1950 a Venezuelan concern, largely government owned, began operations on a large scale in the far upper region of the Gran Sabana, with a landing field and a small power plant established there. Some smaller concerns joined in the search. Two companies. working under government concessions. were using modern equipment. Total production was reported to be (1954) 96.983 carats. These workings yielded gem stones and industrial diamonds in about equal amounts.

Some low-grade bituminous coal fields were worked for many years at Naricual, near Barcelona, the mines being connected by rail with the port of Guanta. Exploitation there, carried on mainly for the use of the Venezuelan navy, before the use of liquid fuel became general, has been suspended, partly because of a mine disaster. partly because of lack of demand. There is little need for coal for domestic uses, in part because of the tropical climate, in part because of the abundance of wood and natural gas for fuel. Other coal deposits are being worked in the states of Táchira and Zulia and along the base of the Maritime Cordillera in the states of Aragua and Guárico. Production from the Zulia region was utilized in the brick and clay products industry and in a cement plant operating there.

Other minerals, worked only on small scale, include asphalt, principally from the lake near the Gulf of Paria and from the Maracaibo region; asbestos, sulfur, copper, salt, mercury and others give promise of moderate future importance, for domestic use at least.

Fisheries. — Fishing occupies a considerable number of persons. The long coast line, the numerous small harbours, the growth of population in close proximity to the sea, have combined to make fish a more important part of the population's food than in most Central and South American countries. About 25,000 inhabitants normally make their living from this occupation and in marketing the fish. Most of the fish are consumed within the country. Pearl fishing is carried on about the Island of Margarita. With the recent marked economic development of the country several new industries have been established (*e.g.,* the manufacture of cement, footwear, flour, textiles and sugar). as yet mostly on a small scale.

(G. M. McB.; R. E. Ct.; J. J. J.)

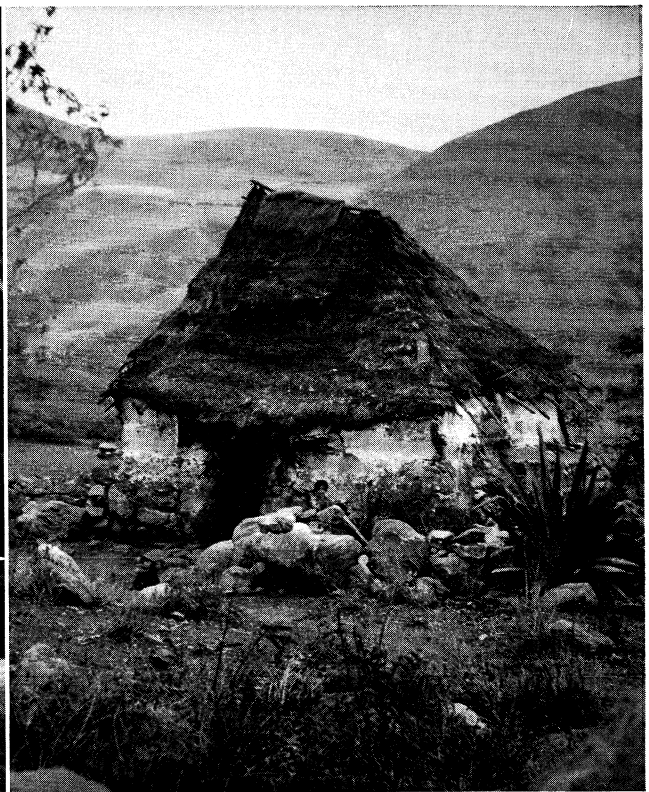
Power. — Venezuela's production of energy increased substantially toward mid-20th century. The rapid increase in population must be regarded as the most important reason, because a steady expansion in energy output was imperative merely to maintain per capita use at a constant figure.

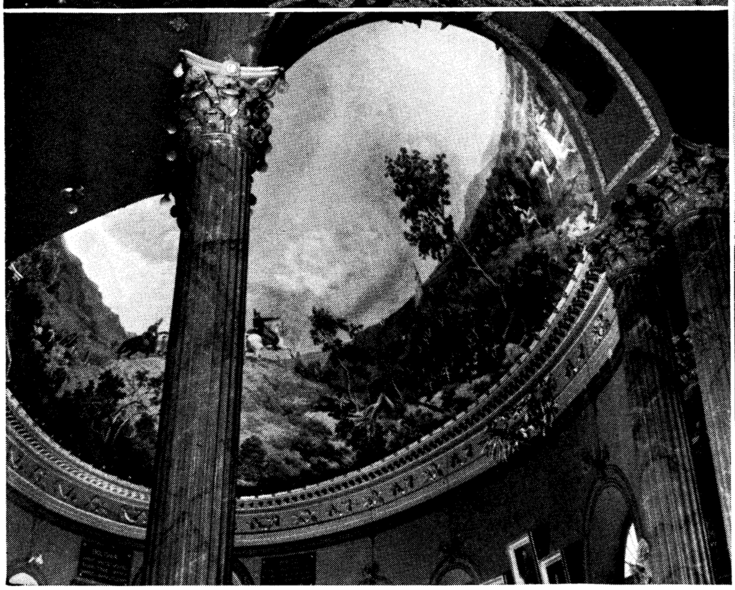
Venezuela possesses several important sources of power—vegetable fuels (wood, straw, bagasse). coal, petroleum, natural gas and water power. While considerable wood still was used for making charcoal in the more remote areas, the swelling migration from farms to cities was reducing the demand for it.

There is considerable coal in Venezuela, but the quality is not high, the deposits are not well located with respect to transport and population, and coal can not compete with petroleum and in some areas not even with natural gas. Some coal is used in iron-making. The wide distribution and active exploitation of petroleum have made Venezuela one of the world's most important producers (about 2,500,000 bbl. daily) and the largest exporter. The country is extremely rich in natural gas but only in the 1950s was it used to any extent; formerly it was wasted. By 1960 Venezuela hoped to consume in economic development more than 50% of the natural gas obtained with oil production.

Natural gas pipelines extended northward from central Guárico state to Caracas and La Guaira, and from Caracas westward to Maracay and Valencia. By the late 1950s Creole Petroleum corporation had completed two gas injector plants in Lake Maracaibo to save natural gas from drilled wells. This gas increased oil production by 50% and would increase by one-third the ultimate recovery of oil from the field where it is located. Although Venezuela does not possess the enormous potential water power reserves of Brazil: Chile, Argentina. Mexico, Peru or Colombia, it is believed to have more than 3,000,000 kw. The largest potential source and the one receiving the most attention in the late 1950s was the lower Caroni (six miles upstream from Puerto Ordaz) where 300.000 kw. of electrical power had been developed for the new iron and steel industry. Other rivers: such as the Chama and the Uribante, possess promising conditions for hydropower.

Industries. — Venezuela still had to be regarded as an agricultural nation in the late 1950s since about 75% of its people are on the land. Nevertheless, like most South and Central American nations. Venezuela is determined to industrialize and its progress is impressive. In the 1950s Venezuela's industrial production index has been the highest in South and Central America. The government actively encouraged establishment of new industries as a means of bringing new wealth into the country, of diversifying the internal economy, of providing greater employment opportunities, of raising the level of living and of helping in the growth of a





PHOTOGRAPHS (TOP LEFT, TOP RIGHT, CENTRE LEFT) WERNER COHNITZ PIX FROM PUBLIX, (BOTTOM LEFT, BOTTOM RIGHT) EWING GALLOWAY

VIEWS IN CARACAS AND THE VENEZUELAN INTERIOR

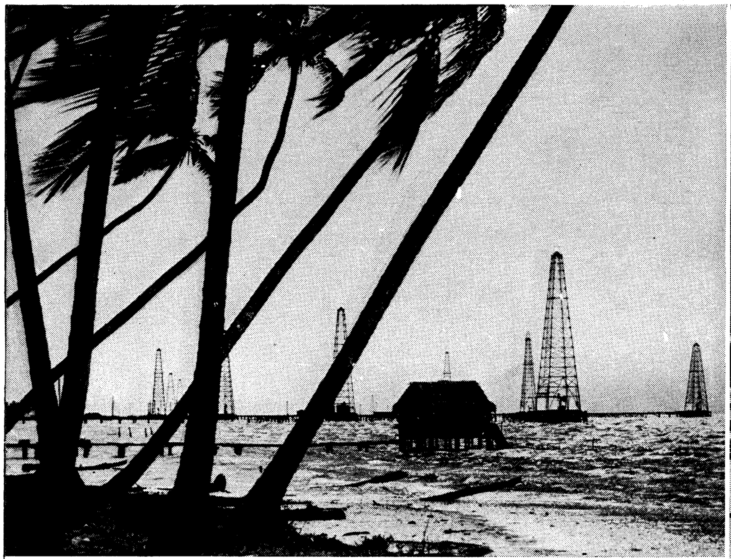
Top left: women of the town of Mérida, in the Andes, wearing their best for an Easter procession

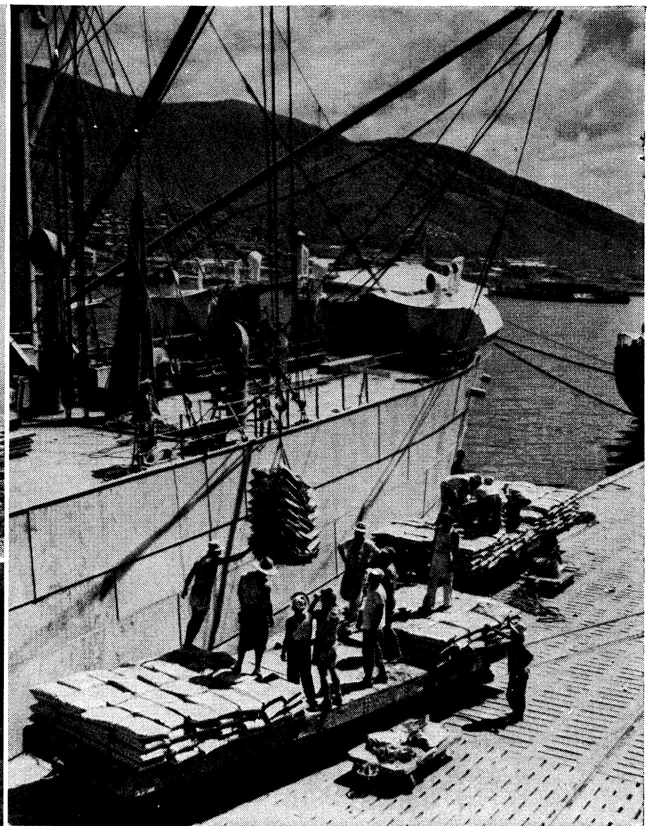
Top right: Characteristic village dwelling in the Venezuelan interior

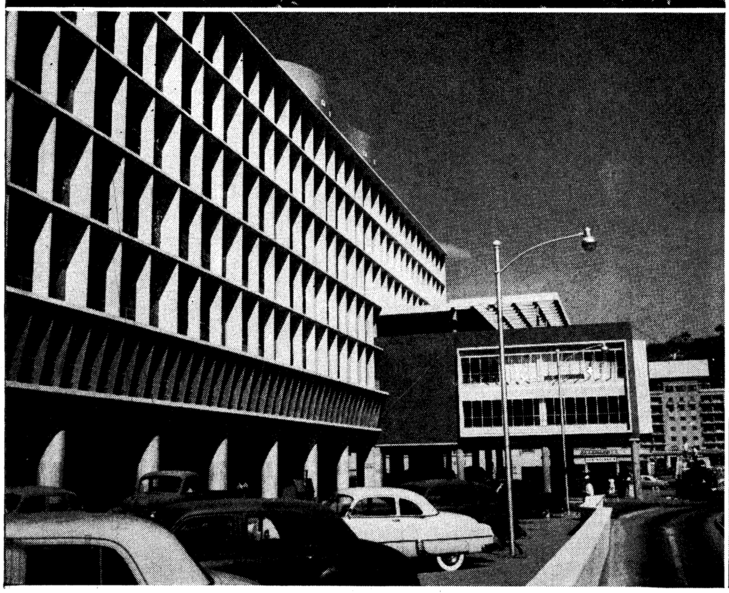
Centre left: A country highway used by the modern jeep and the traditional pack mule

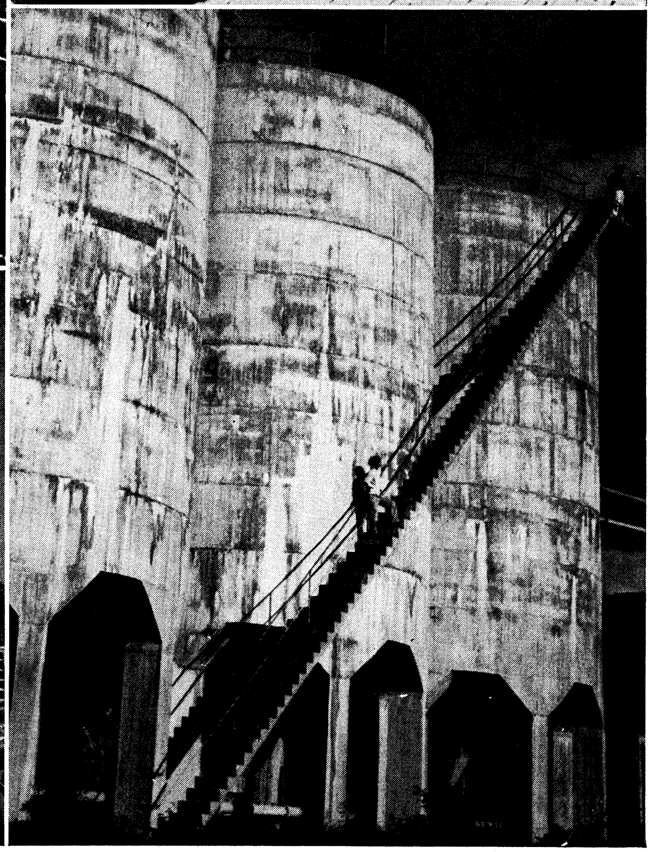
Bottom left: Dome in the Capitol building, Caracas, decorated by Martin Tovar y Tovar (1828–1902), a Venezuelan artist noted for his historical paintings. This one commemorates the colonial struggle for independence from Spanish rule in Venezuela

Bottom *right:* The National Pantheon, tomb of Simon Bolivar, at the Plaza Panteón. The structure was formerly a church









PHOTOGRAPHS (TOP LEFT) EWING GALLOWAY, (TOP RIGHT, CENTRE LEFT, BOTTOM RIGHT) WERNER COHNITZ-PIX FROM PUBLIX, (BOTTOM LEFT) PIX FROM PUBLIX

COMMERCE, INDUSTRY AND TRANSPORTATION

Top left: Offshore oil fields at Lake Maracaibo
Top right: Loading cargo at the port of Lo Guaira, outlet to the sea for Caracas
Centre left: View of the trans-Andean highway which is part of the Pan-American highway
Bottom left: Office building in Caracas typical of the architectural lines on which the Venezuelan capital was revamped at mid-20th century
Bottom right: Silos at a Venezuelan cement factory

larger and stronger middle class. Those industries that make most efficient use of the vast natural resources were particularly encouraged.

The principal manufacturing area lies in the northern mountain region near the Caribbean. the heart of which includes the cities of Caracas. Maracay and Valencia. A part of this complex includes the petrochemical centres at Morón. Carabobo. state. and about 1 j mi. from Puerto Cabello.

Petroleum refining centres are located mostly on or near the coast; *e.g.*, at Las Piedras (Amuay), Caripito. Punta Cardón and El Palito. Yenezuela manufactures fertilizers. chlorine, caustic soda and explosives.

A new but potentially promising industrial area was that near the confluence of the Caroni and Orinoco rivers, particularly at Puerto Ordaz. There the government located its national iron and steel mills. This "seed" industry was expected to start many steel-using plants. With an abundance of water power on the lower Caroni and with large deposits of bauxite nearby. an aluminum industry is expected to arise soon.

Among Venezuela's principal industries are those engaged in food processing (the biggest industry, employing roughly one-half of the labour force engaged in manuiacturing). cement. textiles, glass, paper, ceramics. tobacco products, chemicals (including petrochemicals), rubber tires. paint. pharmaceuticals, soft drinks, matches and numerous others. Although for many years the refining of most Yenezuelan oil was neglected, being carried on at Curacao and Aruba in the Netherlands Antilles. it grew impressively in the 1950s. The various governments insisted that more oil be refined within the country (the law required new concessions to refine 15% of their output in Venezuela). By the latter 1950s Venezuela had more than 12 refineries. (L. WE.)

B. TRADE AND FINANCE

Imports and Exports.——Venezuela's natural resources are sharply divided into those for domestic consumption and those for export. Its agricultural productions are almost wholly for use within the country. Formerly it exported cacao. coffee and a few other products of the farms, but by mid-20th century few of these commodities nent abroad. Corn. rice. sugar. cacao, coffee. bananas. n-heat and a variety of tropical fruits and vegetables barely sufficed for increased home consumption. In spite of the great number oi cattle raised on Venezuela's extensive grasslands. meat was being imported in the 1950s.

Petroleum.— Products for export consist almost entirely of minerals, the most important. by iar. being petroleum. This comes mainly from the margin and shallow waters of Lake Maracaibo. which produced about two thirds of the nation's total. Since the 1940s oil production has extended to the eastern lowlands. halfway between the Orinoco and the Caribbean coast and also near the inner border of the Orinoco delta. Production of petroleum began in Venezuela in 191; and grew rapidly until by the mid-20th century it dominated the economy of the country and made Venezuela the second largest producer alter the United States. and the largest exporter of oil in the world. More than 12,000 wells were in operation and in 1957 an all-time high was reached with a daily average production of 2,801,27j bbl. A government petrochemical industry was founded in 1957. Oil made up from 90% to 95% of the nation's exports, accounting for about 60% of the government's revenue. providing 95% of the foreign exchange needs of the government itself. and about 80% of that for the entire country. Mainly because of its petroleum. Venezuela's per capita income exceeded that of any other country in South America. Moreover. its proven oil reserves amounted to about 10% of the world's total. Nearly all Venezuela's oil was produced for export (95%), about 14% in refined products. the rest as crude petroleum. Of the latter, more than 60% was merely shipped to the Dutch islands of Aruba and Curacao, to be refined there and then shipped overseas. Beginning in 1943, because of government requirements. refining n-ithin the country increased. with the erection of refineries at Las Piedras and Punta Cardón on the Paraguaná peninsula, and. in the east. at Caripito on the San Juan river. Tucupita in the Orinoco delta and at Puerto La Cruz on the Caribbean coast, north of the eastern fields. Pipelines lead to these refineries, which use about 23% of the oil production of the country.

(G. M. McB.; R. E. CT.)

Banking and Currency.— The Banco Central de Yenezuela S.A.: established in 1940, is the sole bank of issue for Venezuela. Half of the share capital of the institution is owned by the state. The Banco Central as well as the Banco Obrero and the Banco Agricola y Pecuario are important instruments of official policy. Foreign exchange rates are pegged by the Banco Central: however, commercial hanks are free to buy and sell. At the close of 1950 there were 16 commercial banks operating in Venezuela. Twelve were domestic banks and four were branches of foreign institutions. Commercial banks in Caracas in 1951 charged from 6% to 9% interest. Interest charged by government institutions ranged from 4% to 6%. The legal maximum rate in the latter 1950s was 1% per month and some loans were placed with individuals at that rate.

The monetary unit of Venezuela is the bolivar. which at the 1958 rate of exchange was equal to about 30 cents U.S. currency. Silver coins are circulated in denominations of 5 bolivares. 2 bolivares. 1 bolivar. 50 centimos and 2j centimos. Nickel coins of 12.j and j centimos are also circulated. Gold coins had been withdrawn from circulation and had been replaced by notes issued by the Banco Central in denominations of 1,000 bolivares. 500 bolivares, 100 bolivares, 50 bolivares, 40 bolivares, 20 bolivares and 10 bolivares. (J. J. J.)

National Finance.— The total foreign debt of the nation has been paid off. Except in wartime there has been no exchange control. The economy of the country is based mainly on one industry, oil production and the government's revenue derived mainly (about 60%) from that one source. According to the petroleum law of 1943 the gross profit from petroleum production was divided equally between the producer and the government.

C. TRANSPORT AND COMMUNICATION

Roads.— Extensive road building was pursued until, in the 1950s, few important centres north of the Orinoco were out of reach by some sort of highway or secondary road. Roads were being extended also southward from the Orinoco into the base of the Guiana highlands. Total extent of all-\yeather roads (1957) was about 15,000 mi. Nearly 1,000 mi. were being added to the system yearly. constructed mostly by the government with revenue from oil exports. Notable among such roads is the superhighway between Caracas and La Guaira and the airport of Maiquetía, a four-lane motor highway in which most of the former steep grades and sharp curves were eliminated, thus reducing the normal travel time from $1\frac{1}{2}$ hr. to about 20 min. Progress was also made in constructing the Venezuelan section of the Pan-American highway by which the distance from Caracas to the Colombian border would be reduced by zoo mi. and the roadbed much improved.

Railways.— In 1956 trackage measured about 700 mi. The network (if it can be so called) consisted of 11 main but disconnected lines of varying ownership and gauge. The longest single line (109 mi.) ran from Tucacas on the coast to Barquisimeto in the edge of the Andes. Built by British interests in 1877 to reach the copper mines at Aroa. this line was later cxtendcd to Puerto Cabello to connect with the railway running to Valencia and from there to Maracay and Caracas (about 150 mi.). The most used line was that between Valencia and Caracas (111 mi.), rivaled by the short (23 mi.) line, now electrified. betn-een Caracas and La Guaira. Several independent lines existed in the far western part of the country. One of them ran from Encontrados. river port on the Catatumbo reached by steamers from the lake. to the ton-n of Tachira and connected across the Colombian border to Cúcuta. A number of local lines were built by oil companies. and two short. but important. ones were constructed in the 1950s in the loner Orinoco region, one a go-mi. line from the iron mines at Cerro Bolivar to Puerto Ordaz; the other a 43-mi. line from similar mines at El Pao to the river port of Palua. The government was actively engaged in constructing connecting links. unifying the gauge and extending the system. The Bolivar railway was widened to standard gauge. A line was constructed from

El Palito on the coast near Puerto Cabello to Palma Sola on the Barquisimeto railway, thus linking two old important routes, and a short line has been built from Santa Barbara to Encontrados, connecting the two far western lines. A program of nationalization was also carried on. In 1936 the government purchased the British-owned Ferrocarril Central. In 1943 it nationalized the German-built railway connecting Valencia and Caracas (paying for it after World War II); and in 1949 it bought the British-owned line between La Guaira and Caracas.

This network fell far short of covering the country. or even the most thickly settled part. The vast area east and south of the capital to the Brazilian and Colombian borders and most of the higher Andean region lacked rail connection in the late 1950s. Highways only in part made up for this lack. The government's plan of "sowing oil" back into development of the country was intended to meet this deficiency. among others.

Shipping.— For its backwardness in highway and railway construction Venezuela has made up in part by the development of shipping. Since most of its populous districts lie on or near the coast: contact between these has been maintained largely by coastwise shipping. The Venezuelan coast is dotted with little ports. most of them with several short roads or railways leading inland. Small vessels transport freight and passengers from one port to another and to the larger ports, such as La Guaira and Puerto Cabello, which in turn give access to more distant points inland. Because of its coastwise shipping Venezuela has always maintained its contact with other countries better by sea than by land. Even its nearest neighbours. the Colombians, generally come to Venezuela by boat. For many years Venezuela collaborated with Colombia and Ecuador in maintaining a joint commercial fleet, the Flota blercante Grancolombiana. It began regular coastwise operations in 1946 and in 1949 extended these to ocean-going service, but in 1953 Venezuela withdrew from the partnership. It subsequently maintained a small fleet of vessels which operated under its own flag, mainly engaged in trade between its own ports and those of the United States and Canada. Since the chief export was petroleum and petroleum products the bulk of Venezuela's outgoing shipping centred in the three harbours best situated to handle that trade: Maracaibo, Las Piedras and the twin ports of Guanta–Puerto La Cruz, which together handled about two-thirds of the country's exports. Imports, however, entered mainly through La Guaira. Puerto Cabello and hlaracaibo. Puerto Cabello is considered the best natural harbour. but extensive improvements have made up for the lack of natural advantages at La Guaira, which in 1956 oifered berth space for 18 ocean vessels and 10 coastwise vessels at the same time. Dredging of the Maracaibo entrance has resulted in greatly increased trade through the ports there and has made Maracaibo a seaport. (G. M. McB.; R. E. Ct.)

Inland Waterways.— Venezuela is rich in rivers but most of them are of limited use because of remoteness, falls and rapids: great variability between high and low water (43 ft. on the Orinoco), and sand bars. Only since 1953 have large vessels been able to ascend the principal river—the Orinoco. In order to transport iron ore by large freighter from Puerto Ordaz to the United States, the United States Steel corporation was obliged to dredge about one-third of the 1j49 mi. between Puerto Ordaz and the Caribbean (33,000,000 cu.yd. of sand, gravel, clay and mud were removed). Ships carrying as many as 45,000 tons of ore could then regularly utilize the lower Orinoco.

The only other navigable inland body of water is Lake Maracaibo —Venezuela's leading oil-producing area. Until the mid-1950s only small oil tankers drawing at most 13 ft. could go from the lake to refineries on Aruba and Curaçao. Large tankers were prohibited by a 20-mi. sand bar at the neck connecting the lake with the Caribbean. At a cost of nearly $50,000,000, this obstacle was eliminated by dredging, thus allowing large tankers carrying 100,000 bbl. of oil to move out of the lake. This improvement aided the entire area and the port of Maracaibo was growing in economic stature. (L. We.)

Pipelines.— An important item in Venezuela's transportation system was the network of pipelines. There were about 2,000 mi. of these lines (1956), carrying crude petroleum and refined petroleum products. and several hundred miles carrying natural gas from the fields to the larger urban centres. Further extension of both types was planned. Though about 80% of the natural gas was flared off there was an increasing demand for it in the growing industrial activity in the country. Gas from the eastern oil fields was being considered as fuel for reducing the iron ore at the projected steel mills on the lower Orinoco.

Air **Transport.**—While at mid-20th century land and water transportation still lagged, Venezuela had advanced rapidly in air transport. There were four fully equipped airports. One at Maiquetía, a few miles west of La Guaira, served this port and Caracas, because the airport at the capital was small and the run irom the city to the coast by the new *autopista* ("superhighway") required less than half an hour. The Grano de Oro airport at Maracaibo handled passengers and freight connected with the oil industry there. At Maturín and Barcelona fully equipped fields were served by national and international carriers. In addition to these principal airports there were more than 80 lesser ones in regular service. Oil concerns and mining companies, ior example, maintained 20 airfields of their own. It was possible to reach by air most of the important centres of the country and many minor ones in the llanos and even back in the Guiana highlands. Some of these points had not yet been reached by rail or highway. Angel Falls was discovered irom the air and tourists visiting that region can fly to within a short distance of the site. There were landing fields also at Tumereno and iar into the Gran Sabana country at Luepa. (G. M. McB.; R. E. Ct.)

Postal Service.—-411 modern postal services are available in Venezuela and all means of communications are employed in order to provide adequate service. The majority of the post offices receive correspondence daily. In 1953 the postal system handled over 72,000,000 letters ior distribution within the national territory, over 18,000,000 ior distribution overseas and received over 18,000,000 from the outside for delivery within the national territory.

Telecommunications.— Telephones, telegraphs, radio telephones and radio telegraph provide rapid domestic communications. Radio telephone, radio telegraph and cable service are available for communications with other countries. In 1955, telephones in use numbered 104,500 (a vast majority of them in Caracas). More than 90% were in automatic systems. The State telegraph system had approximately 700 telegraph offices. There were 53 commercial radio broadcasting stations that were dependent upon advertising for their income and one government-run station. Caracas had three television stations, and there were relay stations to Maracaibo and other large towns. The Pérez Jimenez government often exercised strict censorship over all types of mass communications. (J. J. J.)

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VENICE (Venezia), a city and seaport of Italy, occupying one of the most remarkable sites in the world. The city is an island linked with the mainland by a road and rail causeway $2\frac{1}{2}$ mi. long. The climate is mild.

At the head of the Adriatic, between the mountains and the sea, lies that part of the Lombard plain known as the Veneto. The whole of this plain has been formed by the deposits swept down from the Alps by the rivers Po, Ticino, Oglio, Adda, Mincio. Adige, Brenta, Piave, Livenza, Tagliamento and Isonzo. The substratum of the plain is a bed of boulders, covered during the course of time by a deposit of rich alluvial soil. The rivers when they debouch from the mountains assume an eastern trend in their effort to reach the sea. The result is that the plain is being gradually extended in an easterly direction, and cities like Ravenna, Adria and Xquileia. which were once seaports, lie now many miles inland. The encroachment of land on sea has been estimated to be at the rate of about 3 mi. in 1,000 years. A strong current sets around the head of the Adriatic from east to west. This current catches the silt brought down by the rivers and projects it in long banks, or *lidi*, parallel with the shore. In process of time some of these banks. as in the case of Venice. raised themselves above the level of the water and became the true shore line. while behind them lay large lagoons, formed partly by the fresh water brought down by the rivers, partly by the salt-water tide which found its way in by the channels of the river mouths. On a group of these banks about the middle of the lagoon of Venice stands the city of Venice. The soil only can be made capable of carrying buildings by the artificial means of pile-driving; there is no land fit for agriculture or the rearing of cattle; the sole food supply is fish from the lagoon.

The whole site of Venice is dominated by the existence of one great main canal, the Grand canal, which, winding through the town in the shape of a reversed letter S, divides it into two equal parts. This great canal was probably at one time the bed of a river flowing into the lagoons near Mestre. The smaller canals all serve as arteries to the Grand canal and their windings follow the lines of construction originally determined by the channels which traversed the islands of the lagoon. One other broad canal, once the bed of the Brenta, divides the island of the Giudecca from the rest of the city and takes its name from that island. The alleys or *calli* number 2.327, with a total length of about 90 mi.; the canals number 177 and measure 28 mi. There are frequent boat and launch services along the Grand canal to the Lido and other islands of the lagoon.

The ordinary Venetian house was built around a courtyard. and was one story high; on the roof was an open loggia for drying clothes; in front, between the house and the water, ran the *fondamenta* or quay. The earliest churches were built with cemeteries; and thus is the nucleus of the city of Venice. little isolated groups of dwellings each on its separate islet, scattered, as Cassiodorus, secretary to Theodoric the Great. says, in a letter dated A.D. j23. like sea birds' nests over the face of the waters. Some of the islets were then uninhabited. overrun with a dense low growth which served as cover for game and even for wolves.

Gondolas.—The famous gondolas (flat-bottomed boats) have been the characteristic conveyances on the canals of Venice for centuries. The history of these vessels, and even of the name. is obscure, but already in the 1 jth century they were an intimate part of Venetian life. There were 10,000 gondolas in Venice in the 16th century but the number has decreased. The gondola is a very long and narrow boat terminating at each end in a point or peak. Near the centre is a curtained cabin for passengers. Usually it is propelled by one gondolier standing on the stern cover and thrusting with a single oar, but sometimes by two gondoliers, as seen in the paintings of Vittore Carpaccio. One may also quote the description from Byron's *Beppo:*

> 'Tis a long cover'd boat that's common here
> Carved at the prow, built lightly, but compactly,
> Rowed by two rowers, each call'd "Gondolier,"
> It glides along the water looking blackly,
> Just like a coffin clapt in a canoe.

Before about the 15th century gondolas varied in shape and were often extravagantly coloured. A sumptuary order of the senate, however. restricted the gondola to a standard shape and one colour, black. The only outlet left for extravagance was the beautiful polish given to varnished surfaces. Old traditions of design are always maintained. The planks are of oak. the bottom of larch or fir, the decks of cherry or walnut. the covered part of lime wood, the *farcole* or forks in which the oars are placed are of walnut, while the oars are beech. The elegant. iron peak *ferro,* which resembles a halberd. serves both as an ornament and as a weight to balance the boat; it is made, according to traditional designs, in workshops at Maniago or Forno di Zoldo in the Dolomites. A gondola is about 32 ft. long and about 5 ft. wide. The weight is about 1,000 lb.. without cabin or other fittings.

Venetians still depend to a great extent on boat traffic for supplies. Thus the picturesque appearance of the boats on the lagoons —so graphically described by Gabriele D'Annunzio in *Il* Fuoco— is only one aspect of their importance in Venetian life.

St. Mark's.—The church of St. Mark's. originally the private chapel of the doge, is unique in respect of its richness of material and decoration. It was adorned with the spoils of countless other buildings. both in the east and on the Italian mainland. A law of the republic required every merchant trading to the east to bring back some material for the adornment of the fane. Indeed. the building is a museum of sculpture of the most varied kind. nearly every century from the 4th century down to the latest Renaissance being represented. The present church is the third on this site. Soon after the concentration at Rialto (see *History* below), a small wooden church was erected about the year 828 for the reception of the relics of St. hlark, brought from Alexandria. St. Mark then became the patron saint of Venice in place of St. Theodore. This church was burned in 976 along with the ducal palace in the insurrection against the doge Candiano IV.

Pietro Orseolo and his successors rebuilt it on a larger scale. About 1063 the doge Contarini began to remodel St. Mark's, Byzantine architects having a large share in the work, but Lombards were also employed. giving birth to a new style, peculiar to the district.

In plan St. Mark's is a Greek cross of equal arms, covered by a dome in the centre, 42 ft. in diameter. and by a dome over each of the arms. The plan is derived from the Church of the Holy Apostles at Istanbul, non covered by the mosque of Mohammed II, and bears a strong resemblance to the plan of St. Front at Périgueux in France (1120). The addition of a narthex before the main front and a vestibule on the northern side brings the whole western arm of the cross to a square on plan. In ele ation the façade seems to have connection with the five-bayed façade of the Kahriyeh Jame. or mosaic mosque, at Istanbul. The exterior façade is enriched with marble columns brought irom Alexandria and other cities of the east. Mosaics are employed to decorate the spandrels of the arches. Only one of the original mosaics now exists. It represents the translation of the body of St. Mark, and gives a view of the west facade of the church as it was at the end of the 13th century before the addition of the ogee gables. The top of the narthex forms a wide gallery, communicating with the interior at the triforium level. In the centre of this gallery stand the four colossal bronze horses which belonged to some Graeco-Roman triumphal quadriga. and were brought to Venice by the doge Enrico Dandolo in 1204. The south façade was restored in 1865–78.

Mosaic is the essential decoration of the church, and the architectural details are subordinated to the colour scheme. The oldest remaining belong to the 13th century, and many of them, for example those of the domes of the atrium, are among the finest of their kind; but some parts were restored in the 16th–19th centuries. Below the mosaics the walls and arches are covered with rare marbles, porphyries and alabaster from ancient columns sawn into slices and so arranged in broad bands as to produce a rich gamut of colour.

The eastern crypt, or *confessio,* extends under the whole of the choir and has three apses. like the upper church. Below the nave is another crypt. The floors of both crypts have sunk considerably and are often under water; this settlement accounts for the inequalities of the pavement. The original part of the magnificent mosaic pavement probably dates from the same period as the pavement at Murano, exactly similar in style, material and workmanship, which bears the date 1140. The pavement consists partly of *opus Alexandrinum* of red and green porphyry mixed with marbles. partly of tessellated work of glass and marble. v

The choir stands about 4 it. above the nave and is separated from it by a marble rood screen, on the architrave of which stand 14 figures. the signed work of Jacobello and Pier Paolo dalle Masegne, 1394.

The Pala d'oro, or retable of the high altar (within which rests the body of St. Mark), is one of the chief glories of St. Mark's. It is one of the most magnificent specimens of goldsmiths' and jewelers' work in existence. It was ordered in 976 at Istanbul by the doge Pietro I Orseolo. and was enlarged and enriched with gems and modified in form, first by a Greek artificer in 1105, and then by Venetians between 1209 and 1345. It is composed of figures of Christ, angels. prophets and saints, in Byzantine enamel run into gold plates. The treasury of St. Mark's contains magnificent church plate and jewels.

Byzantine Architecture. — The continuous growth of Venice can be traced through the successive styles of Byzantine. Gothic. early Renaissance and late Renaissance architecture. *(See* John Ruskin's *Stones* of *Venice*.) The two most striking buildings in Venice, St. Mark's and the doge's palace. at once give an example of the two earlier styles, the Byzantine and the Gothic, at least in their general design. though both are so capricious in development and in decoration that they may more justly be considered as unique specimens rather than as typical examples of their respective styles. In truth. because of its isolated position on the very verge of Italy. and of its close connection with the east, Venetian architecture was a distinctly independent development. The Piazza S. Marco, the famous square opposite the basilica of St. Mark, is dominated by the campanile of St. Mark. Under the buildings (see *Later Renaissance* below) forming the other three sides of the oblong runs a continuous colonnade with shops. cafés and offices. A feature of the piazza is the pigeons. which are regularly fed by the municipality. The piazzetta runs from the Riva degli Schiavoni between the west face of the doge's palace and Sansovino's library to meet the southwestern corner of St. Mark's and the open end of the great square, linking it with the Riva and the steamer services and gondolas plying thence. Through these two, the piazza and piazzetta. the life of Venice passes.

Fine examples of Venetian Byzantine palaces. at least of the facades, are still to be seen on the Grand canal and on some of the small canals. The interiors have been modified past recognition of their original disposition. The Byzantine palace seems to have had twin angle-towers, such as those of the Ca' Molin on the Riva degli Schiavoni. where Petrarch lived. The Fondaco dei Turchi (13th century!. now the natural history museum. also has two angle-towers. The facades presented continuous colonnades on each floor with semicircular high stilted arches, leaving a small amount of wall space. The buildings were usually battlemented in fantastic form. Specimens still in existence are Palazzo Loredan and Palazzo Farsetti (now the municipal buildings), and the splendid Palazzo Da Mosto, all on the Grand canal. The richest ornamentation was applied to the arches and string courses while plaques of sculpture. roundels and coats of arms adorned the facades. The remains of a Byzantine facade now almost entirely built into a wall in the Rio di Ca' Foscari offer an excellent illustration of this elaborate style of decorative work.

. Gothic Architecture. — Venetian Gothic, both ecclesiastical and domestic. shares most of the characteristics of north Italian Gothic generally. The materials, brick and terra-cotta, cause the characteristics of north Italian Gothic.

Soon after the concentration at Rialto. the doge Angelo Partecipazio began an official residence for the head of the state. This was a small. strongly fortified castle, one of whose massive angle-towers is now incorporated in St. Mark's and serves as the treasury. It was burned in 9;6 and again in 1106. Sebastian Ziani (1173–79) restored and enlarged the palace. Of his work some traces 'still remain in the richly sculptured bands built in at intervals along the 14th-century façade on the Rio. and part of the handsome larch-wood beams which formed the loggia of the piazzetta façade, still visible on the inner wall of the present loggia.

The ducal palace was begun by Pietro Gradenigo in 1309. Toward the end of the 14th century, this facade. with its lower colonnade. upper loggia with handsome Gothic tracery and the vast impending upper story, which give to the whole building its striking appearance and audacious design, had been carried as far as the tenth column on the piazzetta side. In 1424 the building was resumed and carried as far as the northwest angle. near St. Mark's. thus completing the sea and piazzetta façades of two stories with open colonnades, forming a long loggia on the ground and first floors, with 17 arches on the sea front and 18 on the other facade. Above this is a lofty third story. pierced with a few large windows, with pointed arches once filled with tracery, which is now lost. The whole surface of the ponderous upper story is covered with a diaper pattern in slabs of creamy white Istrian stone and red Verona marble, giving a delicate rosy-orange hue to the building. Beautiful sculpture. executed with an ivorylike minuteness of finish. is used to decorate the whole building with wonderful profusion. The great gateway, the Porta della Carta, was added in 1438–42 from designs by Giovanni Buon (or Bon) and his son Bartolomeo, The block of buildings in the interior, connecting the Porta della Carta with the Rio wing, was added about 1462. Later a fire consumed the earlier buildings along the Rio. which were replaced by the present structure.

The great internal court is surrounded with arcading. From the interior of the court access is given to the upper loggia by a beautiful early Renaissance staircase. built in 1484–1501 by Antonio Rizzo. Two colossal statues of Neptune and Mars at the top of these stairs were executed by Jacopo Sansovino in 1554—hence the name "giants' staircase." As a result of the fire of 1574, the fine series of early Paduan and Venetian frescoes in the chief rooms was lost. The magnificent council chambers for the different legislative bodies of the Venetian republic and the state apartments of the doges are highly decorated with gilt carving and panelling in the style of the later Renaissance. On the walls of the chief council chambers are a magnificent series of oil paintings by Tintoretto and others — among them his masterpiece, "Bacchus and Ariadne," and his enormous picture of "Paradise" which is probably the largest oil painting in the world.

Among the many Gothic churches of Venice the largest are the Franciscan church of Sta. Maria Gloriosa dei Frari (begun in 1338), and the Dominican church of SS. Giovanni e Paolo (1246–1430). The Frari is remarkable for its splendid works of art, including Titian's famous "Assumption of the Virgin" and its fine choir stalls and for the series of six eastern chapels which from outside give a good example of Gothic brickwork, comparable with the even finer apse of the now desecrated church of S. Gregorio. The church of SS. Giovanni e Paolo was the usual burying place of the doges, and contains many noble mausoleums of various dates. S. Stefano is an interesting building of central Gothic. The west entrance is later than the rest of the edifice and is of the richest Renaissance Gothic, a little earlier than the Porta della Carta.

But in the domestic architecture of Venice are the most striking and characteristic examples of Gothic. The introduction of that style coincided with the consolidation of the Venetian constitution and the development of Venetian commerce both in the Levant and with England and Flanders.

The finest example of the ogival style is undoubtedly the Ca' d'Oro. so-called from the profusion of gold employed on its facade. It was built for Marino Contarini in 1422–40, a comparatively late date. With a fine collection of pictures and furniture, it was given to the state by Baron Franchetti in 1916.

Contarini was to some extent his own architect. He had the assistance of Marco d'Amadeo, a master builder, and of Matteo Raverti, a Milanese sculptor, who were joined later on by Giovanni Buon and his son Bartolomeo. By the year 1431 the façade was nearly completed, and Contarini made a bargain with Martino and Giovanni Benzon for the marbles to cover what was yet unfinished. But Contarini mas not content to leave the marbles as they were. He desired to have the façade of his house in colour. The contract for this work. signed with Master Zuan de Franza, conjures up a vision of the Ca' d'Oro ablaze with colour and gleaming with the gold ornamentation from which it took its name.

Other notable examples are the Palazzo Ariani at S. Raffaele, with its handsome window in a design of intersecting circles; the beautiful window with the symbols of the four evangelists in the spandrels, in the façade of a house at S. Stae; the row of three Giustinian palaces at S. Barnaba; the Palazzo Priuli at S. Severo, with a remarkably graceful angle window. where the columnar mullion carries down the angle of the wall; the flamboyant balconies of the Palazzo Contarini Fasan; the Palazzo Bernardo on a side canal near S. Polo, a late central Gothic building (1380–1400).

Early Renaissance. — Toward the close of the 15th century Venetian architecture began to feel the influence of the classical revival; but, lying far from Rome and retaining still its connection with the east, Venice did not fall under the sway of the classical ideals either so quickly or so completely as most Italian cities. Indeed! in this as in the earlier styles. Venice struck out a line for itself and developed a style of its own. known as Lombardesque, after the Lombardo family (Solari) who came from Carona on the Lake of Lugano. The essential point about the style is that it is intermediary between Venetian Gothic and full Renaissance. It retains some traces of Byzantine influence in the decorated surfaces of applied marbles. and in the roundels of porphyry and *verde antico,* while it also retains certain characteristics of Gothic. as. for instance, in the pointed arches of the Renaissance faqade in the courtyard of the ducal palace designed by Antonio Rizzo (1499).

The most perfect example of this style in ecclesiastical architecture is the little church of Sta. Maria dei Miracoli begun by Pietro Lombardo in 1481. The church is without aisles, and has a semicircular roof. and the choir is raised 12 steps above the floor of the nave. The walls, both internally and externally, are encrusted with marbles. The facade has the characteristic circular pediment with a large west window surrounded by three smaller windows separated by two ornamental roundels in coloured marble and of geometric design. Below the pediment comes an arcade with flat pilasters, which runs all round the exterior of the church. Two of the bays contain roundheaded windows; the other three are filled in with white marble adorned by crosses and roundels in coloured marble.

Similar results are obtained in the magnificent faqade of the Scuola di S. Marco, at SS. Giovanni e Paolo, which has six semicircular pediments of varying size crowning the six bays. in the upper order of which are four noble Romanesque windows. The lower order contains the handsome portal with a semicircular pediment. while four of the remaining bays are filled with quaint scenes in surprisingly skillful perspective. The faqade of S. Zaccaria (1458–1515), the stately design of Anton Marco Gambello and Mauro Coducci. offers some slight modifications in the use of the semicircular pediment, the line of the aisle roof being indicated by quarter-circle pediments abutting on the faqade of the nave. S. Salvatore. the work of Tullio Lombardo (1530), is severer and less highly ornamented than the preceding examples, but its plan is singularly impressive, giving the effect of great space in a comparatively small area. . In this connection must be mentioned the Scuola of S. Giovanni Evangelista at the Frari, with its forecourt and screen adorned by pilasters delicately decorated with foliage in low relief, and its noble staircase whose double flights unite on a landing under a shallow cupola. This also was the work of Pietro Lombardo and his son Tullio.

Early Renaissance palaces occur frequently in Venice and form a pleasing contrast with those in the Gothic style. The Palazzo Dario with its dedication. *Urbis genio,* and the Vendramin-Calergi or *Non nobis* palace, whose facade is characterized by its roundheaded windows of grouped twin lights between columns, are among the more important; though beautiful specimens. such as the Palazzo Trevisan on the Rio della Paglia. and the Palazzo Corner Reali at the Fava, are to be found all over the city.

Later Renaissance.— In this period architecture in Venice lacks any peculiarly individual imprint. It is still characterized by great splendour; indeed. the library of S. Marco. begun by Jacopo Sansovino in 1536, is justly considered the most sumptuous example of Renaissance architecture in the world. It is rich. ornate, yet hardly florid, distinguished by splendid effects of light and shade, obtained by a far bolder use of projections than had hitherto been found in the somewhat flat design of Venetian faqades.

The old Procuratie were built by Bartolomeo Buon about 1514, the new by V. Scamozzi in 1580, yet it is clear that each belongs to an entirely different world of artistic ideas. The Procuratie Vecchie is perhaps the longest arcaded faqade in the world and certainly shows the least amount of wall space; the whole design is simple, the molding and ornamentation severe. The Procuratie Nuove, which after all is merely Scamozzi's continuation of Sansuovino's library, displays all the richness of that ornate building. It contains the museum of ancient sculpture, founded by Cardinal Domenico Grimani in 1523, and the Correr museum.

Among the churches of this period those of S. Giorgio Maggiore and of the Redentore are both by Palladio. In 1631 Baldassare Longhena began the fine church of Sta. Maria della Salute. With a large and handsome dome, a secondary cupola over the altar, and a striking portal and flight of steps. it occupies one of the most conspicuous sites in Venice on the point of land that separates the mouth of the Giudecca from the Grand canal. In plan it is an octagon with chapels projecting one on each side. The faqades of S. Moist: and of Sta. Maria del Giglio are good specimens of the baroque style.

Among the palaces of the later Renaissance the more remarkable are Sansovino's Palazzo Corner della Ca' Grande, Sammicheli's Palazzo Corner Mocenigo at San Polo, Longhena's massive and imposing Palazzo Pesaro, the Palazzo Rezzonico, from designs by Longhena with the third story added by G. Massari, and Massari's well-proportioned and dignified Palazzo Grassi at S. Samuele, built around 1750.

The "Scuole."—Among the most remarkable buildings in Venice are the *scuole,* or guild halls, of the various confraternities. The six *scuole grandi,* San Teodoro. Santa Maria della Carità, San Giovanni Evangelista. San Marco, della Misericordia and San Rocco, built themselves magnificent guild halls. The Scuola di San Marco is now a part of the town hospital, and besides its façade, it is remarkable for the handsome carved ceiling in the main hall (1463). Other beautiful ceilings are to be found in the great hall and the hall of the Albergo in the Scuola della Carita, now the Accademia containing the famous picture gallery, with a number of works, returned by Austria in 1919, by Marco Cozzi of Vicenza. But the most magnificent of these guild halls is the Scuola di San Rocco, designed by Bartolomeo Buon in 1517 and carried out by A. A. Scarpagnino and Sante Lombardo. The faqade on the Campo is large and pure in conception. The great staircase and the lower and upper halls contain an unrivaled series of paintings by Tintoretto.

Campaniles.--Among the more striking features of Venice are the campaniles or bell towers. (See CAMPANILE.) These were at one time more numerous! for earthquakes and subsidence of foundations have brought many of them down, the latest to fall being the great tower of San Marco itself, which collapsed on July 14, 1902. Its reconstruction was at once undertaken. and completed in 1912, together with that of Sansovino's beautiful Loggetta, on its east side. In a few other cases, for example at S. Giorgio Maggiore, the fallen campaniles were restored; but for the most part they were not replaced. The Venetian campanile usually stands detached from the church. It is almost invariably square. The campanile is usually a plain brick shaft with shallow pilasters running up the faces. It has small angle windows to light the interior inclined plane or staircase, and is not broken into stories with grouped windows as in the case of the Lombard bell towers. Above the shaft comes the arcaded bell chamber, frequently built of Istrian stone; and above that again the attic, either round or square or octagonal, carrying either a cone or a pyramid or a cupola. Among the existing campaniles the oldest are S. Geremia, dating from the 11th century, S. Samuele from the 12th. S. Barnaba and S. Zaccaria from the 13th.

Public Monuments.— Venetian sculpture is for the most part ancillary to architecture; for example, Antonio Rizzo's "Adam" and "Eve" (1464), which once faced the Giants' staircase in the ducal palace and are non replaced by marble copies, the originals being preserved in the ducal apartments. are parts of the decorative scheme; Sansovino's splendid monument to Tomaso Rangone is an essential feature of the façade of S. Giuliano. The most successful Venetian sculpture is to be found in the many noble sepulchral private monuments. The jealousy of the Venetian republic forbade the erection of monuments to its great men. The sole exception is the superb equestrian statue in honour of the general Bartolomeo Colleoni, standing on the Campo SS. Giovanni e Paolo. It is by the Florentine Andrea del Verrocchio, and was cast by Alessandro Leopardi, who was responsible for the graceful pedestal. Leopardi was also the creator (1505) of the three handsome bronze sockets in front of St. Mark's which held the flagstaffs of the banners of Cyprus, Morea and Crete, when the republic ruled them.

By the side of the sea in the piazzetta, on to which the west façade of the ducal palace faces. stand two ancient columns of Egyptian granite, brought as trophies to Venice by the doge Domenico Michieli in 1126. In 1180 they were set up with their present fine capitals and bases. The gray column is surmounted by a fine bronze lion in oriental style, brought to Venice for the doge Ziani about 1178. In 1329 a marble statue of St. Theodore, standing upon a crocodile. was placed on the other column.

Painting. — Painting developed relatively late in Venice, as is shown by the dates of the activity of Jacopo Bellini (1424–70) and his sons Gentile (1429–1507) and Giovanni (1430–1516), of the Vivarini family of Murano (1440–1505); and of Vittore Carpaccio (c. 1460–1525/26). The greatest artists of the Venetian school are Titian *(c.* 1477–1576), Tintoretto (1518–94) and Paolo Veronese (1528–88) but Palma il Vecchio *(c.* 1480–1528), Bonifazio Veronese and Paris Bordone, are also important. Later masters are G. B. Tiepolo, A. Canal and F. Guardi.

Institutions. — Thearsenal mas founded about the year 1104 by the doge Ordslafo Falier. In 1304, on the design of Andrea Pisano, new building sheds and the rope walk nere erected. Pisano's building sheds, nine in a row, with peculiarly shaped roofs, have been modified. In 1325 the second addition, the *arsenale nuovo,* was made, and a third, the *arsenale nuovissimo,* in 1473; a fourth. the *Riparto delle Galeazze,* about 1539; and in 1j64 the fifth enlargement, the *Canal delle Galeazze e Vasca,* took place. The entire circuit of the arsenal, about two miles in extent, is protected by a lofty wall with turrets. The main door of the arsenal is the first example in Venice of the purely classical style. It is a noble portal, erected in 1460, from designs by Fra Giocondo. with the lion of St. Mark in the attic. The statuary, with S. Giustina on the summit. of the tympanum. was added in 1j71 and 1578. The whole design was modified in 1688 so as to represent a triumphal arch in honour of Morosini Peloponnesiaco, who brought from Athens to Venice the four lions in Pentelic marble which now stands before the gate. (On the largest of these lions is cut a runic inscription recording an attack on the Piraeus in the 11th century by Norse warriors of the Varangian guard, under Harald Hardrada, afterward, in 1047, king of Norway.) The arsenal suffered frequently and severely from fires, the worst being those of 1509 and 1569; yet such was the wealth of Venice that its fleet crushed the Turks at Lepanto in 1571.

Festivals. — Venice is still famous for its festivals: The chief events in its history always have been celebrated either by civic or religious functions. The 11th centenary of the "pious theft" of St. Mark's body from Alexandria was celebrated in the spring of 1928 with a procession around the Piazzetta and the Piazza of S. Marco, in which 50 bishops of Venetia and mitred Canons of San Marco, as well as other dignitaries of the church, took part, robed in gorgeous vestments and recalling the pictures of Bellini and Carpaccio.

The most characteristic feasts are the following: on Holy Thursday the Venetians used to celebrate the victory over Urico, the patriarch of Aquileia. He was forced to pay tribute of a bull and 12 pigs which were meant to represent the primate and the canons of the chapter. Art and literature have immortalized the celebration of Ascension day when the doge used to be rowed out to the lagoon by the Lido in his gala gondola, *il Bucintoro* (or *Bucentaur*), to perform the symbolic rite of throwing a ring into the waters, and espousing the Adriatic with these words: *Ti sposiamo, o mare nostro, in segno di vero e perpetuo domino* ("We wed thee, o our sea, in sign of true and perpetual dominion.") The ceremony originated from Ascension day of the year A.D. 1000, when Pietro Orseolo II set sail from Venice to conquer Istria and Dalmatia.

Two eminently popular festivals of votive origin are still kept: the feast of the Madonna della Salute (Our Lady of Health) and that of the *Redentore* (Redeemer). to whose patronage the Venetians believed they owed their deliverance from the plague in 1576 and 1630. and in whose honour they built the churches of the Salute and the Redentore.

On the feast of the Salute (Nov. 21) the Venetians take votive offerings to the church, and end the day with private banquets for which it was formerly customary to procure Dalmatian mutton as the chief dish. The feast of the Redentore is celebrated on the third Sunday of July with a characteristic vigil kept by the people singing as they row about in boats of every size and shape which are festooned with lights. At dawn they row out to the Lido in great numbers for the sunrise. International film, sculpture and other festivals also take place in Venice.

Libraries, Museums and Galleries. — The library of San Marco contains about 550,000 printed volumes and about 13,000 manuscripts. The true foundation of the library may be dated to the donation of John Cardinal Bessarione. The principal treasures of the collection, including splendid Byzantine book covers, the priceless codices of Homer, the Grimani breviary, an early Dante, etc., are exhibited under cases in the Sala Bessarione in the Zecca or mint where the library has been installed. Another library was left to the public by the munificence of Count Querini-Stampalia. who bequeathed his collections and his house at Sta. Maria Formosa to be held in trust for students.

An up-to-date art library is kept in the Correr museum in St. Mark's square. The state archives are kept in the Franciscan monastery adjoining the Frari. It contains the so-called Golden Book of the patricians, and documents dating from the time of Charlemagne.

The doge's palace, adjoining St. Mark's, has frescoed walls and ceilings, and easel-pictures by Titian, Tintoretto, Paolo Veronese, etc. The names of the various halls: Sala del Collegio, del Senato, del Consiglio dei Dieci, del Maggior Consiglio, etc., recall the days of the proud republic. The Museo Archeologico occupies that part of the doge's palace where the doge used to have his apartment.

The Museo Civico Correr (the Correr museum), in the royal apartments, Piazza S. Marco, has valuable collections of pictures, armour, coins, maps, costumes of state, etc. The Museo Storico Navale, in the arsenal, has models of ancient ships and of the Bucintoro, or Bucentaur (*q.v.*).

The Accademia delle Belle Arti, on the Grand canal, contains a unique collection of masterpieces of the Venetian school. The Galleria Internazionale d'arte Moderna, inaugurated in 1902, has an important collection of international works of art which have been purchased in greater part from the Biennial International Exhibition of Modern Art. This was instituted in 1895 in honour of the silver wedding of King Humbert and Queen Margherita, and is held in the public gardens.

The Pinacoteca Comunale, in Palazzo Querini, once the residence of the patriarch of Venice, has a notable collection of pictures and prints.

Population and Administration. — In 1548 the population of Venice was 158,069; in 1607–29, 142,804; in 1706, 140,256; in 1785, 139,095; in 1881, 132,826; in 1931, 172,654; in 1951, 174,632; in 1957, 336,909 (commune).

Under the republic, and until modern times, the water supply of Venice was furnished by the storage of rain water supplemented by water brought from the Brenta in boats. The famous Venetian *pozzi,* or wells for storing rain water from the roofs and streets, consisted of a closed basin with a watertight stratum of clay at the bottom, upon which a slab of stone was laid; a brick shaft of radiating bricks laid in a permeable jointing material of clay and sand was then built. On the ground level perforated stones set at the four corners of the basin admitted the rain water, which was discharged from the roofs by lead pipes; this water filtered through the sand and percolated into the shaft of the well, whence it was drawn in copper buckets. The present drinking water supply comes from San Ambrogio di Grion near Castelfranco Veneto about 20 mi. away.

All the drains of the houses in Venice are of the kind known as *bottino mouras,* the openings of which have to be more than three feet below the level of the average high tide, all drainage being carried out to sea. With the rise and fall of the tide the discharge pipes are flushed at the bottom. An investigation undertaken by the Bacterioscopical laboratory, with regard to the pollution of the Venetian canals by the city sewage, led to the discovery that the water of the lagoons possesses self-purifying power, not only in the large canals but even in the smallest ramifications of the waterways.

Venice has a patriarch who is usually a cardinal. The patriarchate dates from 1451, when on the death of Domenico Michiel, patriarch of Grado, its seat of that honour was transferred to the cathedral church of Castello in Venice, and Michiel's successor, Lorenzo Giustinian, assumed the title of patriarch of Venice. On the fall of the republic St. Mark's became the cathedral church of the patriarch. There are 30 parishes in the city of Venice and 15 in the lagoon islands and on the littoral.

There is a football and sports ground in Venice, but perhaps more typical sports are those that take place on the water, especially the historic regatta held annually on the first Sunday in September on the Grand canal.

Port, Communications and **Industries.**—Under the republic commercial shipping used to enter Venice by the port of S. Nicolò del Lido and lie along the quay called the Riva degli Schiavoni, in the basin of S. Marco, and up the broad Giudecca canal. But the mouth of the Lido entrance gradually silted up and, when trade expanded, the Italian government resolved to reopen it. Two moles were run out in a southwesterly direction; the westerly is about 2 mi., the easterly about 3 mi. in length. The natural scour thus created gave a depth of 26 ft. of water through the sandbank. The mean rise and fall of the tide is about 2 ft., but under certain conditions of wind the variation amounts to j ft. and over. Docks were constructed near the railway station, but in 1917 plans were made for a new port for Venice on the mainland, at Marghera, south of the railway line to Padua; in 1922 the canal of approach was opened by King Victor Emmanuel III, and named after him, and in 1924 the construction of the main works was begun. The port is accessible at all times to vessels drawing 30 ft. It was the first in Italy n-here railway trucks could be loaded and unloaded on the quays, which are in direct communication with Mestre station.

The maritime station, connected with the mainland by a bridge, and the Marghera industrial port were both dredged to a depth of 33 ft. The maritime station, which includes Mole A at Porto Marghera, has a total length of 18,168 ft.; the whole commercial zone has an area of 27 ac., and the industrial area of Porto Marghera has a total length of 45,932 ft. It has a yearly potential in loading and unloading of at least 1,000 tons of merchandise to every 3 ft. of port frontage. The three industrial zones lying to the north, west and south of the commercial port were nearly all secured by business firms, and a number of factories were built. Each zone has exit to the sea by means of canals; for example, the northern zone communicates with the sea by the Canale Industriale Nord.

Venice is linked by rail with main lines to Milan and Bologna and through Tarvisio and Trieste to Austria and Yugoslavia respectively. The Santa Lucia station, a modern low-pitched building, beautiful in the grace and clarity of its design, is at the western end of the Grand canal. The city is generally served by Treviso airport, 21 mi. away, and occasionally by the small San Nicolò airport at the northern end of the Lido.

A garden city, built on the Mestre-Padua road, provides links with the industrial area.

The ancient glass-bead industry (*conterie*) has regained its position through the union of the different factories. Venetian beads are ordinarily sent in large quantities to Africa and to India, Sumatra and Borneo. Similarly, the glass industry has revived. New amalgams and methods of colouring have been discovered, and fresh forms have been diligently studied. Special progress has been made in the production of mirrors, electric lamps, candelabra and mosaics. There are worked iron and copper industries, and much carved furniture is produced. Venetian filigree jewelry, and long, fine gold chains are also beautifully made.

New industries are those of tapestry, brocades, imitation of ancient stuffs, cloth of silver and gold, and Venetian laces for the manufacture of which there is a government school, with 500 girl pupils. (*See* LACE.)

The Lido.—Bathing establishments were set up on a long beach or strand that separates Venice from the open sea. These proved so popular that a whole town with bathing huts, hotels, gardens and tree-lined avenues grew up facing the Adriatic. Instead of gondolas or ferries there are trolley buses, motor cars and carriages. The curved beach with its firm sands attracts visitors from all parts of the world.

The Islands in the Lagoon.—These include Murano, where an ancient and celebrated tradition of artistic glassmaking still flourishes; Burano, an island of fisherfolk also known for lacework; S. Francesco del Deserto, legend tells of several miracles performed there by St. Francis of Assisi during his journey in 1200; Torcello, farthest to the north, 6½ mi. away, was the political centre of the lagoon before Venice rose to power on the other islands. But more than 1,000 years ago the city that had arisen around the cathedral and the Church of Sta. Fosca was partly dismantled to build the palaces of Venice; S. Lazzaro degli Armeni is an Armenian monastery in the immediate Venice basin, a centre of studies for Roman Catholic monks of the Armenian rite. Lord Byron often visited the monastery. (X.)

HISTORY

It is usually affirmed that the state of Venice owes its origin to the barbarian invasions of north Italy; that it was founded by refugees from the mainland cities who sought refuge from the Huns in the impregnable shallows and mudbanks of the lagoons. Venice, like Rome and other famous cities, was an asylum city. But it is nearly certain that long before Attila and his Huns swept down upon the Venetian plain in the middle of the 5th century, the little islands of the lagoon already had a population of poor but hardy fisherfolk living in quasi-independencc, because of their poverty and their inaccessible site. This population was augmented from time to time by refugees from the mainland cities of Xquileia, Concordia, Opitergium, Altinum and Patavium. But these did not mingle readily with the indigenous population; as each wave of barbarian invasion fell back, these refugees returned to their mainland homes, and it required the pressure, of many successive incursions to induce them finally to abandon the mainland for the lagoon, a decision which was not reached till the Lombard invasion of j68. On each occasion, no doubt, some of the refugees remained behind in the islands, and gradually built and peopled the 12 lagoon townships, which formed the germ of the state of Venice and were subsequently concentrated at Rialto or in the city known as Venice. These 12 townships were Grado, Bibione, Caorle, Jesolo, Heraclea, Torcello, Murano, Rialto, Malamocco, Poveglia, Chioggia and Sottomarina. The effect of the final Lombard invasion is shown by the resolve to quit the mainland and the rapid building of churches which is recorded by the *Cronaca altinate*. The people who finally abandoned the mainland and took their priests with them are the people who made the Venetian republic. But they were not as yet homogeneous.

Independence.—There is little doubt that the original lagoon population depended for its administration, as far as it had any, upon the larger cities of the mainland. There is a tradition that Venice was founded hy "consuls from Padua"; and Padua claimed complete control of the course of the Brenta down to its mouth at Malamocco. The destruction of the mainland cities, and the flight of their leading inhabitants to the lagoons, encouraged the lagoon population to assert a growing independence, and led them to advance the doctrine that they were "born independent." Their development as a maritime people, engaged in small trading and intimately acquainted with their home waters, led Belisarius to seek their help in his task of recovering Italy from the Goths. He was successful: and the lagoons became, theoretically at least, a part of the eastern empire. But the empire was vast and weak, and its capital lay far an-ay: in practice, no doubt, the lagoon population enjoyed virtual independence.

It was from Byzantium that the Venetian people received the first recognition of their existence as a separate community. Their maritime importance compelled Narses, the imperial commander, to seek their aid in transporting his army from Grado; and when the Paduans appealed to the Eunuch to restore their rights over the Brenta, the Venetians replied by declaring that islands of the lagoon and the river mouths that fell into the estuary were the property of those who had rendered them habitable and serviceable. Narses declined to intervene. Padua was powerless to enforce its claims and Venice established a virtual independence of the mainland. Nor was it long before Venice made a similar assertion to the imperial representative, Longinus, who invited the Venetians to give him an escort to Constantinople (which they did) and also to acknowledge themselves subjects of the empire. By dint of promising large concessions and trading privileges, he induced the Venetians to make an act of submission — though not upon oath. The terms of this pact resulted in the first diploma conferred on Venice as a separate community (584). But it was inevitable that, when the barbarians, Lombard or Frank, were once established on the mainland of Italy. Venice should be brought first into trading and then into political relations with its near neighbours, who as masters of Italy also put forward a claim to sovereignty in the lagoons. It is between the two claims of east and west that Venice struggled for and achieved recognized independence.

Internal Fusion and Consolidation.——In 466, 14 years after the fall of Aquileia, the population of the 12 lagoon townships met at Grado for the election of one tribune from each island for the better government of the separate communities, and above all to put an end to rivalries which had already begun to play a disintegrating part. But when the lagoon population was largely augmented in 568 as the result of Alboin's invasion, these jealousies were accentuated, and in 584 it was found expedient to appoint 12 other tribunes, known as the *Tribuni Maiores,* who formed a kind of central committee to deal with all matters affecting the general weal of the lagoon communities. But the *Tribuni Maiores* were equally powerless to allay the jealousies of the growing townships which formed the lagoon community. Rivalry in fishing and in trading. coupled with ancient antipathies inherited from the various mainland cities of origin, were no doubt the cause of these internecine feuds. A crisis was reached when Christopher, patriarch of Grado. convened the people of the lagoon at Heraclea, and urged them to suppress the 12 tribunes and to choose a single head of the state. To this they agreed, and in 697 Venice elected its first doge, Paulo Lucio Anafesto.

The growing importance of the lagoon townships, due to their maritime skill: their expanding trade, created by their position between east and west: their monopoly of salt and salted fish, which gave them a strong position in the mainland markets. rendered it inevitable that a clash must come over the question of independence. when either east or west should claim that Venice belonged to them; and inside the lagoons of growing prosperity, coupled with the external threat to their liberties, concentrated the population into two well-defined parties—what may be called the aristocratic party, because it leaned toward imperial Byzantium and also displayed a tendency to make the dogeship hereditary, and the democratic party, connected with the original population of the lagoons, aspiring to free institutions. and consequently leaning more toward the church and the Frankish kingdom which protected the church. The aristocratic party was captained by the township of Heraclea, which had given the first doge, Anafesto, to the newly formed community. The democratic party was championed first by Jesolo and then by Malamocco.

The Franks. — The advent of the Franks determined the final solution. The emperor Leo, the Isaurian, came to open rupture with Pope Gregory II over the question of images. The pope appealed to Liutprand, the powerful king of the Lombards, to attack the imperial possessions in Ravenna. He did so, and expelled the exarch Paul, who took refuge in Venice and was restored to his post by the doge of the Heraclean or Byzantine party, Orso, who in return for this assistance received the imperial title of *hypatos,* and trading rights in Ravenna. The pope, however, soon had cause for alarm at the spread of the Lombard power which he had encouraged. Liutprand proceeded to occupy territory in the Ducato Romano. The pope, looking about for a saviour, cast his eyes on Charles Martel, whose victory at Tours had riveted the attention of the world. Charles's son, Pippin. was crowned king of Italy, entered the peninsula at the head of the Franks, defeated the Lombards, took Ravenna and presented it to the pope, while retaining a feudal superiority. Desiderius, the last Lombard king, endeavoured to recover Ravenna. Charlemagne. Pippin's son. descended upon Italy, broke up the Lombard kingdom (774), confirmed his father's donation to the pope. and in reprisals for Venetian assistance to the exarch. ordered the pope to expel the Venetians from the Pentapolis. Venice was now brought face to face with the Franks under their powerful sovereign. who soon showed that he intended to claim the lagoons as part of his new kingdom. In Venice the result of this menace was a decided reaction toward Byzantium. In opposition to the Frankish claim, Venice resolved to affirm its dependence on the eastern empire. But the democratic party. the Frankish party in Venice. was powerful. Feeling ran high. A crisis was rapidly approaching. The Byzantine doge Giovanni Galbaio attacked Grado, the see of the Francophil Patriarch Giovanni, captured it, and flung the bishop from the tower of his palace. But the murdered patriarch was succeeded by his no less Francophil nephew Fortunatus, a strong partisan, a restless and indomitable man, who along with Obelerio of Malamocco now assumed the lead of the democratic party. He and his followers plotted the murder of the doge. were discovered. and sought safety at the court of Charlemagne, where Fortunatus strongly urged the Franks to attack the lagoons.

Meantime the internal politics of Venice had been steadily preparing the way for the approaching fusion at Rialto. The period from the election of the first doge to the appearance of the Franks was characterized by fierce struggles between Heraclea and Jesolo. At length the whole population agreed to fix their capital at Malamocco, a compromise between the two incompatible parties, marking an important step toward final fusion at Rialto.

That central event of early Venetian history was reached when Pippin resolved to make good his title as king of Italy. He turned his attention to the lagoon of Venice, which had been steadily growing in commercial and maritime importance, and had, on the whole, shown a sympathy for Byzantium rather than for the Franks. Pippin determined to subdue the lagoons. He gathered a fleet at Ravenna, captured Chioggia. and pushed on up the Lido toward the capital of the lagoons at Malamocco. But the Venetians. in face of the danger, once more moved their capital, this time to Rialto, that group of islands now called Venice, lying in mid-lagoon between the *lidi* and the mainland. This step was fatal to Pippin's designs. The intricate waterways and the stubborn Venetian defense baffled all his attempts to reach Rialto; the summer heats came on; the Lido was unhealthy. Pippin was forced to retire. A treaty between Charlemagne and Nicephorus (810) recognized the Venetians as subjects of the eastern empire, while preserving to them the trading rights on the mainland of Italy which they had acquired under Liutprand.

The concentration at Rialto marks the beginning of the history of Venice as a full-grown state. The external menace to their independence had welded together the place and the people; the same pressure had brought about the fusion of the conflicting parties in the lagoon townships into one homogeneous whole. There was for the future one Venice and one Venetian people dwelling at Rialto. the city of compromise between the dangers from the mainland, exemplified by Attila and Alboin, and the perils from the sea, illustrated by Pippin's attack. The position of Venice was now assured.

The first doge elected in Rialto was Angelo Partecipazio, a Heraclean noble. and his reign was signalized by the building of the first Church of S. Marco, and by the removal of the saint's body from Alexandria, as though to affirm and to symbolize the creation of united Venice.

Growth of The Republic

The history of Venice during the next 200 years is marked externally by the growth of the city, the result of its increasing trade. In the mainland Venice gradually acquired trading rights, partly by imperial diploma, partly by the establishment and the supply of markets on the mainland rivers. the Sile and the Brenta. Internally this period is characterized by the attempt of three powerful families, the Partecipazi. the Candiani and the Orseoli, to create an hereditary dogeship, and the violent resistance offered by the people. There were seven of the Particiachi. five Candiani and three Orseoli reigning in almost unbroken succession. until. with the ostracism of the whole Orseolo family in 1032, the dynastic tendency was crushed forever.

The growing wealth of Venice soon attracted the cupidity of its piratical neighbours on the coast of Dalmatia. The swift Liburnian vessels began to raid the Lido. compelling the Venetians to arm their own vessels and thus to form the nucleus of their famous fleet. the importance of which was recognized by the Golden Bull of the emperor Basil. which conferred on Yenetian merchants privileges far more extensive than any they had hitherto enjoyed. on condition that the Venetian fleet was to be at the disposition of the emperor. But the Dalmatian raids continued to harass Yenetian trade. till. in 1000. the great doge Pietro Orseolo II attacked and captured Curzola and stormed the piratical stronghold of Lagosta. crushing the freebooters in their citadel. The doge assumed the title of duke of Dalmatia. and a great step was taken toward the supremacy of Venice in the Adriatic. which was essential to the free development of its commerce and also enabled it to reap the pecuniary advantages to be derived from the Crusades. It now commanded the route to the Holy Land and could supply the necessary transport. nnd from the crusades its growing aristocracy reaped large profits. Orseolo's victory was commemorated and its significance affirmed hy the magnificent symbolical ceremony of the "wedding of the sea" (*Sposalizio del Mar*). celebrated henceforward every Ascension day. The result of the first three crusades was that Venice acquired trading rights. a l'enetian quarter. church. market. bakery. etc.. in many of the Levant cities: *e.g.*, in Sidon (1102) and in Tyre (1123). The fall of Tyre marks a great advance in development of Venetian trade; the republic had now passed beyond the Adriatic. and had taken an important step toward complete command of the Levant.

Rise of the **Aristocracy.**—This expansion of the trade of Venice resulted in the rapid development of the wealthier classes, with a growing tendency to draw together for the purpose of securing to themselves the entire direction of Venetian politics in order to dominate Venetian commerce. To achieve their object. a double line of conduct was imposed upon them: they had to absorb the powers of the doge. and also to deprive the people of the voice they possessed in the management of state affairs by their presence in the *concione* or genera1 assembly of the whole community, which was still the fountain of all authority. The first step toward curtailing the power of the doge was taken in 1032, when the family of the Orseoli was finally expelled from Venice and the doge Domenico Flabianico was called to the throne. X law was then passed forbidding for the future the election of a doge-consort. a device by which the Particiachi. the Candiani and the Orseoli had each of them nearly succeeded in carrying out their dynastic ambitions. Further, two ducal councilors were appointed to assist the doge, and he was compelled. not merely permitted, to seek the advice of the more prominent citizens at moments of crisis. By this reform two important offices in the l'enetian constitution — the privy council (*consiglieri ducali*) and the cenate (the *pregadi* or invitedj — came into being. Both were gradually developed on the lines desired by the aristocracy, until the year 1171.

The growth of Venetian trade and wealth in the Levant roused the jealousy of Genoa and hostility of the imperia1 court at Constantinople. where the Venetians are said to have numbered 200,000 and to have held a large quarter of the city in terror by their brawls. The emperor Manuel I. urged on by the Genoese and other rivals of Venice. seized the pretext. The Yenetians were arrested and their goods confiscated. Popular feeling at Yenice ran so high that the state was rashly swept into war with the empire. The doge Vitale Michiel II led the expedition in person. It proved a disastrous failure, and on the return of the shattered remnants (1171) a great constitutional reform seemed necessary. The Venetians resolved to create a deliberative assembly. which should act with greater caution than the *concione,* which had just landed the state in a ruinous campaign. Forty members were elected in each of the six divisions of the city, giving a body of 480 members. who served for one year and on retiring named two deputies for each *sestiere* to nominate the council for the succeeding year. This was the germ of the great council, the Maggior Consiglio, which was rendered strictly oligarchic in 1296. As the duties of this council were to appoint all officers of state. including the doge. it is clear that by its creation the aristocracy had considerably curtailed the powers of the people, who had hitherto elected the doge in general assembly; and at the creation of Michiel's succescor. Sebastiano Ziani (1172), the new doge was presented to the people merely for confirmntion.

The assembly protested. but was appeased by the empty formula. "This is your doge if it please you." Moreover. still further to limit the power of the doge, the number of ducal councilors was rnised from two to six. In 1198. on the election of Enrico Dandolo. the aristocrncy carried their policy one step farther, and hy the *promissione ducale*, or coronation oath. which every doge was required to swear. they acquired a powerful weapon for the suppression of all that remained of ancient ducal authority. The *promissione ducale* was binding on the doge and his family. and could he. and frequently was. altered at each new election. a commission. *Inquisitori sopra il doge defunto,* being appointed to scrutinize the actions of the deceascd doge and to add to the new oath whatever provisions they thought necessary to reduce the dogeship to the position of a mere figurehead.

The 4th **Crusade.**—In spite of the check to their trade reteil-ed from the emperor Manuel in 1171, Yenetian commerce continued to Aourish. the Yenetian fleet to grow and the Yenetians to amass wealth. When the fourth crusade was proclaimed at Soissons. it was to Venice that the leaders applied for transport, and it agreed to furnish transport for 4,500 horses. 9.000 knights, 20,000 foot, and provisions for one year: the price was 85.000 silver marks of Cologne and half of all conquests. But Zara and Dalmatia had revolted from Yenice in 1166 and were as yet unsubdued. Venetian supremacy in the Xdriatic had been temporarily shaken. The 85.000 marks, the price of transport. were not forthcoming. and the Venetians declined to sail till they were paid. The doge Dandolo now saw an opportunity to benefit Venice. He offered to postpone the receipt of the money if the crusaders n-ould reduce Zara and Dalmatia for the republic. These terms were accepted. Zara was recovered. and while still at Zara the leaders of the crusade. supported by Dandolo. resolved for their own private purposes to attack Constantinople. instead of making for the Holy Land. Constantinople fell (1204), chiefly because of the ability of the Venetians under Dandolo. The city was sacked. and a Latin empire. with Baldwin of Flanders as emperor, was established at Constantinople. (See BYZANTINE EMPIRE.)

In the partition of the spoils Venice claimed and received. in its own phrase. "a half and a quarter of the Roman empire.!' To Venice fell the Cyclades. the Sporades. the islands and the eastern shores of the Xdriatic. the shores of the Propontis and the Euxine. and the littoral of Thessaly, and it bought Crete from the marquis of Monferrat. The accession of territory was of the highest importance to Venetian commerce. Venice now commanded the Xdriatic. the Ionian islands. the archipelago, the Cea of Marmora and the Black sea. the trade route between Constantinople and western Europe. and it had already become established in the seaports of Syria. and thus held the trade route between Asia Minor and Europe. It was raised at once to the position of a European power. In order to hold these possessions. it borrowed from the Franks the feudal system. and granted fiefs in the Greek islands to its more powerful families. on condition that they held the trade route open for Venice. The expansion of commerce which resulted from the fourth crusade soon made itself evident in the city by a rapid development in its architecture and by a decided strengthening of the commercial aristocracy, which eventually led to the great constitutional reform — the closing of the Maggior Consiglio in 1296. whereby Venice became a rigid oligarchy. Externally this rapid success awoke the implacable hatred of Genoa. and led to the long and exhausting Genoese wars which ended at Chioggia in 1380.

The Venetian Constitution.— The closing of the great council was. no doubt, mainly due to the slowly formed resolution on the part of the great commercial families to secure a monopoly in the Levant trade which the fourth crusade had placed definitely in their hands. The theory of the government, a theory expressed throughout the whole commercial career of the republic, the theory which made Venice a rigidly protective state. was that the Levant trade belonged solely to Venice and its citizens. No one but a Venetian citizen was permitted to share in the profits of that trade. But the population of Venice was growing rapidly. and citizenship was as yet undefined. To secure for themselves the command of trade the leading commercial families resolved to erect themselves into a close guild. which should have in its hands the sole direction of the business concern, the exploitation of the east. This policy took definite shape in 1297, when the doge Pietro Gradenigo proposed and carried the following measure: the supreme court, the Quarantia, was called upon to ballot, one by one, the names of all who for the last four years had held a seat in the great council created in 1171. Those who received 12 favourable votes became members of the great council. A commission of three was appointed to submit further names for ballot. The three commissioners at once laid down a rule that only those who could prove'that a paternal ancestor had sat in the great council should be eligible for election.

This measure divided the community into three great categories: (1) those who had never sat in the council themselves and whose ancestors had never sat; there were of course the vast majority of the population, and they were excluded forever from the great council; (2) those whose paternal ancestors had sat in the council; these were eligible and were gradually admitted to a seat, their sons becoming eligible on majority; (3) those who were of the council at the passing of this act or had sat during the four preceding years; their sons likewise became eligible on attaining majority. As all offices were filled by the great council: exclusion meant political disfranchisement. A close caste was created which very seldom and very reluctantly admitted new members to its body. The Heralds' college, the *avvogadori di comun*, in order to ensure purity of blood: were ordered to open a register of all marriages and births among members of the newly created caste, and these registers formed the basis of the famous *Libro d'oro.*

The closing of the great council and the creation of the patrician caste brought about a revolution among those who suffered disfranchisement. In the year 1300 the people, led by Marin Bocconio, attempted to force their way into the great council and to reclaim their rights. The doors were opened. the ringleaders were admitted and immediately seized and hanged. Ten years later a more serious revolution, the only revolution that seriously shook the state, broke out ahd was also crushed. This conspiracy was championed by Bajamonte Tiepolo, and seems to have been an expression of patrician protest against the *serrata,* just as Bocconio's revolt had represented popular indignation. Tiepolo, followed by members of the Querini family and many nobles with their followers, attempted to seize the Piazza on June 1j, 1310. They were met by the doge Pietro Gradenigo and crushed. Querini was killed, and Tiepolo fled.

The chief importance of the Tiepoline conspiracy lies in the fact that it resulted in the establishment of the Council of Ten. Erected first as a temporary committee of public safety to hunt down the remnant of the conspirators and to keep a vigilant watch on Tiepolo's movements! it was finally made permanent in 1335. The secrecy of its deliberations and the rapidity with which it could act made it a useful adjunct to the constitution, and it gradually absorbed many important functions of the state.

With. the creation of the Council of Ten the main lines of the Venetian constitution were completed. As the base of the pyramid there was the great council, the elective body composed of all who enjoyed the suffrage; *i.e.,* of the patrician caste. Above the great council came the senate, the deliberative and legislative body par excellence. To the senate belonged all questions relating to foreign affairs. finance. commerce, peace and war. Parallel with the senate, but extraneous to the main lines of the constitution, came the Council of Ten. As a committee of public safety it dealt with all cases of conspiracy; for example, it tried the doge Marino Falier and the General Carmagnola; on the same ground all cases affecting public morals came within its extensive criminal jurisdiction. In the region of foreign affairs it was in communication with envoys abroad, and its orders would override those of the senate. It also had its own departments of finance and nar. Above the senate and the Ten came the *Collegio* or cabinet, the administrative branch of the constitution. All affairs of state passed through its hands. It was the initiatory body; and it lay with the *Collegzo* to send matters for deliberation either before the senate or before the Ten. At the apex of the pyramid came the doge and his council.

The Genoese Wars.—To turn now to the external events which followed on the fourth crusade. These events are chiefly concerned with the long struggle with Genoa over the possession of the Levant and Black sea trade. By the establishment of the Latin empire Venice had gained a preponderance. But it was impossible that the rival Venetian and Genoese merchants. dwelling at close quarters in the Levant cities, should not come to blows. They fell out at Acre in 1253. The first Genoese war began and ended in 1258 by the complete defeat of Genoa. But in 1261 the Greeks, supported by the Genoese, took advantage of the absence of the Venetian fleet from Constantinople to seize the city and to restore the Greek empire in the person of Michael VIII Palaeologus. The balance turned against Venice again. The Genoese were established in the spacious quarter of Galata and threatened to absorb the trade of the Levant. To recover its position Venice went to war again, and in 1264 destroyed the Genoese fleet off Trepani, in Sicilian waters. This victory was decisive at Constantinople. where the emperor abandoned the defeated Genoese and restored Venice to its former position. The appearance of the Ottoman Turk and the final collapse of the Latin empire in Syria brought about the next campaign between the rival maritime powers. Tripoli (1289) and Acre (1291) fell to the Mohammedan. and the Venetian title to its trading privileges.

To the scandal of Christendom, Venice at once entered into treaty with the new masters of Syria and obtained a confirmation of ancient trading rights. Genoa replied by attempting to close the Dardanelles. Venice made this action a *casus belli.* The Genoese won a victory in the gulf of Alexandretta (1294); but on the other hand the Venetians under Ruggiero Morosini forced the Dardanelles and sacked the Genoese quarter of Galata. The decisive engagement, however. of this campaign was fought at Curzola (1299) in the Adriatic. when Venice suffered a crushing defeat. A peace. honourable to both parties, was brought about by Matteo Visconti. lord of Milan. in that same year. But the quarrel between the republics, both fighting for trade supremacy—that is to say, for their lives—could not come to an end till one or other was thoroughly crushed. The fur trade of the Black sea furnished the pretext'for the next war (1353–54), which ended in the crushing defeat of Venice at Sapienza, and the loss of its entire fleet. But though Venice itself seemed to lie open to the Genoese, they took no advantage of their victory; they mere probably too exhausted. The lord of Milan again arranged a peace (1355).

Then followed the last phase of the struggle for maritime supremacy. Under pressure from Venice the emperor John V Palaeologus granted possession of the island of Tenedos to the republic. The island commanded the entrance to the Dardanelles. Genoa determined to oppose the concession, and war broke out. The Genoese Adm. Luciano Doria sailed into the Adriatic, attacked and defeated Vettor Pisani at Pola in Istria, and again Venice and the lagoons lay at the mercy of the enemy. Doria resolved to blockade and starve Venice to surrender. The situation was extremely critical for Venice. but it rose to the occasion. Vettor Pisani was placed in command. and by a stroke of naval genius he grasped the weakness of Doria's position. Sailing to Chioggia he blocked the channel leading from the lagoons to the sea. and Doria was caught in a trap. Finally, in June 1380 the flower of the Genoese fleet surrendered at discretion. Genoa never recovered from the blow. and Venice remained undisputed mistress of the Mediterranean and the Levant trade.

Expansion to the Mainland.— But as the city became the recognized mart for exchange of goods between east and west, the freedom of the western outlet assumed the aspect of a paramount question. It was useless for Venice to accumulate eastern merchandise if it could not freely pass the goods on to the west. If the various states on the immediate mainland could levy taxes on Venetian goods in transit, the Venetian merchant would inevitably suffer in profits. The geographical position of Venice and the commercial policy alike compelled it to attempt to secure the command of the roads of the mainland. at least up to the mountains. and of the rivers, of the northwestern outlet, just as the command of the southeastern inlet had been obtained. Venice was compelled to turn its attention. though reluctantly. to the mainland of Italy. Another consideration drove it in the same direction. During the long wars with Genoa the Venetians realized that, as they owned no meat- or corn-producing territory, a crushing defeat at sea and a blockade on the mainland exposed them to the grave danger of being starved into surrender. Both these pressing necessities, for a free outlet for merchandise and for a food-supplying area, drove Venice onto the mainland. and compelled it to initiate a policy which eventually led to the disastrous wars of Cambrai. This period is the epoch of the despots. the ***signori,*** and in pursuit of expansion on the mainland Venice was brought into collision first with the Scaligeri of Verona, then with the Carraresi of Padua. and finally with the Visconti of Milan. Hitherto Venice had enjoyed the advantages of isolation; the lagoons were virtually impregnable; there was no land frontier to defend. But when it touched the mainland it at once became possessed of a frontier which could be attacked, and was compelled either to expand or to lose the territory acquired.

Venice had already established a tentative hold on the immediate mainland as early as 1339. It was forced into war by Mastino della Scala. lord of Padua. Vicenza, Treviso. Feltre and Belluno, as well as of Verona. who imposed a duty on the transport of Venetian goods. A league against the Scala domination was formed, and the result was the fall of the family. Venice took possession of Padua. but in the terms of the league at once conferred the lordship on the Carraresi, retaining Treviso and Bassano for itself. But it is not until the opening of the next century that Venice definitely acquired land possessions and found itself committed to all the difficulties and intricacies of Italian mainland politics. On the death of Gian Galeazzo Visconti in 1402. his large possessions broke up. His neighbours and his generals seized what was nearest to hand. Francesco II Carrara, lord of Padua, attempted to seize Vicenza and Verona. But Venice had been made to suffer at the hands of Carrara, who had levied heavy dues on transit, and moreover during the Chioggian War had helped the Genoese and cut off the food supply from the mainland. Venice was therefore forced in self-defense to crush the family of Carrara and to make itself permanently possessor of the immediate mainland. Accordingly when Gian Galeazzo's widow applied to the republic for help against Carrara it was readily granted, and after some years of fighting, the possessions of the Carraresi, Padua, Treviso. Bassano. commanding the Valsugana route, as well as Vicenza and Verona. passed definitely under Venetian rule. This expansion of mainland territory was followed in 1420 by the acquisition of Friuli after a successful war with the emperor Sigismund, thus bringing the possessions of the republic up to the Carnic and Julian Alps, their natural frontier.

Isolation of Venice.— Venice was soon made to feel the consequences of having become a mainland power, the difficulties entailed by holding possessions which others coveted, and the weakness of a land frontier. To the west the new duke of Milan, Filippo Maria Visconti. was steadily piecing together the fragrnents of his father's shattered duchy. He was determined to recover Verona and Vicenza from Venice. and intended. as his father had done, to make himself master of all north Italy. The conflict between Venice and Milan led to three wars in 1426. 1427 and 1429. Venice was successful on the whole. It established a hold permanently on Verona and Vicenza. also acquired both Brescia and Bergamo and later occupied Crema. The war of Ferrara and the peace of Bagnolo (1484) gave Venice Rovigo and the Polesine. This. with the exception of a brief tenure of Cremona (1499–1512). formed a permanent territory down to the fall of the republic. The frontiers now ran from the seacoast near Monfalcone. following the line of the Carnic and Julian and Raetian Alps to the Adda, down the course of that river till it joins the Po, and thence along the line of the Po back to the sea. But long and exhausting wars were entailed upon Venice for the maintenance of its hold. The rapid formation of this land empire, and the obvious intention to expand. called the attention not only of Italy hut of Europe to this power which seemed destined to become supreme in north Italy. and eventually led to the league of Cambrai for the dismemberment of Venice.

In 1453 Constantinople fell to the Ottoman Turks, and although Venice entered at once into treaty with the new power and desired to trade with it. not to fight with it, yet it was impossible that Venetian possessions in the Levant and the archipelago should not eventually bring Venice into collision with the expanding energy of Mohammedan. Europe persistently refused to assist the republic to preserve a trade in which was established a rigid monopoly. and Venice was left to fight the Turk single-handed. The first Turkish war lasted from 1464 to 1479, and ended in the loss of Negropont and several places in the Morea. and the payment by Venice of an annual tribute for trading rights. The republic was consoled, however, by the acquisition of Cyprus, which came into its possession (1488) on the extinction of the dynasty of Lusignan with the death of James II and his son James III, Caterina Cornaro, James II's widow. ceding the kingdom of Cyprus to Venice, since she could not hope to maintain Cyprus unaided against the Turks. The acquisition of Cyprus marks the extreme limit of Venetian expansion in the Levant; from this date onward there is little to record save the gradual loss of her maritime possessions.

Decline

Exhausting as the Turkish nars were to the Venetian treasury, trade was still so flourishing that Venice might have survived the strain had not the discovery of the Cape route to the Indies cut the taproot of Venetian commercial prosperity by diverting the stream of traffic from the Mediterranean to the Atlantic. When Diaz rounded the Cape in 1486 a fatal blow was struck at Venetian commercial supremacy. The discovery of the Cape route saved the breaking of bulk between India and Europe, and saved the dues exacted by the masters of Syria and Egypt. Trade passed into the hands of the Portuguese, the Dutch and the English. Venice lost its monopoly of oriental traffic.

League of Cambrai.—To complete Venice's misiortunes, the European powers, the church and the small states of Italy, partly from jealous greed of its possessions, partly on the plea of its treason to Christendom in making terms with Islam, partly from fear of expansion in north Italy, coalesced at Cambrai in 1508 for the partition of Venetian possessions. The war proved disastrous for Venice. The victory of Agnadello (1510) gave the allies the complete command of Venetian territory down to the shores of the lagoon. But the mutual jealousy oi the allies saved Venice. The pope, having recovered the Romagna and secured the objects for which he had joined the league, was unwilling to see all north Italy in the hands of foreigners, and quitted the union. The emperor Maximilian failed to make good his hold on Padua, and was jealous of the French. The league broke up, and the mainland cities of the Veneto returned of their own accord to their allegiance to St. Mark. But the republic never recovered from the blow, coming as it did on the top of the Turkish wars and the loss of trade by the discovery oi the Cape route. Venice ceased to be a great power, and was henceforth entirely concerned in the effort to preserve its remaining possessions and its very independence. The settlement of the peninsula by Charles V's coronation at Bologna in 1530 secured the preponderance to Spain, and the combination of Spain and the church dominated the politics of Italy. Dread of the Turks and dread of Spain were the two terrors which haunted Venice till the republic fell.

Turkish Wars.—But the decline was a slow process. Venice still possessed considerable wealth and extensive possessions. Between 1499 and 1516 the republic went to war four times with the Turks. emerging from each campaign with some further loss of maritime territory. The fourth Turkish war (1570–73) was signalized by the glorious victory of Lepanto (1571), chiefly through the prowess of the Venetians under their doge Sebastian Venier. But its allies iailed in support. They reaped no fruits from the victory, and Cyprus was taken from Venice after the heroic defense of Famagusta by Bragadino, who was flayed alive, and his skin, stuffed with straw, borne in triumph to Constantinople. The fifth Turkish war (1645–68) entailed the loss of Crete; and though Morosini reconquered the Morea for a brief space in 1685, that province was finally lost to Venice in 1716.

So iar as European politics are concerned, the latter years of the republic are made memorable by one important event: the resistance which Venice, under the guidance of Fra Paolo Sarpi, offered to the growing claims of the Curia Komana, advanced by Pope Paul V. Venice was placed under interdict (1606), but asserted the rights of temporal sovereigns with a courage which was successful and won the esteem and approval of most European sovereigns. But the chief glory of the republic's declining years was undoubtedly its splendid art. Giorgione, Titian, Sansovino, Tintoretto, Paolo Veronese and Palladio all lived and worked after the disastrous wars of the league of Cambrai. During these years Venice became the great pleasure city of Europe.

United Italy.— The end of the republic came when the French Revolution burst over Europe. Napoleon was determined to destroy the oligarchical government, and seized the pretext that Venice was hostile to him and a menace to his line of retreat while engaged in his Austrian campaign of 1797. The peace of Leoben left Venice without an ally. The government resolved to offer no resistance to the conqueror. and the doge Lodovico Manin abdicated on May 12, 1797. On Oct. 17. Napoleon handed Venice over to Austria by the peace of Campo Formio, and between 1798 and 1814 Venice was passed from France to Austria and Austria to France till the coalition of that latter year assigned it definitely to Austria. In 1848 a revolution broke out and a provisional republican government under Daniele Manin (*q.v.*) maintained itself for a brief space. In 1866 the deieat of Austria by the Prussians led to the incorporation of Venice in Cnited Italy. (H. F. Br.)

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VENIZELOS, ELEUTHERIOS (1864–1936), Greek statesman, was born in Crete Aug. 23, 1864 of a family which had emigrated from Greece in 1770 Having been educated in the schools of Syra and Athens and having taken a degree in the University of Athens at the age of 23, he practised law in Crete, but soon became a politician, and in the insurrection of 1889 was compelled to flee from the island After his return and the re-establishment of tranquillity, Venizelos was elected a member of the Cretan Assembly, and in 1897 came into prominence as one of the leaders of the Cretan uprising; it was he who received the British, French and Italian admirals when they came to negotiate a settlement between the insurgents and the Turks early in Feb. of that year.

In Dec 1898 Prince George of Greece landed in Crete as the High Commissioner of the Great Powers, and a few months later Venizelcs became head of the Island Executive. But he soon found himself at variance with the Prince's autocracy, and in 1904 a complete rupture occurred. Subsequently the Venizelists were defeated at the polls. but the Cretan leader organized a revolt, which greatly increased the unpopularity of the High Commissioner who was accused of misruling the people. In Sept. 1906 the Prince left the island, his place being taken by Alex. Zaimis, who was appointed not by the Powers, but by the King of Greece From that time until 1909 Venizelos was sometimes Chief of the Cretan Government and sometimes Leader of the Opposition But whilst the Cretans often came into sharp conflict with the Protecting Powers. Venizelos' wisdom and moderation were responsible for the generally friendly relations which existed, and his far-sightedness, particularly after the departure of M. Zaimis in Oct 1908, and during the crisis of 1909, facilitated the union of Crete with Greece, which ultimately took place as a result of the first Balkan War.

In 1909 the military league headed a bloodless revolution against political corruption and court favouritism in Greece and invited Venizelos to come to Athens. He persuaded King George and the League that the best way out of a dangerous situation would be the revision of the Constitution by a National Assembly. Elections were held in Aug. 1910, and Venizelos, who had remained technically a Greek citizen during his Cretan political life, took his seat at Athens for the first time. The Chamber having been opened in September, a month later Venizelos became Prime Minister.

He was in a position to enforce practically any situation, including a republic, which he wished; but decided to work loyally with the King and his successors. The Constitution was successfully revised in 1911, reforms in the public services were introduced, and the reorganization of the army and of the navy mere respectively placed in the hands of French and British Missions. In the spring of 1912 Venizelos was returned to power as the leader of an overwhelming majority in an ordinary Chamber which then replaced the Revisionary Assembly. By that time, too, the Prime Minister was busily occupied with the formation of the Balkan League, and on May 29, 1912, the Greco-Bulgarian Treaty was signed.

Whilst the Balkan Wars and Venizelos' diplomacy led to an unexpected Hellenic expansion, the assassination of King George at Salonika on March 18, 1913, removed a man who had always been in favour of moderation, and placed upon the throne his son Constantine, who had not forgiven, and who never really forgave, Venizelos for his attitude towards Prince George in Crete. When the World War broke out, therefore, the position of Greece was greatly complicated by the facts that she was bound to Serbia by a Treaty signed in the summer of 1913; that from the first Venizelos was an ardent supporter of the Allied cause; and that the King was in sympathy with the Central Powers. Before the entry of Turkey into the War, Venizelos openly favoured Hellenic assistance for the Entente in case of that entry, and early in 1915 the Prime Minister advocated concessions to Bulgaria, Greek support for Serbia. and Greek co-operation at the Dardanelles in exchange for the promise of important future compensations in Western Asia Minor But though he appears originally to have approved of the idea, the King vetoed Venizelos' decision to accept this offer, and he was forced to resign, though he possessed a strong majority in the Chamber. In the election which followed in June the Venizelist party secured the return of 190 deputies out of a total of 316, of which the Chamber was then composed.

In spite of this. and with the excuse of the King's illness, Venizelos was not recalled to power until after the meeting of the Chamber in Aug. and by that time the situation had become seriously modified. The mobilization of Bulgaria on Sept. 29, 1915 brought into operation in equity if not in law, the Greco-Serbian Treaty of 1913 and bound Greece to help Serbia. A few days later, Venizelos extorted from the King reluctant consent to a Greek mobilization and to a Greek request that the Allies should furnish an army of 150,000 men to take the place of the contingent Serbia should have supplied under the Treaty.

Immediately after the original Allied landing at Salonika on Oct. 1 Venizelos secured a vote of confidence during an historic and stormy meeting of the Chamber, when he declared that if in aiding Serbia Greece was brought into contact with Germany she would act as her honour demanded. In spite of a formal protest against the Allied passage through Hellenic territory, this speech led to the second dismissal of Venizelos and to the open and final rupture between that statesman and the King, who, it would seem, always intended to withdraw his consent to an Hellenic entry into the War. Zaimis, the new Prime Minister, maintained his position for a month as a result of the patriotism of Venizelos his friend from Cretan times. but, with the accession of Skouloudis to power, on Nov. 6 the Chamber was dissolved and a new election ordered for Dec. 19. Venizelos' party abstained from the polls in protest, M Gounaris securing an overuhelming majority for his policy of neutrality.

Venizelos spent that winter and spring (1915–16) in endeavouring to compel the King to change his point of view. But the surrender of Eastern Macedonia to the Bulgarians in the summer of 1916 and the delay in the success of the Allied Campaign at

Salonika had strengthened the position of Constantine, and on Sept. 25, 1916, Venizelos, together with his principal supporters, sailed for Crete, whence he sent out proclamations calling upon all true patriots to flock to the standard of the Entente. Proceeding thence to Salonika, early in Oct. he founded a provisional government, which was recognized about two months later by Great Britain and France, though not by Italy,

After the dethronement and enforced departure of King Constantine, Venizelos returned to Athens on June 26, 1917, and took over the government of the whole country. The June 15 chamber was convoked, general mobilization was ordered, and Greece formally opened up hostilities upon the Allied side. But the removal of the king, the successes of the central powers, particularly in the Balkans, and an increased Greek desire for neutrality, backed up by German propaganda, were responsible for a great diminution of the prime minister's popularity.

Between the armistice of Nov. 1918 and his fall two years later, Venizelos and his colleagues, who represented Greece at the peace conference, were almost continuously absent in Paris and London and, during this period, they seemed to be reaping for Greece harvests beyond her dreams. About the end of April 1919, the Greeks were permitted, or encouraged, to land at Smyrna; a year later the conference of San Remo promised large areas to Greece, and the treaty of Sèvres (Aug. 10, 1920) coupled with the earlier treaty of Neuilly (Nov. 27, 1919) gave Greece extraordinary advantages. However, at a moment when Venizelos' triumph appeared to be complete, an attempt was made upon his life at a Paris station (Aug. 1920), and three months later (Nov. 14) he received a crushing defeat at the hands of the Greek electorate.

Many factors were present in this: the unpopularity of the war in Asia Minor and the continued mobilization, the maintenance of martial law, the bad administration of Venizelos' subordinates and injustices practised by the Corps de la Sûreté. Further, there was Venizelos' own continued absence; recollection of the foreign support on which he had called so largely, and Constantine's own increasing popularity. After the unexpected death of the young king Alexander, immediately before the election, the dynastic question, open mention of which had previously been prohibited, was brought into the forefront of the political struggle and, in what then became the direct issue between Constantine and Venizelos, the king won an overwhelming victory.

From the arrival of the king in Athens on Dec. 20, 1920, until his final abdication and second departure on Sept. 30, 1922, Venizelos took no official part in Greek affairs. After the revolution (Sept. 1922), however, he represented Greece for a time in western Europe, *inter alia* at the conference of Lausanne which culminated in the peace signed with Turkey on July 24, 1923. In the following December, when the publication of that document and various other events had aggravated the existing internal dissension and when the election (Dec. 16) had again given his party a majority, Venizelos was persuaded to return to Athens, where he arrived on Jan. 4, 1924. King George was already then on leave of absence and Venizelos was prime minister from Jan. 11 till Feb. 4, when he resigned. In 1928, he began to prepare a return to politics. M. Kaptrandair resigned from the leadership of his section of the Liberals, and Venizelos took his place, declaring this to be the best guarantee against a dictatorship. He brought about the fall of the government, formed a new government with himself as premier on July 4, and secured a large majority in the election held on Aug. 19. Thereafter he negotiated a treaty of friendship and arbitration with Mussolini, and treaties of commerce and friendship with Yugoslavia.

Venizelos resigned in May 1932, but was again premier from June to Nov. 1932, and from Jan. to March 1933. In March 1935 he put himself at the head of the republican revolt in Crete, and was sentenced to exile. He died March 18, 1936.

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VENLO, a frontier town in the province of Limburg, Netherlands, on the right bank of the Maas, and a junction station 43 mi. N.N.E. of Maastricht by rail. Pop. (1957 est.) 51,719. Venlo, with narrow streets irregularly built, is not of the ordinary Dutch type in architectural style. The town hall (1595) contains some interesting paintings by Hubert Goltzius (1526–1583). The church dates from 1304. The leading industries are distilling, brewing, tanning, spinning, needlemaking and tobacco manufacture. There is also a considerable trade by river with Rotterdam. Venlo is joined by a bridge with the opposite village of Blerik.

VENNOR, HENRY GEORGE (1840–1884), Canadian geologist, ornithologist and meteorologist, who revised the classification of the Laurentian system of rocks, was born at Montreal, Que., on Dec. 30. 1840. After graduating from McGill university, Montreal. in 1860, he was placed, in 1866, on the staff of the Canadian Geological survey, with which he continued until 1880. His studies of the great Laurentian system brought him a wide reputation and election to the Royal Geographical society. He traced the Lièvre, Rouge and Gatineau rivers to their sources and called attention to the phosphate deposits between the Gatineau and the Lièvre. Over a period of many years he studied the characters and courses of storms, deducing a number of general principles. From 1877 to his death in Montreal on June 8, 1884, he published Vennor's Almanac. He also wrote Our Birds of Prey (1876).

VENOM. Venoms are toxic secretions of animal origin produced by specialized glands often associated with spines, teeth or other piercing devices; some are skin or cuticular secretions. Venom apparatus may be primarily for killing or paralyzing prey or may be a purely defensive adaptation. Venoms of snakes, centipedes and some marine invertebrates are also digestive fluids.

Few venoms are toxic by mouth or injurious when deposited on unbroken skin or mucous membranes. Most are effective only when introduced into the skin or deeper tissues. Among the local effects are wheals, blisters. violent inflammation often followed by necrosis, muscle spasm and disturbances in sensation. Systemic effects include local or widespread hemorrhages, destruction of blood cells and disturbances that render the blood less coagulable or cause abnormally rapid clotting. Irritative effects on the nervous system may include excitement, convulsions, vomiting, diarrhea or tetany; depressive symptoms seen include clouding of senses, paralysis and weakening or arrest of respiration and heartbeat.

Most major animal phyla contain venomous species, but relatively few are significantly dangerous to human life. Among these are some snakes of the families Elapidae (cobras, coral snakes, etc.) and Viperidae (true vipers, rattlesnakes and other pit vipers), some scorpions (chiefly *Buthus,* Centruroides, *Tityus*), a few spiders (*e.g.,* Latrodectus, Atrax, Loxosceles), some social Hymenoptera (bees, wasps and ants), a few jellyfish (*e.g., Chiropsalmus*). Dangerous but causing few accidents because of habitat or habits are sea snakes (Hydrophidae), scorpion fish (Synanceja) and some cone shells. Common venomous animals that rarely or never cause human fatalities include sea anemones, fire corals, most jellyfish, some sea urchins, centipedes, most spiders and scorpions, certain ticks and mites, many insects (nonsocial Hymenoptera, assassin bugs, some caterpillars, blister beetles, black flies), fishes with poisonous spines (sting rays, weever fish, certain catfish) and many mildly poisonous snakes. Of biological interest but little medical significance are the amphibians with toxic skin secretions, venomous lizards (*Heloderma*) and venomous mammals (the platypus and a shrew, Blarina.)

Venom poisoning is primarily a problem of rural tropical regions. Statistical data are frequently unreliable; however, the total morbidity may be roughly estimated as 1,000.000 cases annually. World mortality from snake bite is estimated at 30,000 annually; fatalities from other bites and stings might add another 5,000. The greatest number of deaths occur in the Indian subcontinent and southeastern Asia.

Principles of venom poisoning therapy involve: (1) immobilization of the toxin at the site of injection by ligature or application of cold followed by slow release or removal by incision and suction; (2) neutralization by immune sera; (3) administration of pharmacological antagonists, *e.g.,* corticosteroids, antihistamine drugs; (4) supportive and symptomatic measures, such as blood transfusion and analgesics. Treatment must be carefully adjusted to the situation.

Antivenins are obtained from serum of animals immunized by repeated sublethal doses of venom or detoxified venom. Antivenins possess the usual immunological specificity. Serum produced against one kind of rattlesnake venom will, for example, neutralize to some extent venoms of other rattlesnake species but will be ineffectiveagainst cobra venoms. Antivenins are usually less potent than bacterial antitoxins, and large doses are required. Human immunization against venoms is possible but rarely done. The immunity is of short duration and not highly effective.

The chemical composition of many venoms is imperfectly known. The majority contain several active principles. Chromatography, electrophoresis and antigenic analysis show 4 to 14 protein fractions in snake venoms, and apparently pure protein toxins have been isolated from rattlesnake (*Crotalus durissus terrificus*) and tiger snake (*Notechis scutatus*) venoms. Venom of the spider, *Latrodectus tredecimguttatus,* contains at least 5 protein fractions. Most venoms show enzyme activity; 13 enzymes have been reported in Indian cobra venom. Some scorpion venoms contain a toxin of low molecular weight bound to protein. Bee and wasp venoms contain histamine and acetylcholine, as well as active protein components. Some venoms are relatively simple organic compounds; *e.g.,* bufotoxins from toads, canthardin from blister beetles.

See E. E. Buckley and N. Porges (eds.), Venoms, Publication 44, American Association for the Advancement of Science (1956); Marie Phisalix, *Animaux Venimeux* et *Venins,* 2 vol. (1922). (S. A. M.)

VENOSA (anc. VENUSIA), a town in Potenza province of southern Italy, lies 84 km. (52 mi.) S.S.E. of Foggia by rail. Pop. (1951) 13,154. The town, situated between two ravines on the lower slope of Monte Vulture (4,354 ft.), is an episcopal see and an agricultural centre. Stones from the Roman amphitheatre are built into the walls of the abbey church of Sta. Trinità, consecrated in 1059 but much restored. It contains the tombs of the Norman soldier of fortune Robert Guiscard (*q.v.*), his wife and half-brothers. There is a massive 15th-century castle, and north of the town are Jewish catacombs with inscriptions of the 4th–5th centuries A.D.

Originally a Lucanian settlement, the place was taken by the Romans after the Samnite War (291 B.C.); from its position on the Appian way it became a Roman garrison town of the first importance. The poet Horace was born there and his poems (such as the "Carmen Saeculare") mention places in the vicinity.

VENTIDIUS, BASSUS, Roman general, was born at Asculum. He took part in the Social War and was made prisoner by Pompey the Elder. As a contractor for military transport he aided Caesar in raising an army for the conquest of Gaul and was later given a command under Caesar. In A.D. 46 he became a senator and tribune. After Caesar's death he supported Antony and rendered important aid in the war against D. Brutus by taking three legions, which he raised himself, in a spectacular march over the Apennines to join in the battle. He became Antony's chief lieutenant and for a brief period was consul of Rome. He was afterward sent to the east, where he carried on the wars against the Parthians with brilliant success.

VENTILATION: see HEATING AND VENTILATION.

VENTIMIGLIA (Fr. VINTIMILLE, anc. ALBCM INTIMILIUM or ALBINTIMILIUM), a seaport on the Gulf of Genoa and episcopal see of Liguria, Italy, in the province of Imperia, 94 mi. S.W. of Genoa and 4 mi, from the Franco-Italian frontier. Pop. (1951) 10,957. The new town is important as a frontier station. The Gothic cathedral is built on the ruins of an earlier Lombard church. The ruins of the ancient town are situated in the plain of Nervia, 3 mi. E. of the modern. It was a *municipium* with an extensive territory, and of some importance under the empire, but was plundered by the partisans of Otho in A.D. 69. Remains of a theatre are visible, and remains of many other buildings have been discovered, among them traces of the ancient city walls, a fine mosaic pavement and a number of tombs to the west of the theatre. The caves of the Balzi Rossi near the village of Grimaldi have proved rich in paleolithic remains of the Quaternary period. Around Monte Bego above S. Dalmazzo di Tenda, north of Ventimiglia, are numerous engravings assignable to the Bronze Age.

VENTNOR, urban district on the southeast coast of the Isle of Wight, Eng. Pop. (1951) 7,314. Area 5.6 sq.mi. It is in the Undercliff district at the foot of St. Boniface down, a chalk cliff 787 ft. high, the highest point in the island and belonging to the National trust. The town, built on a succession of terraces, is one of the most popular holiday and health resorts in England. From a small fishing hamlet it grew in the 19th century into a fashionable town. Bonchurch, where Charles Dickens lived and A. C. Swinburne is buried, St. Lawrence and Wroxall are in the urban district. Market gardening and agriculture are carried on.

VENTRILOQUISM, the art of producing the voice in such a manner that it shall appear to proceed from some place altogether distant from the speaker (Lat. *venter,* "belly," and *loqui,* "to speak"). The art of ventriloquism mas formerly supposed to result from a peculiar use of the stomach (whence the name) during the process of inhalation. As a matter of fact, the words are formed in the normal manner, but. the breath is allowed to escape slowly, the tones being muffled by narrowing the glottis, and the mouth being opened as little as possible. while the tongue is retracted and only its tip moves. This pressure on the vocal chords diffuses the sound, and the greater the pressure the greater is the illusion of distance. A figure or dummy is sometimes used by the ventriloquist to assist in the deception. The ventriloquist animates the dummy by moving its mouth at the same time his own lips remain still, thereby completing the illusion that the voice is coming from the dummy. When not using a dummy the ventriloquist employs pantomime to direct the attention of his listeners to the location or object from which the sound presumably emanates. Ventriloquism, which is still a recognized form of conjuring entertainment. is of ancient origin. Traces of the art are found in Egyptian and Hebrew archaeology. Eurycles of Athens was the most celebrated of Greek ventriloquists, who were called after him Eurycleides, and also Engastrimanteis (belly prophets). It is not impossible that the priests of ancient times were masters of this art, and that to it may be ascribed such miracles as the speaking statues of the Egyptians. the Greek oracles and the stone in the river Pactolus. the sound of which put robbers to flight. Many primitive peoples of modern times are adepts in ventriloquism, as the Zulus! the Maoris and the Eskimos. It is well known also in Hindustan and China. (E. J. BN.)

VENTRIS, MICHAEL GEORGE FRANCIS (1922–1956), British archaeologist and architect. won renown in 1953 for deciphering inscriptions on tablets of about 1500–1200 B.C. (See MINOAN LINEAR SCRIPTS.) The brief inscriptions on these tablets, found on the mainland of Greece near Pylos and elsewhere and in the island of Crete, were proved to have been written in Greek. The dialect (conventionally known as Mycenaean) is the oldest Greek known and belongs to the Achaean subdivision. which includes Aeolic. the dialect of Alcaeus and Sappho, as well as of the oral poetry, known only in an Ionic transformation. in which were composed the songs which went into Homer's Iliad.

Born at W'heathampstead, Eng., July 12, 1922, Ventris was an architect by profession, with an interest in Greek archaeology that inspired him to seek the correct interpretation of the tablets, many of which were discovered around 1900 at Cnossus, in Crete. His method was essentially that of statistical analysis, helped out from the stray hints obtained by the so-called combinatory method, and his results, which might have been obtained much earlier but for the opposition of established archaeological authority. were at once acclaimed as correct and supplemented by the co-operation of many Greek scholars. His authoritative work on the tablets, written in collaboration with John Chadwick. was published posthumously in 1956. Ventris died near Hatfield. Eng., on Sept. 6, 1956, as the result of an automobile accident. (J. WH.)

VENTSPILS (Russian VINDAVA), an ice-free seaport and sea-bathing resort of Latvian S.S.R., U.S.S.R., at the mouth of a river of the same name, on the Baltic sea; in 57° 24' N., 21° 32' E. Pop. (1956 est.) 26.200. Its 15-ac. harbour, protected by two long breakwaters, has ample quay space with a depth of 23 to 30 ft. The harbour has been deepened to accommodate large ocean steamers. The imports are coal and various transit goods; the exports are timber, pit props, butter, flax, hemp and grain. The castle dates from 1290, the town from 1343. Ventspils was occupied alternately by the U.S.S.R. and Gerrnany in World War II.

VENTURA (officially SAN BUENAVENTURA), a city in southern California, U.S., and seat of Ventura county. occupies a splendid site on the Pacific coast overlooking Santa Barbara channel. 65 mi. N.W. of Los Xngeles. Incorporated in 1866, the city, the oldest in the county. developed from a settlement outside the Franciscan mission which Father Junipero Serra founded in 1782 and named for St. Bonaventura.

The city's economy depends mainly upon adjacent oil fields; upon a varied agricultural production of the hinterland, including citrus fruits and lima beans, and upon three important nearby military installations. Ventura is not a port: although it was once a stop for coastwise shipping and, at a few moorings in Pierpont hay, ocean-going tankers receive oil pumped through underwater lines.

Under its charter of 1932, the city has a council-manager form of government. Ventura (junior) college was established in 1925.

For comparative population figures *see* table in CALIFORNIA: *Population: San Buenaventura.* (AL. H. C.)

VENTURI TUBE, a short pipe with a constricted inner surface. used to measure fluid flow and as a pump. Named for G. B. Venturi (1746–1822), the Italian physicist who first noted the effects of constricted channels on the flow of fluids, the venturi tube (fig. 1) has a converging portion, or nozzle: and a narrow portion, or throat. If the fluid velocity is t', and the fluid pressure P_1 at the entrance to the converging portion (as indicated by gauge no. 1). the velocity mill increase as the fluid passes through the converging portion, whereas the pressure will drop. At the throat the velocity V_2 is higher than V_1, and the pressure P_2 is lower than P,. The fluid in the converging portion is accelerated. This acceleration is caused by a force due to the pressure difference; thus. P_1 is greater than P_2.

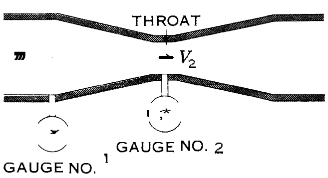
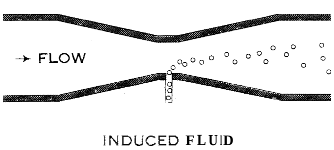


FIG. 1.—VENTURI TUBE

There are countless applications of the venturi principle. Fig. 1 illustrates a venturi meter for measuring rate of fluid flow. The flow rate is correlated with the pressure difference. There are various devices in which the low pressure at the venturi throat is used to cause or induce the flow of some fluid into the venturi tube. As illustrated in fig. 2, the low pressure at the venturi throat can be used to pump or induce the flow of some other fluid.



2.—VENTURI PUMPING DEVICE

In the carburetor of most internal-combustion engines, air flows through a venturi channel; at the venturi throat gasoline vapour is drawn into the air stream. In the usual aspirator pump. water passes through a venturi channel, and air is drawn into the venturi throat by the low pressure.

See F. W. Sears and M. W. Zemansky, College *Physics* (1955); *R. C.* Binder, *Fluid Mechanics* (1955). (R. C. BR.)

VENUE, in law, place of trial. At common lam, trial could be had only in the locality in which the relevant events occurred: since the jury based its verdict on its own knowledge of the facts rather than on the testimony of witnesses. Hence there was only one proper venue. or place of trial. In the course of time most actions came to be recognized as transitory; *i.e.,* such as need not be limited to one particular forum. It then became necessary to regulate the permissible places of trial in the interest of convenience and fairness to the parties. While the term is sometimes used in a loose sense with reference to the appropriate choice between independent states or nations. it is perhaps more appropriately applied to the choice between countries, districts or other localities within a single judicial system. In this sense venue is almost universally prescribed by statutes, although common-law influences remain. Thus it is commonly true still that actions respecting title to, or possession of, land must be brought in the locality where the land lies.

Modern statutes in both England and the United States commonly provide for change of venue for various reasons. such as local prejudice or the convenience of parties and witnesses.

The objection that an action is brought in the wrong place formerly resulted in dismissal, sometimes with harsh consequences, but in modern times the alternative of transfer to a proper venue is often available. The objection is waived if not asserted in timely fashion. Venue should not be. though it often is. confused with jurisdiction of the person of the defendant. (B. CE.)

VENUS is the second of the planets in order of distance from the sun. At its maximum elongations it recedes about 47° or 48° from the sun, so that in middle latitudes it can set or rise more than 3 hours after or before the sun. When seen in the western sky in the evenings, *i.e.*, at its eastern elongations. it was çalled by the ancients Hesperus, and when visible in the mornings, *i.e.,* at its western elongations, Phosphorus.

Like the earth. Venus is enveloped in an atmosphere. This is shown by the fact that near inferior conjunction with the earth the extremely thin crescent of the visible portion of the illuminated hemisphere has often been observed to exceed 180°, while at the time of actual entry on the sun's disk during the transit of 1882. as soon as about three-quarters of the planet's body was in front of the sun, the remaining portion was completely outlined by a narrow border of light. This atmosphere of Venus is apparently heavily cloud-laden. and. since the intensity of the solar radiation is almost exactly twice what it is at the earth's distance, the planet shines with a dazzling lustre, its stellar magnitude varying from −3.3 to −4.4. Its greatest brightness is attained at about 36 days on either side of inferior conjunction, its elongation from the sun then being 39°, and its phase similar to that of a 5-day-old moon. When suitably situated the planet is easily visible at noonday with the naked eye, and after dark it readily casts a shadow.

The Atmosphere of Venus.—Venus is a very disappointing object when viewed through the telescope, because it usually presents nothing but a cloud-covered disk that shows only a general fading of light toward the terminator and perhaps a brightening at the cusps. especially the southern cusp. Faint diffuse markings have occasionally been detected visually, but they are so rare and indefinite in character as to make the planet of scant interest except to the most patient of observers.

Apparently the first photographs of Venus that showed markings were taken by F. Quénisset in 1911. Photographs of Venus in infrared and violet light were taken by W. H. Wright at the Lick observatory in 1921. Contrary to expectation the infrared photographs showed nothing. but faint shadings appeared on the violet images. The first systematic series of photographs of Venus in ultraviolet light was taken by F. E. Ross at the Mount Wilson observatory in 1927. The photographs of Venus in ultraviolet light of effective wave length about λ 3.600 always showed definite markings upon the disk. The markings are predominantly of a banded type that are presumably cloud formations in the upper atmosphere. Since the markings change from day to day, the atmosphere is evideatly in a state of violent turbulence.

Composition of the Venusian Atmosphere.— In 1932 absorption bands in the spectrum of Venus at hh'7.820.0. 7.882.9 and 8.688.i. which later were identified with carbon dioxide·(CO_2), were discovered by W. S. Adams and Theodore Dunham. Jr. G. Herzberg found that the amount of CO_2 above the reflecting layer of Venus corresponds to a path length of 1.000 m. at atmospheric pressure, compared with 2.2 metre-atmospheres for the earth. There can be no doubt of the great abundance of CO_2 in the

Venusian atmosphere.

Repeated attempts to detect oxygen and water vapour in the atmosphere of Venus failed until 1959, when evidence for water vapour was obtained from records of the planet made from a manned balloon flying 15 mi, above the earth's surface.

From spectra of the night sky of Venus, N. A. Kozyrev found many bands which he identified with those arising from molecules of nitrogen and ionized nitrogen. Other bands photographed by Kozyrev have been tentatively identified by H. C. Urey and A. W. Brewer with those of ionized carbon monoxide and ionized carbon dioxide.

In 1959 a broad shallow band between about 3800 and 4500 Å was found in the spectrum of Venus by C. C. Kiess and his co-workers. This structureless band is virtually identical with that produced by nitrogen tetroxide (N_2O_4). Finding nitrogen tetroxide in the planet's atmosphere may explain why free oxygen has never been found. The oxygen apparently is all locked up in other chemical compounds.

Temperature of Venus.—Radiometric measures on the temperature of Venus were made in 1923 and 1928 at Mount Wilson by S. B. Nicholson and E. Pettit, but the details were not published until 1955. They found a mean temperature of −33° C. for the night side and −38° C. for the daylight side. John Strong and W. M. Sinton in 1953–54 obtained a temperature of −40° C. for both dark and light sides. A temperature of 12° C. has been obtained from the distribution of intensity in the infrared carbon dioxide bands. Measures on the radiation from Venus on 3.15 cm. with the 50-ft. radio telescope of the Naval Research laboratory by C. H. Mayer. T. P. McCullough and R. M. Sloanaker gave an apparent black-body temperature of about 320° C. The wide range of these temperatures indicates that they refer to different emitting layers, but just what and where they are it is impossible to say.

The Rotation of Venus.—Visual observations of occasional vague markings are so contradictory as to be useless for discussion. The markings on the ultraviolet photographs of Venus consist of bands that cannot be used for rotation determinations.

V. M. Slipher in 1903 was unable to detect from spectroscopic measures any evidence of rotation from the Doppler effect; neither were C. E. St. John and S B. Nicholson in 1923. Using improved techniques, R. S. Richardson tried to detect spectroscopic evidence for the rotation of Venus in 1956–57 but without result. The negative evidence of the spectroscope indicates a rotation period longer than a week. Yet the fact that the radiometric measures give the same temperature for the dark and illuminated sides indicates a moderately rapid rotation period. The banded form of the ultraviolet clouds also indicates a moderate rotation period. Ross in 1927 from a discussion of all results adopted a compromise period of 30 days. which is still the best guess for the rotation period of the planet.

Position of the Axis of Rotation.—The orientation of the axis of rotation may be calculated on the assumption that the ultraviolet cloud bands are parallel to the planet's equator. Using this method, G. P. Kuiper in 1954 found that the north pole of Venus is directed toward a point in the sky at right ascension (R.A.) 53°, declination (dec.) +81°. The inclination of the equator of Venus to the plane of its orbit is 32". From similar observations the writer found the position of the north pole to be R.A. 311°, dec. +64°, with an inclination of 14°. The difference in position of the axis from the two determinations is 29°, which is about as good agreement as can probably be expected, considering the uncertainties involved.

The Nature of the Surface and Cloud Layer.—Early in the 20th century the cloud layer of Venus was believed to consist of water vapour and the surface to be covered by steaming marshes and oceans similar to those of the earth in its early history. When, in 1932, high dispersion spectra of Venus failed to disclose evidence of water vapour, the composition of the cloud layer was left more of a mystery than ever. The radiometric temperature of −40° C. is too high for the clouds to be condensed carbon dioxide.

The water vapour hypothesis was revived in 1955 by D. H. Menzel and F. L. Whipple. They pointed out that no one had been able to suggest a convincing substitute substance for the cloud layer that is likely to be present in abundance in the atmosphere of a planet. Their contention was supported by the balloon studies of 1959. Also, they pointed out that polarization measures on Venus by B. Lyot are in reasonably good agreement with polarization measures on water droplets made in the laboratory. The great abundance of carbon dioxide in the Venusian atmosphere has been puzzling. On the earth much of the original carbon dioxide in the atmosphere has combined with the surface rocks to form limestone. But if it is assumed that the entire surface of Venus is covered by water, then the abstraction of carbon dioxide from the atmosphere would cease, as soon as a buffer layer of carbonates was formed from the silicates of the ocean bed.

Satellite.—There is no significant evidence for a satellite of Venus. It seems unlikely that the planet can have a companion more than 50 mi. in diameter.

Transits of Venus.—As is the case with Mercury, Venus, revolving round the sun inside the earth's orbit, sometimes transits the sun's face and is seen projected on it as a small black disk. Were the planet's orbit plane coincident with that of the earth, these transits would. of course, occur at each inferior conjunction, but, because of its inclination, a transit can happen only when the two planets pass near one of the nodes of Venus at about the same time, which is possible at present only in June and December. Actually a transit happens but four times in 243 years, and the intervals between transits are successively 8, 105½, 8, 1213, 8, 105½ years et *seq.,* as illustrated in the following table of dates of these phenomena:

1518, June 2	1761, June 6	1882, Dec. 6
1526, June 1	1769, June 3	2004, June 8
1631, Dec. 7	1874, Dec. 9	2012, June 6
1639, Dec. 4		

The first transit to be actually observed was that of 1639, the occurrence of the event having been calculated by Jeremiah Horrocks. a young clergyman, who was curate of Hoole. near Preston, in Lancashire, Eng. Dec. 4 in that year happened to be a Sunday, and Horrocks missed seeing the beginning of the transit through having to take a service in church that afternoon. but on returning home he found to his great delight the black body of the planet clearly projecting on the sun's disk.

Following on the suggestions of Edmund Halley a century later, transits of Venus were utilized for the determination of the solar parallax, which gives the distance of the sun—a quantity of fundamental importance to the astronomer. Practical difficulties, however, in the observations, arising from the effect of irradiation in introducing uncertainties as to the precise moments of the internal contacts between the limbs of the sun and planet, rendered the method unsatisfactory, and far more effective ways of attacking the problems are now available.

In the following data, figures on the orbit of Venus are reliable, but those on the planet itself are very uncertain and may be revised considerably in the future as better values become available.

Mean distance from the sun	67,270,000 mi.
Minimum distance from the Earth	24,600,000mi.
Eccentricity of orbit	0.00680
Sidereal period	224.7 days
Synodic period	584 days
Orbital velocity	22 mi./sec.
Diameter	7,848 mi.
Mass	0.826 (Earth=1)
Density	0.88 (Earth=1)
Density	4.9 (water=1)
Velocity of escape	6.3 mi./sec.
Surface gravity	0.84 g.
Inclination of equator to orbit	32" (Kuiper) 14° (Richardson)
Albedo	0.76
Color index	0.80
Rotation period	Unknown

See also Index references under "Venus" in the Index volume.

(T. E. R. P.; R. S. Rn.)

VENUS is an Italian goddess of very obscure origins and basic functions. The Latin form of her name is Venus, genitive Veneris, plural Veneres. It is generally held that she is connected with vegetable gardens, on the strength of several passages in Latin literature that associate her with gardening, and especially a fragment of a comedy of Gnaeus Naevius (3rd century B.C.), in which *Venerem expertam Volcanum,* "Venus who has felt Vulcan's embrace," means cooked potherbs. *olera cocta.* Naevius is clearly referring not only to the native goddess but also to Aphrodite as wife of Hephaestus, the Greek god of fire. Hence his testimony is somewhat weakened for the earliest period of Venus' cult. On the other hand Venus' name is more or less certainly associated with words, Latin and other, that contain the idea of "charm, winsomeness, beauty." Perhaps the two types of evidence may best be reconciled by comparing her with the Greek Charites *(see* GRACES, THE), who seem originally to have been agricultural deities. In both cases, the "beauty" or "charm!' would be, not that of wild nature, but that of a garden plot producing a good crop and so delighting the eye of its cultivator.

Venus had no worship in Rome in early times, as Varro shows, attesting that he could find no mention of her name in old records. This is corroborated by the absence of any festival for her in the oldest calendar, and by her lack of a *flamen* (special priest). Her cult among the Latins, however, seems to be immemorial, for she had apparently at least two ancient temples, one at Lavinium, the other at Ardea, at which festivals of the Latin cities were held. Hence it was no long step to bring her to Rome, apparently from Ardea itself. But how she came to be identified with so important a deity as Aphrodite remains a puzzle, as does her name, which ought to be neuter, by analogy with, for example, *funus, -eris; munus, -eris.*

That Venus' identification with Aphrodite took place fairly early is certain. A contributory reason for it is perhaps the date (Aug. 19) of the foundation of one of her Roman temples. Aug. 19 is the Vinalia Rustica, a festival of Jupiter; hence he and Venus came to be associated, and this facilitated their equation, as father and daughter, with the Greek deities Zeus and Aphrodite. But the most important cause of the identification was the reception into Rome of the famous cult of Venus Erucina—*i.e.,* of Aphrodite of Eryx (Erice) in Sicily—this cult itself resulting from the identification of an oriental mother-goddess with the Greek deity. This reception took place during and shortly after the second Punic War.

A temple was dedicated to Venus Erucina on the Capitol in 21j B.C., and a second outside the Colline gate in 181 B.C. The latter developed in a way reminiscent of the temple at Eryx with its harlots, becoming the place of worship of Roman courtesans, hence the title of *dies meretricum* ("prostitutes' day!') attached to April 23, the day of its foundation.

The importance of the worship of Venus-Aphrodite was increased by the political ambitions of the *gens Iulia,* the clan of Julius Caesar, and, by adoption, of Augustus. They claimed descent from Iulus, the son of Aeneas; Aeneas was the alleged founder of the temple of Eryx and, in some legends, of the city of Rome also. From the time of Homer onward, he was made the son of Xphrodite—that is, the Trojan clan of the Aeneadae probably had a hereditary cult of their local mother-goddess—so that his descent gave the Iulii divine origin. Others than the Iulii sought to connect themselves with a deity grown so popular and important. notably Gnaeus Pompeius, the triumvir. He dedicated a temple to Venus as Victrix in jj B.C. Caesar's own temple, however (46 B.C.), was dedicated to Venus Genetrix, and as Genetrix she was best known until the death of Nero in A.D. 68. But despite the extinction of the Julio-Claudian line she remained popular, even with the emperors; Hadrian completed a temple of Venus and Rorne in A.D. 135.

As a native Italian deity, Venus had of course no myths whatever. She therefore took over those of Xphrodite, and through her became identified with various foreign goddesses. The most noteworthy result of this development is perhaps the acquisition by the planet Venus of that name. The planet was at first the star of the Babylonian goddess Ishtar, and thence of Aphrodite. By metonymy, Venus' name often means "beauty! charm, (power of) love" and the like.

See G. Wissowa, *Religion und Kultus der Ronzer,* 2nd ed., pp. 288–293 (1912); R. Schilling, *La Religion romaine de Vénus depuis les origines jusqu'au temps d'Auguste* (1954). (H. J. R.)

VENUSIA: *see* VENOSA.

VENUS'S-FLYTRAP *(Dionaea muscipula),* a remarkable carnivorous plant of the sundew family (Droseraceae). First discovered by Arthur Dobbs, governor of North Carolina, it was reported by him to Peter Collinson in a letter dated Jan. 24, 1760, in which he called the plant the "Fly Trap Sensitive." This letter did not become public until 1843. From some plants sent to England and introduced in Kew gardens, John Ellis, a London merchant and by avocation a botanist. drew a description and figure which he sent to Linnaeus in 1770. The latter rewrote the description in Latin and published it in 1773. Though Dobbs had recognized the sensitivity of the leaves. this was also seen independently by Ellis, who drew Linnaeus' attention to the phenomenon. He so far appreciated the nature of the plant that he called it *miraculum naturae,* a miracle of nature. Though Ellis thought that the plant caught insects (flies) and held them, Linnaeus was not of this opinion.

The plant is a small perennial herb, with a native distribution limited to the states of North and South Carolina. It has a rosette of leaves bearing tall scapes with white fiowers. The leaf shows two regions, the leaflike footstalk narrowly to broadly cordate, which is separated from the blade by a narrow isthmus. The blade consists of two trapezoidal lobes which stand at an angle of 40°–50°. The upper surface of each lobe is the site of numerous low glandular trichomes or hairs containing red sap and lending this hue to the whole surface. These are digestive glands and become active after prey has been caught. The outer edge of the lobe is armed with a series of strong projections, suggesting fingers, about 13 in number. On the surface between them and occupying a narrow zone within the margin there are numerous nectar glands. F. M. Jones observed ants. etc., feeding on them. In addition there are, normally, three longish, bristlelike hairs, jointed near the base, and readily bent by the body of an intruding insect. The cells of the joint are extremely sensitive to unequal pressure which is provided by the bending, and, though the blade has been shown to be slightly sensitive elsewhere, it is here that the normal stimulus is received. But a single stimulus does not suffice. It normally requires two stimuli (at normal temperatures): received either by the same or by different hairs, the second not less than I.j seconds nor longer than 20 seconds after the first, to initiate a response. This consists of the rapid apposition of the two lobes, which occurs within one-fourth of a second. at normally high temperatures, until the margins approximate and the fingerlike projections overlap. If prey is present, the movement continues quite slowly until the surfaces of the lobes press against the body of the prey. The secretion of digestive enzymes then sets in and the insect body is disintegrated. This action takes about ten days, after which the lobes reopen. The process can be repeated three times, until the limit of growth is reached; it has been shown that the movement involves growth. The first rapid movement bringing the fingers into overlapping position results in a mutual posture of the lobes which, Charles Darwin held, allows very small insects of little value as food to escape. Darwin also observed that, during the period of digestion, the flow of digestive fluid was so abundant that, on cutting a small hole at the base of the trap, it flowed down the petiole or dropped to the ground.

The closure of the trap is accompanied by electrical disturbances, studied by J. Burdon-Sanderson and by H. Munk. Such disturbances have been likened to those which occur during the stimulation of muscle. and some attempt has been made to find a structural equivalence, without result. The movement resulting from a stimulus is a result of slight changes in the tensions on the parenchyma of the lobes. The mechanism of transmission of the stimulus can be only vaguely guessed. It is little wonder that Darwin said of this plant that it is the "most wonderful" in the world.

Closely related to *Dionaea,* though placed *by* the taxonomists in another genus, is *Aldrovanda vesiculosa,* a freely floating freshwater plant distributed from Spain to Japan, and south to the Chobe swamp in South-West Africa. though it appears to be not generally abundant. It was found in India before 1696 and later in Italy previous to 1747. It was named by Gaetano Monti in honour of an Italian naturalist. Ulisse Aldrovandi. The name was published by Linnaeus as *Aldrovanda*, apparently the result of a mistake in copying. Otherwise it should have been *Aldrovandia,* under which it has often been cited.

The plant is small, about three inches long. and flaccid. floating horizontally in the water. It produces small inconspicuous flowers. The leaves occur in whorls of eight, and each shows the same regional areas as that of *Dionaea*. The basal portion is narrow and wedge-shaped and bears, at its upper end. the trap and usually four bristlelike extensions. The lobes of the trap are approximately semicircular and have turned-in margins, which. when the lobes are approximated, act as valves when pressing against each other. Each lobe has two regions. The inner region, against the midrib, is relatively thick and concave. When the lobes are closed the two inner regions fit together to form an ovate hollow container holding the prey if caught. The outer regions are thin and come slowly into close contact if prey is caught. Within the inner region there are numerous digestive glands and about 40 sensitive hairs, which work like those of *Dionaea* but are of much simpler structure. Prey coming into contact with these stimulate the lobes to close, bringing the marginal valves together. The water escapes between reaches of the margins near the midrib where the valves are absent. Small insect larvae, copepods, acarids, etc., are caught as prey, the trap closing with speed. The number of stimuli required depends on the age of the leaf.

This plant never produces roots subsequent to the seedling radicle, which is of limited growth. The latter end of the plant decays as the growing end extends. *See* also CARNIVOROUS PLANTS.

BIBLIOGRAPHY.—C. Darwin, *Insectivorous Plants* (1875); M. Shene, *Biology of Flowering Plants* (1924); *Nature Magazine*, 28:13–14 (July 1936). 29:154–155 (March 1937); F. E. Lloyd. *The Carnivorous Plants* (1942), with citations of the extensive studies of J. Ashida on *Aldrovanda*. (F. *E. L.*)

VENUS'S-LOOKING-GLASS, a popular garden name for blue- or purple-blossomed plants of the genus *Specularia* in the bluebell family. In North America four native species occur, of which the American Yenus's-looking-glass or clasping bellflower (*S. perfoliata*) and the small Yenus's-looking-glass (*S. biflora*) are found across the continent, the latter extending to South America. A European species. *S. speculum veneris,* is a common field plant in the south of Europe and is grown in gardens because of its brilliant purple flowers.

VERACRUZ, a central gulf state of Mexico, with its capital at Jalapa (*q.v.*). Pop. (1960) 2,749,235; area 27.759 sq.mi. It extends for a 50 mi. strip northwest to southeast along the gulf. averaging 435 mi. in width, bounded north by Tamaulipas. west by the mountain states of San Luis Potosi. Hidalgo. Puebla and Oaxaca and southeast by Chiapas and Tabasco. The principal rivers rising in these inland states terminate in Veracruz, carrying rich soils to the gulf and creating sand bars at their deltas. In addition to the major seaport of Veracruz (*q.v.*), the state also contains minor ports. notably Tuxpan, Xlvarado, Coatzacoalcos (Puerto Mexico) and Tonalá. Lying in tropical lowlands, the area is generally hot, humid and insalubrious, especially in the low, level, sandy strips along the gulf. a zone much broken by tidewater streams and lagoons. Behind the coastal strips the land rises rather sn·iftly to the central plateau of Mexico, cut into rich valleys but often characterized by overwhelming vegetation of a drenched tropical rain forest; in places there is 120 in. of precipitation annually. In the west-central parts of Veracruz terminate major mountain chains of the Mesa and a volcanic axis. which provide the high peaks of Nauhcampatépetl (Cofre de Perote) and Orizaba, the latter perpetually snow-capped. More than 40 rivers cross the state, providing hydroelectric power but also frequent inundations. A massive reclamation project involving drainage, hydroelectric installations. preplanned cities and a balancetl industrial-agricultural economy was inaugurated in 1947 by the national government in the basin of the Papaloapan river system. By the late 1950s three dams were completed and modern farm methods successfully introduced. Veracruz is a rich state, potentially and actually, with its wealth based on commerce. agriculture and manufacturing, supplemented by production and processing of petroleum at its northern and southern extremities. Tropical agricultural products of great importance include cotton. sugar, rum. pineapples, tobacco. cacao. vanilla. oranges and bananas and other fruits. Veracruz coffee is excellent and abundant! while for subsistence the state grows surpluses of maize and beans. Pastoral activities furnish cattle and hides for national consumption. Forest industries supply rubber, cabinet woods. chicle, orchids and numerous medicinal plants. Industries include sugar refining and rum making (centred near Yeracruz port). with scattered plants producing beer, matches. candies. soap, shoes, cement. chemicals and a great range of light industrial products. Manufacturing of cotton and other textiles is also carried on at Orizaba (*q.v.*) and at Cordoba.

The state is rich in archaeological remains of pre-Columbian cultures. Olmec, Totonac and Huastec. one of the most noted ruins being those at Cempoala. A part of the coast of Veracruz was explored in 1518 by Juan de Grijalva. although the first landing in the state was made by Hernán Cortés on Good Friday in 1519 at San Juan de Ulúa. Veracruz became a state in 1824.

(HD. C.; R. B. McCK.)

VERACRUZ (VERACRUZ LLAVE), city and principal seaport of Mexico. on the Gulf of Mexico. in Yeracruz state. Pop. (1950) 101.469; (1958 est.) 121,408. Lying on a slight indentation of the coast line. Veracruz is 263 mi. E. of Mexico City. with which it is connected by two railways and several highways. It is a main entrepôt and communication centre for the gulf littoral and tropical hinterland; it also taps the industrial areas of Puebla and Orizaba. and central areas of the republic to the Isthmus of Tehuantepec, with which it is connected by rail. Built on a hot, low and barren sandy beach only a few feet above sea level, the port site is generally cramped and unhealthful. and natural advantages of the harbour are few. It is a narrow channel bounded by reefs and small islands. guarded by the island of San Juan de Ulúa. a naval base and erstwhile prison. Much of the equipment placed in Veracruz before 1910. including breaknaters to protect it from storms. deteriorated badly, but a rehabilitation program was begun in 1946 to replace and expand unloading equipment, warehousing facilities and cargo-handling devices to expedite the large trade that passes through this chief entrance to Mexico. The port contains three main dock works, capable of handling vessels up to 7,000 tons: a dry dock was completed in 1951. The modern port and city dates from about 1.599, though La Villa Rica de la Yeracruz (Rich Town of the True Cross) was founded as the first Mexican municipality by Cortés in 1519 anti shifted its position a number of times. As the chief link between New Spain (colonial Mexico) and Cádiz (Spain), Veracruz was a thriving place despite its insalubrity, but also a prize of war and pillage. In 1653 and 1712 attacks by privateers led to construction of the fort on San Juan de Ulúa. Captured by the French in 1838 and again by Americans under \\'infield Scott in 1847. it fell into French hands in 1861 and under U.S. occupation in 1914. Numerous revolutionary governments and coups aimed at its capture and customs revenues following Mexican independence (1821). The name Llave was added in honour of Gen. Ignacio de la Llave, governor of Yeracruz state (1857–60). (HD. C.; R. B. McCK.)

VERAGUAS, a province of Panamá. extending across the isthmus between the Caribbean sea and the Pacific. Area 1.336 sq.mi.; pop. (1960) 130,934, of which 85% was rural. Most of the people are in the Pacific lowlands and the lower southern slopes of the central highland. which are important agricultural districts, producing rice. corn and coffee. Pigs, poultry and cattle are also significant.

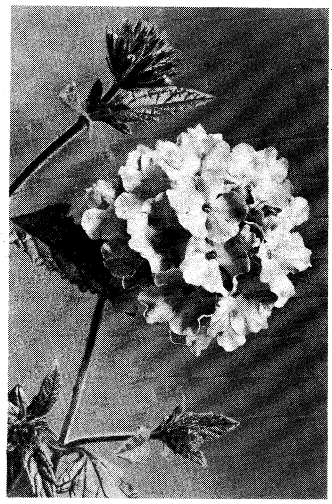
The provincial capital, Santiago (pop. [1950] 5.886). is one of the oldest colonial settlements in Panamá. (C. F. J.)

VERATRUM, a genus of herbaceous plants belonging to the family Liliaceae. Greek physicians were acquainted with a poisonous herb called white hellebore. which has been supposed to represent the *Veratrum album* of modern botanists. *Veratrum* is a tall-growing herb, having a fibrous rootstock, an erect stem with numerous broad, plicated leaves placed alternately, and terminal, much-branched clusters of greenish or purplish polygamous flowers. Each perfect flower consists of six regular petals, as many stamens, whose anthers open outwardly, and a three-celled superior ovary which ripens into a three-celled, many-seeded capsule. The genus comprises ten species, natives of the temperate regions of the northern hemisphere, generally growing in pastures or woods. *V. album* and the North American species *V*. viride are commonly grown in gardens as ornamental perennials, but their poisonous qualities should be kept in mind, particularly as they bear a considerable resemblance in foliage to the harmless *Gentiana lutea*. Both contain the potent alkaloid veratrine. See also HELLEBORE.

VERBASCUM, a genus of weedy biennial herbs. commonly known as mulleins, native to Europe and Asia and naturalized in North America. Of about 250 species, a few are cultivated for ornament. Most have woolly leaves and large spikes of usually yellow but occasionally white or purple blossoms.

See MULLEIN.

VERBENA. The plant genus Verbena (vervain) gives its name to the family (Yerbenaceae) of which it is a member. The species are herbaceous or somewhat shrubby, with opposite or whorled leaves. generally deeply cut. The sessile flowers are aggregated into close spikes. Each flower has a tubular. ribbed calyx, a more or less irregular, tubular, two-lipped corolla. with four (didynamous) stamens springing from the interior of the corolla tube. The anthers are two-celled, The ovary is entire or four-lobed. and always four-celled. with a single ovule in each cell. The fruit consists of four hard nutlets within the persistent calyx. There are about 100 species. mostly natives of tropical and subtropical America, about 20 being native to the United States, a very few species occurring also in the old world. The garden verbenas are mostlv derivatives from a few South American species, such as *V. teucrioides* of southern Brazil and *V*. chamaedrifolia from Argentina and southern Brazil. Various cultivated forms have been derived also from the North American V. canadensis. The range of colours extends from pure white to rose coloured. carmine, violet and purple. Striped forms also are cultivated. The lemon-scented verbena of gardens, much valued for the fragrance of its leaves, was once referred to this genus under the name V. triphylla, subsequently called Aloysia, but is now referred to the genus Lippia as L. *citriodora;* it differs from *Verbena* in having two, not four, nutlets in the fruit. Sand verbena (*q.v.*) belongs to the genus *Abronia.*



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VERBENA

The garden verbenas are easily raised from seeds sown in heat in February or March. but choice varieties can be kept true only when raised from cuttings. These are best secured from old plants cut down in the autumn and started into growth in gentle heat and moisture the following spring. They root readily in a compost of sandy loam. See VERBENACEAE; VERVAIN.

VERBENACEAE, a family of herbs, shrubs and trees, nearly all tropical and subtropical. There are about 70 genera and about 750 species. Vervain (*q.v.*) is widespread in North America, Europe and Asia. Lippia and *Cymbopogon* (a grass) yield verbena oil. and several species, as teak (*Tectona* grandis), supply useful timber. Many are lianas or climbing plants. Some species bear thorns; others are xerophytic. Numerous species are cultivated for ornament. as the verbena (*q.v.*), chaste tree (*Vitex agnuscastus*), glory bower (*Clerodendron*), purple wreath (Petrea *volubilis*), golden dewdrop (*Duranta repens*), bluebeard (Caryopteris *incana*) and French mulberry (*Callicarpa americana*).

VERBOECKHOVEN, EUGÈNE JOSEPH (1798–1881), Belgian painter whose paintings of sheep, horses and cattle in landscape. somewhat after the manner of Paul Potter. brought him universal iame, was born at Warneton in West Flanders on June 9, 1798. He received instruction in drawing and modeling from his father, the sculptor Barthélemy Verboeckhoven. Precise and careful finish is the chief quality of his art, which is entirely objective and lacking in inspiration. Yerboeckhoven visited England in 1826, Germany in 1828 and France and Italy in 1841. He died in Brussels on Jan 19, 1881. In addition to his painted uork he executed about 50 etched plates.

His brother CHARLES LOUIS (1802–1889) was a painter of marine scenes.

VERCELLI (anc. VERCELLAE), a provincial capital and archiepiscopal see of Piedmont, Italy, in the province of Vercelli, 13 mi. S.W. of Novara by rail. Population (1951) 38.898. It is situated 430 ft. above sea level on the river Sesia, at its junction nith the Canterana. Vercelli is a point at nhich railways diverge for Novara, Mortara, Casale Monferrato and Santhia (for Turin). The Piazza Cavour has a statue of Cavour. The cathedral library contains many ancient manuscripts, especially the Codex *Vercellensis* (see VERCELLI BOOK). The church of S. Andrea is a Romanesque Gothic building of 1219–24, with lofty towers and an interior in the French Gothic style and a museum of Roman antiquities in the adjacent cloister. S. Paolo, S. Francesco and S. Cristoforo possess valuable examples of the work of Gaudenzio Ferrari (1471–1546) and of his follower Lanini. The castle of the Visconti is now a prison. Vercelli was the birthplace of the painter Giovanni Antonio Bazzi, called Sodoma (1477–1549). Vercelli is one of the principal Italian centres of the exportation of cereals and especially of rice.

Vercellae, originally the chief city of the Libici (a Ligurian tribe). was at the junction of Roman roads to Eporedia, Novaria and Mediolanum. Laumellum (for Ticinum) and perhaps Hasta Remains of the theatre and amphitheatre were seen in the 16th century, and ancient streets have been traced. Close by (near Rotto on the Sesia) are the Raudii Campi where Hannibal uon his first victory on Italian soil (218 B C.), and uhere in 101 B.C. Marius and Catulus routed the Cimbri. From about 1228 till 1372 Vercelli was the seat of a university. (T. A)

VERCELLI BOOK (CODEX VERCELLENSIS), an Old English manuscript, written in the late 10th century, containing texts of the poem *Andreas,* two poems by Cynewulf (*q.v.*), namely The Fates of the Apostles and Elene, The Dream of the Rood, an Address of the Soul to the Body and a fragment of a homiletic poem, as well as 22 prose homilies and a prose Life of St. Guthlac. It nas found in the cathedral library at Vercelli, north Italy, by F. Blume in 1822. K. Sisam has shown that marginalia in the manuscript prove it to have been in English use in the 11th century, and that an excerpt from a Latin psalm, with neumes (a plainsong form of notation), on folio 24 b, was probably added in Italy, either in the late 11th or first half of the 12th century. This excludes the possibility that the manuscript was taken to Italy, either in the 13th century, by Cardinal Guala, a native of Vercelli, on his return from England where he had been papal legate, or after the Renaissance, as had been previously suggested. It was probably taken there by one of the numerous Anglo-Saxon pilgrims on the nay to Rome. But for the survival of this manuscript, we should possess only two "signed" poems of Cynewulf, and should knon one of the greatest Old English poems, The *Dream* of *the* Rood, only in the brief fragments inscribed on the Ruthwell cross. The homilies include important examples of prose uninfluenced by Aelfric.

For comment on the individual works in the Vercelli Book, see the article ENGLISH LITERATURE.

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VERCINGETORIX (d. 45 B.C.), Gaulish chieftain, waged war with ability against Caesar in 52 B.C. For the history of the campaign *see* CAESAR, GAIUS JULIUS. He fell into Caesar's hands at the capture of Alesia, was exhibited at Caesar's triumph in 45 and was then put to death.

See Caesar, *B.G.* VII.

VERDI, GIUSEPPE FORTUNINO FRANCESCO (1813–1901), Italian composer, was born on Oct. 10, 1813, at Le Roncole, near Busseto. His parents named him Giuseppe Fortunino Francesco but the duchy of Parma being then under French rule, he is entered in the certificate of baptism as Joseph Fortunin François. His father, Carlo Verdi, was a poor innkeeper and grocer, and the house in which he was born is among the lowliest of great composers' birthplaces. The Austrian invasion in 1814 did not improve the family's fortunes and at one time his mother was forced to take refuge with him in the belfry of the village church. His first musical impressions were primitive. What he heard at the church and sang there after the age of seven when he became a chorister, cannot have been of any quality, and the only secular music he knew at that time was that of the barrel organ and the military band. These early impressions are significant: his church scenes (*e.g.*, in *La forza del destino* and even the temple scene in *Aida*) are the weakest. He became the great favourite of organ grinders, who made many of his tunes familiar to those who could not afford visits to the opera house. Up to the time of his fullest maturity he often scored his operatic choruses as though their parts were intended for hand instruments. These casual early influences had to undergo a later process of refinement but perhaps bore more fruit than the formal lessons given him by the local organist on an old keyboard instrument. At the age of 10 he began to deputize for the organist in church, and he succeeded to his post soon after. He continued his duties once or twice a week after 1823, when his father sent him to Busseto, to lodge at a poor cobbler's and to pick up some kind of schooling. He walked to Le Roncole and back on these occasions, a matter of three miles each way, since a salary of about £4 a year did not justify extra outlay.

In 1826 a friend of his father's at Busseto, Antonio Barezzi, took the boy into his business and his home. There he heard the rehearsals of the local amateur orchestra, conducted by Ferdinando Provesi, organist of the collegiate church, who soon offered to teach him free. He was also allowed to practise on the piano of Barezzi's daughter Margherita. A warm childhood attachment later ripened into love, and Margherita became Verdi's first wife in 1836. Meanwhile the gifted boy learned much from Provesi, from the scores in the orchestra's library, which he copied to learn orchestration, and from his own early essays in composition: marches for military band and an overture which Provesi performed at Easter 1828. In 1829, aged 16, he began to assist Provesi in conducting and at the organ.

Barezzi in 1831 contrived to obtain a scholarship for Verdi from a local charitable institution and supplemented this by an allowance of his own in order to send him to Milan for more systematic study. There the youth was examined at the conservatory, but rejected. The director, Francesco Basili, later came in for much opprobrium for having failed to recognize genius; but apart from this the fact was that as a candidate in his 19th year he was past the age for enrolment. A conductor at the Teatro alla Scala, Alessandro Rolla, then advised Verdi to study under Vincenzo Lavigna, who was coach at the famous opera house, and from him young Verdi learned much technically. He was also able to hear the performances, although he did not hear much foreign work, and his acquaintance with Bellini, Donizetti and Rossini, who were then the moderns of Italian opera, meant invaluable experience. Rossini's influence, however, is far less perceptible even in his earliest works than that of the other two masters.

In 1833 Verdi returned to Busseto, where, although he failed to obtain the succession to Provesi's church post—fortunately for posterity—the musical association made him an allowance for three years. During that time he married Margherita Barezzi and wrote his first opera, *Oberto, Conte di San Bonifacio*. This was produced at the Milan Scala on Nov. 17, 1839. It had no great immediate success, but the impression of its crudely vital music lasted for some time.

Verdi had settled again with his family at Milan in 1838, his three years' engagement at Busseto having come to an end. This was a period of terrible tragedy. His infant daughter Virginia died that year, his son Icilio in 1839 and his wife in June 1840. (It is curious that later on Verdi left an account of having lost his wife and children within the space of less than two months. He cannot have forgotten the facts, and this statement has never been satisfactorily explained.) Left utterly alone, he lived in a state of despair bordering on a mental breakdown, when he was asked by the director of the Scala, Bartolomeo Merelli, to write a comic opera, *Un giorno di regno*. This looks like bitter irony, but was no doubt a kindly attempt to take his mind off his unhappiness. The work was a complete failure, and he never attempted another comic opera until he wrote *Falstaff*, his crowning masterpiece, at the end of his long life. That he could have produced admirable works of this kind much earlier is proved by such things as the abduction scene in *Rigoletto*, several incidents in *Un ballo in maschera*, the character of Melitone in *La forza del destino* and even the chorus of murderers in *Macbeth*.

After 1840 Verdi's life was relatively uneventful except in operatic productivity, where it became continually exciting—a tale of gradual progress from success to success, with here and there a failure, and a steady advance in diversity of invention, power of characterization and subtlety of craftsmanship; it might be added, an advance in dramatic force and insight, were it not that this is a quality he evidently possessed from the very first. With only temporary relapses caused by some uncongenial libretto (*e.g.*, *I masnadieri*, 1847) or an unwelcome commission (*e.g.*, *Les Vêpres siciliennes*, 1855), everything worked up to the magnificent last masterpieces: the splendid and profoundly musical *Aida*, the poignant, poetical and sensitive *Otello*, and the sparkling and indulgently human *Falstaff*. Even such comparatively superficial aspects of a composer's workmanship as harmony or orchestration are seen to become gradually more resourceful and refined. The fairylike poetry that invades *Falstaff* during the progress of the third act, for instance, could not have been dreamed of by those who first heard *Rigoletto* (1851) or *Il Trovatore* (1853), though hints of it emerge in such a splendid middle-period work as *Un ballo in maschera* (1859) and more than hints in the revised versions of *Macbeth* (1865) and *Simon Boccanegra* (1881)—the latter actually 10 years later than *Aida*, but still preceding *Otello* and *Falstaff* by 6 and 12 years respectively.

In 1840, after the fiasco of *Un giorno di regno* Verdi, then a prey to artistic as well as personal despair, made up his mind to give up composition forever. But Merelli, undaunted by his previous failure to help him, cunningly asked him to read T. Solera's libretto of *Nabucodonosor*, simply, he said, for his opinion of it. As Merelli had doubtless hoped, the sight of a libretto awakened musical invention in Verdi, who did not rest till the opera was composed. It was produced at the Scala on March 9, 1842, with resounding success, and became affectionately known as *Nabucco*. A soprano, Giuseppina Strepponi, was in the cast. She gave Verdi sound practical advice about the ice he was to ask for his next opera, *I Lombardi alla prima crociata* (Milan, Feb. 11, 1843). She lived with him from 1849, but long regarded herself as unworthy to be his second wife and was not married to him until 10 years later.

Both *I Lombardi* and *Ernani* (Venice, March 9, 1844), with their fiery patriotic tunes, brought Verdi into conflict with the authorities by provoking public demonstrations against the Austrian rule. This was not Verdi's direct intention, but he was as ardently in favour of the liberation and unification of Italy in his own way as Garibaldi and Mazzini were in theirs. So he cannot have failed to feel inspired to write such stirring melodies or to be pleased by the effect they had on his audiences. He was becoming so popular that regulations were powerless to suppress him, though they sometimes induced him to consent to certain changes in the words or action of his operas, but never the music. And it was the music which agitated the Italian blood.

Among the nine works which followed *Ernani* between 1844 and 1849, including *I masnadieri*, written for Jenny Lind (London, July 22, 1847), and *Jérusalem*, a revision in French of *I Lombardi* (Paris, Nov. 26, 1847), none later is important except *Macbeth* (Florence, March 14, 1847), and even that has kept the stage only in the admirable revised version (Paris, April 21, 1865). Verdi was a keen student of Shakespeare, though he knew no English, but *Macbeth* is the only work he drew from that master apart from the last two operas. He did work spasmodically on a *King Lear* for several years, but the magnitude of the undertaking seems to have discouraged him, and the sketches are lost.

Several of the operas dating from before Verdi's 36th year are worth study and occasional revival. The first capable of holding a place in the repertory dates from the end of that year: *Luisa Miller* (Naples, Dec. 8, 1849), which has something of the lyrical quality of *La Traviata* and shows distinct anticipations of the later and more refined manner.

The three most generally popular of Verdi's operas followed each other in quick succession: *Rigoletto* (Venice, March 11, 1851), *Il Trovatore* (Rome, Jan. 19, 1853) and *La Traviata* (Venice, March 6, 1853). The first two at once had enormous success, but the last failed utterly, partly because the subject (Alexandre Dumas's *La Dame aux camélias*) was thought shocking and the breach with tradition in presenting an opera in contemporary dress even more so, but mainly because the cast happened to be grossly inadequate. After its revival later in the year at a different Venetian theatre it became perhaps the first favourite, not to be displaced in many Italian opera lovers' affections even by the final masterpieces.

The first version of *Simon Boccanegra* (Venice, March 12, 1857) is no longer important, but *Un ballo in maschera* (Rome, Feb. 17, 1859) contains some of the finest music in Verdi's fully matured manner, as does *La forza del destino* (St. Petersburg, Nov. 10, 1862), which is marred only by too many irrelevant, merely picturesque incidents. *Don Carlos* (Paris, March 11, 1867), composed, like the less interesting *Vêpres siciliennes,* on a French libretto, is also rather too episodic, but the episodes are striking and there is great mastery in characterization.

Then came the final phase, perhaps the most wonderful summing up of a creative musician's work in extreme old age known to musical history. With all his skill and endless invention, Verdi had up to that time often shown a certain bluntness of imagination and striking deficiencies in taste, only at last, in *Falstaff* (Milan, Feb. 9, 1893), to reach, as a veteran of 79, a flawless refinement comparable with Mozart's alone (though his music is quite different, having something in common rather with Domenico Scarlatti and being for the rest wonderfully original). But as masterly in their way are not only the work commissioned for the opening of the Suez canal, the resplendent *Aida* (Cairo, Dec. 24, 1871), with its quite un-Wagnerian use of a *Leitmotiv* (*q.v.*), and the subtle and profoundly moving *Otello* (Milan, Feb. 5, 1887), but also the wonderful *Requiem* performed in 1874 in memory of Alessandro Manzoni, which incorporates (with alterations) a *Libera me* written for a funeral mass lor Rossini suggested by Verdi in 1868, with music by various Italian composers, which was never performed.

After *Falstaff* Verdi lived in retirement at his estate of Sant' Agata near Busseto. He died at the age of 87 in a Milan hotel on Jan. 27, 1901. He had become increasingly lonely aiter Giuseppina's death in 1897 and wrote nothing more for the stage, but he did produce four sacred pieces, which are as poignantly lovely as the *Requiem.* These works are not church music in any liturgical sense, but are great music and show that Verdi must not be thought of as exclusively an operatic composer, though the musical conditions of his time in Italy as well as his temperament drew him to the theatre in the first place. His string quartet (1873) should also be remembered and if (like the work by Hugo Wolf it slightly resembles) it had been called *Italian Serenade,* it would have been admired as a thing of great charm instead of being criticized as unsatisfactory chamber music.

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VERDUN, a garrison town of northeastern France, capital of an *arrondissement* in the *département* of Meuse, between Paris and Metz, 42 mi. N.N.E. of Bar-le-Duc. Pop. (1954) 16.111.

Verdun (*Verodunum*), an important town at the time of the Roman conquest, was made a part of Belgica Prima. The bishopric, held by St. Vanne (498–525), dates from the 3rd century. Verdun was destroyed during the period of the barbarian invasions and recovered only at the end of the 5th century. Clovis seized the town in 502, and it afterward belonged to the kingdom of Austrasia. In 843 the famous treaty was signed there by the sons of Louis the Pious. *(See* GERMANY: *History.)*

In the 10th century Verdun was conquered by Germany and put under the temporal authority of its bishops. Together with Toul and Metz, the town and its domain formed the territory of the Trois-Évêchés. In the 11th century the burghers began a struggle with their bishops, which ended in their obtaining certain rights in the 12th century. In 1552 Henry II of France took possession of the Trois-Évêchés, which finally became French by the peace of Westphalia. In 1792 the citizens opened their gates to the Prussians. In 1870 the Prussians invested and bombarded it three times, till it capitulated in the beginning of November. (For the part played by Verdun in World War I *see* VERDUN, BATTLES *OF;* WORLD WAR I.)

Verdun stands on the Meuse, canalized there, and was a great fortress. The chief quarter of the town lay on the slope of the left bank of the river and was dominated by the citadel which occupied the site of the old abbey of St. Vanne, founded in the 10th century. The whole town was surrounded by a bastioned enceinte, pierced by four gates; that to the northeast, the Porte Chausshe, 15th–17th century, with two crenelated towers, was little damaged in World War I. The cathedral of Notre Dame, in process of restoration, stands on the site of two previous churches of the Romanesque period, the first of which was burned down in 1017. There are double transepts, and till the 18th century, when the western apse was replaced by a façade, there was an apse at each extremity. To the southwest of the cathedral is a fine 15th-century cloister. The *hôtel-de-ville* (17th century) has been restored.

VERDUN, BATTLES OF. The invader of France coming from the east is confronted by a series of ridges between the Moselle and Paris. The second of these ridges is formed by the historic escarpment 400 metres high, above the Meuse, called the Heights of the Meuse. There is the fortress of Verdun, one of the main barriers on the road to Paris. It was the primary objective of the German campaign of 1916, and the failure to secure it had a far-reaching influence on the course of World War I.

History of the Fortress.— After the war of 1870 Gen. Shrh de Rivière, who was entrusted with the task of organizing the frontier defenses, constructed a protective curtain stretching from Verdun on the north to Toul on the south. Fortresses guarded the routes between these two places. On this rampart of the Heights of the Meuse Verdun formed the northern muzzle, opposite the fortified camp at Metz some 10 mi. away. The fortress was planned so that the principal line of resistance faced north. Inside the two lines of forts was an old fortified enclosure of Vauban's time and a citadel dating back to Henry II.

Verdun in 1914.—At the beginning of the war the fortress was an independent command. After the battle of the Frontiers the III army in retreat pivoted its right upon it as a breakwater against the German tide of advance, which turned on Sept. 13, 1911, by reason of the defeat of the German armies before Paris. (*See* MARNE, FIRST BATTLE OF.) The French lines were then established 10 km. north of Verdun, and the sector was quiet for nearly 18 mo.

The autonomy of the great fortresses was cancelled on Aug. 5, 1915, in order to make their garrisons and equipment available for the armies in the field. Dunkirk, Verdun and Belfort, the three great fortresses on the area of battle, became fortified regions linked up with the armies. The fortified region of Verdun (R.F.V.) was placed under Gen. Herr.

I. THE GERMAN OFFENSIVE

On Feb. 8. 1916, it was discovered that the Germans had brought a mass of maneuver to the neighbourhood of Verdun. A deserter disclosed the presence of two corps. On the 11th an intelligence officer reported a concentration of troops on the east bank of the Meuse. The French command at once took precautions.

On Feb. 21, 1916, at 7:15 A.M., the Germans commenced bombardment on a front of 25 m. from the Bois d'Avocourt to Étain. About 4:15 P.M. the first infantry attack was launched. The Germans, to effect a surprise, had not dug parallels from which to issue and moved from their lines at distances from the French lines which varied from 600 to 1.100 metres. Gillet describes their new tactics thus: "Each troop had a specific task, with an objective of limited breadth and depth. . . . The attack took place in waves about 80 metres apart. . . . Shell fire would support the advance continually. On no account should troops attempt to overcome resistance which has not been broken by artillery fire. Units when held up must wait for fresh artillery action."

Early German Successes.—The French line rested on the village of Brabant, then on the Bois de Consenvoye, Bois d'Haumont, Bois de Caures, Bois de Ville and on Herbebois. A little in the rear the Bois de La Wavrille (southeast of the Bois de Ville) and the village of Beaumont had been strengthened. At Herbebois the Germans captured the first lines but were stopped in front of the supporting trenches. The Bois de Cnures was lost, but its northern part was retaken during the night. The loss of the Bois d'Haumont was a serious matter. A French counter-attack on the 22nd at 6 A.M. failed. The line had been pierced.

The Germans made good use, on the 22nd, of the advantage gained at the Bois d'Haumont. The village of Haumont was destroyed by shell fire and at 5:00 P.M. was attacked by three columns. The main redoubt, built of concrete, collapsed and buried 80 men. The remaining defenders were hunted from the cellars by bombs and liquid fire but rallied at Samogneux. Bois de Ville was lost. Bois de Caures was then enveloped on the right and left and Col. Driant decided to withdraw his chasseurs to Beaumont. He was the last to leave the wood and was then killed. On the 23rd the village of Samogneux was overwhelmed by shells and set on fire but the garrison held on till night fell. On the extreme left the village of Brabant outflanked by the German advance became untenable and was evacuated. On the right Wavrille and Herbebois were lost and the front passed along the northern edges of Bois des Fossés and La Chaume.

In three days the Germans had captured the first of the French positions. Each side was reinforced on the 24th. A fresh regiment from the V. Res. Corps was sent to each of the German corps. The corps on the right which, having gained the greatest success, thereby became as it were a pivotal wing, also received a battalion of Jagers. On the French side the two divisions in line from the 21st were relieved, on the left by a division of the VII. Corps, on the right by two brigades from the XX. Corps. These troops, thrown at night into doubtful. positions in the open country, were immediately destroyed. The 24th was the most critical day of the whole battle. On their right, where the Germans sought to move out from Samogneux, they were nailed down by the French artillery on the left bank. But they started a fresh attack immediately eastwards and captured all the line Beaumont, Bois des Fossés, Bois des Caurières. Further they penetrated towards Douaumont along the ravine of the Vauche.

The second French position was lost in one day. In the evening the situation was so grave that Gen. Langle de Cary, commanding the Centre group of Armies, ordered the II. Corps, then closely engaged in the Woëvre, to fall back on the Heights of the Meuse. This movement was carried out during the night. That same evening (24th) Gen. Joffre handed over the operations before Verdun to a fresh army, the II., commanded by Gen. Pétain, who after the Battle of Champagne had been resting at Noailles. The X. Army, on relief by the British Army, was placed in the general reserve.

New French Dispositions.—The initial task of the army under instructions of Feb. 25 at 9.00 A.M. was to concentrate the troops of the Verdun area on the west bank and to prevent the Germans from crossing the Meuse. But on the 24th at midnight Gen. Castelnau set out for Verdun armed with full powers from the commander-in-chief. He halted at Avize, headquarters of Gen. Langle de Cary, whence at 5.45 A.M. on the 25th he telephoned to Gen. Herr to order him to hold at all costs the line on the east bank facingnorth between the Meuse apd Douaumont and, facing east, on the Heights of the Meuse. Gen. Pétain went on the morning of the 25th to Chantilly and thence to take charge of the battle, from the 25th at midnight.

During the 25th, on the French left, the Germans advanced 1,500 metres south of Samogneux up to the mill of Cotelettes. Further east they captured Bezonvaux. A party of Brandenburgers crept up to the fort of Douaumont, found it empty and took possession of it. Gen. de Bonneval, commanding the 37th Div. on the French left on the Talou and the Poivre Hills was afraid of being surrounded and ordered retreat on the Bellevilie Hills. This order was only partially carried out. The Zouaves held their position on the west of the Poivre. On the other hand while the 37th Div. retreated, the 39th Div. of the XX. Corps, going up into the line, passed it and covered the line Bras-Hardaumont.

On the 26th Gen. Pétain, at his headquarters at Souilly, reorganized the battle plan. He drew a sharp line—Bras-Douaumont—which he entrusted to the XX. Corps. He divided the area into four sections: (1) under Duchesne in the Woevre, (2) under Balfourier from the Woëvre to Douaumont, (3) under Guillaumat astride the Meuse, and (4) under Bazelaire on the left bank. The artillery as it arrived was divided between these four commands. On Feb. 21 it consisted of 388 field guns and 244 heavy guns. In a few weeks there were 1,100 field guns, 225 guns of calibres from 80 to 105 mm. and 590 heavy guns. The French regained the mastery of the air. The 59th Div. was set to build two defensive positions chosen on the 27th and redoubled on March 2 by two intermediate lines. Three thousand territorials repaired and widened the Sacred Way.

Reinforcements arrived. The I. Corps was at Souilly on the 25th and the XIII. Corps at Revigny. The XXI. Corps followed it two days later. The XIV. Corps detrained on the 20th and the III. Corps on the 29th. Between the 26th and the 29th the Germans hurled violent attacks against Douaumont. On the east they reached the position of Hardaumont and attacked Bois de la Caillette. They stopped, exhausted, on the 29th.

The Second Phase.—The Germans failed to gain an immediate decision at Verdun. They soon realised that the British Army was about to attack them on the Somme. For four months they kept the battle of Verdun going with furious tenacity in order to disorganize the attack prepared by the Allies in Picardy. For the French Staff the problem was to hold on at Verdun without ceasing to prepare for the Somme. On March 6, as Gen. Pétain had expected and feared from the beginning, the Germans extended the action to the west bank. The attack was made by two corps, the VI. Res. and the X. Res., the latter taken from the General Reserve. On the 6th they captured the Hill de l'Oie and on the 10th Bois de Cumiiires. They were thus enabled to attack one of the pillars of the main line of defence, the Mort Homme. On the 14th they captured the lower crest of that double hill. The higher crest, Peak 295, could be held by neither side and was No Man's Land.

The second pillar of the French line, further to the west, and known as Hill 304, was attacked on March 20 by the 11th Bavarian Div. which took the Bois d'Avocourt but could not issue thence.

The Germans brought up fresh troops and the battle began again on March 28 on the west bank. It ended on April 8 by the French losing all that remained of their former front line. The new front passed thereafter by the redoubt at Avocourt, the first slopes of Hill 304, the southern reverse of the Mort Homme and the north of Cumières. On the right bank on March 31 the Germans captured the village of Vaux, which had held out till then, and on April 2 took the lake behind the village. Then on April 9 the Crown Prince attacked on both banks on a scale not known since the first attacks in February. The results were insignificant. On the morrow Gen. Pétain wrote in his orders of the day "the 9th April was a glorious day for our Armies . . . Courage. *Nous les* aurons."

On April 20 the French counter-attacked on the east bank in order to clear the Mort Homme. But on May 3 the Germans renewed the offensive by an attack on Hill 304. On the 8th they captured Bois Camard, west of the Hill. On the 13th and 16th they attempted without success to advance from this position. They then organized a new attack on the 18th with a fresh corps, the XVIII. Res. Corps and two divisions of the XVIII. and added on the 22nd the 22nd. Res. Division. This violent battle ended on the 24th with the capture of Cumières. As the Germans had no reserves available the tired units could not be relieved and on the 26th they lost a portion of the trenches they had won.

There had been changes in the command. On April 2 the east bank sector had been placed under the orders of Gen. Nivelle, the west bank under Gen. Berthelot. At the end of April Pétain was called to command the Armies of the Centre and handed the II. Army over to Nivelle. The Germans, too, from March had divided the field of battle into two sections, Gen. von Mudra commanding on the right bank, Gen. von Gallwitz on the left bank. In April Mudra was replaced by Lochow. In July François relieved Gallwitz. The Allies' preparations on the Somme took definite shape. Before all things the Germans had to prevent the French from taking part in these operations. For this *a* new success in the Meuse was necessary.

The main French line of defence on the east bank was the Côte de Froide Terre—Fleury—Fort de Souville. On the right this position was covered by the fort of Vaux, on the left by the crest of Thiaumont It was first necessary to capture Vaux and Thiaumont. On June 1 these two positions were attacked. Vaux was taken on the 9th. Thiaumont farm, taken by the Germans on the 1st, was recaptured by the French on the 2nd, who lost it again on the 9th. German attacks on the Thiaumont outworks behind the farm failed completely. They succeeded in establishing themselves on the west and opposite side in the ravine of La-Dame. At the same time battle was resumed on the west bank. Between May 29 and 31 the Germans took Cumières but tried vainly to move out of Bois Camard against Hill 304.

Time pressed more and more. On June 4 Gen. Brusilov started a wide offensive in Volhynia. In these conditions the Germans delivered a large scale attack on the line Froide Terre–Souville on June 21. On the west the Bavarian Corps took the fortified post of Thiaumont but was checked in front of the fort at Froide Terre. In the centre the Alpine Corps captured Fleury. On the west the 103rd Div. took the first line of trenches in front of Souville but failed before the second line. So serious was the situation for the French that on June 23 Pétain warned Gen. Joffre and suggested moving to the west bank if the enemy reached the counterscarps. Joffre's answer on the 27th was a peremptory order to hold on to the east bank.

Meanwhile the preliminaries of the great Franco-British offensive on the Somme started on June 24 and the actual battle began on July 1. On July 11 the Germans made yet another attack on Verdun—from Vaux to Souville. It crumpled up on the slopes of Souville, the principal objective. On Aug. 3 the French retook Thiaumont and Fleury on Aug. 4. The Germans regained Thiaumont on the 8th. Throughout the whole month there was local fighting. The last German attack on Sept. 3 also failed. The battle of Verdun, properly called, had come to an end. From Feb. 21 to June 1j the Army at Verdun had seen 66 divisions on its front. Up to July 1 the Germans had used up 433 divisions. It is true that they maintained them on the ground by depots situated a march behind the front and left them fighting till worn out. The French artillery fired 10,300,000 rounds with the field artillery, 1,200,000 rounds of medium and 600,000 rounds of large calibre.

II. THE FRENCH COUNTER-OFFENSIVE

On Sept. 13 M. Poincaré handed to Verdun the cross of the Legion of Honour and Allied decorations. The ceremony took place in the casemates of the citadel. From that moment began a new phase, that of the liberation of Verdun. To a large extent the glory of this feat belongs to Gen. Mangin. Called from the battlefield of Verdun on June 22 he was placed in command of Group D, which then stretched from the Meuse to Fleury and was progressively enlarged right up to the cliffs of the Meuse. On Sept. 17 in a report to Nivelle he set forth reasons for abandoning operations in detail and for seeking to free Verdun by a plan on broad lines.

The first scheme, approved by Nivelle on Sept. 21, dealt only with an advance up to 300 metres north of the farm of Thiaumont. The scheme of the 24th went further and included the fort of Douaumont as far as possible. A third scheme, that of Oct. 9, covered the capture of the fort of Douaumont and perhaps that of the fort of Vaux. A formidable artillery preparation with 650 guns started on Oct. 21. The assault was delivered on Oct. 24 at 11.40 A.M. by three divisions, the 38th on the left, 133rd in the centre, and 74th on the right. The first waves marched under a creeping barrage which progressed according to a set time-table, so that the infantry were as it seemed fastened to a wall of steel. By night Douaumont was taken with 6,000 prisoners. The division on the right had not reached the fort of Vaux which was evacuated by the Germans on Nov. 2, the day before the date fixed for attack by the 63rd Division.

In order to develop this success to the full Gen. Mangin was obliged to restore his ammunition reserves by continued economy. He intended to attack again on Dec. 5 over a front of 10 m. in order to retake at one blow the whole of the former second French line which had been lost on Feb. 24. Artillery preparation started on Nov. 29 with 750 guns. Bad weather intervened. The Germans had been warned and the value of a surprise was lost. In order to upset the plans of the French the Germans made a violent attack on Dec. 6 and captured Hill 304. Fine weather returned on the 9th and Nivelle recommenced the. artillery preparation. On the 15th at 10 AM. the attack was made The German barrage started two minutes too late. The attack had started, four divisions being in line. By night they had retaken the whole of Poivre Hill. The line ran in front of Hill 378, stopped 20 metres south of the farm at Chambrettes, then turned south across Bois d'Hardaumont and la Vauche up to the outwork at Bezonvaux. The French captured 11j guns and 9,000 prisoners, This, known as the battle of Louvemont, was completed on the 18th by the recapture of Chambrettes. The spring passed in organising the area conquered and preparing for the final battle.

The Final Battle.—In the summer of 1917 Pétain formulated plans for a series of limited offensives for the purposes of raising the spirit of the army and decided on an operation on the northern front of Verdun on both banks having as objectives Mort Homme on the left and Samogneux and Beaumont on the right. The attack planned by Pétain was delivered on Aug. 20 after six days' heavy artillery preparation. The XIII. and XVI. Army Corps attacked on the left bank, the XV. and XXII. on the right bank, 16 divisions in all being engaged. Mort Homme was captured on the 20th, Hill 304 on the 24th. On the right bank Hill 344 was taken on the 20th, Samogneux on the 21st. More than 10,000 prisoners were taken. Beaumont alone remained in German hands. This was the final battle of Verdun.

Dugard, *La Victoire de Verdun,* Feb. 1916–Nov. 1917, Paris 1918. Falkenhayn, *General Headquarters,* 1914–1916, London, 1919. Thomasson, *Les Préliminaires de Verdun,* Paris, 1921. Moser, *Kurzer strategischer Überblick über den Weltkrieg,* Berlin, 1921. Corda, *La Guerre Mondiale,* Paris, 1922. Palat, *La Rude sur Verdun,* Aug. 1915–June 1916, Paris, 1925. Moser, *Ernsthafte Plaudereien uber den Weltkrieg,* Stuttgart, 1925. Reichsarchiv, *Die Tragodie von Verdun 1916,* Oldenburg, 1926. Moser, *Das militärisch und politisch Wichtigste vom Weltkriege,* Stuttgart, 1926. Grasset, *Verdun,* Paris, 1927. *See* also WORLD WAR I: *Bibliography.*

VERE, the name of an English family extolled by Macaulay as "the longest and most illustrious line of nobles that England has seen." is derived from the village of Ver. near Bayeux. Its founder. Xlberic de Ver (d. 1088) held lands in Middlesex, Suffolk, Cambridgeshire and Essex (Castle Hedinpham) ; the family badge, the blue boar, is still found in Essex churches. In 113j his son, Aubrey de Vere (d. 1141) was made great chamberlain of England; this office was confirmed to Aubrey, his successor, by the empress Maud, who also made him 1st earl of Oxford (1142). Robert (1170?–1221), who became 3rd earl of Oxford in 1214. was one of the 25 executors of Magna Carta. The 5th earl. also Robert (1240–1296), sided with Simon de Montfort, and temporarily forfeited his earldom and offices. John. the 7th earl (1313–1360), fought at Crécy and Poitiers. His grandson Robert, the 9th earl of Oxford (*q.v.*), Richard II's favourite, was attainted in 1388. His uncle. Aubrey, was restored in 1393, and was succeeded by his elder son Richard (d. 1417) who fought at Xgincourt. The 12th earl. John. was beheaded (1462). with his eldest son, as a Lancastrian; their death was avenged by his younger son, John (*q.v.*). On the death of the 14th earl. also John, without issue, in 1526, the family baronies fell to his sisters, but the earldom passed to his cousin John (d. 1540?), grandfather through his younger son of "the fighting Veres" (*see* below). His eldest son John became 16th earl and regained the great chamberlainship which had been lost in 1526.

Edward, 17th earl of Oxford (*q.v.*), squandered much of the family wealth. When his son Henry (1593–1625) died at the siege of Breda, the titles were disputed between Robert Vere, his second cousin. who became earl, and Lord Willoughby d'Eresby, con of his aunt. who became great chamberlain. The 19th earl n-as killed at the battle of Maastricht (1632) and his son. Aubrey (1626–1703), became 20th and last earl. A royalist during the Great Rebellion, he received various rewards at the Restoration, including command of a regiment of horse called after him "the Oxford Blues" (later "the Blues"; the royal horse guard). His only surviving descendant. Diana. married the 1st duke of St. Albans (*q.v.*), and their descendants received the barony of Vere in 17jo.

VERE, SIR FRANCIS (1560–1609), English soldier, was a nephew of the 16th earl of Oxford. He served under the earl of Leicester and Lord Willoughby in the Netherlands. 1585–89, distinguishing himself at Sluys (1587) and Gergen-op-Zoom (1588).

As sergeant major general he commanded the English forces in the field there after Willoughby's resignation and played a prominent part in the campaigns of Maurice of Nassau, which finally drove the Spaniards out of the provinces east of the Ijsel river (1590–95). In 1596 he served as lieutenant general in the Cadiz expedition and in 1597 took part in the islands' voyage.

Returning to the Yetherlands. Sir Frances helped to take Turnhout and then to negotiate a new treaty with the Dutch in 1598. He was made general of all the English forces there and governor of the Brielle. Wounded helping Maurice to win the victory of Nieuport in 1600, he then conducted the defense of Ostend (1601–02). He returned to England on the conclusion of peace with Spain in 1603 but went on another mission to the Dutch in 1605–06. He died in London on Xug. 28. 1609.

SIR HORACE VERE, BARON VERE OF TILBURY (1565–1635), Sir Francis' younger brother, served under him in the Netherlands (1590–94), took part in the Cadiz expedition and fought at Nieuport and Ostend. On Sir Francis's retirement, Sir Horace was left as senior English colonel in the Netherlands. From 1609 till 1616 he was governor of the Brielle and in 1610 he was present at the siege of Julich.

After the outbreak of the Thirty Years' War he commanded the expedition to assist the elector palatine in 1620 but, ill-supported and with inadequate forces: he was compelled to capitulate at Mannheim in 1622. Returning to Dutch service in 1623, he made a brilliant but unsuccessful attempt to relieve Breda (1625) and took a leading part in the sieges of 's Hertogenbosch (1629) and Maastricht (1632). He was created Baron Vere of Tilbury in 1625. Sir Horace died on May 2, 1635. (R. B. WM.)

VERESCHAGIN (VERESTCHAGIN), **VASILI VASILIEVICH** (1842–1904), Russian painter, noted for his war canvases, was born at Cherepovets on Oct. 26. 1842. He attended the St. Petersburg academy and studied under Jean Léon Gérôme in Paris. Devoting his life to travel, he acquired subjects for canvases from on-the-spot impressions in the Caucasus. in the Crimea, along the Danube and in Turkistan with the Russian army. In the Balkans during the Russo-Turkish War (at which time he was wounded), Vereschagin was provided with the themes of some famous war pictures. He also painted in Syria and in Palestine and between 1885 and 1903 traveled in Russia, the United States and Japan. He died at Port Arthur on April 13. 1904, during the Russo-Japanese War. while aboard the flagship of Xdm. Stepan Makárov. Vereschagin's historical scenes of the invasion of Russia by Napoleon in 1812 enjoyed extraordinary popularity: innumerable reproductions of them were made. The pacifist and humanitarian movement of the time made use of a painting of his representing a pyramid of skulls ("The Apotheosis of War"), and of the series of three representing a Roman execution ("The Crucifixion"). sepoys blown from the guns in India and the execution of Nihilists in St. Petersburg. His works are to be found in Moscow at the Tretyakor gallery and in Leningrad at the Russian museum. His memoirs were published in English in 1887.

See Eugen Zabel, *Weretschagin* (1900); A. Lebediev, *Vereschaguin* (1959). (M N B.)

VERGA, GIOVANNI (1840–1922), Italian novelist. was born at Catania. Sicily. In 1865 he published *Stovia di una peccatrice* and *I Carbonari della montagna,* but his literary reputation was established by his *Eva* and *Stovia di una capinera* (1869). Other novels followed. *Malavoglia* (1881) and *Maestro Don Gesualdo* (1889. Eng. trans. 1923). His finest work. however. is seen in his short stories and sketches of Sicilian peasantry. *Medda* (1874) and *Vita dei campi* (1880); and his *Cavalleria Rusticana* (Eng. trans. of this and other stories 1928) acquired new popularity from its dramatization and from Alascagni's opera on this subject. Verga and Fogazzaro between them may be said to have faithfully chronicled the inner and popular life of southern and northern Italy. D. H. Lawrence translated many of Verga's works into English. Verga died in Rome on Jan. 27, 1922.

VERGENNES, CHARLES GRAVIER, COMTE DE (1717–1787), French statesman. was born at Dijon on Dec. 20, 1717. He entered the diplomatic service under his uncle M. de Chavigny, at Lisbon. He became ambassador at Constantinople and then in Sweden, where he assisted Gustavus III in the revolution of 1772.

With the accession of Louis XVI Vergennes became foreign minister. His general policy was one of friendly relations with Austria, combined with the limitation of Joseph II's ambitious designs; the protection of Turkey; and opposition at all points to England. His hatred of England led to his support of the American States in the War of Independence. Vergennes sought to secure the armed neutrality of the Northern Powers eventually carried out by Catherine II; he ceded to the demands of Beaumarchais that France should secretly provide the Americans with arms and volunteers. In 1777 he informed the American commissioners that France was willing to form an offensive and defensive alliance with the new Republic. In 1781 he became chief of the council of finance.

Vergennes died on Feb. 13, 1787.

VERGIL: *see* VIRGIL.

VERGNIAUD, PIERRE VICTURNIEN (1753–1793), French orator and revolutionist, was born on May 31. 1753, at Limoges. The son of a merchant of that town, he attracted the notice of Turgot, who was then intendant of Limousin. Turgot secured his admission to the college of Plessis in Paris. where he received a solid classical education. On leaving college he became secretary to Duputy. president of the parlement of Bordeaux. Vergniaud was thereafter called to the bar (1782). In 1789 Vergniaud was elected a member of the general council of the department of the Gironde. He was chosen a representative of the Gironde to the National Legislative assembly in August 1791.

The extremists used the passions which his oratory awakened for objects he did not foresee. This happened even with his first assembly speech, on the *émigrés.* His proposal was mainly that a treble annual contribution should be levied on their property; but the assembly confiscated their goods and decreed their deaths. Step by step he was led on to palliate violence and crime, to the excesses of which his eyes were only opened by the massacres of September, and which ultimately overwhelmed the party of Girondists which he led. It has always been held against him that on March 19. 1792, when the perpetrators of the massacre of Xvignon had been introduced to the assembly by Collot d'Herbois. Vergniaud spoke indulgently of their deeds and lent the authority of his voice to their amnesty. In language sometimes turgid. but nearly always of pure and powerful eloquence, he worked at the theme of the *émigrés,* as it developed into that of the counterrevolution; and the project of an address to the French people which he presented to the assembly on Dec. 27, 1791, shook the heart of France; and, especially by his call to arms on Jan. 18, he shaped the policy which culminated in the declaration of war against the king of Bohemia and Hungary on April 20. This policy in foreign affairs, which he pursued through the winter and spring of 1791–92, he combined with another—that of fanning the suspicions of the people against the monarchy, which he identified with the counterrevolution, and of forcing on a change of ministry. On March 10. Vergniaud delivered a powerful oration in which he denounced the intrigues of the court and uttered his famous apostrophe to the Tuileries: "In ancient times fear and terror have often issued from that famous palace; let them re-enter it to-day in the name of the law!" The speech overthrew De Lessart, whose accusation was decreed; and Roland, the nominee of the Girondists, entered the ministry. The Mountain used Vergniaud, whose lofty and serene ideas they applauded and travestied in action. Then came the ribt of June 20, and the invasion of the Tuileries. He rushed among the crowd. but was powerless to quell the tumult. But his speeches breathe the very spirit of the storm, and they were perhaps the greatest single factor in the development of the events of the time. On Xug. 10, the Tuileries was stormed, and the royal family took refuge in the assembly. Vergniaud presided. To the request of the king for protection he replied in dignified and respectful language.

On Dec. 31, 1792, Vergniaud delivered one of his greatest orations. He pictured the consequences of that temper of vengeance which animated the Parisian mob and was fatally controlling the policy of the Convention, and the prostration which would ensue to

France after even a successful struggle with a European coalition. which would spring up after the murder of the king. On Jan. 16, 1793. the vote began to be taken in the Convention upon the punishment of the king. On the 17th Vergniaud announced the fatal result of the voting. When the institution of a revolutionary tribunal was proposed. Vergniaud vehemently opposed the project. and on March 10 had to go into hiding. On March 13 Vergniaud boldly exposed the conspiracy in the Convention. The antagonism caused by such an attitude had reached a significant point n-hen on April 10 Robespierre himself laid his accusation before the Convention. Vergniaud made a brilliant reply, and the attack for the moment failed. On June 2, 1793, things came to a head. The Convention nas surrounded with an armed mob. who clamoured for the "twenty-two." The decree of accusation was voted, and the Girondists were proscribed. Vergniaud was offered a safe retreat. He accepted it only for a day. and then returned to his own dwelling. In July he was imprisoned in La Force. The Girondists appeared before the Revolutionary tribunal on Oct. 2i. On Oct. 31, 1793, they went to the scaffold. Vergniaud was executed last. (Sh.; X.)

VERHAEREN, ÉMILE (1855–1916), the most outstanding Belgian poet to write in French, whose work, by its strength and range. will stand comparison with that of Victor Hugo. Born May 21. 1855. at Saint Amand lez-Puers. a village on the river Scheldt. he was educated at Brussels and Ghent and from 1875 to 1881 studied law at Louvain. where he became acquainted with Max Waller. the founder of the influential periodical *La Jeune Belgique* (1881). Articled to the barrister and patron of the arts Edmond Picard, he became one of the group in Brussels who brought about the literary and artistic renaissance of the 1890s. His first hook—a collection of violently naturalistic poems (*Les Flamandes,* 1883) created a sensation. It was followed by short stories and a monograph on Joseph Heymans, but *Les Moines* (1886). *Les Soirs* (1887; Eng. trans., 1918), *Les Débâcles* (1888), *Les Flambeaux noirs* (1890), *Au Bord de la route* (1891; later retitled *Les Bords de la route*), *Les Apparus dans mes chemins* (1891) and *Les Campagnes hallucinées* (1893) confirmed his reputation as a lyrical poet. In 1895 growing concern for social problems inspired *Les Villages illusoires* and *Les Villes tentaculaires. Lcs Heures claires* (1896; Eng. trans.. *The Sunlit Hours*, 1917), an avowal of his love for his wife. led to the series of his major works. among which the most outstanding are *Les Visages de la Vie* (1899), *Les Forces tumultueuses* (1902). *Les Tendresses premières* (1903, the first part of the five-part *Toute la Flandre*), *La Multiple Splendeur* (1906), *Les Rythmes souverains* (1910) and *Les Blés mouvants* (1912). During this period he also published books on art. two further collections of personal lyrics to his wife and plays—*Les Aubes* (1898; Eng. trans. by A. Symons), *Le Cloître* (1900: Eng. trans.! 1915), *Philippe II* (1901; Eng. trans.. 1916) and *Hélène de Sparte* (1912; Eng. trans.. 1916).

Deeply stirred by the outbreak of war in 1913. Verhaeren took refuge in France where he addressed meetings in many towns to rally support for his country. On Nov. 27. 1916. after one such meeting. he was accidentally killed when catching a train at Rouen station.

The qualities most characteristic of Verhaeren's considerable poetic output — more than 30 collections — are vigour and breadth of vision. His unusually strong lyrical gift, his burning vitality and originality, by which he transforms the technique of the Symbolists into a highly personal instrument, are expressed in a fresh. unpolished language of great power and flexibility. His three main themes are Flanders, human energy (expressed in the desire for progress. for the brotherhood of man and for the emancipation of the working classes) and his tender, understanding love ior his wife. It is perhaps in the poems celebrating the quiet joys of hearth and home that he is most moving. More generally popular are those glorifying Flanders — the greatness of its painters and the pleasures of its common people—and those which exalt. the triumph of human intelligence over matter and praise the epic beauty of the industrial age, in which man's servitude has power to bring about his liberation.

His plays in verse. although often showing dramatic power and poetic inspiration. are marred by an over-rhetorical style and are rarely produced. His works on art show sympathy with those painters — Remhrandt. Rubens, James Ensor and others — who depict life at its boldest, most picturesque and most colourful.

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VERLAINE, PAUL (1844–1896), French lyric poet, was born at Metz on March 30. 1844. He was the son of one of Napoleon's soldiers. who had become a captain of engineers. Verlaine was educated in Paris. and became clerk in an insurance company. He was a member of the Parnassian circle. with Catulle Mendès, Sully Prudhomme, François Coppée and the rest. His first volume of poems, the *Poèmes saturniens* (1866), was written under I'arnassian influences, from which the *fêtes galantes* (1869), as of a Watteau of poetry, began a delicate escape; and in *La Bonne Chanson* (1870) the defection was still more marked. He married in 1870 Mlle. Mautet. During the Commune he was involved with the authorities for having sheltered his friends, and was obliged to leave France. In 1871 the strange young poet Jean Arthur Rimbaud came somewhat troublingly into his life: into which drink had already brought a lasting disturbance.

With Rimbaud, he wandered over France, Belgium, England, until a pistol shot. fortunately ill-aimed, against his companion brought upon him two years of imprisonment at Mons. Solitude, confinement and thought converted a pagan into a Catholic, without, however, rooting out what was most human in the pagan; and after many years' silence he published *Sagesse* (1881), a collection of religious poems, which, for humble and passionate conviction, as well as originality oi poetic beauty, must be ranked with the finest religious poems ever written. *Romances sans paroles,* composed during the intervals of wandering. appeared in 1874, and shows us Verlaine at his most perfect moment of artistic self-possession. before he has quite found what is deepest in himself. He returned to France in 1875. His wife had obtained a divorce from him. and Verlaine made another short stay in England, teaching French. After about two years' absence Verlaine was again in France. He taught in more than one school and even tried farming. The death of his mother dissolved the ties that hound him to "respectable" society. During the rest of his life he lived in poverty. often in hospital, but always with the heedless and unconquerable cheerfulness oi a child. After a long obscurity, famous only in the Latin Quarter, among the cafés where he spent so much of his days and nights. he enjoyed at last a European celebrity. In 1894 he paid another visit to England, this time as a distinguished poet. He died in Paris on Jan. 8, 1896.

His 18 volumes of verse, which also include *Jadis et naguère* (1884), *Amour* (1888), *Parallèlement* (1889). *Bonheur* (1891) vary greatly in quality (A Sy.)

His *Oeuvres complètes* were published in 1899 and in later editions and his *Oeuvres posthumes* in 1903 His *Poètes maudits* (1888) and *Confessions* (1895) thron light on his own life -1 bibliography of Verlaine. with an' account of the existing portraits of him, is included in the *Poètes d'aujourd'hui* (11th ed.. 1905) of A. van Bever and P. Léautaud. *See* monographs by C. Morice (1888), M. Dullaert (1896), B. E. Delahaye (1919), and H. Nicolson (1921); E. Lepelletier. *Paul Verlaine, sa vie, son oeuvre* (1907, Eng. trans. 1909); F. A. Cazals and G. Le Rouge, *Les Derniers Jours de P. Verlaine* (1923); L. Eckhoff, P. *Verlaine og Symbolismen* (1923).

VERMEER; JAN (Jan van der Meer van Delft) (1632–167j). Dutch painter, mainly of interior genre subjects. was baptized in Delft on Oct. 31. 1632. He lived all his life in Delft; among the sparse records of him in the city archives are those of his marriage in April 1653 and his enrollment in December of that year in the Guild of St. Luke. of which he was chairman in 1662–63 and 1670–71. He was buried in the Old church on Dec. 15, 1675. Further records are mainly concerned with his financial troubles. He died insolvent. owing a large sum to his mother-in-law. and his widow had to part with two of his paintings in settlement of a baker's bill. Thus Vermeer's life and character are mysteries of which the only key is his mysterious art. It seems that he looked principally to his activities as an art dealer to support his large family. and not to the sale of his own pictures. This helps to explain the rarity of his works (only 35 unquestionably authentic paintings survive) and his independence of popular taste and values. He worked slowly, with a refinement of perception that goes far beyond that of any contemporary, for his analysis of

BY COURTESY OF RIJKSMUSEUM, AMSTERDAM

"SERVANT POURING MILK" BY JAN VERMEER. IN THE RIJKSMUSEUM. AMSTERDAM

optical experience had no parallel until the age of photography in the second half of the 19th century, when — significantly — his unique qualities were first understood and prized.

Vermeer's pictures yield little evidence as to his early training, though the example of Carel Fabritius was not lost on him. Only two of the paintings are dated — the "Procuress" (1656, Dresden) and the "Astronomer" (1668, in a French collection) — but these provide some basis for studying his development. The paintings of his early years tend to be larger in scale than the late works, and include experiments with historical subjects and landscape as well as genre. Among the earliest of all are "Christ in the House of Mary and hfartha" (Edinburgh) and "Diana With Her Companions" (The Hague), together with the "Procuress" and the "Sleeping Girl" (New York). These are fairly fluent and "painterly" in execution. though in places the pigment is applied quite thickly in successive layers. A noticeable impasto persists in the works attributable to his next phase, about the years 1658–62. These include the "Servant Pouring Milk" (Amsterdam), "Soldier and Laughing Girl" (New York). the "Street in Delft" (Amsterdam) and the celebrated "View of Delft" (The Hague). From this point onward Vermeer confined himself to genre subjects and portrait heads of a genre character, the one exception being the comparatively unsuccessful "Allegory of the New Testament" (New York). His technique became progressively more polished and refined, until in the late works the individual brush strokes can.seldom be distinguished. Characteristic genre pictures are the "Concert" (Boston), the "Music Lesson" (Buckingham palace), "Woman With a Jug" (Kew York), "Artist in His Studio" (Vienna) and "Lady Standing at the Virginals" (National gallery, London). Among the genre portraits one may mention the "Girl's Head" (The Hague) and also the "Girl With a Flute" and the "Girl in a Red Hat" (both in Washington. D.C.).

Vermeer had an unerring grasp of pictorial design and a pure and individual colour sense. But the most extraordinary element in his art is the unswerving objectivity with which he recorded the eye's experience of the soft play of daylight on varied shapes and surfaces. achieving thus a timelessness and truth both satisfying and deeply moving. See also PAINTING: The Netherlands: *17th Century.*

See A. B. de Vries, *Jan **Vermeer** van **Delft,*** Eng. ed. (1948); L. Gowing, *Vermeer* (1952); ***L.*** Goldscheider, *Jan **Vermeer*** (1958).

(R. E. W. J.)

VERMES, the term used by Linnaeus to include all invertebrates except insects. Restricted and modified by subsequent authors, and considered by many to be obsolete, it remains in use in the 20th century. as in Kiikenthal and Krumbach's *Handbuch* der *Zoologie,* and comprises a heterogenous assemblage of segmented and unsegmented wormlike animals. (G. E. P.)

VERMICELLI: see MACARONI.

VERMICULITE is a hydrated magnesium silicate resembling mica in appearance and in basic atomic structure (see MICA). It differs from mica in that when heated the mineral flakes expand (exfoliate) perpendicular to the plane of easy cleavage as a result of very rapid loss of water of hydration. The swelling may amount to 20 or more times the original thickness. The exfoliated product is extremely light (density as low as 0.09) and is used for lightweight concrete and plaster, for thermal and acoustic insulation, as a packing medium, a soil conditioner, a starting medium for seeds and for many other purposes. The mineral is formed in various ways, for example, in the soil by the weathering of micas, and by hydrothermal processes (*i.e.,* action of water vapour at elevated temperatures and pressures). Large deposits occur in the United States (in Montana. the Carolinas and other states), in South Africa. Australia, U.S.S.R., Brazil and elsewhere. Annual production in the U.S. increased from about 20.000 tons in 1940 to about 200.000 tons by the second half of the 20th century. Annual production in South Africa ranged from about 30.000 tons to 62.000 tons.

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VERMIGLI, PIETRO MARTIRE, known as PETER MARTYR (1500–1562), was born at Florence, Italy, on May 8, 1500, and educated in the Augustinian cloister at Fiesole and the convent of St. John of Verdara near Padua. graduating D.D. about 1527. About 1533 he read Bucer's commentaries on the Gospels and the Psalms and also Zwingli's De *vera* et *falsa religione;* and his Biblical studies began to affect his views. He was accused of erroneous doctrine, and the Spanish viceroy of Naples prohibited his preaching. The prohibition was removed on appeal to Rome, but in 1541 Vermigli was transferred to Lucca. where he again tell under suspicion. Summoned to appear before a chapter of his order at Genoa, he fled in 1542 to Pisa and thence to another Italian reformer. Bernardino Ochino, at Florence.

Ochino escaped to Geneva, and Vermigli to Zürich and finally to Strasbourg, where, with Bucer's support, he was appointed professor of theology. Vermigli and Ochino were invited to England by Cranmer in 1547, and given a pension by the government. In 1548 Vermigli was appointed regius proicssor of divinity at Osiord. In 1549 he took part in a great disputation on the Eucharist.

He had abandoned Luther's doctrine of consubstantiation and adopted the doctrine of a Real Presence conditioned by the faith of the recipient. This was similar to the view now held by Cranmer and Ridley, but it is difficult to prove that Vermigli had any great influence in the modifications of the Book of Common Prayer made in 1552. He was consulted on the question, but his recommendations seem hardly distinguishable from those of Bucer, the effect of which is itself disputable. He was appointed one of the commissioners for the reiorm of the canon law. On Mary's accession \-ermigli returned to Strasbourg, and was reappointed professor of theology, but his increased alienation from Lutheranism drove him to Switzerland. Re was professor of Hebrew at Zurich, where he died on Nov. 12. 1562.

VERMONT, the "Green Mountain state," named from the evergreen forests of its mountains (Fr. *verd mont,* "green mountain"), is a North Atlantic state of the United States, the most northwesterly of the so-called New England group. It is bounded north by the Canadian province of Quebec; east by New Hampshire. from which the Connecticut river separates it: south by Xlassachusetts; and west by New York,' from which Lake Champlain separates it for about two-thirds of the distance. In length. north and south, the state measures 157.6 mi.: its approximate width at the northern border is 90 mi.. at the southern border 40 mi. Its total area is 9,609 sq.mi., and of this 333 sq.mi. is water surface; among the states it ranks 43rd in size. Vermont was admitted to the union in 1791 as the 14th state. Its flap consists of a blue field on which is represented the state coat of arms. The state floner is the red clover (*Trifolium pratense*), the tree the sugar maple. the bird the hermit thrush (*Hylocichla guttata*), the motto "Freedom and Unity." The capital is at Montpelier.

PHYSICAL GEOGRAPHY

Physical Features. — The mean elevation of the state (which lies between the extremes of approximately latitude 42° 44' and 45° 1' N. and longitude 71° 33' and 73° 26' W.) above the sea is approximately 1.000 ft., extremes varying from 95 it.. the surface of Lake Champlain, to 4.393 ft. at the summit of Mt. Mansfield, 25 mi. E. of that lake. Mountain ranges break much of the general surface, the most prominent of these being the Green mountains extending nearly north and south through the state a little west of the middle (see GREEN MOUNTAINS). The crest line is generally more than 2,000 ft. high, with the following summits: hft. Mansfield, 4,393 ft.; Killington peak, 4,241 ft.; Mt. Ellen, 4,135 ft.; Camel's Hump (Lyon Couchant), 4,083 ft.; and Mt. Abraham. 4,049 ft. More than 900 peaks rise above 2,000 ft. The eastern border has several cone-shaped mountain masses. Mt. Ascutney rises abruptly from the floor of the Connecticut valley to a height of 3,144 ft. In the north, Jay peak and Burke and Belvidere mountains are prominent. In the south and near the western border the Taconic mountains nearly parallel the Green mountains and extend northward toward the centre of the state.

Lake Champlain (*q.v.*) lies in a beautiful valley between the Green and Adirondack mountains. About two-thirds of its area is in Vermont; and the northern portion contains numerous islands, several of which are large. Connected with each other and with the mainland by bridges, the islands constitute a county in themselves. On the northern border of the state is Lake Memphremagog, with a rugged prominence known as Owl's Head on its west border. Jay peak farther back and farming country eastward. The lake is 27 mi. long and from 1 to 4 mi. wide, two-thirds of it lying in Canada.

There are many other lakes and ponds. Willoughby lake, one of the largest, lies in a narrow valley between Mt. Pisgah and Mt. Hoar (Hor) in the north. Lakes Morey and Fairlee are in the Connecticut river valley. Lake Dunmore in the towns of Salisbury and Leicester, Lake Bomoseen in Castleton and Hubbardton, Lake St. Catherine in Wells and Poultney, and Lake Hortonia in Sudbury, all west of the Green mountains, are noted for their scenery.

The Winooski and Lamoille rivers rise in the east, cut deeply into the Green mountains on their westward course. and empty into Lake Champlain. The hlissisquoi also rises east of the range but flows just north of the Canadian boundary, then back into Vermont and west to Lake Champlain. The Mettawee, Poultney Otter and La Platte flow generally west and north, also into Lake Champlain The Vermont tributaries to Lake hlemphremagog are the Barton and Black rivers from the south and the Clyde river from the east. Most important of the Vermont tributaries of the Connecticut river (*q.v*) are the Nulhegan, Passumpsic, Wells, Waits, Ompompanoosic, White, Ottauquechee. Black, Williams. Saxtons, West and Deerfield. The southwestern part of the state is drained to the Hudson river by the Batten Kill and Hoosic rivers. Vermont streams are usually swift-flowing and in comparatively narron and scenic valleys. Among the most spectacular cuts are the Williamstown gulf. the Proctorsville gulf in the centre of the state, and Quechee Gorge near Woodstock.

Climate. — The mean annual temperature varies from 40° to 47° F., the eastern part of the state being generally colder than the western, and the centre mountainous part coldest of all. Average annual precipitation over a long period is approximately 37.5 in. Snow often appears in November in the higher altitudes but does not come to stay before December, generally remaining until March. The average snowfall throughout the state is about 90 in. annually, but there is less snow near Lake Champlain and in the southwestern part than in central and eastern Vermont. Spring comes earliest in these sections and in the lower portions of the Connecticut valley.

Soils and Vegetation. — Agricultural classification of Vermont soils shows a division of the land into seven classes: (1) smooth, well-drained, highly productive land suitable for all crops grown in the state (10%); (2) highly productive land nith imperfect drainage. which is smooth and contains no stone (5%); (3) medium productive land but iimited in crop range. smooth. and containing some stone (20%); (4) medium productive land located at elevations allowing a wide range of crops including fruit (15%); (5) smooth to strongly rolling land of relatively low productivity containing varying quantities of stone (15%); (6) strongly rolling land of low productivity, containing stone which interferes somewhat with use of machinery (20%); and (7) steep stony land having little or no agricultural value, which may be used for limited pastureland (15%).

White pine and hemlock are abundant on lower slopes; spruce and fir are common on higher slopes. Among the deciduous trees, the state is especially noted for its sugar maples. Birch and beech grow on the hills, and in the lower areas. oak, elm, hickory, ash, poplar, basswood, willow and butternut are found. Indigenous fruit-bearing trees, shrubs, vines and plants include the plum, cherry, grape, blackberry, raspberry, cranberry and strawberry. More than two-thirds of the land area is covered with forest growth.

Animal Life. — Vermont provides a natural habitat for wild animals, to the delight of hunters and tourists and sometimes to the annoyance of farmers and motorists. Early in the state's history, wolves, panthers, bears and wildcats were abundant. Wolves and panthers have declined in numbers, but bear is today a big game animal and wildcats or bobcats are still found. Muskrat, beaver and red fox abound in Vermont in addition to small game such as squirrels, pheasants and waterfowl.

The wild animal that is taken in greatest numbers by hunters is the white-tailed deer. Prior to 1907 the annual deer kill was less than 1,000. The population of both deer and hunters has increased enormously: in the late 1950s, 150 deer were taken during one special archery season and 10,510 during the regular season.

Parks, Historic Sites and Recreation. — The tourist business, based on the state's beautiful scenery, historic places and facilities for outdoor sports, is one of Vermont's largest income producers.

From November to March, about two dozen ski areas are in operation. Mt. Mansfield in Stowe. Mad River glen in Waitsfield, Sugarbush in Warren, Pico peak near Rutland, Big Bromley in Manchester and Jay peak in the north are among the best known. Other seasons bring many tourists to enjoy fishing and hunting, to occupy cottages on the many lakes, to hike in the mountains or to see the autumn foliage. The state has built numerous roadside picnic areas and access areas to lakes and streams, and has developed 28 state forests and 27 state parks with a total acreage nearing 90,000. Green Mountain National forest, in the main range of the Green mountains, occupies land in 33 towns and comprises a gross area of 580.000 ac.

The Vermont Historic Sites commission has saved or has developed in the public interest some of the many historic places and structures in the state. Among these are the Calvin Coolidge home in the small village of Plymouth; the Bennington battle monument at Old Bennington, commemorating Gen. John Stark's victory over Gen. John Burgoyne on Aug. 16, 1777; the Hubbardton battlefield and museum, on the site of the only Revolutionary battle fought on Vermont soil (July 7, 1777); the Chester A. Arthur birthplace at Fairfield; the Hyde log cabin at Grand Isle, built in 1783 and considered the oldest log cabin in the United States still standing in its original condition; and the Scott covered bridge at Townshend, the longest single span in the state.

HISTORY

Exploration and Settlement. — French explorations first opened up the area now known as Vermont. On July 4, 1609, Samuel de Champlain and two French companions crossed the lake to which he gave his name while traveling with an Algonkin war party into Iroquois country. This is the earliest known visit of white men to the area. For almost a century and a half thereafter, the Champlain valley was French territory. Lake Champlain and the Richelieu river form a great trunk water route between the valley of the St. Lawrence and the area of southern New England and the Hudson valley. Increase of the Iroquois compelled the French to erect a chain of forts to command the approach to Canada from the south; thus Ft. Ste. Anne, built in 1666 on Isle La Motte in Lake Champlain, became the first white settlement. As the English settlements in Massachusetts and adjacent colonies grew stronger. the Indians withdrew into Canada, from which they joined the French in raids upon English settlements. After the second raid upon the Deerfield settlement in Rlassachusetts in 1704, French and Indians took prisoners through the Connecticut, White, Winooski and Champlain valleys to Canada.

'The first permanent English settlement dates from 1724 when Ft. Dummer was erected on the Connecticut river just north of the present Massachusetts border, for the protection of Deerfield and other settlements. Later in the same year a group of Dutch squatters settled in the southwestern corner of Vermont. By mid-18th century. Benning Wentworth, royal governor of New Hampshire, was pushing further settlement. Assuming that the vague limits of his province, like those of Connecticut and Massachusetts, extended westward to a line 20 mi. E. of the Hudson river, he made grants of land between the Connecticut river and Lake Champlain in the region commonly known as the New Hampshire grants. From 1749 to 1764 he provided for 138 towns. New York officials challenged his right to grant these lands, however, and for 14 years ownership of the region was debated. On July 20, 1764, an order of the king in council decided in favour of New York, the governors of which proceeded to issue grants though the debate continued. After the French and Indian War ended, several thousand persons, largely from Connecticut and Massachusetts, purchased lands in the New Hampshire grants, cleared farms, built houses and planted crops. New York left the settlers in the Connecticut river towns relatively alone. though its authority there was recognized nominally for a period. West of the Green mountains, New York titles were successfully defied in defense of New Hampshire titles. In 1770 the New York courts refused to consider the New Hampshire charter as evidence in an ejectment suit concerning property in Shaftsbury. Ethan Allen, in charge of the defense, returned to Bennington where the town voted to protect its rights under Wentworth's charter, by force if necessary. A militia had been formed there in 1764 and subsequently in several other towns. With Ethan Allen as commander, these groups formed an association that came to be known as the Green Mountain Boys, and their resistance continued for many years.

Revolution, Independence and Statehood. — The Green Mountain Boys were soon in conflict with foreigners as well as with neighbours. On May 10, 1775, with the aid of some sympathizers from Rlassachusetts and Connecticut, they captured the Lake Champlain fortress at Ticonderoga in the first aggressive act of Americans in the Revolutionary War. Green mountain settlers continued an active role in the fight for independence. They were among the American forces defeated at Hubbardton, Vt., July 7, 1777, in retreat from Ticonderoga. With New Hampshire and Massachusetts troops under Gen. John Stark, they helped defeat (Aug. 16, 1777) the British detachments attempting to capture American stores at Bennington; this was the beginning of Burgoyne's reverses, which ended in his surrender to Gen. Horatio Gates on Oct. 17, 1777. Green mountain men participated in the invasion of Canada in the autumn of 1777.

Town government appeared in the New Hampshire grants at settlement. 'Town committees of safety emerged after 1770, in the conflicts with New York. In the movement toward statehood in 1776, a general convention mas formed. It held several sessions, ultimately with delegates from the towns on the east as well as the west side of the Green mountains. Ira Allen, Ethan's brother, was among the most active in the movement. During an adjourned session of the general convention on Sept. 27, 1776, a covenant or compact was "made and subscribed by the members." On Jan. 16, 1777, they adopted a declaration of independence, deciding on New Connecticut as the name of the state; in June they abandoned this name. as it had been used elsewhere, and substituted the name Vermont. In July a state constitution was adopted in convention in Windsor. This was the first U.S. state constitution to forbid slavery and to establish manhood suffrage. The convention also appointed a council of safety to govern the state temporarily. with 'Thomas Chittenden as president, Jonas Fay as vice-president and Ira Allen as secretary. Elections were held on March 3, 1778, and the new state government came into existence on March 12, with Chittenden as governor.

Despite external opposition. Vermont continued to function as an independent republic for 14 years. In 1790 New York conceded the independence of Vermont conditional upon the payment of $30.000; New Hampshire and Massachusetts abandoned claims which they had developed. In Jan. 1791 Vermont adopted the U.S. constitution, and on March 4 became the 14th state to enter the union.

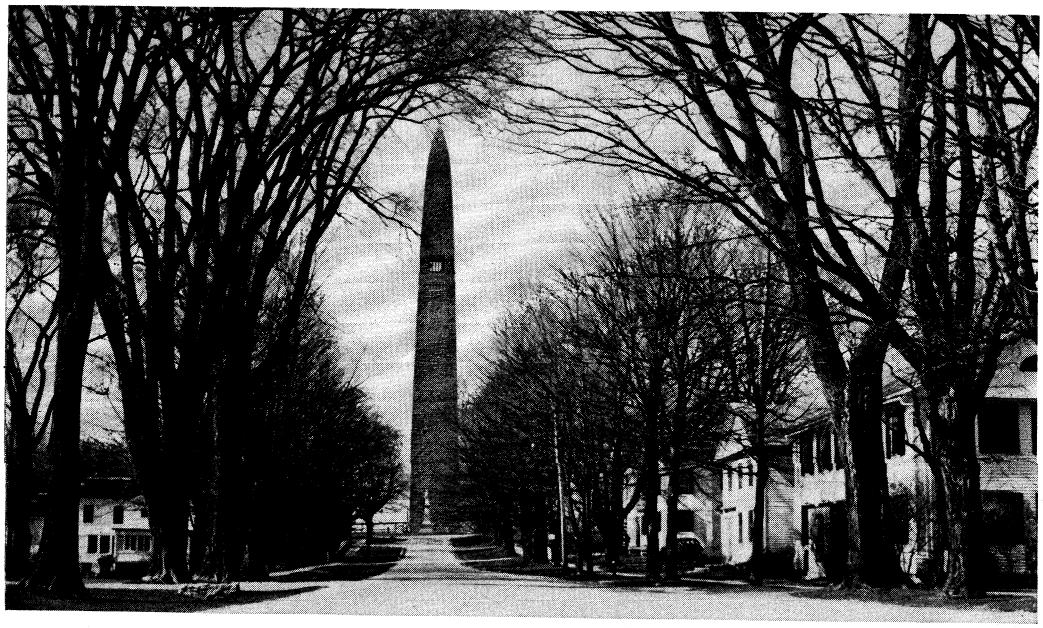
After its declaration of independence, Vermont issued its own land grants and chartered towns. Early historians estimated that about 7,000 people had settled there by 1771. In 1779 the legislature planned that lands were to be in towns six miles square, each including 70 rights or divisions, five of which were reserved, one each for the support of a college, a county grammar school, an English school. the support of preaching and the first settled minister. Settlement was rapid during the latter years of the Revolutionary War, and in 1781 the population was estimated at 30,000.

During the first 30 years the legislature convened successively in the larger towns. Montpelier was chosen as the capital in 1805, and on completion of the first statehouse the legislature met there in 1808. A second statehouse was completed in 1838. The present (third) statehouse was built after the second was nearly destroyed by fire in 1857.

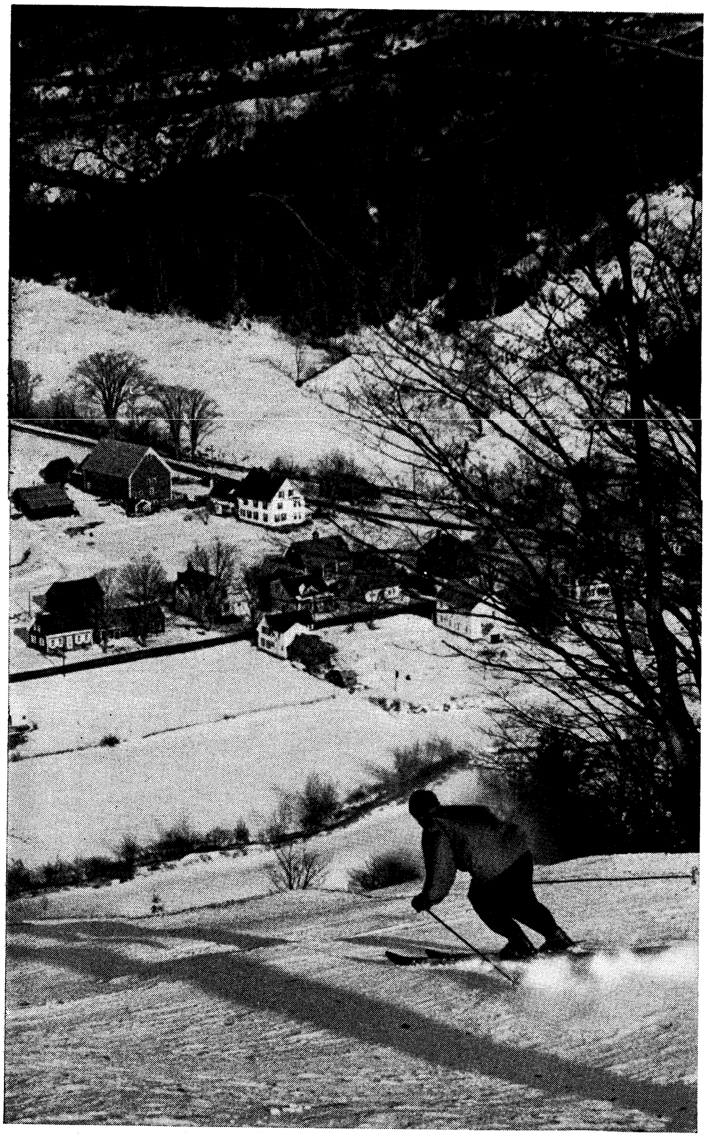
Business activity was stimulated by population growth and by the War of 1812. In that war Vermont troops took part in the battles of Chippewa, Lundy's Lane, Lake Erie and Plattsburg, but the only engagement in the state itself was that in defense of Ft. Cassin at the mouth of Otter creek in 1813. Steady expansion followed the war. Farm produce and cattle were sold south to older markets. The breed of Morgan horses was developed; ultimately these horses became a leading export to all parts of the country. Lumber business expanded along the shores of the Connecticut and Lake Champlain where water transportation mas available. During the winter, sledges took Champlain valley produce to Montreal. Produce from the southwest went to Albany, that from the Connecticut valley to Portsmouth or Boston.

After 1830 many Vermonters joined the westward movement, helping to build many of the northern states of the Mississippi valley. Others went south to the growing industrial centres of Massachusetts and Connecticut. Despite these losses, however, the population increased. Vermont sent to the American Civil War 34.328 men. of whom 5,128 died. On Oct. 19, 1864, a small band of Confederates crossed the frontier from Canada and raided the town of St. Albans, robbing the banks and then escaping back into Canada. In 1870 St. Albans was the headquarters of an attempted Fenian (*q.v.*) invasion of Canada.

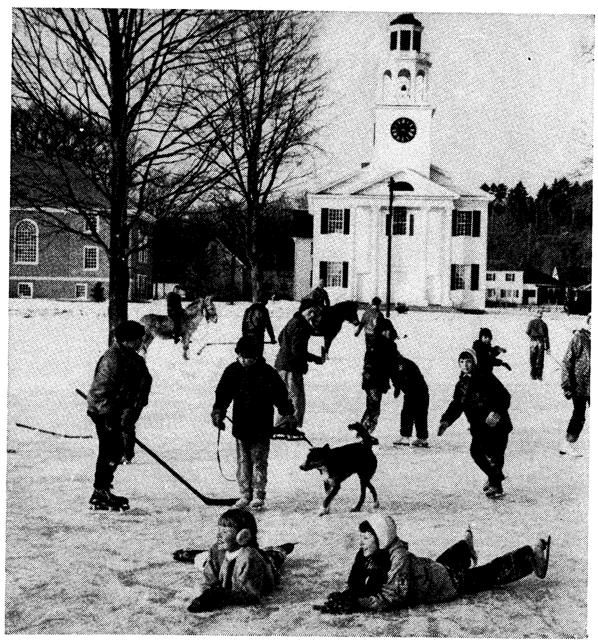
Post-Civil War Period. — After the Civil War, the attention of Vermonters returned to domestic affairs. In 1870 the governor's term was increased from one to two years and legislative sessions became biennial, Kinety years later the legislature held an unprecedented adjourned session. A state court reorganization in 1906 relieved the supreme court justices from riding circuit to preside over the 14 county courts, by providing for six superior judges to perform this service. During the late 1800s the expansion in activities of state government increased. The state board of health was organized in 1886, and the office of state highway commissioner was created in 1897. State administration was centralized in Montpelier in 1917, a departmental organization was created in 1923, numerous separate agencies were added during the following three and one-half decades, and in 1960 a general reorganization was ordered by the legislature; this last was highlighted by creation of a department of administration. Central purchasing dates from 1912, a budget system was developed



Battle monument at Old Bennington commemorating Revolutionary War victory of Gen. John Stark's New England troops over detachments of Gen. John Burgoyne's army in 1777



Vermont state house at Montpelier. Constructed of native granite, the capitol was first built in 1836, renovated in 1859. The portico is designed after the Greek temple of Theseus, Athens



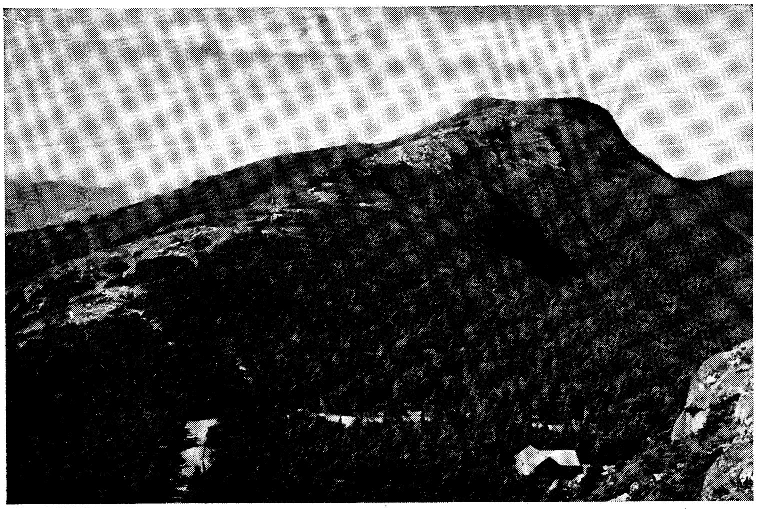
Skiing on one of the slopes overiooking the village of Woodstock, a Popular winter and summer resort

Children skating on the ice-covered village green of Norwich, a small town in the Connecticut river valley near White River Junction

SCENES IN VERMONT

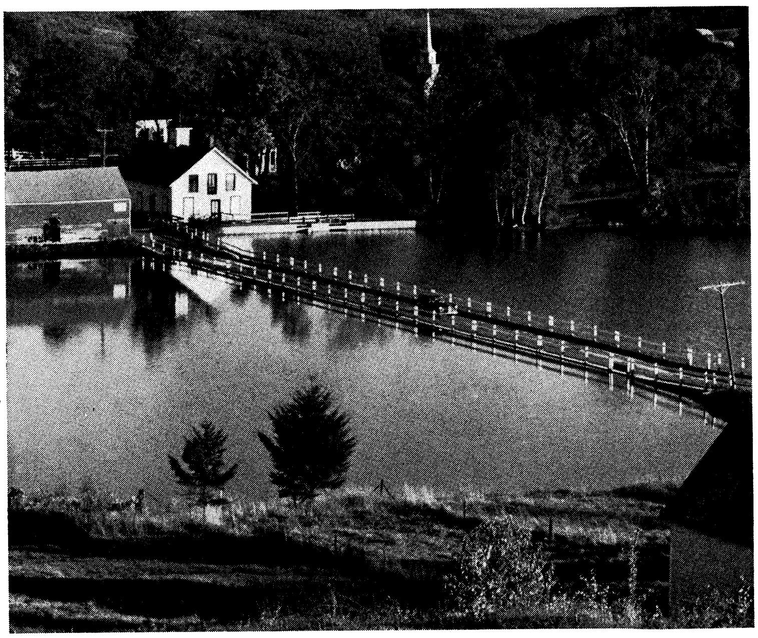
BY COURTESY OF (CENTRE RIGHT) VERMONT DEVELOPMENT COMMISSION; PHOTOGRAPHS, (TOP) AUTHENTICATED NEWS. (BOTTOM LEFT, BOTTOM RIGHT) HANSON CARROLL, NORWICH

VERMONT

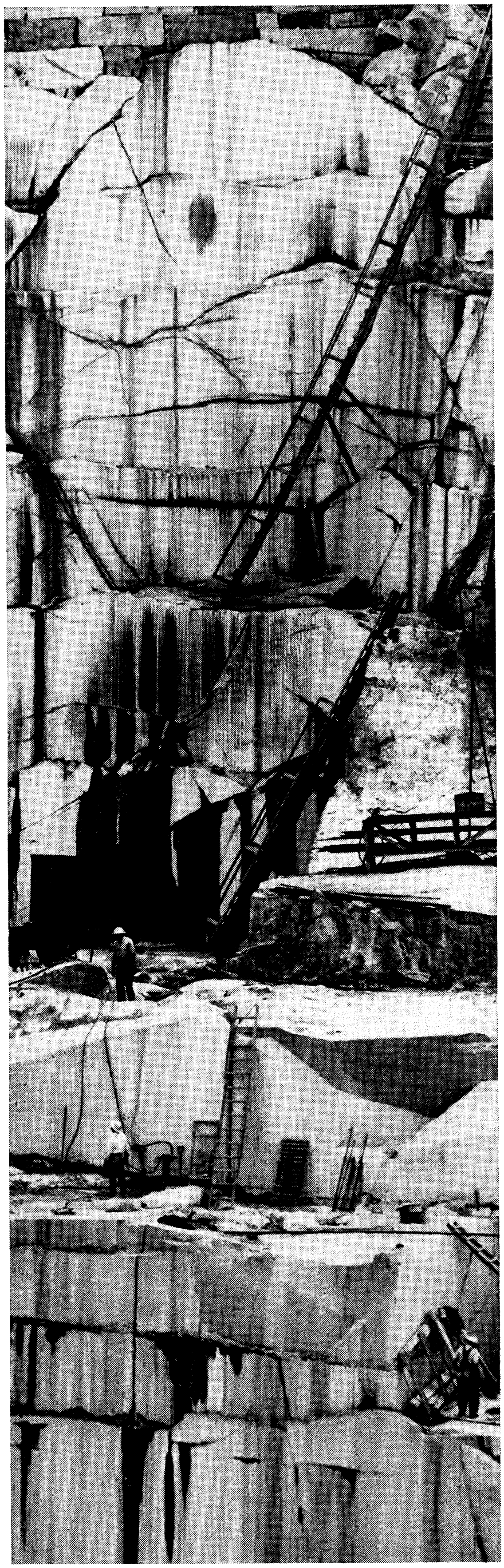


Mt. Mansfield, highest peak of the Green mountains, at 4,393 ft. It is located in the northwest section of the state, east of the city of Burlington

Farmer bringing in a load of maple sap to sugar house where it will be boiled down to make maple sirup, one of the state's most famous products



Floating bridge at Brookfieid, a 320-it. span for which tarred wooden barrels serve as pontoons. The bridge crosses Sunset iake



Working in one of the granite quarries at Barre. Granite and marble are two of the state's largest industries

VIEWS OF VERMONT

BY COURTESY OF (TOP, CENTRE LEFT. RIGHT) VERMONT DEVELOPMENT COMMISSION: PHOTOGRAPH, (BOTTOM LEFT) JACK J. ZEHRT FROM F.P G during the period 1917 to 1923, and a personnel system following World War II. In 1953 the house of representatives elected its first woman speaker, and in 1954 the people elected the first woman lieutenant governor.

Large numbers of Vermonters served in the armed forces during the 20th century; 642 lost their lives in World War I and 1,233 in World War II. A flood in 1927 was devastating, and a tropical storm that struck the state in 1938 also caused enormous damage. After World War II, the state carried out a comprehensive program of road construction and park development.

In presidential campaigns the state has been Federalist, 1792–1800; Democratic-Republican, 1804–20; Adams-Republican, 1824–28; Anti-Masonic, 1832; Whig, 1836–1852; and Republican since 1856.

GOVERNMENT

Units of government in Vermont include the state, the 14 counties into which the state is divided, the 238 towns and the 8 cities that also occupy most of the area, and certain other districts and areas. Five unorganized towns, five areas called gores, and one called a grant are administered by the state. Within the towns. there are 65 incorporated villages, 54 fire districts, 2 lighting districts and 13 soil conservation districts. Each town also constitutes a school district, and there are 20 specially incorporated school districts, as well.

The people are governed under a constitution first adopted in 1777, which includes a "Declaration of Rights" and a "Plan or Frame of Government." The preamble adopted in 1777 was omitted in 1793. As amended, the "Plan or Frame" provides for the delegation and distribution of powers; legislative, executive and judiciary departments; qualifications of freemen; elections and terms of office; and other basic features of government. The Vermont constitution is the shortest of U.S. state constitutions.

For nearly a hundred years, amendments were effected by constitutional conventions called by successive Csuncils of Censors elected every seven years to perform several specified duties "in order that the freedom of this Commonwealth may be preserved inviolate, forever." The use of councils of censors and conventions mas eliminated in 1870, and under the amending process which dates from that year the senate (established in 1836) may propose amendments, by a two-thirds vote, in every tenth year. If the house concurs in the proposal by majority vote, the proposal is published in the principal newspapers; if both houses approve it by majority votes in the next regular session, the proposal is submitted to the people, and a majority of the popular votes cast is decisive.

Suffrage is possessed by all citizens 21 or more years old who have lived in the state for one year, are "of a quiet and peaceable behavior" and will take the freeman's oath, as follows:

> You solemnly swear (or affirm) that whenever you give your vote or suffrage, touching any matter that concerns the State of Vermont, you will do it as in your conscience you shall judge will most conduce to the best good of the same, as established by the Constitution, without fear or favor of any person.

This practice, through which one becomes a freeman, or full-fledged member of the political community, was used in several of the New England colonies! having been inherited from post-feudal England. The freeman's oath now exists only in Vermont.

Executive. — The executive officers of the state are the governor, lieutenant governor, treasurer, secretary of state and auditor of accounts: as provided in the constitution; and the attorney general, whose office was created by statute. The officers are elected by the freemen for terms of two years. The adjutant general, the sergeant-at-arms and 9 of the 23 trustees of the University of Vermont and State Agricultural college are elected by the joint assembly composed of members of the senate and house. The administrative organization consists of nearly 60 separate agencies. During a two-year term, a governor appoints nearly 100 state officers with senate approval, and more than 200 others. About 40 agencies have regular staffs. Most state positions are covered by a merit system for personnel management.

Legislature. — The Vermont constitution provides for a legislative department consisting of a senate of 30 members (to be apportioned among the counties according to population, with a proviso that each county is to have at least one) and a house of representatives with one member from each town and city (246). Members of both houses are elected biennially. The regular biennial session begins on the first Wednesday after the first Monday of January in odd-numbered years. The governor may call special sessions.

Judiciary. — The supreme court, consisting of one chief justice and four associates, holds five general terms annually at Montpelier and special sessions elsewhere. The justices are elected biennially by the joint assembly, along with six superior judges who preside over the county courts to which they are assigned by the chief superior judge, in rotation. Two assistant judges, elected by the freemen in each county, sit with the assigned superior judge to compose the county court, nhich holds two sessions annually in each county. The superior judge sits alone, as chancellor, to hold chancery court in each county. The governor appoints judges to fill supreme and superior bench vacancies occurring in the interim between legislative sessions. It is the practice of the joint assembly to elect the interim appointees, to re-elect justices and judges and to promote from within the bench.

The general assembly created 20 probate courts in the state, with at least one in each county. Probate judges are elected by the freemen in districts; their salaries differ from district to district and are supplemented by fees. The general assembly also created 17 municipal courts. with at least one in each county. Municipal judges are appointed by the governor, with consent of the senate, and they also are paid varying salaries. supplemented by fees. The jurisdiction of municipal courts is limited. Justices of the peace also may exercise limited jurisdiction.

Local Government. — The organization of county government is relatively spare, consisting of two assistant judges of the county court, who commonly are called side judges and constitute a county board, a state's attorney, a sheriff, a high bailiff, a treasurer and a clerk. Each of the eight cities operates under a special charter enacted as a "municipal act" by the legislature. All towns but one have the traditional town meeting form of local government. A moderator presides over annual and special town meetings in each town, and business is conducted between meetings by selectmen, a clerk and other officers, elected annually. Under legislation adopted in 1959, the town of Brattleboro in 1960 became the first in Vermont to establish the representative, or limited, town meeting form of government.

Finance. — The increase in responsibilities and activities which the state government experienced in the first quarter of the 20th century accelerated during the second quarter and continued into the third. Local governments continued to perform the traditionally local services, although some transfer to the state occurred. A relatively steady increase in state expenditures was a consequence of these developments. The largest shares of expenditures have been for education, highways, social welfare and institutional care.

Traditionally, Vermont borrows only for emergencies; *e.g.,* for support of the Civil War and for flood reconstruction in 1927. This tradition has been modified because of the need of funds for construction of state buildings, highway development and aid to local communities in improving school plants. For several decades major sources of state revenue have been gasoline. liquor, cigarette. income and franchise taxes and sale of nonbusiness licences. Financial grants from the U.S government ha e become an increasingly large source of income, representing 14.5% for the years 1939–42 and about 20% at the end of the 1950s.

POPULATION

The population in Vermont in 1790 was 85.425. In 1830 it was 280.652; in 1870, 330,551: in 1910, 355.956; in 1940, 359.231; in 1950, 377,747; and in 1960, 389,881. The last figure represents an increase of 12.134 or 3.2% over 1950 The population per square mile in 1960 nas 42.0%, compared with 40.7 in 1950 and with 49.6 for the U.S. in 1960.

The urban population in 1960 was 149,921, or 38.5% of the state

*Vermont: Places of 5.000 or More Population (1960 Census)**

Place	Population 1960	1950	1940	1920	1900
Total state	389,881	377,747	359,231	352,428	343,641
Barre	10,387	10,922	10,909	10,008	8,448
Bennington†	13,002	12,411	11,257	9,982	8,033
Brattleboro	9,315	9,606	9,622	7,324	5,297
Burlington	35,531	33,155	27,686	22,779	18,640
Essex Junction	5,340	2,741	1,901	1,410	1,141
Montpelier	8,782	8,599	8,006	7,125	6,266
Newport	5,019	5,217	4,902	4,976	1,874
Rutland	18,325	17,659	17,082	14,954	11,499
St. Albans	8,806	8,552	8,037	7,588	6,239
St. Johnsbury	6,809	7,370	7,437	7,164	5,666
Springfield	6,600	4,940	5,182	5,283	2,040
Winooski	7,420	6,734	6,036	4,932	3,783

*Populations are reported as constituted at date of each census. †Township.

total, compared with 36.4% in 1950 and 34.3% in 1940. The state has no standard metropolitan statistical areas. Rural population in 1960 was 239.960, a decrease of 0.1% from 1950. Of the total rural population, 10.2% was rural nonfarm and 51.4% was rural farm.

The number of occupied dwelling units: or households, in 1960 was approximately 110.732, as compared with 101.000 in 1950. The average per household declined from 3.9 persons in 1940 to 3.5 in 1950 and to 3.4 in 1960. Population distribution by colour and nativity in 1950 was: 92.2% native white; 7.6% foreign-born white; and 0.1% nonwhite, practically all Negro. There were 99.2 males per 100 females in the native white population; 10.5% of the people were 65 years old or over: 52.4% who were 14 years old and over were in the labour force. Of all employed males, 23.8% were in agriculture. 7.0% in construction. 25.5% in manufacturing and 20.4% in transportation and trade.

EDUCATION

Vermont's system of public education extends from the primary grades through several branches of higher education. Numerous private academies, colleges and other institutions increase substantially the educational opportunities. Attendance is compulsory for all children between 7 and 16 years of age.

Public interest in education dates from the earliest years. Vermont was the first state to make constitutional provision for a complete state system (1777), to include town common (primary) schools. a grammar school in each county and a state university. Girls as well as boys have attended the common schools from the beginning. The town of Middlebury established an academy for girls in 1800, and a few years later, Emma Hart (Willard) there opened one of the first private schools for girls in America. The first normal school in America was established in Concord in 1823. The state library dates from 1825. The legislature first created a state board of commissioners of common schools in 1827.

Public Schools.—In the towns and cities, locally elected boards maintain public schools under the provisions of state law. A superintendent serves each of the larger communities; smaller communities are grouped into superintendency unions. The state department of education, headed by a board appointed by the governor and a board-appointed commissioner. provides services in teacher training and certification, curriculum development and planning of school buildings. as well as programs in vocational education, vocational rehabilitation. health education, preservation of skills in arts and crafts and education of the mentally retarded and physically handicapped.

The state apportions large sums annually among the local school districts for current expenses and grants small special-purpose sums for standardization, special education of handicapped children, tuition of war orphans, vocational education and visual education equipment. During the mid 20th-century it distributed several million dollars for aid in school construction.

Every town and city (except nine local units that have contracts with their neighbours) maintains at least one elementary school. The secondary level includes more than 80 public high schools and 25 academies. Business schools are located in Rutland, Montpelier and Bennington. Commerce is a principal subject in Champlain college, a junior college in Burlington, and is among the offerings of other colleges. Vermont college in Montpelier and Green Mountain college in Poultney are junior colleges. The state maintains an agricultural and technical institute at Randolph. Nursing education is offered in several hospitals not connected with the universities and colleges.

Higher Education.—The University of Vermont and State Agricultural college, in Burlington, is the first U.S. institution founded by state legislative action to offer instruction at the university level. The university mas chartered in 1791; Vermont Agricultural college was chartered under the Morrill act in 1864. and the two were combined in 1865. The university is governed by a board of trustees of 23 members. It includes colleges of arts and sciences, agriculture, medicine, technology, and education and nursing, a graduate college, a school of dental hygiene and a summer session and adult education division. The university libraries comprise a collection of more than 200.000 volumes, including a collection of Vermontiana and supplemented by U.S. government depository documents.

Teacher training courses are offered in the state teachers' colleges in Castleton, Johnson and Lyndon Center, for elementary and junior high school teaching. Some secondary teacher training is available in private colleges.

Several private institutions also have excellent standing. Middlebury college in Middlebury, chartered in 1800, is a liberal arts college; its world-famous English and foreign language schools provide graduate instruction on the Middlebury campus, at its Bread Loaf Mountain campus and abroad. Norwich university, founded in 1819 and located in Northfield, is the nation's oldest private military college, emphasizing several branches of engineering. Bennington college for women (founded 1932) is located in Bennington (*q.v.*). Trinity college for women (Roman Catholic; 1925) is in Burlington, and St. Michael's college for men (Roman Catholic; 1904) in Winooski Park. Three other four-year colleges are Goddard (1863), in Plainfield; Marlboro (1947), in Marlboro; and Windham (1951), in Putney.

HEALTH, WELFARE AND CORRECTIONS

State institutions include the State Prison and House of Correction for men at Windsor; the Women's Reformatory at Rutland, which operates under an interstate agreement: the Weeks school for training and rehabilitation of boys and girls, at Vergennes; a sanatorium for tuberculosis patients at Pittsford; a training school for mentally deficient persons at Brandon; the Kinstead home for children in Montpelier; and several "half-way houses" for mental rehabilitation. The state also assigns patients to the Brattleboro Retreat, well known for care and rehabilitation of the mentally ill.

Providing public health services is largely a state function in Vermont. The state health department carries out preventive programs in cancer and chronic disease control; communicable disease control; child health services, for crippled children. maternal and child health. and guidance; environmental sanitation programs including inspection and licensing and regulation for proper sanitation of schoolhouses and public buildings generally and of public water supply; hospital services, including hospital survey and construction, and inspection and licensing of hospitals, nursing homes and homes for the aged; laboratory services, including chemical and bacteriological examinations of water. milk. foods. drugs, materials and substances helpful in the diagnosis of disease; free distribution of certain vaccines; public health education; keeping and publishing certain statistics; public health nursing, industrial hygiene and public dental health programs.

More than two dozen licensed hospitals and more than 150 nursing homes are located throughout the state. The third quarter of the 20th century witnessed considerable improvement in hospital standards and facilities. The hospitals in the Burlington area are associated with the University of Vermont medical college and form with it a major medical centre for the area.

THE ECONOMY

Agriculture.—Approximately one-half the land area of Vermont is in farm land. The number of farms (about 16.000) is decreasing. but individual units are growing in size (average about

200 ac.) and the output per worker is increasing. Both before and after the American Civil War, sheep raising was a dominant pursuit. but after 1880 it declined rapidly because of competition from the western states and Australia.

A cool climate, irregular topography and inherently fertile soils enable Vermont to produce hay and pasture better than other farm crops. Dairying thus has become the most important agricultural industry. Vermont has a bonding law to protect dairy farmers. Farms producing milk for local consumption are subject to state regulation and inspection. In 1936 the state became a bovine tuberculosis-free area. In 1957 it was the ninth state declared a modified certified brucellosis-free area. Approximately 100 creamery companies operate about 135 dairy plants. The total fluid milk distribution exceeds 1,600,000,000 lb. annually, of which 400,000,000 lb. is converted into other milk products.

A large percentage of farm land is used to produce hay. Other crops include potatoes, corn and northern grains. Poultry raising. beekeeping, apple growing and maple sugaring are important. A new farm crop, birds-foot trefoil, was developed in Vermont.

Mining. — Virtually every section of the state contains mineral deposits: the chief slate deposits are in the Taconic mountains; the Vermont valley between the Taconic and Green mountains contains the world-famous marble deposits; the Green mountains contain talc, marble and other deposits; great granite deposits and the copper mines lie in the Vermont piedmont between the Green mountains and the Connecticut river; asbestos deposits are located in the north.

The first granite quarry was opened in Barre in 1815, and more than 36,000,000 cu ft. have been quarried there since that time. Vermont marble, distinguished for its quality and constituting more than half the fine marble used for monuments in the U.S., is quarried principally at Proctor. Commercial quarrying dates from 1785. Vermont produces 96% of the domestic asbestos supply, serving about 5% of national requirements. Other mineral industries are slate, copper, silver, gold, limestone, talc and China clay.

Manufacturing — While most Vermont manufacturing plants are small, they are noted for quality production and are distributed among more than half of the state's cities and towns. Industries multiplied rapidly in the early 1800s. In St. Johnsbury, the manufacture of knife-edged scales dates from 1830. In Rutland, the making of ball-bearing scales dates from 1856. Inventive men of those and subsequent years laid foundations for the high-grade machine-tool industry that is centred in Windsor and Springfield. Burlington is noted for quality printing and Brattleboro for organs. Other industrial centres include Barre, Bellows Falls, Bennington, Montpelier and St. Albans.

The state's major manufacturing industries include food and kindred products; metalworking; paper and allied products; and mining, quarrying and manufacturing stone and mineral products. Other Vermont products include furniture, textiles, slate, rubber goods, garden tools, paints, hosiery, cereals, dyes, clothespins, roofing, electric equipment and ceramics.

Electrical energy is supplied by private and municipal electric utilities and by electric co-operatives. Much power is generated in plants on the Connecticut, Deerfield and other rivers, and the state's 30-year contract for St. Lawrence power adds 100,000 kw. of power annually.

Transportation and Communication. — Water, rail, motorbus and air services are available for transportation. Opening of the Champlain canal in 1823, connecting the lake with the Hudson river, increased commerce with New York. This waterway extends also through the Richelieu river to the St. Lawrence. Vermont had a period of energetic construction of canals and waterways and also roads and turnpikes; stagecoach lines carried mail and passengers throughout the state. By 1849 the Vermont Central railroad reached Burlington from Windsor and the Rutland reached there from Bellows Falls. Railroad building ceased after 1910, when the mileage was 1,100; by 1950 it had been reduced to 889 and by 1956 to 846. Two lines run north and south along the western and eastern borders, and four cross in a general east and west direction.

After World War I motorbus lines became a principal means of transportation, covering more than 1,000 route miles and reaching many places not served by rail. The trucking business also became extensive. By the late 1950s nearly 4,000 of the 13,800 mi. of road were hard surfaced. Bridges cross the Connecticut river at several points. Bridges cross Lake Champlain at Chimney Point and at East Alburg, under an interstate compact. Five ferry routes also provide lake crossings; those from Charlotte, Burlington and Grand Isle are operated by the oldest steamship company in the U.S. By the late 1950s, the state had 23 airports and airfields, of which 13 were public and 10 limited.

Telephone service is provided through about 90 central offices. Of 15 broadcasting stations, 14 are AM radio and one is television. There are ten daily newspapers.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (R. N. B. H.)

VERNE, JULES (1828–1905), French author, was born at Nantes on Feb. 8, 1828. After completing his studies at the Nantes lycée, he went to Paris to study law. About 1848, in conjunction with Michel Carré, he wrote librettos for two operettas, and in 1850 his verse comedy, *Les Pailles rompues*, in which Alexandre Dumas fils had some share, was produced at the Gymnase. For some years his interests alternated between the theatre and the bourse, but some travelers' stories which he wrote for the *Musée des Familles* revealed to him the true direction of his talent — the delineation, viz., of delightfully extravagant voyages and adventures, in which he foresaw, with marvelous vision, the achievements of scientific and mechanical invention of the generation of 1900. Verne was a real pioneer in the wide literary genre of *voyages imaginaires*. His first success was obtained with *Cinq semaines en ballon*, which he wrote for Hetzel's *Magazin d'Éducation* in 1862, and thenceforward, for a quarter of a century, scarcely a year passed in which Hetzel did not publish one or more of his amazing stories. The most successful include: *Voyage au centre de la terre* (1864) ; *De la terre à la lune* (1865) ; *Vingt mille lieues sous les mers* (1869); *Les Anglais au pôle nord* (1870) ; and *Voyage autour du monde en quatre-vingts jours*, which first appeared in *Le Temps* in 1872. The adaptation of this last (produced at the Porte St. Martin theatre on Nov. 8, 1874) and of another excellent tale, *Michael Strogoff* (at the Chbtelet, 1880), both written in conjunction with Adolphe d'Ennery, proved the most acceptable of Verne's dramas.

He died at Amiens on March 24, 1905. The novels of Jules Verne are dreams come true, dreams of submarines, aircraft, television; they look forward, not backward. Therefore they are still the books of youth.

VERNET, the name of a family of eminent French painters.

CLAUDE JOSEPH VERNET (1714–1789), born at Avignon, Aug. 14, 1714, began as painter of decorations at Avignon and Aix. In Rome during 1734–53, he studied landscape, being particularly influenced by Claude Lorrain and Salvator Rosa. The stormy sea and picturesque shores became his own specialty.

His shipwrecks, sunsets and conflagrations reveal an unusually subtle observation of light and atmosphere and won the highest praise of contemporary critics (*e.g.,* Diderot). Back in France, he painted a series of the "Harbours of France" (1753–63, Louvre) at royal command. They are not only among his best works but constitute a remarkable record of 18th-century life. His later work shows a marked decline, the consequence of overproduction. In his Livres de raison he recorded his transactions. He died in Paris on Dec. 3, 1789.

CARLE (ANTOINE CHARLES HORACE) VERNET (1758–1836), the son of Claude, was born on Aug. 14, 1758, at Bordeaux. After insignificant beginnings as a neoclassical history painter ("Triumph of Paulus Aemilius," 1789; New York), and an unhappy stay at Rome (1782–83), he found his true avocation in the field of sporting art, his chief patron being the anglophile duke of Orléans. In temporary eclipse during the Revolution, he became productive again with the revival of luxury during the Directory. His long series of fashionable and often satirical commentaries on contemporary manners and costume were reproduced by the best engravers of the time. Kapoleon made him paint vast battles ("Marengo," 1804; "Morning of Austerlitz"), but Carle's real talent was for intimate genre, and for drawing rather than painting. Under the Restoration he produced innumerable sporting subjects and pioneered in lithography. He died in Paris on Nov. 27, 1836.

HORACE VERNET (1789–1863), the son of Carle, was born in Paris, June 30, 1789. Extremely precocious and facile, he began at an early age a copious production of sentimental and patriotic pictures, eventually becoming one of the most famous and richest artists of the century. His earliest works include fashion engravings which are still esteemed, as are some early portraits and caricatures. Having fought in the last battles of the empire, he made the glorification of the Kapoleonic era his particular specialty as painter and lithographer ("Defense of the Barrière de Clichy," 1820; Louvre).

During the Restoration, his studio was a centre of Bonapartist and Orléanist intrigue, as well as a fashionable meeting place of sportsmen, artists and writers (cf. "My Studio," Louvre). After serving 1829–35 as director of the French Academy in Rome, he was commissioned by Louis Philippe and, later, by Napoleon III to execute vast battle panoramas. particularly in the historical galleries of Versailles. He improvised these with reckless speed, but, for all their verve, they appear to modern eyes dismally trivial. Horace died on Jan. 17, 1863.

ÉMILE CHARLES HIPPOLYTE VERNET-LECOMTE (1821–1900), a grandson of Carle, was a painter of genre and landscape.

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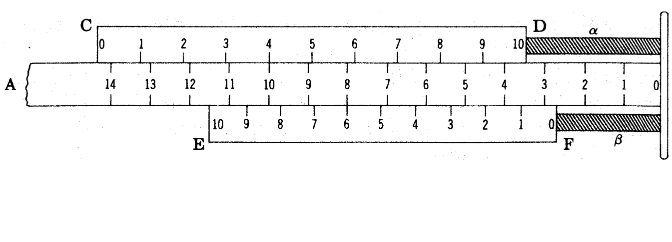
(L. E. A. E.)

VERNIER INSTRUMENT, a measuring device invented by a Frenchman, Pierre Vernier (c. 1580–1637), which enables either linear or angular magnitudes to be read with a degree of accuracy many times greater than is possible with a scale as ordinarily divided and subdivided.

The principle of the vernier is readily understood from the following figure and illustration.

Let AB (see fig.) be the normal scale, *i.e.* a scale graduated according to a standard of length, CD, a scale (placed in contact with AB for convenience) graduated so that 10 divisions equal 11



divisions of the scale AB, and EF a scale placed similarly and graduated so that 10 divisions equal 9 divisions of the scale AB. Consider the combination AB and CD. Obviously each division of CD is $\frac{1}{10}$th greater than the normal scale division. Let a represent a length to be measured, placed so that one end is at the zero of the normal scale and the other end in contact with the end of the vernier CD marked 10. It is noted that graduation 4 of the vernier coincides with a division of the standard, and the determination of the excess of a over 3 scale divisions reduces to the difference of 7 divisions of the normal scale and 6 divisions of the vernier. This is 0·4, since each vernier division equals 1·1 scale divisions. Hence the scale reading of the vernier which coincides with a graduation of the normal scale gives the decimal to be added to the normal scale reading. Now consider the scales AB and EF, and let β be the length to be measured, the scale EF being placed so that the zero end is in contact with an end of β. Obviously each division of EF is $\frac{1}{10}$th less than that of the normal scale.

It is seen that division 6 of the vernier coincides with a normal scale division, and obviously the excess of β over two normal scale divisions equals the difference between 6 normal scale divisions and 6 vernier divisions, *i.e.,* 0·6. Thus again in this case the vernier reading which coincides with a scale reading gives the decimal to be added to the normal scale. The second type of vernier is the one commonly used, and its application to special appliances is quite simple.

VERNIS MARTIN, a brilliant translucent lacquer used for the decoration of furniture and small articles such as snuffboxes and fans. The name derives from that of a family of 18th-century artist-artificers which included four brothers: Guillaume (d. 1749), Simon Étienne (d. 1770), Julien (d. 1782) and Robert (1706–65).

The Martins did not invent the lacquer but perfected its composition and application in their attempts to imitate the far eastern lacquers then-winning great favour in France.

Vernis *Martin* was made in several colours, of which green was perhaps the most characteristic.

See LACQUER.

VERNON, EDWARD (1684–1757), English admiral, was born in Westminster on Nov. 12, 1684, the second son of James Vernon, secretary of state in 1697–1700. Edward Vernon entered the navy in 1707, and saw much active service in various seas. During the long peace under Walpole he sat in the house of commons (1722–34); he clamoured for war with Spain and in 1739 declared he would capture Portobello with a squadron of six ships.

He got the command and the ships and captured Portobello on Nov. 22, with a loss of only seven men. In 1740, with a large squadron. he attacked Cartagena without success and had to retire to Jamaica (this episode is described in Roderick Random, chap. xiii, etc.).

Vernon suffered another reverse at Santiago de Cuba in 1741 and returned home in 1743. He had been elected M.P. for Ipswich in 1741 and continued to sit for that borough. He was in command in the Downs in 1745, but in annoyance at intervention from Whitehall, he published some of his instructions and was struck off the flag list. He died on Oct. 30, 1757, at Nacton, Suffolk.

VERONA, a city and episcopal see of Veneto, Italy, the capital of the province of Verona, situated 194 ft. above sea level in a loop of the Adige (anc. Athesis). Pop. (1957 est.) 198,337 (commune).

Churches.—The Romanesque basilica of S. Zeno (the first bishop of Verona and its patron saint) was remodelled in 1117–38, including the richly sculptured west front and the open *confessio* or crypt, raising the choir high above the nave.

The cathedral, consecrated in 1187. is smaller than S. Zeno, but has a fine west front, rich with Romanesque sculpture (1135); the upper part was added during 1565–1606 It has a noble Romanesque cloister, with two stories of arcading. The campanile by Sammicheli is unfinished. Its baptistery, rebuilt early in the 12th century, is a quite separate building, with nave and apse, forming a church dedicated to S. Giovanni in Fonte. Pope

Lucius III (d. 1185) is buried in the cathedral. The very fine Gothic Dominican church of S. Anastasia (1290–1481) consists of a nave in six bays, aisles, transepts, each with two eastern chapels, and an apse, all vaulted with simple quadripartite brick groining. The vaults are gracefully painted with floreated bands along the ribs and central patterns in each "cell," in rich soft colours on a white plastered ground. There are many fine frescoes in the interior including Pisanello's beautiful painting of St. George. This church also contains fine sculptured tombs of the 14th and 15th centuries. S. Fermo Maggiore was rebuilt in 1313 at a higher level than the earlier church (1065–1138). The roof is magnificent. Delicate patterns cover all the framework of the panelling and fill the panels themselves. Rows of half-figures of saints are painted on blue or gold grounds, forming a scheme of indescribably splendid decoration. The church of Sta. Maria in Organo (1481), with a façade of 1592 from Sammicheli's designs, contains paintings by various Veronese masters, and some fine choir-stalls of 1499 by Fra Giocondo. The church of S. Giorgio di Braida was also designed by Sammicheli.

The strongly fortified castle (Castel Vecchio) built by Cangrande II della Scala (1354) stands on the line of the wall of Theodoric, close by the river. It contains the municipal museum and picture gallery. There are five bridges across the Adige: one, the graceful Ponte di Pietra. rests upon ancient foundations, while the two arches nearest to the left bank are Roman; but it has been frequently restored. Remains of another ancient bridge were found in the river itself behind S. Anastasia. On a steep elevation stands the castle of St. Peter, founded by Theodoric, on the site, perhaps, of the earliest citadel, mostly rebuilt by Gian Galeazzo Visconti in 1393 and dismantled by the French in 1801. The episcopal palace contains the ancient and valuable chapter library. (See GAIUS.) The Piazza delle Erbe (fruit and vegetable market) on the site of the ancient Forum and the Piazza dei Signori, adjoining one another, are surrounded by many fine mediaeval buildings, notably the Palazzo del Comune, with a tower 273 ft. high, while in the northeast corner of the latter piazza is the fine early Renaissance Loggia del Consiglio (1476–93).

Roman Remains. — The Roman remains of Verona surpass those of any other city of northern Italy The most conspicuous of them is the great amphitheatre, a building of the end of the 1st century A.D., which closely resembled the Flavian amphitheatre (Colosseum) in Rome. Its axes measured 505 and 404 ft. Almost the whole of its external arcades, with three tiers of arches, have now disappeared; it was partly thrown down by an earthquake in 1183, and subsequently used to supply building materials. The interior, with seats for about 25,000 people, has been restored. There are also remains of a well-preserved Roman theatre, close to the left bank of the river adjacent to which is the archaeological museum. The Museo Lapidario contains a fine collection of Roman and Etruscan inscriptions and sculpture, begun by Scipione Maffei in 1714.

Veronese Art, Painting and Sculpture. — Painting in Verona may be divided into four periods. (i.) The first is characterized by wall paintings of purely native style, *e.g.*, in SS. Nazaro e Celso (996). (ii.) The Byzantine period lasted during the 12th and 13th centuries. (See S. Zeno for examples.) (iii.) The Giottesque period begins contemporaneously with Altichieri and Giacomo d'Avanzo (second half of the 14th century). These two painters, among the ablest of Giotto's followers, adorned Verona and Padua with very beautiful frescoes, rich in composition, delicate in colour, and remarkable for their highly finished modelling and detail. (iv.) To the fourth period belong several important painters. Pisanello or Vittore Pisano, a charming painter and the greatest medallist of Italy, probably a pupil of Altichieri, has left a beautiful fresco in the church of S. Anastasia, representing St. George and the Princess after the conquest of the Dragon. His only other existing fresco is an Annunciation in S. Fermo Maggiore (See PAINTING.) His pupils include Liberale da Verona, Domenico and Francesco Morone, Girolamo dai Libri (1474–1556), etc. Domenico del Riccio, usually nicknamed Brusasorci (1494–1567), was a prolific painter whose works are very numerous in Verona. Paolo Cagliari or Paul Veronese, and Bonifacio, though natives of Verona, belong rather to the Venetian school.

Verona is specially rich in early examples of decorative sculpture. (i.) The first period is that of northern influence, exemplified in the reliefs which cover the western façades of the church of S. Zeno and the cathedral, dating from the 12th century, and representing both sacred subjects and scenes of war and hunting, mixed with grotesque monsters. Part of the western doors of S. Zeno are early examples of caste bronze reliefs. (ii.) In the 13th century the sculpture lost its vigour, without acquiring grace or refinement, *e.g.*, the font in the cathedral baptistery. (iii.) The next period is that of Florentine influence, exemplified in the magnificently sculptured tombs of the Della Scala lords, those of Cangrande I. (d. 1329), Mastino II. (d. 1351) and (the most elaborate of all) of the fratricide Can Signorio, adorned with statuettes of the virtues, executed during his lifetime (*c.* 1370), by the sculptor Bonino da Campione. (iv.) In the 15th century Florence influenced Verona by way of Venice.

Architecture. — The architecture of Verona, like its sculpture, passed through Lombard, Florentine and Venetian stages. The early Renaissance developed into very exceptional beauty, mainly through the genius of Fra Giocondo (1435–1514), a native of Verona, who was at first a friar in the monastery of S. Maria in Organo. He rose to great celebrity as an architect, and designed many graceful and richly sculptured buildings in Venice, Rome and even in France; he used classical forms with great taste and skill, and with much of the freedom of the older mediaeval architects, and was specially remarkable for his rich and delicate sculptured decorations. Another of the leading architects of the next stage of the Renaissance was the Veronese Michele Sammicheli (1484–1559), a great military engineer, and designer of an immense number of magnificent palaces in Verona, among which the most outstanding are the Bevilacqua, Canossa and Pompei palaces.

History. — The ancient Verona was a town of the Cenomani, a Gaulish tribe, whose chief town was Brixia. It became a Latin colony in 89 B.C. Inscriptions testify to its importance, indicating that it was the headquarters of the collectors of the 5% inheritance tax under the Empire in Italy beyond the Po. Its territory stretched as far as Hostilia on the Padus (Po), 30 m. to the south. It lay on the road between Mediolanum and Aquileia, while here diverged to the north the roads over the Brenner. It was the birthplace of the poet Catullus. In A.D. 69 it became the headquarters of the legions which were siding with Vespasian. It was defended by a river along two-thirds of its circumference. The existing remains of walls and gates date from the period between the 3rd of April and the 4th of December of the year 265. A very handsome triumphal arch, now called the Porta de' Borsari, was restored in this year by Gallienus and became one of the city gates. The same was the case with the Porta dei Leoni, on the east of the city, and with a third arch, the Arco dei Gavi, demolished in 1805. The emperor Constantine, while advancing towards Rome from Gaul, besieged and took Verona (312); it was here, too, that Odoacer was defeated (499) by Theodoric the Goth, Dietrich von Bern—*i.e.*, Verona—of German legends, who built a castle at Verona and frequently resided there.

In the middle ages Verona gradually grew in size and importance. Alboin, the Lombard king, captured it in 568, and it was one of the chief residences of the Lombard and later of the Frankish monarchs; and though. like other cities of northern Italy, it suffered much during the Guelph and Ghibelline struggles, it rose to a foremost position both from the political and the artistic point of view under its various rulers of the Scaliger or Della Scala family. The first prominent member of this family and founder of his dynasty was Mastino I della Scala, who ruled over the city from 1260 till his death in 1277. Verona had previously fallen under Ezzelino da Romano (1227–59). Alberto della Scala (d. 1301) was succeeded by his eldest son, Bartolomeo, who was confirmed as ruler of Verona by the popular vote, and died in 1304. It was in his time that Romeo and Juliet are said to have lived. Alboino, the second son, succeeded his brother, and died in 1311, when the youngest son of Alberto, Can Grande, who since 1308 had been joint lord of Verona with his brother, succeeded to the undivided power. Can Grande (Francesco delln Scala, d. 1329) was the best and most illustrious of his line, and is specially famous as the hospitable patron of Dante (*q.v.*). In 1387 Gian Galeazzo Visconti, duke of Milan, became by conquest lord of Verona. Soon after his death the city fell by treacherous means into the hands of Francesco II. di Carrara, lord of Padua. In 1404–05 Verona, together with Padua, was finally conquered by Venice, and remained subject to the Venetians till the overthrow of the republic in 1797 by Napoleon, who in the same year, after the treaty of Campo Formio, ceded it to the Austrians with the rest of Venetia. They fortified it strongly in 1814, and with Peschiera, Mantua and Legnago it formed part of the famous quadrilateral which until 1866 was the chief support of their rule in Italy. The town was greatly damaged by a flood in 1882. During World War II Verona suffered considerable damage from bombings; in most cases, historic landmarks were later reconstructed. (J. H. Mi.; T. A.; X.)

VERONA, CONGRESS OF, the last of the series of international conferences or congresses based on the principle enunciated in article six of the treaty of Paris of Nov. 20, 1815 (see EUROPE. History).

It met at Verona on Oct. 20, 1822. The emperor Alexander I of Russia was present in person. There were also present Count Nesselrode, the Russian minister of foreign affairs; Prince Metternich, representing Austria; Prince Hardenberg and Count Bernstorff, representing Prussia; Duc de Montmorency and Vicomte de Chateaubriand, representing France; and the duke of Wellington, representing Great Britain in place of Lord Londonderry (Castlereagh), who died on the eve of his leaving for Verona.

In the instructions drawn up by Londonderry for his own guidance, which had been handed to Wellington by Canning without alteration, was clearly defined the attitude of Great Britain toward the three questions which it was supposed would be discussed: the Turkish question (Greek insurrection); the question of intervention in favour of the royal power in Spain together with that of the revolted colonies; and the Italian question.

As regards the last, it was laid down that Great Britain could not charge itself with any superintendence of a system in which it had merely acquiesced, and the duty of the British minister would be merely to keep himself informed and to see that nothing was done "inconsistent with the European system and the treaties." To make this attitude quite clear, Wellington was not to hand in his credentials until this question had been disposed of In the Spanish question Wellington was to give voice to the opposition of Great Britain to the principle of intervention.

In the Turkish question, he was to suggest the eventual necessity for recognizing the belligerent rights of the Greeks and, in the event of concerted intervention, to be careful not to commit Great Britain beyond the limits of good offices. The immediate problems arising out of the Turkish question had been settled between the emperor Alexander and Metternich at the preliminary conferences held at Vienna in September, and at Verona the only question raised was that of the proposed French intervention in Spain.

The discussion was opened by three questions which were formally propounded by Montmorency: (1) Would the Allies withdraw their ministers from Madrid in the event of France's being compelled to do so? (2) In case of war, under what form and by what acts would the powers give France their moral support, so as to give to its action the force of the alliance and inspire a salutary fear in the revolutionaries of all countries? (3) What material aid would the powers give, if asked by France to intervene, under restrictions which it would declare and they would recognize?

The reply of Alexander, who expressed his surprise at the desire of France to keep the question "wholly French," was to offer to march 150,000 Russians through Germany to Piedmont. where they could be held ready to act against the Jacobins whether in Spain or France. This solution appealed to Metternich and Montmorency as little as to Wellington; but although they were united in opposing it, four days of "confidential communications" revealed a fundamental difference of opinion between the representative of Great Britain and those of the continental powers on the main point in issue.

Wellington, who had been instructed to express the uncompromising opposition of Great Britain to the whole principle of intervention, refused to accept Metternich's suggestion that the powers should address a common note to the Spanish government in support of the action of the government of France.

Finally, Metternich proposed that the Allies should "hold a common language, but in separate notes, though uniform in their principles, and objects." This solution was adopted by the continental powers; and Wellington, in accordance with his instructions, took no part in the conferences that followed. On Oct. 30 the powers handed in their formal replies to the French.

Russia, Austria and Prussia would act as France should in respect of their ministers in Spain and would give to France every countenance and assistance it might require, the details "being reserved to be specified in a treaty." Wellington. on the other hand, replied on behalf of Great Britain that "having no knowledge of the cause of dispute, and not being able to form a judgment upon a hypothetical case, he could give no answer to any of the questions."

Thus was proclaimed the open breach of Great Britain with the principles and policy of the Great Alliance. (W. A. P.)

VERONESE, PAOLO (PAOLO CAGLIARI or CALIARI) (1528–1588), a major painter in Venice and the Veneto after 1550, was known after his birthplace, Verona. Paolo's father had come to Verona from Lake Lugano to pursue the family trade of stonecutting, and the young Paolo was at first apprenticed in this trade. He showed so marked an interest in painting, however, that in his 14th year he was apprenticed to his uncle and future father-in-law, Antonio Badile, a minor painter. From him the young Paolo derived. in addition to a sound basic painting technique, a Veronese passion for paintings in which people and architecture were integrated, a tradition ultimately traceable to the late medieval painter Altichiero.

Paolo was influenced in Verona by two other local masters, Paolo Farinato and Brusasorci; from the latter he derived a characteristic attitude about the use of colour and application of paint. Vasari states that he was, in addition, a pupil of Giovanni Caroto, who was an architect as well as a painter, but this seems improbable, as little or no resemblance can be discovered in the styles of the two men. He was influenced by the Mannerist painters Francesco Primaticcio and Parmigianino, and by Raphael himself, whose "Sistine Madonna" was in Vicenza and "Madonna of the Pearl" (from Raphael's studio) was in Mantua. The young Paolo copied the latter work. Added to these major influences were the minor ones of Lorenzo Lotto, Girolamo Romanino, Moretto, Titian and even Diirer whose prints Paolo is said to have studied. Though

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DETAIL FROM "THE DISCIPLES AT EMMAUS" BY PAOLO VERONESE. IN THE LOUVRE, PARIS these influences may be traced by the discerning eye, Paolo arrived, early in his career, at a mature and essentially unchanging style.

The hallmarks of Paolo's style are: an amplitude of form and an academic correctness of drawing of a sort always ignored by Titian; a generally blond tonality with an emphasis upon clear and cool colours, which give the impression of lightness in spite of their real sombreness; an interest in two-dimensional patterns (both in the structure of the paintings and in the objects portrayed); a clarity of architectural rendering with a concomitant clarity of relationship between the space and the objects in the space; and a gently noble type of personage as his typical subject. These characteristics appear in such early works as the decorations for the Villa Soranzo of 1551 and the "Faith" (S. Liberale, Castelfranco). In these earliest works Paolo struck a protorococo note nhich anticipated Tiepolo by more than a century and a half. In 1553 he executed the "Temptation of St. Anthony" (Caen) for Ercole Cardinal Gonzaga for the cathedral at Mantua; this work shows an amazing accomplishment in crowding ample forms into a small area and a virtuosity which later became more subtly expressed.

By 1554 Paolo had received a commission for decorations in the hall of the council of ten for the doge's palace, Venice, and by 1555 he was permanently established in that city. The "Jupiter Striking His Thunderbolts" (Louvre) shows his development of the illusionism of Giulio Romano and Andrea Mantegna, whom he knew in Mantua, into a form which anticipates the great baroque ceiling designs of the 17th century. His principal early altarpiece, done for the Giustianini family for S. Francesco della Vigna, is a variation on the plan of Titian's Pesaro altarpiece. In slightly later works done for S. Sebastiano and SS. Giovanni e Paolo, Venice, his hesitancy disappears, and his thorough assimilation of the grand manner in composition becomes evident. The monastic establishment of S. Sebastiano in Venice was in his career what the Scuola di S. Rocco was in Tintoretto's, and by 1556 he had begun his major decorations for this establishment. of which his uncle uas prior. In 1556 he received a commission for three allegorical *tondi* for the Marcian library. Venice, and his work done in competition with others is clearly the best.

C. Ridolfi states that Paolo went to Rome in 1j60 in the company of the Venetian ambassador to the Holy See, but this has been doubted. At any rate, there is a sudden maturity and consolidation visible in his work after this date. His frescoed decorations for the Villa Barbaro at Maser, near Asolo, built by Andrea Palladio with sculptural ornament by Alessandro Vittoria. crowned that lovely villa and made it one of the supreme examples of interior decoration in the world. Not only are there ample compositions of gods at play. but there are also homely genre bits, such as the *trompe-l'oeuil* detail of the door opened by a servant with a dog at his feet. An implied confirmation of the Roman visit may be seen in the landscape details which seem to reflect examples of Roman wall painting uhich by 1560 were being uncovered in Rome. The technique is the purest fresco method of water colour on wet plaster, and not even Nicolas Poussin in the 17th century. Hubert Robert in the 18th or Jean Baptiste Corot in the 19th was able to achieve more glowingly luminous atmospheric effects than Paolo achieved from meagre earth colours with a few touches of lapis blue added.

In the late 1560s Paolo painted the "Madonna of the Cuccina Family" (Dresden), one of his mature masterpieces. In the left third. the Virgin. Child. St. Jerome. St. John the Baptist and an angel are isolated; to the right. the Cuccina family kneels in adoration, presented by the allegorical figure of Faith, who is dressed in a radiant nhite. Paolo gives a cogent series of portraits of the family seen in dramatic relationship to one another, and he adds the homely detail of the youngest Cuccina child shyly gripping the column as he peers out at the beholder. At the extreme right the façade of the family palazzo is visible in the distance. All of Paolo's virtues appear in this picture: his poetry, his uncanny knack for the just accent in design, his noble amplitude of concept, his soft and glowing colour and lovely surfaces and his quiet insistence on veristic detail.

In 1562 Paolo received the commission for "The Marriage at Cana" for the refectory of S. Giorgio Maggiore in Venice. This picture was installed in 1563 and completed magnificently the vista formed by Palladio's architecture. The picture was carted off to France during the revolutionary wars and after the peace settlement in 1815 the French used its colossal size as a pretext for not restoring it to Italy; they consistently maintained this excuse, and the picture is still in the Louvre.

In 1566 Paolo executed another monumental work, this time for his own former parish church at Verona, and in 1572 a "Feast of St. Gregory" for Monte Berico, Vicenza. In 1573 he painted for SS. Giovanni e Paolo. Venice. "The Feast in Levi's House" (now in the Accademia. Venice), which work he had to justify before the council of the Holy Office. This body recommended that Paolo make some changes in the interest of historical propriety, after Paolo had explained that his usual practice was to put into his pictures those elements he thought looked well; the changes he made in the work seem slight enough in the light of the Holy Office's instructions.

After 1577 he began more works for the doge's palace, of which the most important is the "Apotheosis of Venice," a complicated, monumental design in which a great horde of elegant Venetians is set between and in front of a colossal pair of columns seen in sharply receding perspective. The design befits its principal ceiling position, and the work seemed to be the most brilliant of a long series still to come. but Paolo contracted a fever and after a few days of illness died April 19, 1588. His brother and sons had him buried in S Sebastiano Venice, where a bust was placed above his grave. The firm was continued in business for a number of years by these men who, with his nephew, signed their works *Heredes Paoli* ("Paul's heirs").

Paolo's work represents the hedonistic best of the Venetian Renaissance in its last phase. With his emphasis on softly used colour and elegant forms, he was not only continuing an old Venetian tradition but also was pointing a way for the future which was to be reaffirmed not only by Tiepolo but also by Francesco Guardi.

Important examples of his work include: the "Family of Darius Before Alexander" (London); the early "Presentation," the "Epiphany." "The Marriage at Cana." the "Via Dolorosa," the "Resurrection" and the late "Christ and the Centurion" (all in Dresden); the "Lady" (Dublin); the "Lady and Girl" (Baltimore); "Mars and Venus" (Edinburgh); the four "Allegories" and the "Vision of St. Helena" (London); the "Susannah." the "Venus and Adonis," the "Christ Among the Doctors," the "Magdalen" and the "Youth Betneen Virtue and Vice" (all in Madrid); the "Rest on the Flight" (Sarasota, Fla.) and "Mars and Venus" (New York).

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VERONICA, SAINT, was according to legend a pious woman of Jerusalem who, moved with pity by the spectacle of Jesus carrying His cross to Golgotha. gave Him her kerchief in order that He might nipe the drops of agony from His brow. He accepted the offering, and after using the napkin handed it back to her with the image of His face miraculously impressed upon it.

This. however, is not the primitive form of the legend, which close examination shows to be derived from a story related by Eusebius in *Historia Ecclesiastica* (vii. 18). He tells how, at Caesearea Philippi, lived the woman whom Christ healed of a hemorrhage (Matt. ix. 20). At the door of her house stood, on one side, a statue of a woman in an attitude of supplication and, on the other side, a statue of a man stretching forth his hand to the woman. It was said that the male figure represented Christ and that the group had been set up in recognition of the miraculous cure.

Legend was not long in providing the woman of the Gospel with a name. In the west she was identified with Martha of Bethany; in the east she was called Berenike. or Beronike. the name appearing in as early a work as the *Acts of Pilate,* the most ancient form of which goes back to the 4th century.

Toward the 6th century the legend of the woman with the hemorrhage became merged in the legend of Pilate, as is shown in the writings known in the middle ages as *Cura sanitatis Tzberii* and *Vindicta Salvatoris.* According to the former of these accounts Veronica caused a portrait of the Saviour to be painted. The emperor Tiberius, when sick, commanded the woman to bring the portrait to him, worshiped Christ and was cured. The legend continued to gather accretions, and a miraculous origin came to be assigned to the image. According to the legends in France, Veronica was married to Zaccheus, who had been converted by Christ, and went with him to Quiercy, where he became a hermit. She then joined Martial in his apostolic preaching. In the Bordeaux district, Veronica is said to have brought relics of the Virgin to Sonlac, where she died and was buried. In the 12th century the image began to be identified with one at Rome, and in the popular speech the image too was called Veronica. St. Veronica's feast is kept on July 12.

See M R James, *The Apocryphal New Testament,* p. 102 and pp 157 ff. (1924); E. von Dobschutz, *Christusbilder,* in *Texte und Untersuchungen cur Gesclzichte der altchristlichen Literatur,* vol xviii (1899).

VERPLANCK, GULIAN CROMMELIN (1786–1870), U.S. writer and politician, was born Aug. 6, 1786, in New York city. Graduated from Columbia college in 1801, he was admitted to the bar in 1807. In 1811 he was involved in the Columbia college commencement riot, and his long antagonism to DeWitt Clinton resulted from the trial that followed. Verplanck was a member of the New York assembly (1820–23), of the U.S. house of representatives (1825–33) and of the New York senate (1837–41). He was professor of the evidences of revealed religion and moral science in the General Theological seminary of the Episcopal Church. He died May 18, 1870, in New York city.

Besides published addresses, political pamphlets and contributions to magazines, Verplanck's principal writings are *The Bucktail Bards* (1819); *Essays on the Nature and Uses of the Various Evidences of Revealed Religion* (1824); *An Essay on the Doctrine of Contracts* (1825); *The Talisnzan* (1827; 1828; 1829), an annual on which he collaborated with William Cullen Bryant and Robert C. Sands; *Discourses and Addresses on Subjects of American History, Arts, and Literature* (1833); *The Advantages and Dangers of the American Scholar* (1836); and *Shakespeare's Plays: With His Life,* 3 vol. (1847), the best edition of Shakespeare produced in the United States to that time. (S. K. Hy.)

VERRES, GAIUS (*c.* 120–43 B.C.), Roman magistrate, notorious for his misgovernment of Sicily. It is not known to what gens he belonged. He at first supported Marius but soon went over to Sulla, nho gave him land at Beneventum and secured him against punishment for embezzlement. In 80, Verres was legate in Asia on the staff of Cn. Cornelius Dolabella, governor of Cilicia. The governor and his subordinate plundered in concert, till in 78 Dolabella had to stand his trial at Rome and was convicted, mainly on the evidence of Verres, who thus secured a pardon for himself. In 74, by a lavish use of bribes, Verres secured the city praetorship and as a creature of Sulla abused his authority to further the political ends of his party. He was then sent as governor to Sicily, the richest of the Roman provinces.

The people were for the most part prosperous and contented, but under Verres the island experienced more misery and desolation than during the time of the first Punic or the recent servile wars. The corngrowers and the revenue collectors were ruined by taxation and the canceling of contracts; temples and private houses were robbed of their works of art; and the rights of Roman citizens were disregarded. Verres returned to Rome in 70, and in the same year, at the request of the Sicilians, Cicero prosecuted him. Verres was defended by the most eminent of Roman advocates, Q. Hortensius. The court was composed exclusively of senators, some of whom might have been his personal friends. But the presiding judge, M. Acilius Glabrio, was not corruptible. Verres tried to get the trial postponed till 69 when his friend Metellus nould be the presiding judge, but in August Cicero opened the case.

The effect of the first brief speech was so overwhelming that Hortensius refused to reply and recommended his client to leave the country. He went to Massilia and lived there till 43, when he was proscribed by Antony.

VERRI, PIETRO, CONTE (1728–1797), Italian political economist and gifted man of letters who devoted his life to the reform of public administration and the spread of useful knowledge, was born at Milan on Dec. 12, 1728. After serving as a captain in the Seven Years' War (1759), he became the moving spirit in an "enlightened" group of young Milanese intellectuals called the *Società dei Pugni* (1761) and contributed some 38 articles to their periodical, of which he was director, known as *Il Caffè* (1764–66. "Il tempio dell'ignoranza." "La coltivazione del lino," "Pensieri sullo spirito della letteratura d'Italia"). Verri later wrote treatises on economic and philosophical matters (*Sulle leggi vincolanti il commercio dei grani,* 1769; *Sull'economia politica,* 1771; and *Discorso sull'indole del piacere e del dolore,* 1773). His other works include *Osservazioni sulla tortura* (1777), a highly esteemed *Storia di Milano,* 2 vol. (1783–98) and a correspondence (1766–97) with his brother which provides a vibrant document of contemporary Italian life. Verri died at Milan on June 28. 1797.

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His brother, CONTE ALESSANDRO VERRI (1741–1816), Italian novelist of preromantic sensibility, was born at Milan on Nov. 9, 1741, and died at Rome on Sept. 23, 1816. As a young man he collaborated in the production of *Il Caffè;* in 1767, after visiting France. England and Germany, he settled in Rome where he wrote among other works the *Avventure di Saffo* (1780), the *Vita di Erostrato* (1793; published 1815) and the *Notti ronzane al sepolcro degli Scipioni* (1792–1804), a sequence of imaginary conversations between the shades of the ancient Romans, mournful in tone and influenced by the *Night Thoughts* of Edward Young.

See Alessandro Verri, *Opere scelte,* 2 vol (1822) and M Gallioli, *Alessandro Verri* (1921) (D. M We.)

VERRILL, ADDISON EMERY (1839–1926), U.S. zoologist and naturalist, a specialist in the study of marine invertebrates. was born in Greenwood, Me., Feb. 9, 1839. He graduated from Harvard and attended Yale. and from 1860 to 1864 worked as assistant to Louis Agassiz (*q.v.*). In the latter year he was named professor of zoology at Yale. In 1865 Verrill became curator of the Peabody zoological museum at Yale and in 1868 nonresident professor of comparative anatomy and entomology at the University of Wisconsin, Madison. In 1870 he became instructor in geology at the Sheffield scientific school, Yale, and was elected to the National Academy of Sciences in 1872. From 1871 to 1887 he was in charge of scientific explorations by the U.S. Commission of Fish and Fisheries. In that capacity he was responsible for important technical improvements in the equipment used for the collection of marine specimens. His investigations of marine invertebrates took him along both coasts of North America, as well as to South and Central America and Hawaii. He found and described many hundreds of previously undiscovered specimens and made a valuable collection for the Peabody museum. Verrill died at Santa Barbara, Calif., on Dec. 10, 1926.

Of his more than 300 papers, many have become standard references, particularly his *Report on the Invertebrate Animals* of *Vineyard Sound and Adjacent Waters* (1873) and his monographs on the coelenterates of the Canadian arctic. He was also the author of a number of works on the Bermuda Islands.

VERRIO, ANTONIO (1639–1707), Italian painter, was born at Lecce, in the Neapolitan province of Terra di Otranto. In 1660 at Naples he executed a large fresco work "Christ Healing the Sick," for the Jesuit college. He subsequently went to France nhere at Toulouse he painted an altarpiece for the Carmelites. He was invited to England by Charles II and employed in the decorating of Windsor castle. Little of his work is extant. He was a rapid painter, fertile in invention and best at covering large surfaces in decorative frescoes. Charles II named him "master gardener," gave him a lodge in Hyde Park and paid him lavishly. He was employed by James II on Cardinal Wolsey's tombhouse. He painted James and several of his courtiers in the hospital at Christ Church, London, and also executed a number of decorative frescoes at St. Bartholomew's hospital. He was later employed by Lord Exeter at Burleigh and painted the large staircase at Hampton court for King William. He was very successful but his work was often criticized by his contemporaries for gaudy colours, bad drawing and, senseless composition. He died at Hampton Court on June 17, 1707.

VERRIUS FLACCUS, MARCUS (fl. late 1st century B.C.), a Roman freedman who became a learned scholar and grammarian and the most famous teacher of his day. He introduced the principle of competition among his pupils and awarded old books, beautiful or rare, as prizes. Augustus entrusted the education of his two grandsons to him and thenceforward his school was in the imperial house on the Palatine. He died at an advanced age during the reign of Tiberius. His works are lost. He is known to have written *fasti* (*q.v.*, a type of calendar), which were set up at Praeneste, where in fact *fasti* have been found which have been accepted as his, though some scholars have held that these Praeneste *fasti* were excerpted by Verrius Flaccus from an otherwise unknown work on *fasti*. A work of his, which was much used, was his *De verborum significatu,* a large lexicon which was the first of its kind and a storehouse of antiquarian learning in which Latin authors were quoted extensively. Some idea of its value is obtainable from what remains of the abridgement made by Festus (*q.v.*) in the 2nd or 3rd century and from the abridgement of that made by Paulus Diaconus in the 8th century.

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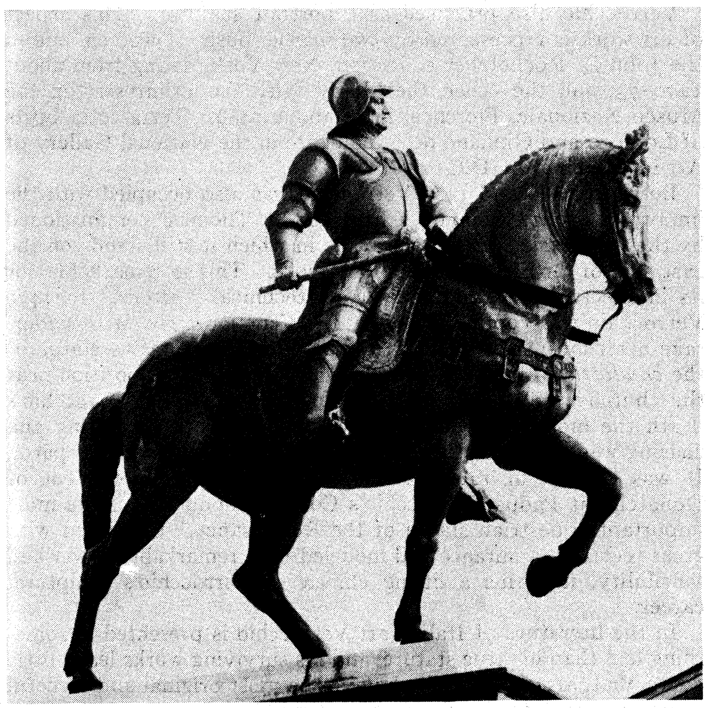
(G. B. A F.)

VERROCCHIO, ANDREA DEL (1435–1488), Florentine painter and sculptor, properly Andrea di Michele di Francesco Cioni, best known as the author of the Colleoni monument in Venice and as the master of Leonardo da Vinci, was born at Florence in 1435. He was trained initially under a goldsmith Giuliano Verrocchio. As a painter he was perhaps a pupil of Alesso Baldovinetti, and as a sculptor he is traditionally supposed to have worked with Donatello; however, the affinities of his early sculptures are rather with Antonio Rossellino.

Verrocchio's single documented painting, an altarpiece in the cathedral at Pistoia (completed 1486), was executed in large part by his pupil Lorenzo di Credi; its handling is inconsistent with that of a "Baptism of Christ" in the Uffizi gallery, Florence, from S. Salvi, which, from the time of G. Vasari, has been unanimously given to the artist. In the latter picture (painted about 1470–72) one of the two angels and part of the distant landscape were painted by Leonardo da Vinci. Other paintings ascribed to Verrocchio are Madonnas in the Kaiser Friedrich museum, Berlin (two), the Städel institute at Frankfurt, the Metropolitan museum, New York, and the National gallery, London. The few paintings that can be looked upon as autograph works by Verrocchio probably date from before 1475, and it seems that from this time on he dedicated himself in the main to sculpture, in which from the first he manifested the strong personal convictions and the inventive ability that are absent from his paintings.

According to his brother Tommaso, Verrocchio was responsible for an inlaid slab in S. Lorenzo recording the place of burial of Cosimo de' Medici (1467). Before 1469 he also carved the marble lavabo of the old sacristy of the same church. This was followed by his first major commission, the tomb of Piero and Giovanni de' Medici in the old sacristy, completed in 1472. This deeply impressive work is double-sided and consists of a sarcophagus set inside a high arch carved with foliated ornament Composed of a number of different mediums—porphyry in the sarcophagus, green marble in the inscribed medallions in the centre of the sides, marble in the platform and containing arch and bronze in the feet and ornament of the sarcophagus and in the ropework decoration



ALINARI

BRONZE STATUE OF THE CONDOTTIERE BARTOLOMMEO COLLEONI MODELED BY ANDREA DEL VERROCCHIO (1479—88). IN THE PIAZZA OF SS. GIOVANNI E PAOLO. VENICE, ITALY

aith which the arch is filled—the tomb contains no figurated sculpture. In its over-all design, however, its inspired use of colour and its rich bronze ornament, it reveals a creative intelligence of the first rank.

In 1468–69 Verrocchio received payments for a bronze candlestick for the Sala dell'Udienza of the Palazzo della Signoria; this is now in the Rijksmuseum, Amsterdam. Verrocchio's earliest figure sculpture, a small bronze statue of David in the Museo Nazionale, Florence. is undated, but was executed before 1476. A second bronze figure. the "Child With Dolphin," is somewhat later in date. Commissioned about 1480 for the Medici villa of Careggi, this was set up in the 16th century in the position it still occupies in the courtyard of the Palazzo della Signoria (Palazzo Vecchio). This fountain figure has an important place in the history of the freestanding statue, since its spiral design represents a first successful effort to evolve a pose in which all views are of equal significance.

In 1477 it was decided to extend the silver altar in the Florentine baptistery (now in the Museo dell'Opera del Duomo, Florence), and one of the four supplementary scenes, with the "Beheading of the Baptist." was allotted to Verrocchio. This was completed in 1480. On a larger scale Verrocchio emerges at this time as one of the great relief artists of the 15th century. The only autograph Madonna from his hand, a terra-cotta relief of about 1480 from Sta. Maria Nuova, now in the Museo Nazionale, Florence, is treated with a freedom and plasticity that recalls the work of Donatello. In a marble relief of Alexander the Great, in the National Gallery of Art in Washington, these same characteristics are preserved.

When in 1476–77 Verrocchio designed the cenotaph of Niccolo Cardinal Forteguerri for the cathedral at Pistoia, this was also conceived in terms of deep-cut relief. On Verrocchio's death in Venice in 1488 it was still unfinished. Its completion was entrusted initially to Lorenzo di Credi, was subsequently taken over by Giovanni Francesco Rustici (who completed Verrocchio's figure of the cardinal) and by Lorenzo Lotti (who carved the central figure of Charity). After 1753 it uas revised and set up by Gaetano Masoni in its present confused form. Though its effect is now neutralized by changes and additions foreign to Verrocchio's scheme, the Forteguerri monument contains some of the artist's finest marble sculptures.

Verrocchio also practised as a portrait sculptor. This aspect of his work is represented by two marble busts of women, one in the John D. Rockefeller collection, New York, dating from about 1470–75, and the other, the "Lady With the Primroses" in the Museo Nazionale, Florence, from about 1480. Terra-cotta busts of Lorenzo and Giuliano de' Medici are in the National Gallery of Art in Washington, D.C.

Between 1466 and 1483 Verrocchio was also occupied with the important bronze group of "Christ and St. Thomas" commissioned by the *mercanzia* for the tabernacle in which it still stands on the east side of Or San Michele in Florence. This is remarkable for its intellectual elevation and for its technical mastery. In 1479 Verrocchio was commissioned by the Venetian *signoria* to undertake a second major work in bronze, a commemorative statue of the *condottiere* Bartolommeo Colleoni destined for a position near the church of SS. Giovanni e Paolo at Venice. At Verrocchio's death the model was not yet cast, and the work of casting and chasing was entrusted to a Venetian sculptor Alessandro Leopardi. It was erected in 1496. After the Gattamelata monument of Donatello at Padua, Verrocchio's Colleoni monument is the most important equestrian statue of the Renaissance. Contrived with great technical assurance and modeled with remarkable power and sensibility, it forms a fitting climax to Verrocchio's sculptural career.

In the literature of Italian art Verrocchio is presented in something less than his true stature, and his surviving works leave little doubt that, after Donatello, he was the most original and forceful Florentine sculptor of the 15th century.

See M. Cruttwell, *Verrocchio* (1904); *L.* Planiscig, *Andrea del Verrocchio (1941).* *(J. W.* **P.-H)**

VERSAILLES, a town of northern France, capital of the *département* of Seine-et-Oise, 12 mi. W.S.W. of Paris, with which it is connected by rail and streetcar. Pop. (1954) 72,038. Versailles owes its existence to the palace built by Louis XIV. It stands 460 ft. above the sea, and the fresh healthful air and nearness to the capital attract many residents. The three avenues of St. Cloud, Paris and Sceaux converge in the Place d'Armes. Between them stand the former stables of the palace, later occupied by the artillery and engineers. To the south lies the quarter of Satory the oldest part of Versailles, with the Cathedral of St. Louis, and to the north the new quarter. with the church of Notre Dame.

The Palace.—To the west of the Place d'Armes a gilded iron gate and a stone balustrade mark off the great court of the palace. In this court stand statues of Richelieu, Condé, Du Guesclin and other famous Frenchmen. At the highest point there is an equestrian statue in bronze of Louis XIV. To the right and left of this stretch the long wings of the palace, while behind extend the Cour Royale and beyond it the smaller Cour de Marbre, to the north, south and west of which rise the central buildings. To the north the Chapel court and to the south the Princes court, with vaulted passages leading to the gardens, separate the side from the central buildings. The palace chapel (1696–1710), the roof of which can be seen from afar rising above the rest of the building, was the last important work of J. Hardouin-Mansart.

The north wing contains galleries and halls of historical pictures and sculptures, and other great apartments, the most famous of which historically is the theatre built under Louis XV where the banquet to the Gardes du Corps was held, the toasts at which provoked riots that drove Louis XVI from Versailles. Here the national assembly met from March 10, 1871, till the proclamation of the constitution in 1875, and the senate from March 8, 1876, till the return of the two chambers to Paris in 1879. The central buildings include the former dauphin's apartments and many others on the ground floor and fine staterooms on the first floor with the great Galerie des Glaces (Hall of Mirrors) (1678) overlooking the park. The Hall of Hercules was till 1710 the upper half of the old chapel famed for its associations with Bossuet, Massillon and Bourdaloue. The queen's apartments and the rooms of Louis XIV are on this floor. The Oeil de Boeuf, named from its oval window, was the anteroom where the courtiers waited till the king rose. It leads to the bedroom which Louis XIV used from 1701 and in which he died and which Louis XV occupied from 1722 to 1738. In the south wing of the palace, on the ground floor, is the gallery of the Republic and the first empire. In the south wing is also the room where the chamber of deputies met from 1876 till 1879, and where the congress later sat to revise the constitution voted at Versailles in 1875 and to elect the president of the republic. The first floor is almost entirely occupied by the Battle gallery. In the window openings are the names of soldiers killed while fighting for France, with the names of the battles in which they fell, and there are more than 80 busts of princes, admirals, constables, marshals and celebrated warriors who met a similar death. Another room contains exhibits connected with the events of 1830 and the accession of Louis Philippe.

The Gardens.—The gardens of Versailles were planned by André Le Nôtre. The ground falls away on every side from a terrace adorned with ornamental basins, statues and bronze groups. Westward from the palace extends a broad avenue, planted with large trees, and having along its centre the grass of the Tapis Vert; it is continued by the Grand canal, 200 ft. wide and 1 mi. long. On the south of the terrace two splendid staircases lead past the Orangerie to the Swiss lake, beyond which is the wood of Satory. On the north an avenue, with 22 groups of three children, each group holding a marble basin from which a jet of water rises, slopes gently down to the basin of Neptune, remarkable for its fine sculptures and abundant water.

The Orangerie (built in 1685 by Mansart) is the finest piece of architecture at Versailles; the central gallery is 508 ft. long and 42 ft. wide, and each of the side galleries is 375 ft. long. There are 1,200 orange trees, one of which is said to date from 1421, and 300 other kinds of trees.

The alleys of the parks are ornamented with statues, vases and regularly cut yews, and bordered by hedges surrounding the shrubberies. Under Louis XIV the Grand canal was covered with Venetian gondolas and other boats. Around the Tapis Vert are numerous groves, the most remarkable being the Ballroom or Rockery. with a waterfall; the Queen's shrubbery, the scene of the intrigue of the diamond necklace; that of the Colonnade, the King's shrubbery, the Grove of Apollo. and the basin of Enceladus.

Among the chief attractions of Versailles are the fountains and waterworks made by Louis XIV in imitation of those he had seen at Fouquet's chbteau of Vaux. Because of the scarcity of water at Versailles, the works at Marly-le-Roi were constructed in order to bring water from the Seine; but part of the supply thus obtained was diverted to the newly erected château of Marly. Vast sums of money were spent and many lives lost in an attempt to bring water from the Eure, but the work was stopped by the war of 1688. At last the waters of the plateau between Versailles and Rambouillet were collected and led by channels (total length 98 mi.) to the gardens, the soil of which covers innumerable pipes, vaults and aqueducts.

The **Trianons.**—Beyond the present park, but within that of Louis XIV, are the two Trianons. The Grand Trianon was originally erected as a retreat for Louis XIV in 1670, but in 1687 Mansart built a new palace on its site. Louis XV, after establishing a botanic garden, made Gabriel build in 1766 the small pavilion of the Petit Trianon. It was a favourite residence of Marie Antoinette, who had a garden laid out in the English style, with rustic villas in which the ladies of the court led a mimic peasant life. The Grand Trianon contains a museum of state carriages, old harness. etc.

The Town.—The church of Notre Dame, built by Mansart, and the Cathedral of St. Louis, built by his grandson, are uninteresting. The celebrated tennis court (Jeu de Paume) is now used as a museum. The palace of the prefecture, built during the second empire, was a residence of the president of the republic from 1871 to 1879. The military hospital formerly accommodated 2.000 people in the service of the palace. A school of horticulture was founded in 1874, attached to an excellent garden, near the Swiss lake.

Versailles is the seat of a bishop, a prefect and a court of assizes and has tribunals of first instance and of commerce, a board of trade arbitrators, a chamber of commerce and a branch of the Bank of France and, among its educational establishments, *lycées* and training colleges for both sexes and a technical school. It is an important garrison town and has a school of military engineering and artillery. Distilling, boot and shoe making and market gardening are carried on.

History.—Louis XIII often hunted in the woods of Versailles, and built a small pavilion at the corner of what is now the rue de la Pompe and the avenue of St. Cloud. In 1627 he entrusted Jacques Lemercier with the plan of a chkteau. In 1661 Louis Levau made some additions which were further developed by him in 1668. In 1678 Mansart took over the work. the Galerie des Glaces, the chapel and the two wings being due to him. In 1682 Louis XIV took up his residence in the chkteau. Till his time the town was represented by a few houses to the south of the present Place d'Armes; but land was given to the lords of the court and new houses sprang up, chiefly in the north quarter. Under Louis XV the parish of St. Louis was formed to the south for the increasing population, and new streets were built to the north on the meadows of Clagny. Under Louis XVI the town extended to the east and received a municipality; in 1802 it gave its name to a bishopric.

In 1783 the armistice preliminary to the treaty of peace between Great Britain and the United States was signed at Versailles. The states-general met here on May 5, 1789, and on June 20 took the solemn oath in the tennis court by which they bound themselves not to separate till they had given France a constitution. Napoleon neglected, and Louis XVIII and Charles X merely kept up. Versailles, but Louis Philippe made great alterations. some of which were later altered back to the original designs, partly with the help of a large gift from the United States. In 1870 and 1871 the town was the headquarters of the German army besieging Paris, and in the Galerie des Glaces William I of Prussia was crowned German emperor in 1871.

After the peace Versailles was the seat of the French national assembly while the commune was triumphant in Paris, and of the two chambers till 1879, being declared the official capital of France.

After World War I the treaty between the Allied powers and Germany was signed in the Galerie des Glaces.

See A. P. Gille, Versailles et *les* deux Trianons, with illustrations by M. Lambert **(1899)**; P. **de** Nolhac, La *Création* de Versailles (1901); J. **E.** Farmer, Versailles and the Court Under Louis XIV (1905).

VERSAILLES, TREATY OF, the treaty of peace signed at the close of World War I by the Allied and Associated powers and Germany at Versailles, France, on June 28, 1919, and brought into force on Jan. 10. 1920. The original intention had been that it should be only one part of a general and inclusive settlement with Austria, Hungary, Bulgaria and Turkey as well as with Germany but the delays in dealing with the smaller states. particularly Hungary and Turkey, not only separated the German treaty from the others, but caused it to be the first to be signed and the first to come into force, just as it was the first in importance.

NEGOTIATIONS BEFORE THE ARMISTICE

On Oct. 4, 1918, the German government requested the president of the United States to bring about the immediate conclusion of a general armistice as a preliminary to the restoration of peace and declared its acceptance of the fourteen points (*q.v.*) formulated by him on Jan. 8. 1918. After lengthy negotiations with Germany. Pres. Woodrow Wilson communicated its request to the Allied governments and inquired whether they were willing to grant an armistice and to make peace on the basis of the fourteen points. The Allies accepted the proposal, but made two reservations: (1) they excluded the "freedom of the seas" (point 2); and (2) they demanded that "compensation will be made by Germany for all damage done to the civilian population of the Allies and their property by the aggression of Germany by land, by sea and from the air." These conditions were communicated to the German government by President Wilson on Nov. 5, 1918. The German government made no reply in writing to these terms. but in fact accepted them by getting in touch with Marshal Foch, asking for an armistice and accepting the conditions set forth by the marshal. Thus the note of Nov. 5 became a kind of contract between Germany and the Allied and Associated powers. The exact meaning of the language concerning reparation was, however. obscured by the insertion in the Armistice of a reservation, which was accepted by Germany, to the effect that "any subsequent concessions and claims by the Allies and the United States remain unaffected" (art. 19).

For the negotiations leading to the treaty of Versailles see PARIS, CONFERENCE OF.

ANALYSIS OF THE TREATY

Part **i, the** Covenant.—Part i (art. 1–26) deals with the covenant of the League of Nations (*q.v*). The covenant united its signatories in a league guaranteeing their independence and territorial integrity (art. 10); according to President Wilson, this was the "heart" of the matter. The entrance of Germany into the League was opposed by some of the Allies and did not take place until after the signature of the agreements of Locarno on Dec. 1, 1925, and their ratification in 1926. The most important power granted to the League was the supervision of mandated territories (art. 22). by which the government of the former German colonies and parts of the former Ottoman empire, after having been assigned to various mandatory powers, was subject to supervision by a permanent mandates commission. This was appointed hy the League and inspected the annual reports of the mandatory powers on the territory committed to their charge (see MANDATE). Other duties of the League were to formulate plans for the reduction of armaments (art. 8) and to supervise the trade in arms and ammunition with "the countries in which the control of this traffic is necessary in the common interest" (art. 23).

There were also provisions for international co-operation in labour questions (art 23) and for voluntary international control of health and disease (art. 2 j); in the 20 years that followed. these responsibilities of the League were widely and successfully extended.

The most important obligation of the covenant was found in art. 12–16, by which members of the League bound themselves not to go to war in disregard of its covenants until three months after an award of arbitration or a report by the council of the League; art. 16 provided for the application of economic sanctions against a member who resorted to war in disregard of its covenants. These articles of the covenant were put to the test, unsuccessfully, against Japan in Manchuria in 1931–33 and against Italy in Ethiopia in 1935–36.

The machinery through which the League functioned consisted of a council and an assembly. The council was to have five members, the United States. France, Great Britain. Italy and Japan being permanent members (in order to give the great powers a majority). The failure of the United States to join the League upset this plan, and ultimately the number of seats held hy the smaller powers was increased to ten, of which three were "semi-permanent"; these seats were filled by the assembly. Germany entered the League in 1926 and occupied a permanent seat until its withdrawal from the League in 1933. Japan withdrew from the League in 1933, and Italy in 1937. The U.S.S.R. entered the League in 1934 and occupied a permanent seat until its expulsion in 1939 following the attack on Finland. The assembly consisted of representatives of all member states, and was a kind of international parliament.

Two institutions connected with, but actually separated from, the League were the Permanent Court of International Justice (art. 14) (see INTERNATIONAL COURT OF JUSTICE) and the International Labour organization (*q.v.*) (part xii. art. 387–427).

Other duties of the League, nssigned to it by other articles of. the treaty, were the governance of the Saar basin and the free city of Danzig, the supervision of German disarmament after the dissolution of the inter-Allied naval and military commissions in 1925, and the supervision of the racial and religious minorities' treaties which were signed as part of the general settlement of 1919–20. (See MINORITIES.)

Parts **ii** and **iii,** Territorial Dispositions.—Western Frontier.—Germany lost territory in the west, north and east, and had its influence greatly weakened beyond its own borders. Belgium, which ceased to be a neutral state (art. 31), acquired from Germany the districts of Moresnet, Eupen and Malmédy (art. 32–34) as compensation for damage resulting from the German occupation. Luxembourg ceased to be a neutral state and to form part of the German *Zollverein* (art. 40); later it entered into an economic union with Belgium. The Saar basin, a rich mining area vainly claimed by France, was placed under the control of the League, which governed it by an international commission, and its coal mines were ceded to France as compensation for the destruction of coal mines in northern France by the German army (art. 45–50). At the end of 15 years a plebiscite was to be taken, whereby the inhabitants would vote as to their preference for (1) the existing international regime, (2) union with France, (3) union with Germany. In 1935 the Saar voted to return to Germany. Finally. Alsace and Lorraine were ceded by Germany to France (art. 51–79) "to redress the wrong done by Germany in 1871." France thus gained nearly 2.000.000 inhabitants, great strategic advantages and valuable economic resources, particularly the iron fields of Lorraine.

The left bank of the Rhine and the right bank to a line drawn 50 km. to the east of the Rhine were demilitarized. Fortifications were to be dismantled, and no permanent works for maneuver or mobilization were to be permitted (art. 42–43). Violation of these articles by Germany was to be regarded as "a hostile act" (art. 44). The articles were violated by Germany in March 1936 when German troops reoccupied the Rhineland — and the signatories of the treaty contented themselves with a verbal protest.

Northern Frontier. — In the north Germany lost northern Schleswig to Denmark as the result of a plebiscite held in two zones (art. 109–114). The northern zone voted for return to Denmark, the southern or Flensburg zone elected for Germany. Thus Denmark finally received that plebiscite which Bismarck had promised in 1866 but which Germany had never allowed to be held.

Eastern Frontier. — Beginning at the Baltic, Germany ceded to Poland West Prussia and most of the province of Poznan (art. 87); this meant that a "corridor," as the Germans called it, was run between Pomerania and East Prussia and separated the latter province from the main body of Germany. On the other hand. the territory was historically Polish (*i.e.*, before the partitions of Poland) and was inhabited by a Polish majority. No provision of the treaty caused so much animosity and resentment as this arrangement which, it should be noted, accorded with President Wilson's 13th point for giving Poland "a free and secure access to the sea." The territory ceded did not, however, include Danzig, a purely German town, which was established as a free city under the sovereignty of the League (art. 100–108). In East Prussia plebiscites were provided for in the Allenstein and Marienwerder districts (art. 94–98). where there was a mixture of Germans and Poles; both plebiscites went in favour of Germany (1920). The city and hinterland of Memel were ceded to the principal Allied and Associated powers (art. 99), who in 1924 awarded the territory to Lithuania. Farther south. a plebiscite was provided for in upper Silesia (art. 88). where the population was partly German, partly Polish. This resulted (1921) in a majority for Germany, but inasmuch as the treaty clearly implied a partition of the territory. the League of Nations — at the request of the Allies and Germany — rendered a decision by which the southern half of the area — including valuable mines — passed to Poland, the northern half returning to Germany. Less than one-third of the population ceded by Germany to Poland and Lithuania were German. Provision was made (art. 91) by which Germans who did not wish to become Polish nationals might opt for German nationality and leave Poland.

Altogether, Germany ceded to the various powers about 25,000 sq.mi. of territory and nearly 6.000.000 inhabitants. This loss was, however, probably less serious than the loss of iron ore (65% in Lorraine and Luxembourg). coal (45% in the Saar and Silesia), zinc (72%), lead (57%) and potash (Alsace).

Part iv, German Rights and Interests Outside Germany. — Germany ceded its oversea colonies to the principal Allied and Associated powers (art. 119), which distributed them to mandatories. In Africa the Cameroons and Togoland were divided between France and Great Britain, and East Africa between Great Britain and Belgium; South-West Africa was awarded to the Union of South Africa. These territories contained about 18,000 Germans and more than 12,000,000 natives. In the Pacific Germany lost the Marshall Islands to Japan. New Guinea to Australia, Western Samoa to New Zealand and Nauru to Great Britain, Australia and New Zealand. It also renounced outright to Japan the province of Shantung (art. 156–158), which Japan returned to China in 1923. In addition to these cessions of territory, Germany lost all its state property. movable and immovable, in its colonies and was obliged to cancel all its treaty rights, capitulations (*q.v.*) and concessions in China, Siam, Liberia. Egypt and Morocco (art. 128–154). (For provisions regarding German missionaries, see part xv, miscellaneous provisions.)

Part v, Military, Naval and Air Clauses. — "In order to render possible the initiation of a general limitation of the armaments of all nations." Germany agreed to reduce its army to 100.000 men, with stores of guns, ammunition, etc., in proportion. Beyond this figure all existing munitions were to be surrendered and destroyed and the manufacture of munitions closely restricted; the importation of munitions of war was prohibited (art. 159–170). Conscription was abolished, and Germany was required to adopt a system of voluntary enlistment of at least 12 consecutive years for the men and 25 consecutive years for officers. Military training outside the army was forbidden (art. 173–179) and the existence of a general staff prohibited (art. 160).

The naval clauses were equally severe, for the German navy was restricted to 6 battleships of an antiquated type, 6 light cruisers, 12 destroyers, and 12 torpedo boats and submarines were forbidden (art. 181). For purposes of replacement no ship was to be built in excess of 10.000 tons. Other ships of the German navy were to be handed over to the Allies (art. 185). The personnel were to be recruited in the same manner as the army and were limited to a total of 15,000 men and 1,500 officers and warrant officers (art. 183). Naval works and fortifications within 50 km. of the coast were to be demolished. The fortifications of Heligoland were to be dismantled.

The air clauses (art. 198–202) were the most drastic of all for they absolutely prohibited all naval and military air forces and called for the destruction of all air matériel. Inter-Allied commissions of control were provided for each arm of the service and functioned until 1925, when their work was taken over by the League of Nations. This supervision was never fully effective and gradually ceased to be exercised; there was no kestraint when Hitler decided on the rearmament of Germany in 1935. (See also DISARMAMENT.)

Part vi, Prisoners of War and Graves. — This section (art. 214–226) provided for the return of prisoners of war and for the upkeep and maintenance of graves.

Part vii, Penalties. — William II, "formerly German emperor," was arraigned "for a supreme offence against international morality and the sanctity of treaties" (art. 227). although in 1914 war was a legal procedure and had not been officially renounced as an instrument of national policy. The principal Allied powers proposed to try the former emperor, but the Netherlands government, in whose territory he had taken refuge, refused to surrender him and nothing came of the project.

There were further provisions (art. 228–230) for the punishment before Allied military tribunals of Germans "accused of having committed acts in violation of the laws and customs of war." Eventually a list of more than 100 such criminals was drawn up and their extradition was demanded of Germany. On account of the excitement produced in Germany, the demand was not insisted upon; instead. the Allies agreed to about a dozen being tried in Germany by Germans, and when a few had been convicted and given mild sentences. the Allies dropped the matter. In 1925 Field Marshal Hindenburg, himself a "war criminal," was elected president of the German Reich without any Allied protest. (See also WAR; WAR CRIMES.)

Part **viii**, Reparation. — This (art. 231–243) was perhaps the most important section of the treaty, for it produced bitter controversy almost from the beginning and was much affected by outside and popular influences. In the pre-Armistice agreement of Nov. 5, 1918 (see above), Germany had undertaken to make compensation for "all damage done to the civilian population of the Allies and property by the aggression of Germany by land, by sea and from the air." In the treaty this obligation was rephrased thus (art. 231): "The Allied and Associated Governments affirm, and Germany accepts, the responsibility of Germany and her allies for causing all the loss and damage to which the Allied and Associated Governments and their nationals have been subjected as a consequence of the war imposed upon them by the aggression of Germany and her allies." Although the Germans, partly because of a faulty translation, interpreted this clause to imply that Germany was solely responsible for the war, the intention of the Allies was, as has been disclosed by a study of the records of the peace conference, merely to reaffirm the obligation assumed by Germany when it signed the Armistice. The fact that the same language is used. *mutatis mutandis,* in the treaties with Austria, Hungary and Bulgaria adds further proof. In the definition (art. 232; annex 1) of the categories of loss and damage under which Germany mas liable, however, pensions to military persons and separation allowances to civilians were included, which seems contrary to the definition laid down in the note of Nov. 5, 1918 (but may possibly be justified by the reservation in the armistice that subsequent claims remained unaffected; see above). A memorandum Justifying the inclusion of these items was prepared by Gen. Jan C. Smuts of South Africa, but its argument was not generally accepted.

There was sharp disagreement among the Allies as to how much Germany could pay on account of reparation. British experts placed the figure at something like £2,000,000,000 or $10,000,000,000, and the Americans at £3,000,000,000 or $15,000,000,000; some sanguine British and French estimates ranged as high as £20,000,000,000 or $100,000 000,000 (in 1871 Germany imposed an indemnity of $1,000,000,000 on France). As no sum could be agreed upon, a scheme was adopted of postponing the fixing of the amount until more data about the damage done was available and passions had cooled. A reparation commission was established aith extensive powers, to assess the German obligation not later than May 1, 1921 (art. 233); in the meantime, Germany was to make certain preliminary payments in kind and in gold (£1,000,000,000 or $5,000,000,000), which would tide over the immediate needs of the Allies. The commission was to be composed of representatives of the United States, France, Great Britain and Italy, and a fifth member from Japan, Belgium or Yugoslavia, according to the claims being considered; it was to give Germany "a just opportunity to be heard," but was not bound to accept the German argument. It was expected that the United States would become a kind of arbiter between conflicting claims and that the commission uould be able to reduce the demands on Germany to a reasonable figure. But the failure of the Cnited States to ratify the treaty reduced the commission to four; ordinarily France and Belgium voted together against Britain and Italy; France, as the country nhich had suffered the greatest devastation, held the presidency of the commission and in this capacity possessed a casting vote in case of a tie (part xv, art. 437). In consequence, France and Belgium were able to outvote Britain and Italy and often did so. On April 28, 1921 the commission determined the debt of Germany to be approximately $33,000,000,000, in addition to the war debt of Belgium ahich Germany had assumed as "a consequence of the violation of the treaty of 1839" (art 232); this was more. than twice the American estimate of Germany's "capacity to pay," and about one-half of this sum was accounted for by the inclusion of pensions and separation allowances. It should be noted. honever, that in their counterproposals to the treaty, the Germans offered to pay 100,000 000.000 gold marks, or approximately $2 5,000,000,000.

Although Germany's obligations were reckoned in gold marks. the actual payments had to be made largely in kind, and the treaty contained elaborate provisions for the transfer by Germany to the Allies of various commodities (art. 236 and annexes). They included the replacement by German ships, on the basis of "ton for ton and class for class," of Allied vessels sunk by German submarines. Great Britain received most under this head. France obtained large deliveries of coal and coal derivatives; Belgium received much livestock. Germany had also to furnish much material for the restoration of the devastated regions, and to renounce numerous ocean cables.

Since German resistance to the payment of reparation was to be expected, the treaty provided that the Allies might employ "economic and financial prohibitions and reprisals and in general such other measures as the respective governments may determine to be necessary" and that Germany was not to regard them as "acts of war." From the beginning Germany protested that the terms were not only impossible of execution but were contrary to the pre-Armistice agreement. The French, for their part, insisted that Germany could pay if it wished to or were forced to pay, and they tried to insist on the letter of the treaty. British opinion took a middle ground and opposed pressing Germany to the point where payment would really "hurt." In the United States there was much confusion of thought, for many persons aho advocated reducing the burden on Germany were insistent that the Allies should pay their "war debts" to the United States. Ultimately it became clear that the colossal sums involved in reparation could not be transferred from one country to another without seriously upsetting the internal economy of both. For the history of reparations (1920–32) see REPARATIONS. (See also WAR FINANCE: COST OF WORLD WARS I AND II.)

Part ix, Financial Clauses.—This section (art. 248–263) was largely technical, dealing with the order of priority of German payments, the meeting of special debts from special assets. currency questions. and the like. and was closely connected with the reparation clauses. The powers to which German territory was ceded had to assume a portion of the German debt as it stood at the outbreak of the nar (art. 254), but "inasmuch as in 1871 Germany refused to undertake any portion of the burden of the French debt," France was exempted from any obligation in respect of recovered Alsace-Lorraine (art. 255). The powers which assumed mandates of the former German colonies were also exempted from taking over the debts of those colonies (art. 2j7). (See also SUCCESSOR STATE.)

Part x, Economic **Clauses.**—Sec. i (art. 264–281) dealt with the restoration of commercial relations. The most important provision nas that securing "most favoured nation" treatment from Germany for five years aithout reciprocity (art. 267). France obtained the exemption from customs duties of products of Alsace-Lorraine for five years (art. 268). Sec. ii (art. 282–295) dealt with the revival of treaties which had been nullified by the war.

Sec. iii–viii (art. 296–312) provided for the collection of debts and the regulation of various property rights and interests, contracts. patents, insurance, etc. In the liquidation of German property in foreign countries the principle was adopted of giving the Allies power to confiscate the private property of German nationals and of crediting the sums obtained to the amount paid as reparation by the German government (art. 297); Germans whose property was thus taken were left to collect compensation from their government. This departure from long-established practice was of course challenged by the Germans and was sometimes criticized in Allied countries as "socialistic." The Allies justified their position by saying that "all available means" must be used to meet Germany's obligations and that they themselves had taken over the foreign property of their own nationals. A considerable sum was obtained by this device.

Part xi, Aerial Navigation.——This provided for full liberty of passage and facilities for Allied aircraft flying over Germany until Jan. 1. 1923, unless Germany had been previously admitted to the League of Nations (art. 313–320).

Part **xii,** Port, **Waterways** and Railways.—This (art 321–386) mas a highly technical section. Its aim was to secure international control over rivers nhich flowed through more than one country—a rather striking development of the doctrine as to international rivers laid down at Vienna in 1815. There was a natural desire. honever. to provide access to the sea for countries like Snitzerland and Czechoslovakia. nhich were landlocked but were the sources of rivers running to the sea. International commissions were accordingly set up to control the Rhine. Elbe, Oder, Niemen and Danube rivers, with the result that Germany was left in a minority position as regards three rivers regarded as essentially German, the Rhine, the Elbe and the Oder. The Kiel canal was in effect internationalized so as to give freedom of access to all vessels of whatever country at peace with Germany (art. 380), but was left under German administration. Access to the sea was provided for Czechoslovakia by the establishment of free zones in the harbours of Hamburg and Stettin. Certain clauses governing international transport through Germany were of a temporary nature and were replaced by the decisions of an international transport conference held at Barcelona in 1921 under the auspices of the League of Nations. This section of the treaty was denounced by Germany in Nov. 1936. Several powers protested individually against this unilateral action, but to no effect. (See also WATERWAYS, INTERNATIONAL.)

Part xiii, Labour. — This section (art. 387–427) created the International Labour organization as the instrument to carry out art. 23a of the covenant of the League of Nations, by which the members undertook "to endeavour to secure and maintain fair and humane conditions of labour for men, women and children, both in their own countries and in all countries to which their commercial and industrial relations extend." Three representatives of labour took part in the formulation of the plan: Samuel Gompers of the U.S.. George N. Barnes of Great Britain and Albert Thomas of France, the last named of whom became the head of the International Labour office. The office was established at Geneva, side by side, but not identical with, the secretariat of the League of Nations; though an integral part of the League. its character and organs were autonomous. Its governing body consisted at first of 24 members, 12 representing governments, 6 elected by employers' delegates to the general conference. 6 by workers' delegates. Later the number was increased to 32, in the same proportion, with the proviso that 8 of the government members must represent Canada, France, Great Britain. India, Italy. Japan, the U.S.S.R. and the United States. thus ensuring adequate representation to the states of greatest industrial importance. The general conference, which met annually, consisted of four delegates from each member state, two chosen by the government, one by employers. one by labour. The conference acted by recommendations, and the governments were pledged to submit such recommendation to their respective competent authorities, who then decided what action, if any, to take. All members of the League were automatically members of the International Labour organization. Germany was admitted in 1919, long before it joined the League; when it left the League in 1933, it left the labour organization also. Japan and Italy, however, continued in the organization after they had resigned from the League. In 1934 the United States joined the organization without joining the League. In 1939 there were 57 member states.

After the defeat of France in 1940, the International Labour office was transferred to Montreal, Que. For work of the office. see the article INTERNATIONAL LABOUR ORGANIZATION. THE.

Part xiv, Guarantees. — In addition to the provisions for the demilitarization of the Rhineland (see above parts ii and iii), a military occupation by Allied troops was also provided for (art. 428). The whole of this area, together with bridgeheads across the Rhine, was to be occupied for 15 years from the coming into force of the treaty (Jan. 10, 1920). If, however, Germany "faithfully carried out" the terms of the treaty, the bridgehead and zone of Cologne was to be evacuated in 5 years, that of Coblenz in 10 and that of Mainz in 15 (art. 429). Because of suspicion that Germany was evading the military clauses, the evacuation of the Cologne zone was postponed from Jan. to Dec. 1925.

In June 1930 both the Coblenz and the Mainz zones were evacuated as part of a general settlement with Germany.

There was also a provision (art. 420) that if any time during the occupation or after the expiration of the 15-year period the reparation commission found Germany not observing its obligations with regard to reparation. the whole or part of the areas evacuated would be immediately reoccupied. It seems doubtful whether this article justified the action taken by the Allies in 1921 when they occupied areas in Germany east of the bridgeheads. That it justified the occupation of the Ruhr by France and Belgium in 1923 was warmly disputed by the British government. As a guarantee for the settlement of the eastern frontier of Germany, Germany was required to abrogate the treaty of Brest-Litovsk and other agreements made with the U.S.S.R. and to withdraw its troops in the east within its new frontiers when the Allies "shall think the moment suitable" (art. 433).

Part xv, Miscellaneous Provisions. — This section (art. 434–440) consists of a number of miscellaneous and technical matters which were accidentally omitted elsewhere. The most important was the recognition that the free zones of upper Savoy and Gex, lying between France and Switzerland, established in 1815 were "no longer consistent with present conditions" and that it was "for France and Switzerland to come to an agreement" for modification (art. 435). Switzerland, however, resisted the proposals of France for modification. and its position was sustained by the Permanent Court of International Justice in 1932. The property and stations of German missionaries overseas were to be handed over to trustees and individual missionaries were to be controlled or expelled at the will of the mandatory power (art. 438).

The treaty was drawn up in English and French, and the texts in both languages were authentic.

ESTIMATE

The treaty of Versailles was bitterly criticized by the German government and people and by many people in other lands. The first complaint was that the treaty had been "dictated," not merely in the sense that it had been imposed on a defeated enemy (the usual result of a lost war). but that no opportunity had been allowed for verbal negotiations. This was true, and the Allies may have blundered psychologically in refusing to meet the Germans for personal negotiations; it may be doubted, however, whether this procedure would have resulted in any large modification of the treaty.

Secondly, the Germans contended that the treaty was not in harmony with the fourteen points, which the pre-Armistice agreement provided should form the basis of peace. There was some truth in this contention. Point 3 calling for "the removal. as far as possible, of all economic barriers and the establishment of an equality of trade condition" was not observed, although the restrictions imposed on Germany were temporary. The provisions of part v of the treaty relating to German disarmament were far from fulfilling the promise of point 4 for "adequate guarantees given and taken that national armaments will be reduced to the lowest point consistent with domestic safety," although they marked a step in that direction. The "free, open-minded, and absolutely impartial adjustment of all colonial claims" demanded in point 5 was not satisfied, even though the adoption of the mandate system was somewhat less selfish than outright annexation. Also, on various points of detail, it could be maintained that the treaty failed to observe that "impartial justice" which President Wilson talked of so often in his speeches of 1918. On the other hand, the territorial clauses of the treaty were substantially in accord with points 7 (Belgium), 8 (Alsace-Lorraine) and 13 (Poland). Germany was not made an original member of the League of Nations, as it was perhaps entitled to expect under point 14, but at least it was assured that in due course it would be admitted. The treaty, then, was not a complete realization of the fourteen points, so far as they concerned Germany, but neither was it the complete travesty of them so often represented.

The third German complaint was that the treaty demanded intolerable sacrifices of Germany and that it could not be carried out without wrecking the economic life of the country. What the Germans really meant was that the treaty would make it impossible to restore the standard of living which had existed in 1914. No doubt the various items of loss and obligation, when assembled together, made the treaty as a whole appear much more crushing and severe than they did to the numerous committees which worked them out separately, and apparently the treaty in its definitive form was not reviewed by the Big Four from the point of view of its cumulative effect on the Germans. On the other hand, they were under such strong popular pressure not to make a lenient peace that they would not have dared to reduce the German burden in any large measure. The Germans, for their part, made the mistake of challenging almost every article of the draft treaty, instead of concentrating on a few fundamental issues, with the result that their objections were regarded as largely factious and only a few concessions were made. Apart, however, from such considerations, the Germans greatly exaggerated the probable effects of the treaty on their economic position. A competent U.S. authority, not unfriendly to Germany, has shown that the burden of taxation in Germany after 1919 was only a quarter as heavy as the burden in Britain and only half as heavy as in France or Canada. Furthermore, Germany's claim that it was ruined by reparation was not justified, for the total amount paid by Germany between 1920 and 1931 (when the Hoover moratorium was proclaimed) amounted to 21,585,000,000 gold marks, and it borrowed more than twice that amount in the United States alone and then defaulted on most of those loans. What ruined the German economy was the four years of war, during which the German government floated loans to the amount of 98,000,000,000 marks (or four times the amount paid in reparations); the total cost of the war to Germany was about $100,000,000,000 (or 20 times the amount paid in reparations). It can be argued that although Germany lost the war in a military sense and was then forced to yield certain territories. it won the peace in an economic sense.

Even if the harshest view be taken of the treaty of Versailles, the fact remains that no other diplomatic instrument was ever so speedily modified, revised or altered. Part i was modified to admit Germany to the League of Nations. Part v was torn up unilaterally by Germany when it began to rearm. Part vii went largely by default. Part viii was repeatedly whittled away and finally abandoned. Parts x, xi were modified or abandoned in large measure. Part xii was denounced by Germany. Part xiv, the section on guarantees, the crux of the treaty, was abandoned by the Allies five years ahead of schedule. Except as regards parts v and xii, these concessions were made to Germany before the advent of Adolf Hitler to power. Hitler's denunciations of parts v and xii evoked only faint and futile protests.

Thus, in 1938, only parts ii, iii and iv of the treaty remained; these concerned the territorial settlements of 1919. The real German grievance against the treaty of Versailles was not so much the burden of reparation or the so-called "war guilt" clause (art. 231) as the loss of territory in Europe and elsewhere. By the *Anschluss* of Austria in March 1938 (forbidden by art. 80), the partition of Czechoslovakia in Sept. 1938, and the occupation of Bohemia and Moravia in March 1939 (contrary to art. 81), the seizure of Memel in March 1939 (contrary to art. 99), Germany largely destroyed the political structure of eastern Europe as erected by the treaty of Versailles. The last step was to make war on Poland on Sept. 1, 1939.

Whereas Germany complained that the treaty was too severe, French opinion considered the treaty inadequate for the defense of France and Georges Clemenceau was defeated for the presidency of the republic in 1920 because he had made too weak a settlement. Curiously enough, when France. in the years following the negotiation of the treaty, tried to enforce it against Germany, it was not supported by its associates who had compelled it to accept the treaty against its better judgment. the United States retiring altogether from European politics. Great Britain and Italy constantly demanding that France make concessions to Germany. It is true that the treaty of Versailles failed to bring peace, order and prosperity to Europe; it is also true that the treaty was never fully applied. Rigorous enforcement of the treaty might have convinced Germany not only that it had lost the war, but also that war did not pay. Once the Allies began not to enforce the treaty and to modify it, they lost all chance of reconciling Germany to its provisions and encouraged it to nullify them. It is only from that point of view that the treaty of Versailles can be considered the cause of the war of 1939.

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(B. E. S.)

VERS DE SOCIETE, a term for social or familiar poetry, originally borrowed from the French, which came to rank as an English expression. The use of the phrase as an English one is first met at the opening of the 19th century, and it is to be observed that the English meaning is not wholly equivalent to that of the French original. The prince of the French graceful triflers was the Abbé de Chaulieu (1639–1720), of whom it was said that he made verses solely for the amusement of his friends, without the smallest intention of seeing them in print.

An enormous collection of *vers de société* was brought together by Titon du Tillet (1676–1762), in his *Parnasse françois,* where those who are curious about the subject may observe to satiety how ingenious and trifling these artificial verses of the French 18th century could be. The fashion for them followed upon the decline of interest in rondeaux, ballades and villanelles, and Chaulieu himself had not a little to do with throwing these ingenuities out of fashion. Of the writers of *vers de socie'te'* in France, J. B. Rousseau had the most poetical faculty.

If in England the expression *vers de société* carries with it more literary dignity, this is mainly due to the genius of one man—Matthew Prior. Prior's *Poems on Several Occasions,* collected in 1709, presents us with some of the earliest entirely characteristic specimens, and with some of the best. Here the poet consciously, and openly, resigns the pretension of high effort and an appeal to Parnassus. He is paying a visit at Burghley House, where the conversation turns on the merits and adventures of Fleetwood Shepherd; Prior then and there throws off, in extremely graceful verse, a piece appropriate to the occasion. He addresses it, and he dates it (May 14, 1689); and this is a typical example of *vers de socie'te'.* It will be seen that Prior, who learned much from his residence in the heart of the French world of fashion between 1711 and 1715, treats very much the same subjects as did Chaulieu and La Fare, but he does so with more force of style and dignity of imagination. As the 18th century progressed, the example of Prior was often followed by English poets, and the *vers de socie'te'* tended to merge with the epistle and the epigram. Swift, however, when he was neither coarse nor frigid, sometimes achieved a genuine success, as in the admirable verses on his own death. The odes of Ambrose Philips (1671–1749), addressed by name to various private persons, and, most happily, to children, were not understood in his own age, but possess some of the most fortunate characteristics of pure *vers de socie'te'.* In his "Welcome from Greece," a study in *ottava rima,* Gay produced a masterpiece in this delicate class, but most of his easy writings belong to a different category. Nothing of peculiar importance detains us until we reach Cowper, whose poems for particular occasions, such as those on "Mrs. Throckmorton's Bullfinch" and "The Distressed Travellers," are models of the poetic use of actual circumstances treated with an agreeable levity, or an artful *naïveté.* In a later age Byron, who excelled in so many departments of poetry, was an occasional writer of brilliant *vers de socie'te',* such as the epistle "Huzza, Hodgson," but to find a direct successor to Prior it is necessary to pass Henry Luttrell (1765–1851) and W. R. Spencer (1769–1834), and come down to Winthrop M. Praed (1802–39). A certain character was given to English *vers de société* by Hood and Barham, but the former was too much addicted to a play upon words and the latter was too boisterous to be considered as direct continuers of the tradition of Prior. That tradition, however, was revived by Frederick Locker, afterwards Locker-Lampson (1821–9j), whose *London Lyrics,* first printed in 1857 and constantly modified until 1893, is in some respects a typical example of pure *vers de société.* Numerous others attempted to carry on the tradition in English. Superior to all of them was Austin Dobson (1840–1921), who was. however, more than a writer of *vers de socie'te'.*

VERSE. Verse is metrical language; that is, language in continuous rhythm. The smallest possible section of rhythmic language is called a foot; it is a group of syllables completely expressing a rhythmical relation, yet incapable, by itself, of producing metre. Thus the syllables in "again" constitute an iambic foot (∪ –), but do not produce iambic metre until they are succeeded by at least one more iambic foot. A succession of feet completely expressing a given metre is called a verse, or, since it is usually written as a single line, a line. A succession of feet incompletely expressing a given metre is called a *caesural division* or a line section; it is usually set off by a caesura or pause within the line. When foot rhythm is present, the metre is measured by the number of feet contained within the line or verse, and is called monometer, dimeter, trimeter, tetrameter, pentameter, hexameter, etc., accordingly as the verse contains one, two, three, four, five, six or more feet. Lines or verses ordered into a complete group are called a stanza; stanzas are described, according to the number of lines they include, as couplets, tercets, quatrains, sestets, octaves, etc., according to the rhythm and metre of the lines; *e.g.*, iambic pentameter; and according to the rhyme scheme, if rhymes are employed. A complete group of stanzas is called a verse form. Thus the sonnet is a verse form; and the sonnet form employed by Shakespeare is that of three quatrains rhyming a b *a* b, c d *c* d, e *f e f*, followed by a rhymed couplet (g g), all in iambic pentameter.

Pyrrhic	∪ ∪	Second Paeon	∪ – ∪ ∪
Iamb	∪ –	Third Paeon	∪ ∪ – ∪
Trochee	– ∪	Fourth Paeon	∪ ∪ ∪ –
Spondee	– –	Major Ionic	– – ∪ ∪
Tribrach	∪ ∪ ∪	Minor Ionic	∪ ∪ – –
Anapest	∪ ∪ –	Diiamb	∪ – ∪ –
Dactyl	– ∪ ∪	Ditrochee	– ∪ – ∪
Cretic	– ∪ –	Choriamb	– ∪ ∪ –
Amphibrach	∪ – ∪	Antispastic	∪ – – ∪
Bacchius	∪ – –	First Epitritus	∪ – – –
Palimbacchius	– – ∪	Second Epitritus	– ∪ – –
Molossus	– – –	Third Epitritus	– – ∪ –
Proceleusmatic	∪ ∪ ∪ ∪	Fourth Epitritus	– – – ∪
First Paeon	– ∪ ∪ ∪	Dispondee	– – – –

The study of versification seems to have been brought to early perfection by the Greeks. The rapid development of Greek poetry and music and the importance of these arts in Greek education had such effect that by the 4th century B.C. an adequate phonetics had been established, the basic principles of rhythm discovered, the types of quantitative metre analyzed and assigned to their appropriate literary species, and the psychological and mathematical bases of verse and music explored.

Plato and Aristotle, cautious as they were in accepting the scientific and artistic theories of their predecessors, seem content with the state of musical and prosodic knowledge in their day: the former holds up the method of phonetics as a model of dialectical procedure (*Philebus* 17 A ff.), and the latter, even in dealing with poetry, is content to refer questions of versification to the metrists. Unfortunately, early Greek musical and prosodic theories have been handed down only in fragments, the most extensive and important of which are the works of Aristoxenus, a pupil of Aristotle, on harmonies and rhythms.

The Alexandrian grammarians wrote voluminously on prosody; a surviving work, the *Encheiridion* of Hephaestion (2nd century A.D.), suggests that the broad philosophical principles of older theory had long been supplanted by academic rules and formulas. Latin verse in its maturity was modelled on the quantitative measures of the Greeks, but the Romans, little given to speculative thought and interested in prosody chiefly as it bore on rhetoric, made no important contributions to the subject. During the middle ages the Byzantine grammarians, influenced by Hephaestion, continued the Alexandrian tradition, while Latin literary theory, usually in corrupt and garbled form, reigned in the west; such notable figures as St. Augustine (354–430), Boethius (*c.* 480–525), Aldhelm (c. 640–709) and Bede (673–735) touched upon the subject without substantially advancing it. As the Latin language fell into decay, quantitative distinctions among syllables disappeared, and from the 4th century accent became increasingly the basis of Latin verse. The Romance languages, developing out of popular Latin, produced verses based upon syllable counting; early Teutonic versification depended not upon foot construction, but upon the counting of alliterated or accented syllables; and, in brief, as the modern languages developed, poets constructed verses of such variety and upon such a diversity of bases that the induction and generalization requisite for philosophical analysis became ever more difficult and dangerous.

"Rules of versification," advanced in great number by European theorists from the 16th century onward, were no sooner stated than they were violated, and such violations seldom impaired the beauty and effectiveness of the verse. Classical prosody, even as rehabilitated by Richard Bentley (1662–1742), was too narrow to explain the vast diversity of structures; and the gradual increase of linguistic knowledge, bringing ever greater varieties of verse into the purview of the prosodist, complicated further the general problems of verse structure. In the 19th century and throughout the first half of the 20th, prosodic questions engaged the attention of physiologists, psychologists, phoneticists and acoustical physicists, without the discovery of any determinate principles. The modern state of the subject was in varying terms pronounced chaotic by such authorities as G. E. Saintsbury, Paul Verrier, T. S. Omond, W. P. Ker and E. W. Scripture.

Yet the principles laid down in antiquity are perfectly sound, and require only development and proper application to explain all verse. The solution to prosodic problems lies partly in the nature of rhythm, partly in the capacities of a given language, through determinations of its pronunciation, to satisfy the conditions of rhythm. The term "rhythm" is often applied figuratively to spatial proportions, such as those of landscapes, buildings and paintings; strictly, however, it applies only to such things as have successive existence in time, and possess order rather than position; for spatial objects, having coexistent parts, may have their parts viewed in any order without altering their proportions, whereas rhythm reversed or converted usually results in a different rhythm. Again, rhythm is not every proportion, but only such as are perceptible to sense, and capable of retention in the memory. Rhythm may therefore be defined as a numerical proportion, perceptible to sense, of things occurring in different intervals of time. Thus even prose may be rhythmic, in the sense that certain parts of it may be predominantly of this or that rhythmic character; *e.g.*, iambic or trochaic, but the consistent use of the same rhythmic ratio, however constituted, invariably produces metre, or verse.

Rhythms differ as to their form and matter. The form of a rhythm is the numerical proportion, based on some unit, constituting the rhythmic ratio; the matter is the sounds or movements entering into the ratio. All rhythm derives from number; hence, although rhythmical kinds are very numerous, all ultimately depend upon two possibilities of numbering: measurement in terms of some sound or movement taken as a unit, or measurement of sounds and motions in terms of their multitude merely. For example, the classical iamb (∪ –) is a three-count rhythm, the unit of measurement being the short syllable, the long syllable being equal to two of these, so that the ratio is 1:2; and rhythms may also be constructed by counting the number of syllables merely, without regard to any unit of time value, as in French syllabic verses.

In language the simplest rhythmic construction is the foot, which, like its analogue the musical measure, is based upon equal or proportional intervals of time measured by the length of the short syllable as unit. Every simple foot is a ratio between its two constituent parts, arsis and thesis, in terms of the time units or counts comprised in each part. The thesis is distinguished from the arsis by emphasis achieved by the use of certain characteristics of the syllable, such as accent or loudness, quantity or duration, etc., which will be discussed below. Foot rhythms differ formally according to the relative order of thesis and arsis and according to the difference of the ratio constructed. There are four possible orders: arsis as a whole may precede thesis as a whole, as in the iamb (∪ –); thesis as a whole may precede arsis as a whole, as in the trochee (– ◡); half of the arsis may precede, and half of it succeed, the whole thesis, as in the amphibrach (◡ – ◡); or half of the thesis may precede, and half succeed, the whole arsis, as in the cretic (– ◡ –). Since rhythm is temporal proportion, order is important; the ratio of 1:2, for example, is not the same as the ratio of 2:1. The common numerical ratios on which feet are based are 1:1, 1½:1, 2:1 and 3:1; thus the English iamb and trochee are both in the ratio of 1:1, difference in the quantity or duration of the syllables being disregarded; the classical iamb and trochee, in which the long syllable is given twice the value of the short, present the ratios of 1:2 and 2:1 respectively; the classical first paeon, composed of a three-count arsis and a two-count thesis (– ◡ ◡ ◡), is in the ratio of 1:1½; and the English paeon, a four-count measure, is in the ratio of 1:3. Two simple feet may be combined to form one compound foot; thus trochee and iamb combine to form the choriamb (– ◡ ◡ –) or the antispastic (◡ – – ◡), two trochees combine to form the ditrochee, two iambs make a diiamb, etc.

The material structure of the foot—the sounds and silence entering into proportion--can be described in terms of the kind of emphasis involved and in terms of the *rhythmical figuration.* All languages construct syllables out of vowels and consonants and determine the pronunciation of these, as they enter into discourse, according to accent, pitch, or quantity; syllables therefore are characterized in general by entity (their consonantal and vocalic construction), accent, pitch and quantity. These characteristics, as determined by the pronunciation of a particular language, are used to achieve emphasis in footed verse; unless they are determinate, construction of foot rhythm is impossible, and verse must be constructed on other bases. For example, since the Greeks and Romans pronounced syllables with attention to quantity, classical verse could be based upon quantity, the long syllable generally marking the thesis of the foot; as the sense of quantity disappeared, a new basis for versification had to be found. Similarly, English accentual verse was not possible until accentuation became determinate, and English quantitative verse has always remained only an artificial possibility because the syllables have no "natural quantity." Entity gives emphasis by alliteration, assonance, or rhyme, and pitch can create emphasis in languages with fixed pitches or intonations. Once rhythm has been established, it is possible in some verse to shift the principle of emphasis; *e.g.*, from accent to quantity, or from quantity to entity; or several of the characteristics of the syllable can be combined to create special emphasis, as in

> Stigma, signal, cinquefoil token
> For lettering of the lamb's fleece, ruddying of the rose-flake.[1]

Rhythmical figuration results from the number of sounds and silences and from their disposition within the foot. Thus, in a two-count foot, two syllables concurrent with the "counts," and disposed in the order of arsis and thesis requisite for a given rhythm, produce *strict representation,* and any variation from strict representation is variation in rhythmical figure. Strict representation, if continued at any length, produces monotony and fails to express emotion, character and even meaning adequately, since it restricts the possibility of inflections and nuances of the voice; hence poets utilize different rhythmical figures while maintaining the same formal rhythmical proportion, *i e.,* rhythm, just as composers use different numbers of notes differently disposed while keeping to the same musical measure. Thus, in a given verse foot, arsis or thesis may have its syllables doubled or tripled, sharing the allotted counts among them, even as in music two eighth notes or a triplet of eighth notes may be substituted for a quarter note; the arsis, or even in certain cases the thesis, may be suppressed, a silence taking its place in the rhythm; and the speech sound of arsis or thesis may be prolonged throughout the whole foot, or from part of one foot into part of another, as for example, the word cold is prolonged in Shakespeare's

> Toad, that under cold stone
> Days and nights has thirty-one.

Since the days of the Alexandrian grammarians, prosodists have confused rhythm with rhythmic figure, and consequently troubled themselves over "irregularities" of rhpthm; but variations in rhythmic figure do not disrupt the rhythm, as the slightest reflection will show. All substitutions of rhythmic figure are based upon the principle that, in rhythmic as in other proportions, equals may be substituted for equals.

As observed earlier, rhythm may also be based upon the multitude of sounds, without reference to any unit of duration. Such rhythm may be called *demarcative rhythm.* Languages capable of foot rhythm combine both forms; all other languages are confined to the various kinds of demarcative rhythm. Demarcative rhythm consists of sections, measured either in terms of the number of syllables contained, or in terms of certain syllables only, distinguished from the rest by alliteration, accent, or some comparable device, or in terms oi certain speech groups, such as phrases, rhythmical figures and the like. Larger sections are measured either in terms of the number of smaller sections contained, or in terms of the number of syllables, differentiated or undifferentiated, contained in these. Since such rhythm is more difficult to apprehend than foot rhythm, demarcative verses tend to be governed by rigorous rules as to the place of caesurae or pauses; and the beginning or ending of a section is often signalized by alliteration, assonance or rhyme.

It will be observed that verse is hierarchical in structure: each part, that is, enters into a whole which is in turn part of yet another whole, until the final composite is reached; for example, the foot is part of a line section, that section is part of a line, which is in turn part of the stanza. A second kind of hierarchy is possible through the use of superimposed or *mounted rhythm.* For example, an iambic pentameter line may have the first, third and fifth of its theses much more strongly emphatic than the rest, *e.g.*, by alliteration, quantity, or grammatical or rhetorical accent, and the consistent use of such three-stress rhythm against the "ground rhythm" of iambic pentameter will obviously generate another rhythm; this in turn may have yet another superimposed upon it. Thus in "The King was in his counting-house,/Counting out his money;" the ground rhythm is iambic tetrameter in the first line, iambic trimeter in the second; but "King," the first syllables of "counting-house," "counting" and "money" receive special stress and set up a mounted rhythm of trochaic dimeter in both lines. Again, in Browning's "Kentish Sir Byng stood for his King,/ Bidding the crop-headed Parliament swing:" the ground rhythm is dactylic tetrameter; but "Byng," "King," "crop" and "swing" have special stress, and establish a mounted rhythm of iambic dimeter. Mounted rhythm is capable of imparting a brisk swing or a slow swaying motion to the verse; it is very common in folk poetry and folk music.

While continuation of the same proportions, whether of foot, line or stanza, results always in symmetrical verse, poets frequently abandon such symmetry in favour of the greater expressiveness or appropriateness which may sometimes be achieved by a change of rhythm. Such changes may be made without disruption of the rhythmic beat, by increasing or diminishing the counts of a foot, although retaining the order of thesis and arsis; thus trochaic measures easily augment to dactylic, or anapests diminish to iambics. Similarly, the counts of a section can be increased or diminished. Again, where there is mounted rhythm, the ground rhythm can be replaced by another, or the ground rhythm maintained while the mounted rhythm is shifted. The powerful effects of such rhythmical transitions can be observed in Dryden's "Alexander's Feast," Schiller's "Der Handschuh" and Hugo's "Les Djinns."

Anyone who has heard a piece of music played too slowly or too rapidly is aware of how tempo influences the character of rhythm; and in verse as well the effectiveness of rhythm is relative to the tempo of the verse. The tempo of verse, like that of piose, is partly dependent upon the grammatical construction and significance of the language, but it also depends upon certain devices of versification. All things being equal, short-count measures like iamb and trochee tend to be faster than long-count measures like paeon and epitritus (◡ – – –); falling rhythm, in which thesis precedes arsis, is faster than rising rhythm, in which arsis precedes thesis; rhythms in strict representation and regular figuration are faster than those which are not. Yet such is the relativity of verse that short feet can be slowed by the use of long and sonorous syllables, by rendering both thesis and arsis forceful, and by using detached sounds; *i.e.*, monosyllabic rather than polysyllabic words. Conversely, the longer measures can be accelerated by the use of light and brief syllables, by using composite (doubled or tripled) arses and theses, and by using connected sounds. Since tempo is a matter of the speed or slowness with which rhythmic intervals succeed each other, shortening of the duration of the unit of measurement, especially when coupled with the doubling or tripling of the syllables of each count, will increase the speed of foot rhythms; conversely, deceleration can be achieved by lengthening the unit and reducing the number of syllables, even to the extent of prolonging one syllable from thesis to arsis. Milton's "L'Allegro" and "Il Penseroso" provide many examples of these and similar devices.

In scanning foot rhythms, it must not be supposed that the rhythm of a word or phrase, taken by itself, is necessarily the same as that of the verse in which it is found; that, for example, a verse is necessarily trochaic because it contains trochaic words. This supposition—a stumblingblock even to so eminent a theorist as Robert Bridges—is quite unfounded; poets have repeatedly demonstrated the various effects achieved by the confinement or nonconfinement of grammatical units, whether words, phrases, or clauses, within the metrical interval. Analysis has also been hindered by another supposition: that the most strongly stressed syllables are always necessarily theses. This overlooks the fact that emphasis is, after all, relative and not absolute; a heavily marked syllable frequently turns out to be nonemphatic because it is coupled with one still more heavily marked, and conversely, the weak secondary or even the tertiary accent of a polysyllable may be emphatic; *cf.* T. S. Eliot's use of the word "polyphiloprogenitive" to fill out an entire iambic tetrameter line.

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VERTEBRATE is the name given to the group of animals having vertebral columns or backbones. The vertebrates, which include the fishes, amphibians, reptiles, birds and mammals, are the predominant members of the Chordate (*q.v.*) phylum. In addition to the backbone from which they derive their name, the vertebrates are characterized by (1) a muscular system consisting primarily of bilaterally paired masses and (2) a central nervous system partly enclosed within the backbone. The heart and other visceral organs lie below the backbone.

Vertebrates are unique in possessing an internal skeleton. By its ability to provide support during growth, this skeleton allows vertebrates to achieve large size, so that most vertebrates are bigger than most invertebrates. Except in the most primitive forms, the skeleton consists of skull, vertebral column and two pairs of limb elements, although one or both pairs of limbs are absent from a few higher forms (*e.g.*, snakes, whales) that have lost limbs in the course of evolution. The skull, by providing a secure housing for brain, eyes, ears and olfactory organs, has facilitated the evolution of intelligence and a high degree of responsiveness to the environment.

The vertebral column and limb skeleton provide support for the body as a whole. Movement is effected by the action of muscles that are attached to the bones. The mass of musculature forms the contours of the body. The outer surface is covered by skin which protects the inner parts not only by providing a general covering, but also by forming structures of specific protective value, such as bony or horny scales, feathers and fur. Teeth have evolved from scalelike structures formed inside the mouth.

Internally the vertebrate trunk is a hollow cavity in which the visceral organs are suspended. The cavity is subdivided, the heart having a chamber to itself. Other organs occupy a common pleuroperitoneal cavity, except in the mammals, in which each lung has a separate chamber.

The heart and respiratory organs are closely associated. The heart lies just behind the gills or between the lungs; it sends impure blood directly into these organs for oxygenation and removal of carbon dioxide. The gills of fishes lie along the sides of the pharynx, a large chamber that is part of both respiratory and digestive tracts. In land-living forms the enlarged pharynx perforated by gill slits is repeated in early embryonic development but later regresses. The remainder of the digestive tract includes esophagus, stomach and intestine, and usually terminates in a cloaca, a chamber common to the digestive, genital and urinary systems. In mammals, however, the digestive tract acquires a separate terminal opening. The urinary and genital systems are closely associated, particularly in males, in part because the kidneys, which develop early, make contributions to the later-developing reproductive system.

The central nervous system consists of brain and spinal cord. Although both of these become very thick walled, they always retain a small central canal (*i.e.*, are hollow). The brain in lower vertebrates is devoted largely to serving the sense organs of the head. During the course of evolution, however, the brain has become much larger, relative to body size, through the development of association areas that permit more intensive interchange of information among the parts of the brain. The spinal cord, extending backwards from the base of the skull, gives off pairs of nerves at repeated intervals. These nerves run to the skin, muscles and internal organs. The brain also gives off a series of nerves, not regularly arranged, of which one passes through the neck to innervate the heart, lungs and other viscera.

Vertebrate history may be traced back to the Ordovician period, approximately 400,000,000 years ago. The primitive vertebrates existing at that time were the Ostracoderms, now totally extinct. These were small, armoured creatures lacking either jaws or fins.

The body form was, however, fishlike and their armour was made of true bone, a material found only in vertebrates. Their closest surviving relatives are the finless, jawless cyclostomes (lampreys, hagfishes). The later occurring Placoderms possessed jaws, which apparently evolved through shifting and conversion of the supports of the most anterior gills. The true fishes added the two pairs of appendages that have become part of the standard vertebrate pattern. Thus equipped with fins and jaws, the fishes have been able to flourish for more than 200,000,000 years.

Fishes breathe by means of gills, over which a continuous stream of water passes. Many fishes, however, also have lungs which supplement the action of the gills. The possession of lungs, plus thick fleshy fins that made waddling possible, enabled the ancient crossopterygian fishes to come out on land. These fishes gave rise to the first amphibians, in which the fins became transformed into walking legs. The gills disappear in most amphibians in the adult state. Correlated with this change is the appearance of a subdivision in the heart to receive pulmonary blood, since blood that has been refreshed in the lungs is returned to the heart rather than being distributed directly to the tissues, as is done in a gill system. Although amphibians were the first animals to live successfully on land, their expansion has been limited by the need to lay their eggs in wet places.

The reptiles, which evolved from the amphibia, were the first vertebrates to be able to live entirely out of water. This independence resulted partly from the formation of a horny skin covering that conserves body moisture, partly from the development of a large egg, laden with food and water, and encased in a leathery coating that protects against drying. Structurally and functionally the reptiles show numerous other advances beyond the amphibian stage, including a heart in which the freshly oxygenated blood that has circulated through the body is kept partly separate from the spent blood from the other organs. Body temperature, however, varies according to the ambient temperature, as in lower forms.

At the time of reptilian predominance, about 100,000,000 years ago, two groups of reptiles gave rise to the birds and mammals separately. In the birds, the skeleton has been greatly modified through elimination and fusion of elements and the bones have become very light. The heart is completely subdivided into right and left halves, so that there is no mixing of refreshed and spent blood. The supply of fully oxygenated blood that the tissues thus receive facilitates the maintenance of constant temperature and makes possible a sustained high level of bodily activity. A covering of feathers, evolved from reptilian scales, helps to retain body heat. Birds reproduce by laying large eggs, but unlike reptiles they tend the eggs and care for the young.

Mammals resemble birds physiologically in being able to maintain constant temperature and high activity. Mammals differ importantly in brain development and mode of reproduction The enlargement and elaboration of the brain permits more adaptable, less stereotyped behaviour patterns than occur in birds In all but the primitive monotremes, which lay eggs, mammalian reproduction involves the internal development of tiny eggs that derive oxygen, water and nutrients from the blood stream of the mother. Milk secreted by the mammary glands sustains the young after birth. All major vertebrate classes have shown striking ability to produce a great variety of species capable of exploiting every possibility for survival. This tendency is well illustrated by the mammals Beginning as rat-sized, ground-living animals, mammals have evolved into forms as small as the shrew and as huge as the whale, adapted to survive in swamps and jungles, on grassy plains or deserts, in burrows or tree tops, in fresh or salt water, on the arctic ice or under it. *See* FISHES; CHONDRICHTHYES; AMPHIBIA; REPTILES; MAMMALIA; EVOLUTION, ORGANIC; MONOTREMATA; *see* also references under "Vertebrate" in the Index volume.

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VERTEBRATE EMBRYOLOGY. The science of embryology (*q.v.*) had its first beginnings in the study of the Vertebrate (*q.v.*), the group that includes those forms of life whose eggs and breeding habits naturally first attracted attention, and even today the mass of known embryological detail relating to vertebrates far exceeds that relating to any other phylum. Further there is no phylum of the animal kingdom which shows in so varying degrees the modifying influence of such factors as amount of yolk in the egg, external environmental conditions, etc.

The vertebrate animal, like most other animals, begins its existence as a single cell, the zygote or fertilized egg, formed by the fusion of two gametes, derived one from each parent. The zygote possesses in itself all the specific peculiarities of the complete individual of its species. To human observation, however, the zygotes of different animals do not exhibit any of the peculiarities differentiating the adults. Such peculiarities as they do present are in such comparatively trivial characters as size, shape, colour. Otherwise each zygote is to all appearance simply a typical cell with cytoplasm and nucleus. The superficial differences have to do mainly with adaptive features enabling the young individual to remain for a more or less prolonged period within the shelter of an egg shell. This is rendered possible in the first instance by the zygote possessing in its cytoplasm a store of yolk—highly concentrated food material—which provides it with subsistence. The greater the amount of this yolk capital stored away in the zygote, the greater its size: there is a rough proportion between size of egg and quantity of yolk. Thus in *Amphioxus* the zygote has a very minute trace of yolk in its cytoplasm and its diameter is about 0.1 mm.; in the extinct bird *Aepyornis* of Madagascar, judging from the size of the shell, the zygote may have been as much as 160 mm. in diameter.

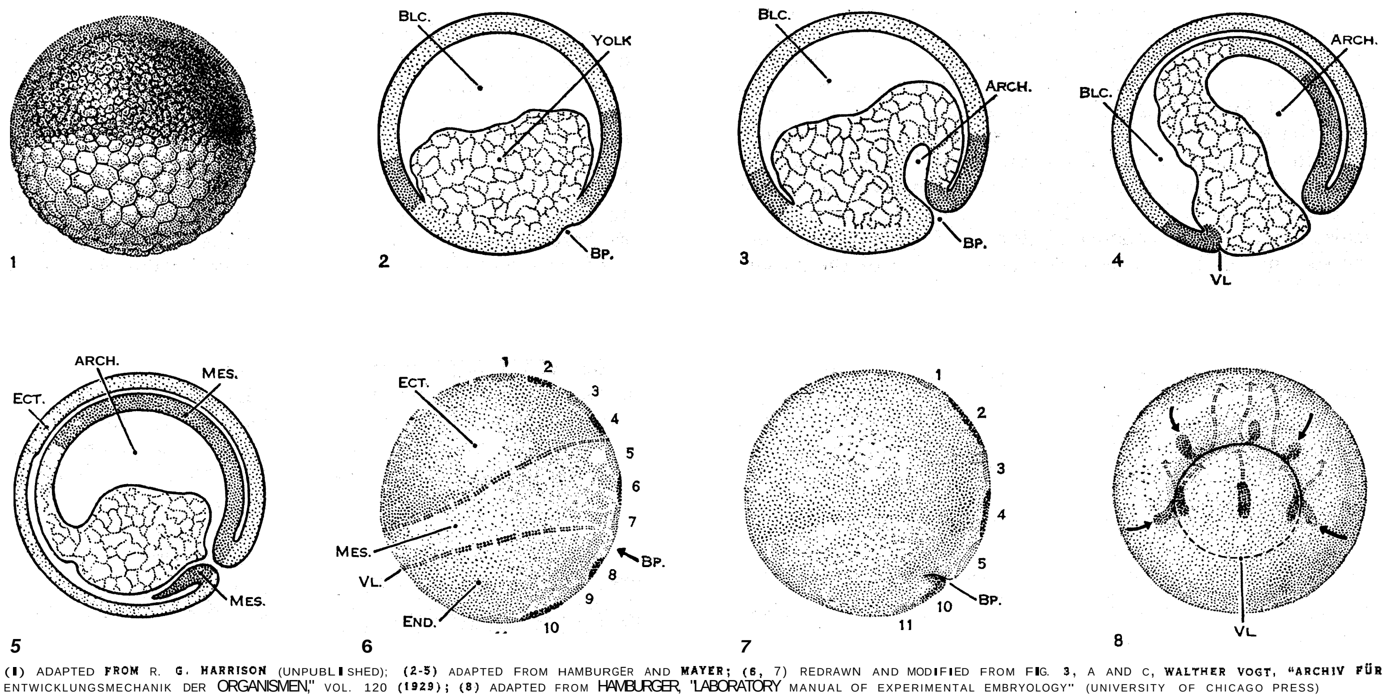
In the Mammalia of the most ancient type (Monotremata, *q.v.*), which still lay their eggs, these are large and richly yolked (*Echidna* 3.5 mm., *Ornithorhynchus* 2.5 mm.), and the young pass through the early development within the egg shell.

In the ordinary modem mammal, on the other hand, the egg is not laid in the ordinary sense. The zygote is retained within the uterus and there proceeds with its development, absorbing such nourishment as it requires from the mother. The store of yolk, no longer necessary, has disappeared and the zygote has reverted to the small size of from 0.1 mm. to 0.3 mm. in diameter.

Embryology of a Typical Vertebrate.—The basic features of vertebrate development can best be illustrated by an account of the transformations of the salamander embryo during the earlier formative stages. The first step following fertilization is the cleavage, by cell division, of the egg into a greatly increased number of smaller cells, together constituting the spherical *blastula* (fig. 1). The latter develops a cavity, the *blastocoele,* which is eccentrically situated because of the large amount of nutritive yolk stored in the cells composing the lower half of the embryo (fig. 2). There now ensues a remarkable process termed *gastrulation,* during which the primitive gut cavity and the germ layers are established. The first indication of the onset of gastrulation is the appearance of a small transverse indentation on the surface of the embryo below the equator (fig. 2). This groove is called the *blastopore,* and the tissue bordering it above, its *dorsal lip. Lateral* and *ventral lips* are formed as the groove extends to become crescentic and finally circular in form (figs. 7 and 8).

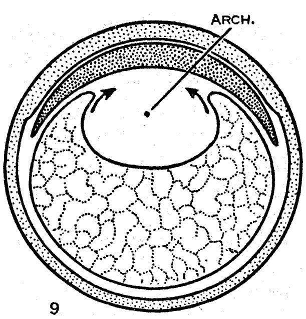
Meanwhile the original pocket formed beneath the overhanging dorsal lip has pushed deeper internally, where it gradually displaces the blastocoele and expands to form the primitive gut cavity, or *archenteron* (figs. 3 to 5). The understanding of the manner in which the archenteron is established is due largely to the classical studies of Walther Vogt. Fig. 6 represents a blastula on which a meridional series of closely spaced spots have been "painted" by the application of harmless dyes. As gastrulation proceeds the spots nearest the blastopore gradually disappear from view, until at the stage shown in fig. 7 all of the tissue lying between marks No. 5 and 10 has moved into the interior, where dissection shows it to form the roof and floor of the gut cavity. Before the latter is finally completed, at the close of gastrulation, all of the tissue below mark No. 4 moves in to share in its formation.

This inrolling of surface material, although initiated first at the dorsal lip and proceeding here most actively, takes place around the entire circumference of the blastopore as the lateral and ventral lips are formed. By applying spots of colour at various points on the blastula, Vogt was able to map out the portions of the blastula which are thus tucked into the interior, and to foretell what these invaginated materials will form after they have reached their new position. Some of this information is represented in fig. 6, showing the blastula in surface view just before the onset of gastrulation. Except for the area labelled



(1) ADAPTED FROM R. G. HARRISON (UNPUBLISHED); (2-5) ADAPTED FROM HAMBURGER AND MAYER; (6, 7) REDRAWN AND MODIFIED FROM FIG. 3, A AND C, WALTHER VOGT, "ARCHIV FÜR ENTWICKLUNGSMECHANIK DER ORGANISMEN," VOL. 120 (1929); (8) ADAPTED FROM HAMBURGER, "LABORATORY MANUAL OF EXPERIMENTAL EMBRYOLOGY" (UNIVERSITY OF CHICAGO PRESS)

Fig, 1.—Salamander embryo in blastula stage of development. Note differences in cell-size and pigmentation between upper and lower hemispheres. Figs. 2 to 5.—Sagittal sections of young embryo at successive stages during gastrulation, showing invagination of mesoderm (heavily stippled) and endoderm to form the primitive gut cavity. (arch., archenteron; *blc.*, blastocele; bp., blastopore: ect., ectoderm; end., endoderm; mes., mesoderm; *vl.*, ventral lip.) Fig. 6.—An embryo (blastula stage) bearing a meridional series of marks applied to the surface tissue by means of vital dyes. bp., point where blastopore will shortly appear, The line demarcating the endoderm (end.) and mesoderm (*mes.*) coincides with the position where the future lateral and ventral lips (*vl.*) of the blastopore will appear. Fig. 7.—Same embryo as in fig. 6, after invagination of surface tissue has begun. Fig. 8.—Ventral view of embryo in gastrula stage, showing the inrolling of surface tissue along the dorsal and lateral lips of the blastopore. Solid arrows indicate direction of past movements and stippled arrows the direction of future movements after the marked tissue has moved to the interior of the embryo, The tissues invaginating at the outer and inner margins of the crescentic blastopore groove are mesoderm and endoderm, respectively. Later, as indicated by the dotted line, the blastopore groove completely encircles the **endoderm. It** is at the ventral blastopore lip (*vl.*) thus formed that the ventral mesoderm of the embryo is finally invaginated (see figs. 4 and 5).



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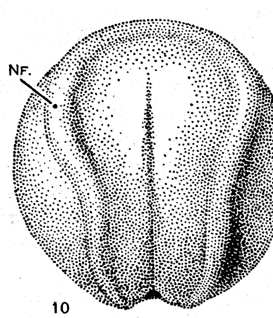

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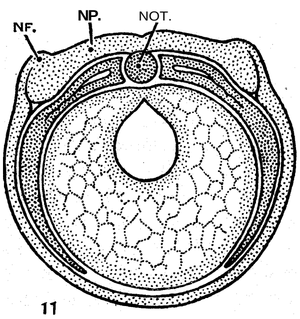

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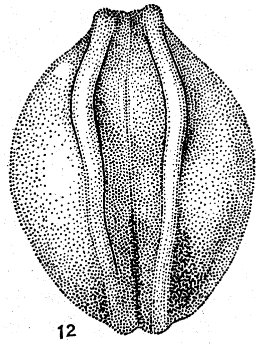
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(9-11) ADAPTED FROM HAMBURGER AND MAYER; (12) ADAPTED FROM R. G. HARRISON (UNPUBLISHED)

Fig. 9.—Transverse section of embryo in advanced stage of gastrulation. The roof of the gut cavity *(arch.)* is formed by the mesoderm. Later the lateral margins of the endoderm will grow upward (note arrows) and fuse to form an intestinal tube lined entirely with endoderm (see fig. 11). Fig. 10.—Dorsal view of embryo showing primordium of central nervous system. The tissue bordered by the horseshoe-shaped ridge will later form the brain and spinal cord. ***nf.***, neural fold. Fig. 11.—Transverse section of embryo at stage shown in fig. 10. ***nf.***, neural fold; ***np.***, neural plate; ***not.***, notochord. Fig. 12.--Showing the beginning closure of the neural folds to form the tubular central nervous system. Compare with fig. 10.

ectoderm, all of the surface tissue passes to the interior, where the regions marked mesoderm and *endoderm* constitute the germ layers bearing these names. Meanwhile the ectoderm undergoes a process of stretching or expansion which enables it to envelop entirely the two internal germ layers.

The diagram in fig. g shows the relationships of all three layers as seen in a transverse section of the embryo toward the completion of gastrulation. The mesoderm, which has invaginated at the dorsal and lateral lips (fig. S), forms an arched mantle roofing the archenteron and extending ventrally on either side between the ectoderm and endoderm. Its original continuity with the endoderm along the line labelled vl. in fig. 6 has become interrupted during the process of invagination. The lateral margins of the trough-like endoderm are seen to be pushing upwards (note arrows) and will later meet to form the definitive roof of the alimentary tube.

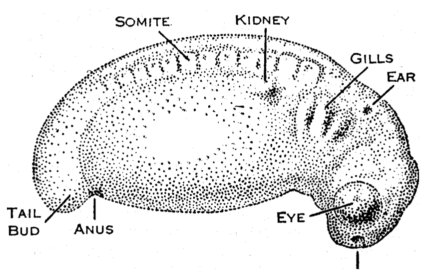
First, however, attention may be called to an important development which now ensues in the dorsal ectoderm. As viewed externally (fig. 10), this consists of the appearance of a pair of longitudinal ridges, the neural folds, continuous with one another anteriorly and converging posteriorly toward the blastopore, which is now greatly reduced in aperture and constitutes the anus. The neural folds bound a large horseshoe-shaped area of ectoderm, the neural plate, which will subsequently differentiate as the brain and spinal cord. The neural plate in transverse section, as well as the condition of the internal germ layers at this stage are represented in fig. 11. The gut cavity is now completely enclosed within the endoderm, through fusion dorsally of the processes noted in fig. 9, and the axial portion of the mesoderm has constricted off as a rod-like structure, the notochord, or forerunner of the backbone.

The neural plate, which at this stage is broad and flat, gradually becomes narrower and more trough-like as the folds bordering it laterally become further elevated and move closer together (fig. 12). They finally meet and fuse along the mid-dorsal line of the embryo, and it is in this manner that the tubular central nervous system of the vertebrate embryo is characteristically formed. The anterior portion of the tube later differentiates as the brain and the remainder as the spinal cord.

Following closure of the neural folds and the increasing elongation of the embryo one can begin to recognize the emergence of several organ primordia (fig. 13). The eye is visible as a bulge on the side of the head, and immediately below it is a depression in the epidermis which will later form the nasal passage communicating with the mouth cavity. The pit noted higher on the head subsequently sinks to the interior and differentiates as the membranous labyrinth (semicircular canals, etc.) of the internal ear. Elevated ridges mark the beginning outgrowth of the external gills, and further back the embryonic kidney, or *pronephros*, is becoming visible as a swelling beneath the skin. The dorsal portion of the mesoderm has become divided by transverse furrows into a number of segments, or somites, visible through the semitransparent skin.

The internal relationships at this stage are seen in fig. 15, which will also serve as a basis for indicating the subsequent fate of the principal structures shown. The notochord, after a transitory existence, is replaced by the vertebral column, formed by adjacent portions (sclerotomes) of the somites. The remaining tissue of the somites differentiates principally into the segmented muscles (*myotomes*) of the back, and, by a process of downgrowth, those of the abdominal wall. Meanwhile the spinal nerves grow out from the spinal cord to supply the muscles and the skin. The individual fibres constituting these nerves represent greatly elongated processes of the cells of the spinal cord; the sensory fibres to the skin growing out from the cells of the *neural* crest, and the motor fibres to the muscles from cells in the ventral portion of the cord. The so-called "white-matter" which gradually envelops the embryonic cord consists principally of innumerable nerve fibres connecting with the brain and other levels of the central nervous system.

The coelom, or cavity housing the viscera, originates as paired clefts formed by a splitting into two sheets of the lateral layers of unsegmented mesoderm. At first small (fig. 16), these clefts gradually expand, as room is made by the increasing withdrawal



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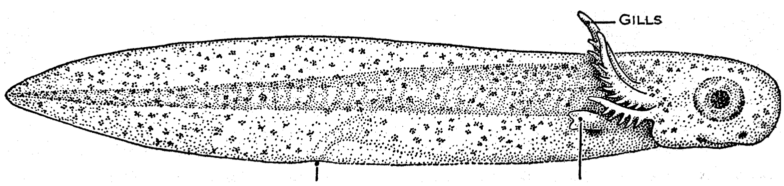

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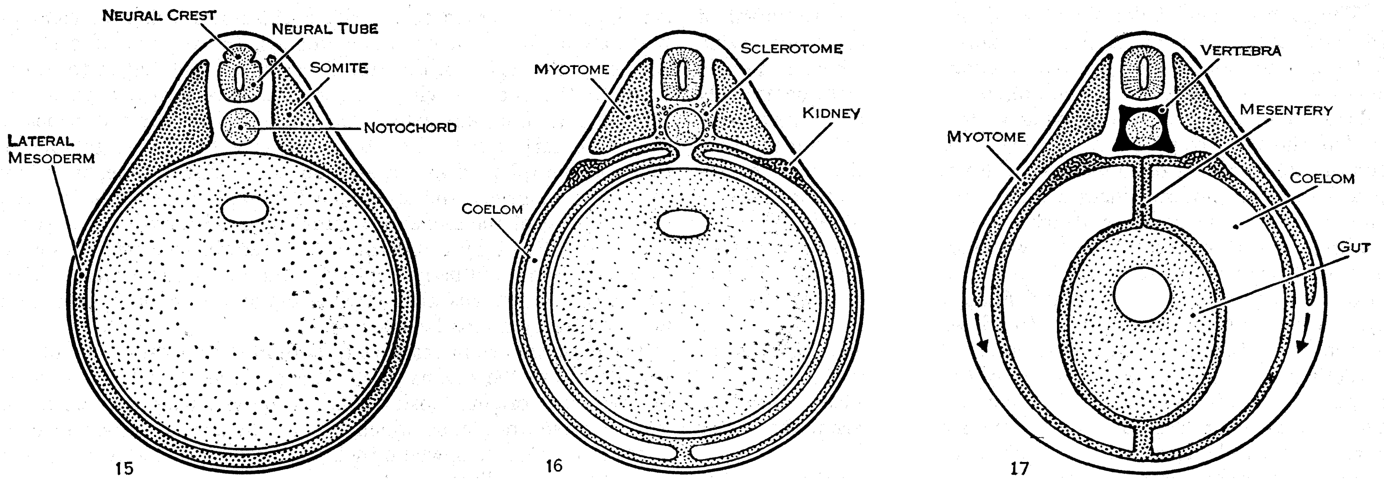
(13, 14, ADAPTED FROM R. G HARRISON (UNPUBLISHED)

Fig. 13.—Embryo at stage of development when various organ primordia first appear. The mouth opening, which forms as a secondary perforation, does not break through until considerably later. Fig. 14.—Young larva (tadpole) at stage of hatching from protective jellylike membranes in which the embryos develop. Note that the fore limb has as yet only two digits. The small dark spots scattered in the skin are the pigment cells (chromatophores).



(15) COURTESY V. C. TWITTY; (16, 17) ADAPTED FROM HYMAN, "COMPARATIVE VERTEBRATE ANATOMY" (UNIVERSITY OF CHICAGO PRESS)

Figs. 15, 16 and 17.—Diagrams illustrating the formation of the coelom, mesenteries, musculature of the body wall (myotomes), and the vertebral column. The aggregations of cells labelled *sclerotome* in Fig. 16 are budded off from the somites and later (fig. 17) form the vertebral column. The *neural crest* (fig. 15), in addition to forming the nerves (not shown) to the skin, gives rise to wandering cells which differentiate into chromatophores (see fig. 14).

of yolk from the wall of the gut into the blood stream, and eventually the medial sheets from each side meet to form the *mesentery* supporting the intestine (fig. 17). It is during this period of coelom formation that the myotomes grow ventrally beneath the skin to complete the musculature of the body wall.

In its broad outlines the preceding account of the early development of the salamander is applicable to vertebrates in general. For example, if we ignore the inevitable differences imposed by variations in the amount of yolk stored in the egg, the processes of cleavage, gastrulation, coelom formation, etc., are remarkably similar in such widely related vertebrates as the amphibians, fish and birds. One of the most notable differences between the embryos of the lower and higher vertebrates is the development by the latter of the extra-embryonic membranes, an innovation essential to embryos developing within a shell on land (reptiles and birds), and inherited and adapted by the mammal for uterine life.

The remainder of the article will be devoted to special accounts of the development of the various *organ systems*.

The Skin.—The skin of vertebrates is formed by the ectoderm, with a backing of tough connective tissue traversed in all directions by fine intercellular fibres and constituting the dermis. In all members of the group the epidermis, by cell multiplication, loses its original condition of being only one cell thick. In fish numerous epidermal cells become glandular and secret slime. From the lungfish upwards, local aggregations of these cells form definite flask-shaped glands, opening by minute pores on the body surface. These epidermal glands undergo specialization in various directions—salivary glands, poison glands, sweat glands, milk glands, etc. In terrestrial vertebrates the superficial ectoderm cells become converted into keratin, forming a horny layer which obstructs evaporation, and these horny cells are shed from time to time as loose scurf, as coherent flakes, or as a continuous slough (*e.g.,* snakes). In reptiles they form a hard layer, covering underlying bony plates in tortoise shell or the surface of the head in reptiles generally, or forming, with a dense backing of connective tissue, the scales of ordinary reptiles. Innumerable special developments of the horny layer occur, some of which will be found described in other articles: such are claws, feathers, hair, hoofs, rhinoceros horn, whalebone, etc.

The Nervous System.—In most of the more primitive holoblastic vertebrates the brain first becomes differentiated into an anterior cerebrum and a posterior rhombencephalon, demarcated from one another by an upward fold of the brain floor. Of these the former becomes later differentiated into the thalamencephalon in front and the mesencephalon behind. The cerebral hemispheres, which in the higher mammals assume great importance, seem to arise primitively as paired outward bulgings of the side wall of the brain towards its front end—related to the sense of smell. The main part of the thalamencephalon undergoes thickening of its side walls (optic thalamus) while its roof becomes for the most part degenerate, forming a thin membrane in intimate contact with a network of blood vessels (choroid plexus) lying immediately outside it. At its hind end an outgrowth—the pineal body—develops which may remain a simple club-shaped or tubular structure, but in several cases becomes differentiated into two portions, the anterior of which (parapineal) develops into an eye *(Sphenodon,* various lizards).

In front of the fold of the brain floor already alluded to. the floor of the thalamencephalon dips down as the infundibulum, and this becomes in the course of development closely associated with an independent structure—the pituitary body. In the more typical vertebrates the two become inextricably involved with one another and it is customary to speak of the nervous part of the pituitary body. The pituitary ingrowth of the ectoderm is typically a hollow pocket and in the surviving crossopterygians it retains this form through life, forming a gland which opens into the buccal cavity. In those vertebrates in which yolk is present at the site of its formation, the pituitary ingrowth is, as in other such cases, solid, developing its cavity secondarily.

The *organs* of *special sense* arise as localized developments of the ectoderm. In the case of the olfactory organ and the auditory organ, the rudiment shows first as a localized thickening of the ectoderm, which then, through extension in area, becomes involuted below the surface of the skin as a saucer-like depression. Finally, the opening to the exterior becoming gradually constricted, the organ assumes the form of a more or less completely closed vesicle. In the case of the olfactory organ the closure is never complete, the function, that of chemical testing of the surrounding medium, necessitating free communication between its cavity, in the lining of which the sensory cells develop, and the outside. In the majority of vertebrates however partial closure takes place, to divide the opening into two—one at each end of the organ—and so render possible the drawing in of a current of the external medium through the organ. The first vertebrates that have this power of "sniffing" are the lungfishes and the origin of the arrangement which makes this possible is well seen in *Protopterus,* where the opening of the olfactory organ narrows, except at its two ends, so as to form a slit. The edges of the slit then undergo fusion and the original single opening is now represented by two separate openings a considerable distance apart. As the anterior boundary of the buccal cavity becomes delimited, one, the anterior or external naris, is left outside and the other, posterior or internal naris, is enclosed within the buccal cavity, perforating its roof. In terrestrial vertebrates in general the olfactory organ becomes similarly provided with external and internal nares, though the process of development shows various modifications in detail.

The early stages of development of the otocyst or rudiment of the auditory organ are similar to those of the olfactory organ, but the reduction of the external opening goes further: in fact in all vertebrates except elasmobranchs, it becomes completely closed. The peculiar feature which distinguishes the vertebrate is that the usually pyriform otocyst of early stages undergoes a complicated process of modelling, whereby its wall comes to project into three hollow ridges situated in planes perpendicular to one another. The basal or attached portion of each of these becoming obliterated except at its two ends, the ridge is converted into an arched tube — the semicircular canal — opening at each end into the cavity of the otocyst and filled, like the rest of the otocyst, with watery endolymph. In all except the most archaic vertebrates, the otocyst undergoes a still further process of modelling whereby its lower portion (saccule), which develops a special pocket-like outgrowth devoted to the sense of hearing, becomes more or less completely constricted off from the upper portion or utricle, carrying the semicircular canals.

The vertebrate eye differs from the other sense-organs in that its main portion — that containing the actual sensory cells — is developed, not from the external ectoderm, but from the involuted portion of the ectoderm which forms the brain. In a typical case, as in a bird embryo, the optic rudiment consists in its earliest stage simply of the lateral portion of the wall of the thalamencephalon, which here extends outwards on each side so as to give the brain a T-shape. As development proceeds the optic rudiment becomes narrowed at its base to form the optic stalk, which later will become the optic nerve. The distal dilated portion gives rise to the retina, while the region of external ectoderm in contact with its outer end gives rise to the lens. In a typical case, *e.g.*, a bird, the lens is at first simply a slight thickening of the ectoderm, but this soon sinks inwards to form a saucer-shaped depression of the surface, which, by a gradual narrowing of its opening, becomes converted into a closed vesicle. The deep wall of this becomes greatly thickened, its individual cells becoming tall and columnar, and gradually takes on the form of a biconvex lens, the outer wall forming a thin layer of epithelium covering its outer surface. As development goes on the cells of the lens become keratinized and transparent.

Meanwhile the original optic rudiment is undergoing differentiation. Its distal portion next the lens becomes involuted within the proximal portion, so that the whole rudiment now takes the form of a double-walled optic cup the mouth of which is blocked by the lens. The inner wall of the cup increases much in thickness and gradually assumes the immense complexity characteristic of the functional retina, of which the most striking peculiarity is that the visual cells are situated on its deep face, the sensory rods facing not towards the lens but away from it — so that rays of light have to traverse the whole thickness of the retina, which is therefore necessarily transparent. On the other hand, the nerve-fibres which pass from the retina to the brain emerge from the retina on its face next the lens, instead of from its deep face as one would expect. This extraordinary reversal of the vertebral retina is at once explained by the method of its development, the deep surface carrying the rods having been originally, before the involution of the brain rudiment took place, part of the outer surface of the head. The outer layer of the optic cup undergoes none of the complicated histogenesis seen in the retina. It persists as a single layer of polygonal cells within which there is deposition of granules of dark melanin pigment. They constitute what is termed the pigment layer of the retina.

The ectodermal lens and retina, which constitute the essential optical part of the eye, become ensheathed during development by a thick coating of connective tissue or mesenchyme. This, in its outer layers, becomes condensed into the tough protective wall of the eyeball, the part between the lens and the surface of the head becoming clear and transparent (cornea) while the remainder becomes white and opaque (sclerotic). Between the sclerotic and the pigment layer of the retina there is a rich development of blood spaces and of dark melanin, which gives its characteristic appearance to the choroid.

Alimentary Canal. — The alimentary canal of the vertebrate is in its early stages closed anteriorly, the mouth being a secondary perforation. As in many other animals, the portion of external surface in the region of the mouth becomes involuted to form the lining of the buccal cavity, so that the protective and glandular functions of the skin extend inwards into the first portion of the alimentary canal. The buccal cavity of the vertebrate is therefore morphologically a stomodaeum. For a time, in many vertebrate embryos, the stomodaeal involution remains isolated from the rest of the alimentary canal by a thin partition, covered on its buccal face by ectoderm, on its enteric face by endoderm. This partition eventually ruptures and disappears, although in *Amphioxus* it remains distinctly visible as the velum, perforated in its centre by a circular opening.

The most important features to note in the buccal cavity of the vertebrate are the organs in its lining which have been brought in from their original position on the outer surface of the head. Among these are glands which become of special importance in terrestrial vertebrates, where their watery secretion serves to keep moist the buccal lining, and in certain cases play a preliminary part in the digestive process, as the salivary glands. Still more conspicuous however are the placoid scales, which, in the primitive elasmobranch scattered all over the outer surface of the body, are also recognizable in the buccal lining. Around the margin of the jaw a series of these placoid scales become specially enlarged, forming the teeth of the adult. The embryology of the elasmobranch then demonstrates that the teeth of vertebrates are vestiges of the placoid scales on the surface of the body.

The buccal cavity is continued into the pharynx, characterized in all vertebrates by the development of (1) the gill clefts or pouches and (2) the thyroid. The gill clefts, normally six in number, arise as pocket-like extensions of the pharyngeal wall (visceral pouches), which at their tips undergo fusion with the external ectoderm and open to the exterior, the original visceral pouch becoming thus converted into a visceral cleft, lined with endoderm except towards its outer end, where the lining is ectodermal. The cleft lining, in view of its respiratory function, undergoes increase of area by growing out into folds (respiratory lamellae) and develops a rich blood supply.

Visceral cleft I develops in all gnathostomes characteristic differences from the others. In elasmobranchs its respiratory lamellae are reduced to the vestigial pseudobranch on its anterior wall, its function being, as in crossopterygians and sturgeons, that of a mere passage for the water of respiration. In Dipnoi its outer ectodermal end forms a sensory organ (organ of Pinkus) embedded in the side of the head. In these and in all terrestrial vertebrates, it has lost its communication with the exterior. In anurous amphibians and in all amniotes it expands towards its outer end into a wide tympanic cavity lying immediately under the skin so as to allow a wide flat area of the latter to vibrate freely (tympanic membrane or eardrum). The pharyngeal portion of the cleft remains as the narrow Eustachian tube, providing a means of keeping the air pressure equal on the two sides of the eardrum.

While the presence of pharyngeal visceral clefts constitutes one of the most striking vertebrate characteristics, the evidence of comparative anatomy clearly indicates that the series of clefts is undergoing a gradual process of reducticn. This is shown by the diminishing number of clefts present in the series *Amphioxus*—cyclostomes (up to 14 in *Bdellostoma*)—Gnathostomata. Embryology shows us this process of reduction actually at work. In various elasmobranch embryos vestigial pouches appear behind those which actually develop into clefts. In teleosts the vestigial spiracular rudiment flattens out while its pseudobranch remains visible on the inner surface of the operculum, thus appearing in the adult as if it belonged to visceral cleft II. The operculum of fishes above elasmobranchs is simply the exaggerated valvular flap formed by the outer edge of visceral arch II (hyoid) which grows back to cover the visceral clefts further back in the series.

The thyroid, an equally characteristic development of the vertebrate pharynx, arises as a mid-ventral downgrowth of the pharyngeal floor about the level of the hyoid arch. This rudiment, arising either as a hollow pouch or as a solid structure which develops a cavity secondarily, soon becomes isolated from the pharynx as a closed vesicle, and this in turn becomes subdivided into a multitude of little spherical sacs of endoderm separated by mesenchyme, in which there arises a rich network of blood spaces. The endodermal epithelium is glandular, producing a clear colloid secretion which distends the numerous rounded vesicles. In its later development the thyroid differs in different vertebrates. It may, as in teleostean fishes, become diffuse and no longer recognizable as a compact organ, while in tetrapods it retains its compact form but becomes more or less completely separated into a right and left lobe. The clue to the evolutionary history of the thyroid is given by the embryology of the lamprey (Petromyzon), in the larva of which it is recognizable as an endostyle, an organ known also in *Amphioxus* and Tunicates.

The lung, a characteristic feature in the main groups of Vertebrata above the elasmobranchs, arises normally from a rudiment very similar to that of the thyroid, only situated farther back, about the hinder limit of the pharynx. Normally unpaired at first, the rudiment soon divides into right and left branches. In simple urodeles each lung remains a thin-walled membranous sac, but in other tetrapods increase in area of the endodermal respiratory lining is brought about by its bulging out into more and more complicated recesses, culminating in large reptiles and in mammals in a spongy texture. In birds, the endoderm-lined cavities of the lung become converted into fine tubular channels (air capillaries) interwoven with the blood capillaries and constituting the most highly evolved respiratory organ known. To enable it to function, a bellowslike arrangement is formed by pocketlike outgrowths of the lung wall which become greatly dilated and constitute the air sacs. Portions of these grow out into the substance of the bones, replacing the bone marrow, while others extending in among the muscles of flight provide a mechanism whereby air is automatically passed in and out through the air capillaries during flight.

The postpharyngeal portion of the alimentary canal forms the digestive tube and in different vertebrates undergoes varying degrees of differentiation into distinct parts. The great glands of the intestine arise in the embryo as pocketlike diverticula of its wall. The pancreas is peculiar in that it arises normally from three distinct diverticula--a pair situated ventrally in the neighbourhood of the bile duct, and the third dorsal. The pancreas of the adult is formed by the fusion of these three rudiments and it may retain (birds) all three openings to the intestine; *i.e.,* three distinct pancreatic ducts.

Coelomic Organs.—The *coelom* or body cavity becomes normally subdivided into a smaller pericardiac and a larger peritoneal cavity. In some of the more archaic vertebrates (*e.g.,* elasmobranchs) the two cavities remain continuous through a narrow pericardioperitoneal canal.

The loss of the primitive coelomic segmentation has brought with it characteristic modifications in the development of the archinephros or series of nephridial tubes.

It is a normal characteristic of the embryo of metamerically segmented animals that the head end, with its special nerve centres and sense organs, develops first, the process of development spreading slowly tailward, and this principle applies to the nephridial tubes as to other organs. The disappearance of the coelomic septa in the Vertebrata has, however, eliminated the necessity of each segment having its independent pair of drainage tubes. There has accordingly come about a loss of the serial regularity in the development of the nephridial tubes and these tend to develop in three successive batches, known as pronephros, mesonephros and metanephros. Of these the pronephros is the functional kidney in the early stages of those vertebrates in which these stages are free living (larval). Where, on the other hand, early development is embryonic, it no longer becomes a functional organ, the excretory products presumably passing away by diffusion from the extensive network of blood vessels on the surface of the yolk. The pronephros is purely larval: eventually it atrophies, a pair of its nephrostomes, however, persisting in greatly enlarged form, at least in selachians, as the ostia of the oviducts. The excretory function is now carried out by the series of tubules extending back to the region of the cloaca and termed the opisthonephros. In the fishes and amphibians, this constitutes the kidney of the adult, though already in many of these (*e.g.,* elasmobranchs and urodeles) there is seen a tendency for the excretory function to become concentrated in the hind portion of the opisthonephros, its front portion remaining small and serving for the transmission of the spermatozoa. This condition foreshadows that of the Amniota in which the opisthonephros has become completely divided into mesonephros and metanephros. The former, representing the greater part of the opisthonephros, acts as the functional kidney during embryonic life but later becomes purely reproductive, forming the epididymis attached to the testis. The metanephros—the extreme hind end of the opisthonephros, in which the tubules become greatly increased in size and number—alone forms the kidney of the adult amniote.

The renal organs of vertebrates present many other features of embryological interest. In various of the more archaic types the rudiments of the first pronephric tubules, in the form of little outgrowths of the somatic mesoderm, bend backward at their outer ends and become joined together, forming in this way the rudiment of a longitudinal duct (archinephric duct) which gradually extends back, receiving the successive tubules which undergo fusion with it, and eventually opens into the cloaca. This opening of the tubules into a longitudinal duct instead of directly to the exterior constitutes one of the striking differences between the Vertebrata and the Annelida.

In elasmobranch fishes the archinephric duct becomes split longitudinally into two—a Mullerian duct, into which opens the persistent pronephric nephrostome, and a Wolffian duct, into which open the tubules of the opisthonephros. Functionally, the former becomes the oviduct. In the Amniota the functional tubules of the metanephros open into a third duct—the ureter—while the Wolffian duct now functions exclusively as a vas deferens or male genital duct.

The gonads—ovaries or testes—develop from a pair of elongated ridges, the genital ridges, which arise just mesial to the kidneys. In the female, the reproductive cells (eggs or macrogametes) are still shed into the coelom, finding an exit through the Mhllerian ducts. In the male, however, the testis is shut off as an isolated chamber into the cavity of which the reproductive cells (spermatozoa or microgametes) are shed. They eventually reach the vas deferens by way of fine tubular channels (vasa efferentia), which arise in the embryo as outgrowths from the wall of certain of the Malpighian bodies.

The mesenchyme cells, distributing themselves through the body of the embryo, settle down into spongy connective tissue which forms a support and backing to the various developments of ectoderm and endodern. As development proceeds, special tracts take on special characters—fatty tissue, tendon, ligament and so on—but there are two developments of the mesenchyme which are of special importance. These are the vascular and the skeletal systems.

Vascular System.—The blood vessels originate from condensations of mesenchyme cells which hollow out into channels containing the watery tissue fluid which bathes all the cells of the embryo The corpuscles may arise either *in situ,* by differentiation of central cells of the original mesenchyme aggregations, or may enter the blood stream from special centres of proliferation, ahich include, especially in later developmental stages, liver, bone marrow and lymphatic glands Detailed study of the later development of the blood system shows that it provides a most interesting chapter in vertebrate embryology The fundamental plan is seen to be that of two main longitudinal blood vessels, one ventral to the alimentary canal, in which the blood runs forward, and one dorsal (dorsal aorta), in which the blood streams in a tailaard direction, these two longitudinal vessels being connected by a series of hooplike aortic arches, situated between the gill clefts, in uhich the blood passes from the ventral vessel to the dorsal The vertebrate heart consists of the portion of the ventral vessel immediately behind the pharynx, in which contraction of the vessel wall, elsewhere comparatively inconspicuous, becomes greatly exaggerated and occurs rhythmically throughout life

The *heart or cardiac tube* is that part of the ventral vessel which is contained within the pericardiac chamber At first straight, its rapid increase in length, combined uith the fact that it is fixed at each end where it traverses the pericardiac wall, causes it to assume a characteristic S-shaped curvature As may be well seen in the embryo of a fowl during the third day of incubation, waves of contraction pass forward along the cardiac tube, propelling the blood in its interior forward toward the aortic arches. As development proceeds the originally uniform cardiac tube becomes at intervals relatively enlarged to iorm a series of four dilatations. demarcated from one another by relatively less dilated portions. These four dilatations become the sinus venosus, atrium, ventricle and conus arteriosus. With this morphological change in diameter comes a physiological change in that the originally uniform wave of contraction becomes replaced by serial contractions of each chamber in turn. As development proceeds further, the four chambers become compacted together and the original tubular shape of the heart is completely lost. The pumping activity of the heart becoming more and more concentrated in the ventricle, the muscular wall of this part becomes much more highly developed than that of the others.

To secure that the blood stream flows in the proper direction a valvular apparatus becomes developed in the interior of the heart and this, in its earliest stages, takes the form of longitudinal ridgelike thickenings oi the inner layer oi the heart wall. These are best seen in the conus arteriosus, where they are normally four in number and where they are jammed together when the conus contracts, obliterating its cavity and so preventing any backward suction when the ventricle dilates. These endocardiac ridges, dependent for their efficiency upon physiological activity, become in such relatively archaic vertebrates as elasmobranchs and ganoids converted into a purely mechanical apparatus which works automatically, each ridge becoming segmented into a row of valves shaped like match pockets, with their openings directed toward the head. These flatten against the wall when the blood streams forward, but open out and occlude the cavity by their edges coming in contact the moment the bloods tends to regurgitate. In the air-breathing vertebrates from lungfish upward, the conus with its valvular apparatus undergoes an extraordinarily interesting series of evolutionary changes. In the lungfish the conus is relatively long and is bent into a characteristic Z-iorm. Along its interior run the four endocardiac ridges. Two of these, the right and the left, project as thin bladelike structures more than haliway across the lumen, their free edges overlapping so that they subdivide the cavity into two portions, one dorsal and one ventral. The two cavities are continued forward into the ventral aorta by a horizontal partition which extends as far forward as the level of aortic arch V where it merges into the roof of the ventral aorta. Aortic arches V and VI take oripin irom the dorsal or pulmonary cavity, while the remaining aortic arches spring irom the continuation forward of the ventral cavity. The atrioventricular portion oi the heart also has its cavity divided, in this case by a vertical septum projecting forward from its posterior wall. This septum is incomplete, not extending completely across the atrioventricular cavity except when the wall of this part of the heart is contracted. Owing to the peculiar flexure of the conus, its incomplete septum — horizontal at its front end — becomes at its ventricular end vertical and in line with the atrioventricular septum. The result is that, in the contracted condition of the ventricle, the right hali of its cavity is continuous with the right half of the cavity of the conus and this cavity, owing to the peculiar flexure, ends off at its headward end by being dorsal, *i.e.,* continuous with the pulmonary cavity of the ventral aorta.

Correspondingly the leit ventricular cavity is continued through' the conus to the ventral or systemic cavity of the ventral aorta.

In the tetrapods the conus develops endocardiac ridges similar to those seen in lungfish, but the conus has now greatly shrunken in length, with the result, owing to its ends being fixed, that the Z-flexure is drawn out and replaced by a spiral twist. Further, in the Amniota, the two prominent ridges, which in the lungfish merely overlap, undergo complete fusion, so that the cavity of the conus, as of the ventral aorta, becomes divided completely into pulmonary and systemic cavities, continuous respectively with the right and left ventricles, which also become completely separated during development. In the higher Amniota the septum so iormed in the conus becomes itseli split, so that the conus comes to be represented by two separate vessels, pulmonary and systemic, spirally twisted round one another.

Of all features in the development of the blood system of vertebrates, perhaps the most interesting is that the great arteries of the higher amniotes repeat in the course of their development the series of aortic arches between the visceral clefts. Although the bird or human being will never use its gill clefts for breathing, yet it shows for a time the typical piscine arrangement of aortic arches. As development proceeds, large tracts of this primitive scheme disappear while others persist and become straightened out into the great arteries of the adult.

The *venous system* of the vertebrate shows also many features of interest in its embryology. Perhaps the most important of these is that the venous system of the higher vertebrates shows for a time in the embryo the same main trunks — duct of Cuvier, anterior and posterior cardinal veins — as those of an adult fish. The main new development in the venous system of tetrapods, the inferior or posterior vena cava, presents the striking peculiarity that it has a double origin in the embryo. its anterior portion being associated with the liver and its posterior portion with the posterior cardinal veins. This points to the posterior vena cava having originated in evolution from an arrangement similar to that of modern dinnoans. where the anterior end of the opisthonephros is fused with the tip of the liver, thus rendering possible the direct passage of blood from kidneys to heart through the liver substance.

The Skeletal System. — The vertebrae are formed from cells oi the segmented mesoderm (somites), and differentiate first as paired cartilaginous rudiments of the neural and haemal arches, two pairs of each in the lower types within the length of a single muscle segment. In two of the more archaic groups, Elasmobranchii and Dipnoi, cartilage cells from the arch-rudiment burrow through the primary sheath and colonize the secondary sheath of the notochord. The notochord thus becomes enclosed in a cylinder of cartilage, which in the elasmobranch becomes segmented into vertebral centra, each carrying two pairs oi neural and of haemal arches. In other vertebrates this invasion of the secondary sheath by cartilage cells does not take place, and the centra arise outside the primary sheath by expansion of the bases of the arches. In the head region traces of cartilaginous vertebrae can be traced in various archaic vertebrates as far forward as the tip of the iniundibulum, the hinder region of the cranium representing a part of the axial skeleton in which the vertebral segmentation has disappeared and the neural canal become greatly enlarged in correlation with the expansion of the central nervous system to form the brain. The olfactory organ and the otocyst each becomes enclosed in a capsule of cartilage and these become incorporated in the complete cranium. The anterior portion of the cartilaginous cranium, including the capsule of the olfactory organ, has been demonstrated to arise in large part from the cranial neural crest (see fig. 15). Most of the cartilaginous visceral skeleton has a similar origin. The principal elements of the limb skeleton are also preformed in cartilage. Later the cartilaginous skeleton of the embryo is largely replaced in the adults of most vertebrates by bony tissue.

In addition to those portions of the skeleton already mentioned, which appear first in cartilaginous form, there are many elements which develop directly into bone from membranous concentrations of mesenchyme. In the typical mammal these are confined principally to the skull, but in lower types such as the turtle, and in many extinct forms, they are often abundant in other portions of the body as variously sized plates situated in the deeper part of the skin. These are believed to have evolved irom enlarged or compound dermal scales. In the elasmobranch, the placoid scales of the skin extend into the buccal cavity, where some oi them enlarge to form the teeth. In other lower vertebrates, embryology demonstrates that the bones which underlie the base of the cartilaginous cranium and reinforce it are formed of originally separate denticles, which become united into a continuous plate by the spreading out and fusion of their basal portions. This origin through fusion of small scalelike elements is no longer evident in the embryonic development of the homologous dermal bones of the higher vertebrates, including man.

Adaptations to Environment. — In certain cases the environment and the young individual's relations to it present no special peculiarities. The young crossopterygian or lungfish or urodele leads a normal kind of aquatic existence and the strikingly uniform type of larva in these three relatively archaic vertebrates suggests strongly that it repeats an early stage of vertebrate evolution. In most vertebrates, however, development is either embryonic or secondarily larval. In elasmobranchs, in teleosts and in reptiles and birds, the early stages are passed within the shelter of egg envelopes and this involves the modifications associated with the storing up of a supply of yolk— modifications which still persist in cases such as the majority of teleosts, where a larval mode of development is re-acquired. Embryonic development is seen in its highest expression in the terrestrial vertebrates and these, in addition to the immense exaggeration of the ventral part of the endoderm to store up yolk (*yolk* sac), show two other striking peculiarities: (1) the body of the embryo becomes enclosed in a water jacket (*amnion*) in which it floats suspended and is thus protected from the sudden jars incidental to a terrestrial existence. and (2) the allantois (the pouchlike outgrowth from the hinder end of the alimentary canal which in the amphibian functions as a urinary bladder) becomes precociously enlarged and, spreading around the inner surface of the egg shell, constitutes the breathing organ during a large part of embryonic life. In ordinary mammals the allantois has developed a new function, that of absorbing nourishment from the uterine wall, and in correlation with this, the supply of yolk, which in the reptilian egg was so conspicuous, has now disappeared almost entirely.

See also GESTATION PERIODS.

BIBLIOGRAPHY.—*The Embryology of the Chick* (1929), and *The Embryology of the Pig* (1931), both by B. M. Patten, present clear and well illustrated accounts of the development of the animals specified in the titles. L. B. Arey's *Developmental Anatomy* (1941) stresses mammalian and human embryology, and includes illustrated descriptions of many of the commoner developmental anomalies.

(J. G. K.; V. C. T.)

VERTIGO AND DIZZINESS. Dizziness is a subjective symptom of disturbed stability. not a specific disease. In its mild form it may be a sensation of weakness, giddiness, confusion, insecurity or unsteadiness. Its severer form — properly designated as vertigo — is a feeling of whirling or propulsion, often accompanied by sweating, nausea. vomiting and inability to stand.

Normal stability (or the feeling of proper orientation in space) is controlled by a balanced interaction of three body mechanisms: (1) the muscles and joints of the body; (2) the muscles of the eyes; and (3) the end organ of equilibrium, situated in the internal ear and consisting of three small, extremely sensitive semicircular canals so related to each other that body motion in any direction stimulates one or more of them.

The motion that stimulates the semicircular canals, and to a lesser degree the other two mechanisms, may be voluntary or caused by an external force such as the rhythmic movement of a swing, an airplane or a ship. It sets up nervous impulses that are immediately transmitted to the brain. The brain, in turn, automatically (by reflex action) relays the message back to the muscles through an intricate pathway of nerves. The result is prompt adjustment of the body to changes of its position in space. If prompt adjustment cannot be made—either because the equilibrium system is not working properly or because of inability to compensate for abrupt or sustained unaccustomed motion—dizziness or vertigo will probably ensue. Ability to adapt to motion varies, which explains why some persons become sick and dizzy on a boat or on an airplane while others do not.

Mild forms of dizziness (without whirling) may result from causes other than motion. Commonest are eye-muscle or visual disturbances, chronic alcoholism, anemia. changes in blood supply to the brain when blood pressure falls, fainting, certain infections of the coverings of the brain, injury to the head, mild forms of epilepsy, lowering of blood sugar and, sometimes, tension.

Whirling vertigo is usually produced by disturbances of the ear and its pathways to the brain. Some of these are: infections of the middle and internal ear (including mastoid infection), toxicity from drugs. allergy, Ménière's disease, meningitis, brain tumours, strokes and certain neurological diseases such as multiple sclerosis. Vertigo may also follow head injuries, skull fractures or any conditions that produce bleeding into the internal ear or its nervous connections or that suddenly shut off the blood supply.

Because of the multiplicity of causes, of which those mentioned constitute only a partial list, it is often necessary to conduct detailed diagnostic studies before specific cause is determined.

See also EAR; ANATOMY OF; EQUILIBRIUM, ANIMAL; MÉNIÈRE'S DISEASE; MOTION SICKNESS. (D. D. DEW.)

VERTUE, GEORGE (1684–1756). English engraver and antiquary, who collected records of English art. was born in London, where he began to engrave portraits after Sir Godfrey Kneller about 1709. He soon acquired a large practice; among his chief works, besides his many portrait engravings. were the Oxford Almanac (1713–51) and the plates to Paul Rapin's History *of England* (1736).

In 1717 Vertue was made engraver to the Society of Antiquaries of London and elected a fellow. The plates of his "Historic Prints" from Tudor paintings are still owned by the society. Skilled though he was as an engraver, his notebooks. which provide a major primary source of information concerning art in England. add to his importance. These, mainly in the British museum. were used hy Horace Walpole as the foundation of his Anecdotes of *Painting* in England (4 vol., 1762–71), and have been published in full by the Walpole society. Vertue died in London. July 24, 1756, and was buried in the cloisters of Westminster abbey.

See *Walpole* Society, vol. xviii, including autobiography (1930), vol. xx (1932), vol. xxii (1934), vol. xxiv (1936), vol. xxvi (1938), vol. xxix (1942) and vol. xxx (1950). (M. D. WY.)

VERTUMNUS, in Roman cult, a god of uncertain functions and origin, although he probably was from Etruria (Volsinii). The Romans later connected his name with Lat, vertere ("turn." "change"). and thus he became a god of the changing year with its seasons, its flowers and its fruits. In the last connection he is found associated with Pomona (*q.v.*). Ovid records the story of his wooing of Pomona, which is brought to a successful conclusion by Vertumnus' power to change into any form he wishes (*Metamorphoses*, xiv, 641 ff.). He had a shrine and statue in the Vicus Tuscus marking the spot where. according to one tradition, the god turned back an inundation of the Tiber. The appropriate offerings here were the first fruits of the changing season. From the god's connection with this busy street he was regarded as having a special interest in trade and barter, also forms of exchange.

Vertumnus had in addition a temple on the Aventine, dedicated in 264 B.C., where an annual sacrifice was performed on Aug. 13, an appropriate time for ripening of fruit.

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VERULAMIUM, a Romano-British town situated in the territory of the Catuvellauni, close to the modern St. Albans (Hertfordshire). Before the Roman conquest it was the capital of Tasciovanus, prince of the Catuvellauni, who issued coins inscribed with the name of the place, and of his son, Cunobelin; afterward it received the dignity of a municipium (implying municipal status and Roman citizenship). Tacitus tells us that the town was burned by Boadicea (*q.v.*), in A.D. 60 or 61, but it again rose to prosperity. The visit of Germanus to the tomb of St. Alban shows that it was still inhabited in 429. Its site is still easily recognizable. Its walls of flint rubble survive.

VERVAIN (Verbena *officinalis*), a plant of the family Verbenaceae (*q.v.*), native to Europe and Asia, common in the south of England and naturalized across the continent of North America. It is a smooth slender annual, one to three feet high, with opposite, deeply incised leaves and numerous very slender spikes of purplish or white flowers. In the U.S. the name vervain is applied to several native species of Verbena, as the white vervain (V. *urticifolia*), the blue vervain (P. hastataj, the hoary vervain (*V.* stricta), the bracted vervain (V. *bracteata*) and the spreading vervain (V. *prostrata*). Most of these interhybridize. To the vervain, which was held in superstitious veneration by the ancient peoples of Great Britain, were ascribed remarkable medicinal virtues, now wholly discredited. *See* also VERBENA.

VERVET, a Central and South African monkey. *Cercopithecus aethiops pygerythrus.* It is allied to the grivet (*q.v.*), but distinguished by the presence of a rusty patch at the root of the tail and by the black chin, hands and feet.

VERVIERS, a town, province of Liège, Belg. Pop. (1955 est.) 37.843. It is on the Vesdre, which flows into the Ourthe a few miles before its junction with the Meuse; and the water of that river is supposed to be especially good for dyeing purposes.

VERWEY, ALBERT (1865–1937), Dutch man of letters, was one of the leading figures of the revival of Dutch literature, called "the movement of 1880." He helped to found and from 1884 to 1889 was one of the editors of the *Nieuwe Gids;* from 1894 to 1904 of the Tweemaandelijksch *Tijdschrift* and De *XXe Eeuw,* and from 1905 to 1919 of De *Beweging*. In 1924 Verwey was appointed professor of Dutch literature in the University of Leyden. His anthology with commentaries of *Nederlandsche* Dichters *behalve Vondel* (1893, etc.) and his essay on Potgieter and his circle, Het *Testament* van Potgieter (1908), are works of lasting value. Verwey, who held an honorary doctor's degree from the University of Groningen, translated into Dutch Shelley's 4 *Defence* of Poetry, Sidney's *An* Apology for Poetry (1891) and Shelley's *Alastor* (1922j. In 1885 he issued an article on The Sonnet and the Sonnets of Shakespeare.

He published several volumes including *Inleiding tot* de *nieuwe Nederlandsche* dicht *Kunst, 1880–1900* (1914) ; *Proza* (1911, etc.); De *Maker* (1924); and *Rondom mijn Werk, 1890–1923* (1925).

VESALIUS, ANDREAS (1514–1564), founder of modern anatomy. was born in Brussels, son of a well-to-do court apothecary and educated at Louvain and afterward (1533–36) at the University of Paris. There he came under the influence of the great teachers of anatomy, Jacques Dubois (Sylvius) and Johann Guenther of Andernach. The latter's Latin translation (1531) of the *De anatomicis* administrandis of Galen deeply impressed him by its practical character. After a time spent in Louvain, where he reintroduced the study of human anatomy, Vesalius left for Padua in 1537 where he obtained his M.D. and was appointed lecturer in surgery and anatomy. His success was immediate. and in 1538 he published at Venice, in collaboration with his fellow countryman the artist Jan van Calcar, his Tabulae *anatomicae* sex.

These six very large plates are a landmark in the history of anatomical nomenclature, for they embody an attempt to standardize both the form and the meaning of anatomical terms, contrasting the newly interpreted Greek terms with those of the middle ages, many of which originate in Arabic and Hebrew. Modern anatomical nomenclature is directly descended from that adopted by Vesalius. The physiology he presents is largely that of Galen.

During 1539–42 Vesalius prepared his masterpiece, the *De humani corporis fabrica.* For this he had the help of artists, of whom one was of very great ability; it is likely that Calcar was responsible for some of the illustrations but was not the most significant artistically. The *Fabrica,* published in 1543 as an enormous folio at Basel by the printer Johannes Oporinus (Herbst), is beyond dispute one of the great books of the 16th century. Its figures introduced a new standard into illustrated works in general and medical works in particular. Despite its turgid and verbose character, the text is of great importance both as a clear statement of the need for introducing a scientific method into the study of anatomy and for the many important discoveries that are presented in its seven books: i and ii, on bones, ligaments and muscles, with figures of superlative excellence and accuracy; iii, on the blood vessels, probably partly illustrated by Vesalius himself and inferior to i and ii; iv, on the nerves, conservative and closely following Galen; v, on the abdominal viscera, a considerable advance on any previous work; vi, on the thoracic organs, too brief, sometimes confused and erroneous; vii, on the brain, a pioneer work of great importance. The *Fabrica* was an immediate success and was reprinted, pirated, abridged, copied and translated. It heralds the advent of biology as a science. At the same time, Vesalius issued what he miscalled an *Epitome* of it, a work for students of art rather than of medicine. In 1555 he produced a new edition of the *Fabrica* with a vast number of alterations of content and style of presentation. The typography and layout of the illustrations greatly surpass those of the first edition.

Vesalius' other works are of lesser scientific importance, and the rest of his life has little scientific interest. Leaving Padua, he accepted the position of physician to the imperial household of Charles V and in 1559 to the royal household of Philip II. In 1564 he undertook a pilgrimage to Jerusalem but died on his way back. Romantic stories and myths have accumulated round his career. Of his character little is known save that he had a mordant wit. *See* also ANATOMY, GROSS: *History of Anatomy.*

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VESPASIAN, in full TITUS FLAVIUS VESPASIANUS, Roman emperor A.D. 70–79, was born on Nov. 18, A.D. 9, in the Sabine country near Reate. After having served with the army in Thrace and been quaestor in Crete and Cyrene, Vespasian rose to be aedile and praetor, having meanwhile married Flavia Domitilla, by whom he had two sons, Titus and Domitian, afterwards emperors. Having already served in Germany, in the years 43 and 44, in the reign of Claudius, he distinguished himself in command of the 2nd legion in Britain under Aulus Plautius. He reduced Vectis (Isle of Wight) and penetrated to the borders of Somersetshire. In 51 he was for a brief space consul; in 63 he went as governor to Africa, where, according to Tacitus (ii, 97), his rule was "infamous and odious"; according to Suetonius (*Vesp.* 4), "upright and highly honourable." He went with Nero's suite to Greece, and in 66 was appointed to conduct the war in Judaea.

On the first of July, 69, while he was at Caesarea, he was proclaimed emperor, first by the army in Egypt, and then by his troops in Judaea. The legions of the East at once took the customary oath of allegiance. Nevertheless, Vitellius, the occupant of the throne, had on his side the veteran legions of Gaul and Germany, Rome's best troops. But the feeling in Vespasian's favour quickly gathered strength, and the armies of Moesia, Pannonia and Illyricum soon declared for him, and made him in fact master of half of the Roman world. They entered Italy on the northeast under the leadership of Antonius Primus, defeated the army of Vitellius at Bedriacum (or Betriacum), sacked Cremona and advanced on Rome, which they entered after furious fighting, in which the Capitol was destroyed by fire. The new emperor received the tidings of his rival's defeat and death at Alexandria, whence he at once forwarded supplies of corn to Rome, which were urgently needed, along with an edict or a declaration of policy, in which he gave assurance of an entire reversal of the laws of Nero, especially those relating to treason.

Leaving the war in Judaea to his son Titus, he arrived at Rome in 70. He at once devoted his energies to repairing the evils caused by civil war. He restored discipline in the army, which under Vitellius had become utterly demoralized, and, with the cooperation of the senate, put the government and the finances on a sound footing. He renewed old taxes and instituted new, increased the tribute of the provinces, and kept a watchful eye upon the treasury officials. By his own example of simplicity of life, he put to shame the luxury and extravagance of the Roman nobles and initiated in many respects a marked improvement in the general tone of society. By taking over the censorship, the last of the republican magistracies, he gained complete control over the entry to the senate. He altered the constitution of the praetorian guard, in which only Italians, formed into nine cohorts, were enrolled, while Italians seem to have been excluded from the legions; he tended to assimilate the auxiliaries to the legions in personnel. The time-expired men, when they went back to their homes, he made use of to promote the urbanization and Romanization of the more backward and unorganized provinces. In 70 a formidable rising in Gaul, headed by Claudius Civilis, was suppressed and the German frontier made secure; the Jewish War was brought to a close by Titus's rapture of Jerusalem, and in the following year, after the joint triumph of Vespasian and Titus, the temple of Janus was closed, and the Roman world had rest for the remaining nine years of Vespasian's reign. In 78 Agricola went to Britain, and both extended and consolidated the Roman dominion in that province, pushing his arms into north Wales and the Isle of Anglesey. In the following year Vespasian died, on June 23.

The "avarice" of Tacitus and Suetonius seems to have been an enlightened economy, which, in the disordered state of the Roman finances, was an absolute necessity. Vespasian could be liberal when he chose, as Quintilian's pension shows. Pliny's great work, the *Natural History,* was written during Vespasian's reign and dedicated to his son Titus. Of the philosophers who encouraged conspiracy by republican theorizing only one, Helvidius Priscus, was put to death, and he had affronted the emperor by studied insults. "I will not kill a dog that barks at me," were words honestly expressing the temper of Vespasian.

Much money was spent on public works and the restoration and beautifying of Rome—a new forum, the splendid temple of peace, the public baths and the vast Colosseum being begun under Vespasian. The roads and aqueducts were repaired, and the limits of the *pomerium* extended.

The most important of his changes in the provinces was the reorganization of the eastern provinces, whereby Judaea became a province of its own, Syria absorbed the vassal kingdom of Commagene and had its legionary forces strengthened and centred at Samosata, and Cappadocia and lesser Armenia were absorbed in Galatia, whose governor also was given legionary troops to hold the upper river, stationed at Melitene; second to this comes the annexation of the *agri decumates,* the first step to cutting out the salient in the Rhine-Danube frontier. Mention may be made of his extension of Latin rights to Baetica.

To the last, Vespasian was a blunt soldier, with strength of character, and with a steady purpose to establish good order and secure the prosperity and welfare of his subjects. In his habits he was punctual and regular, transacting his business early in the morning, and enjoying his siesta after a drive. He was free in his conversation. and his humour was apt to take the form of coarse jokes. Characteristic is the exclamation he is said to have uttered in his last illness, "An emperor ought to die standing."

VESPERS, in the Roman Catholic liturgy, the seventh of the eight "hours" which make up the daily office. (*See* BREVIARY.)

VESPERS, SICILIAN, the revolution of the Sicilians against' Angevin domination. so called because it broke out at the hour of Vespers on Easter Tuesday, 1282. The government of Charles I of Anjou (see CHARLES I, king of Naples) was highly oppressive, and the people of Sicily were strongly attached to the house of Hohenstaufen. The actual outbreak was a purely unpremeditated popular movement. Charles at that time was making preparations for an attack on the East Roman empire, and heavily taxing the Sicilians in order to meet his expenses. Peter III, king of Aragon, wishing to assert the claims to Sicily which he possessed in right of his wife, Constanza, daughter of Manfred (*q.v.*), was negotiating with the enemies of Charles, when the people of Sicily, goaded beyond endurance, rose unexpectedly against their rulers. On March 31, 1282, a riot broke out in a church near Palermo, in consequence, according to tradition, of the insults of a French soldier toward a Sicilian woman, and a general massacre of the French began. The rising spread to the city, where a republic was proclaimed. and then through the rest of the island; thousands of French men, women and children were butchered (there may be some exaggeration in the wholesale character of the slaughter), and by the end of April the whole of Sicily was in the hands of the rebels. Charles at once led an expedition against the Sicilians and besieged Messina. The island mas saved from re-conquest by the intervention of Peter of Aragon, but this intervention changed the character of the movement, and the free communes which had been proclaimed throughout the island had to submit to royal authority and a revived feudalism. Peter. having reached Palermo in Sept. 1282, accepted the Sicilian crown, and declared war on Charles. (See NAPLES, KINGDOM OF; SICILY.)

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VESPUCCI, AMERIGO (1454–1512), Italian merchant and navigator whose traditional family name Amerigo was given to the continent of America, was born at Florence. the son of Nastagio, a notary. As a boy Vespucci was given a humanistic education by his uncle Giorgio Antonio. In 1479 he accompanied another relation, sent by the Medici family to be their spokesman to the king of France. On returning Vespucci entered the "bank" of Lorenzo and Giovanni di Pier Francesco de' Medici and gained the confidence of his employers. At the end of 1491 they sent him to Seville, where they had a business directed by a man named Giannotto Berardi who appears to have been engaged chiefly in fitting out ships and he was probably present when Columbus returned from his first expedition, which Berardi had assisted Later S'espucci was to collaborate, still with Berardi, in the preparation of a ship for Columbus' second expedition and of others for the third. On the last occasion Vespucci and Columbus became personally acquainted. When Berardi died. either at the end of 1495 or at the beginning of 1496, Vespucci became manager of the Seville agency.

The period during which Vespucci made his voyages falls between 1497 and 1504. At the beginning of 1505 he was summoned to the court of Spain for a private consultation, and as a man of experience was engaged to work for the famous Casa de Contratación de las Indias (Commercial House for the West Indies), which had been founded two years before at Seville. In 1508 the house appointed him chief navigator — a post of great responsibility, which included the examination of the pilots and ships' masters licences for voyages. He also had to prepare the official map of newly discovered lands and of the routes to them (for the royal survey), interpreting and co-ordinating all data which the captains were obliged to furnish. This position Vespucci, who had obtained Spanish citizenship, held until his death. His widow, Maria Cerezo. was granted a pension in recognition of her husband's great services.

Two series of documents on Vespucci's voyages are extant. The first consists of a letter from Vespucci himself dated from Lisbon, Sept. 4, 1504, written in Italian, perhaps to the gonfaloniere Pier Soderini and printed in Florence in 1505, and of two Latin versions of this letter printed under the titles of *Quatuor Americi* Navigationes and *Mundus Novus*, or *Epistola* Alberici de *Novo* Mundo. The second series consists of three private letters (*i.e.*, letters not intended for publication) addressed to the Medici. In the first series of documents four voyages by Vespucci are mentioned; in the second, only tno. Until the 1930s the documents of the first series were considered from the point of view of the order of the four voyages. According to a theory of A. Magnaghi, on the contrary. these documents are to be regarded as the result of skillful manipulations and the sole authentic papers would be the private letters, so that the verified voyages would be reduced to two. The question is fundamental for the evaluation of Vespucci's work, and has given rise to fierce controversy which had not ended by the late 1950s, and attempts to reconcile the two series of documents cannot generally be considered to be successful.

The voyage completed by Vespucci between May 1499 and June 1500 as navigator of an expedition of four ships sent from Spain under the command of Alonso de Ojeda is certainly authentic. (This is the second expedition of the traditional series.) Since Vespucci took part as navigator. he certainly cannot have been inexperienced; but it does not seem possible to accept as having really taken place in this area a previous voyage (1497–98), believed to have been made around the Gulf of Mexico and the Atlantic coasts from Florida to Chesapeake bay.

In the voyage of 1499–1500, Vespucci would seem to have left Ojeda after reaching the coast of what is now Guiana. Turning south, he is believed to have discovered the mouth of the Amazon and to have gone as far as the Cape of La Consolación or São Agostinho (about 6° lat. S.). On the way back he reached Trinidad, sighted the mouth of the Orinoco and then made for Haiti. Vespucci thought he had sailed along the coasts of the extreme easterly peninsula of Asia, where Ptolemy believed the market of Kattigara to be; so he looked for the tip of this peninsula calling it Cape Kattigara. He supposed that the ships, once past this point, emerged into the seas of southern Asia. As soon as he was back in Spain he equipped a fresh expedition with the aim of reaching the Indian ocean, the Gulf of the Ganges and the island of Taprobane (Ceylon). But the Spanish government did not welcome his proposals, and at the end of 1500 Vespucci went into the service of Portugal. Under Portuguese auspices he completed a second expedition which set off from Lisbon on May 13, 1501. After a halt at the Cape Verde Islands the expedition traveled southwestward. reached the coast of Brazil toward Cape São Agostinho, discovered (Jan. 1502) Rio de Janeiro bay and certainly sailed as far as the Plate river, which Vespucci was the first to discover. In all probability the ships took a quick run still farther south, along the coast of Patagonia to the Gulf of San Julian or beyond. The return route is unknown. The ships anchored at Lisbon on July 22, 1502.

This voyage is of fundamental importance in the history of geographical discovery in that Vespucci, himself, and scholars as well, became convinced that the newly discovered lands were not part of Asia, but a "New World." In 1507 a humanist, M. Waldseemuller, reprinted at St. Die in Lorraine the *Quatuor Americi Vesputii* Navigationes preceded by a pamphlet of his own entitled Cosmographiae *Introductio*, and he suggested that the newly discovered world be named "ab Americo Inventore . . . Amerigen quasi Americi terram sive Americam" The proposal is perpetuated in a large planisphere of Waldseemüller's, in which the name America appears for the first time, although applied only to South America. The suggestion caught on; the extension of the name to North America, however, came later. On the upper part of the map. with the hemisphere comprising the old world, appears the picture of Ptolemy; with the new world hemisphere is the picture of Vespucci.

It is uncertain whether Vespucci took part in yet another expedition (1503–04) for the Portuguese government (it is said that he may have been with one under G. Coelho). In any case this expedition contributed no fresh knowledge. Subsequently Vespucci returned to the service of Spain and certainly, in the capacity of *piloto* mayor, helped to prepare other expeditions, but never again joined one in person. Some scholars have held Vespucci to be an ignorant usurper of the merits of others. The fact that Spain entrusted him, a foreigner, with the office of chief navigator is sufficient to dispose of these accusations. The Spaniards saw that he possessed an outstanding knowledge of the theory and practice of nautical science and that he was an upright and scrupulous person to whom confidential matters could be entrusted. As a seaman and navigator he may be said to stand comparison with Columbus, though the latter became the more famous.

BIBLIOGRAPHY.—Vespucci charted the coast line he had discovered and mapped it, but his map is lost, as also are his logbooks. A few maps, however, survive (apart from Waldseemiiller's already mentioned) which originate directly or indirectly from Vespucci, but see *Amerigo Vespucci y el Nuevo Mundo: Cartas relativas a sus viajes y descubrimentos* (1951). *See* also: Alexander von Humboldt, *Examen critique d l'histoire de la géographie du nouveau continent,* vol. iv (1837); F. A. de Varnhagen, *Amerigo Vespucci, son caractère, ses écrits . . . sa vie . . .* (1865); Clements R. Markham (trans.), *The Letters of A. Vespucci,* Hakluyt Society (1894); H. Harrisse, *A. Vespuccius* (1895); J. Fischer and F. R. von Weiser, *The Oldest Map With the Name America . . .* (1903); H. Vignaud, *A. Vespucci* (1917); A. Magnaghi, *A. Vespucci* (1926); F. J. Pohl, *Amerigo Vespucci, Pilot Major* (1944); T. O. Marcondes de Souza, *Amerigo Vespucci e suas viagens* (1949); R. Levillier, *America la bien llamada,* 2 vol. (1949); "Amerigo Vespucci nel V centenario della nascita," numero speciale della *Rivista Geografica Italiana* (1954). Articles by various scholars have appeared in *Revista de Historia* (1954 *et seq.)* (R. Aà.)

VESTA, the Roman goddess of the hearth. The name probably is etymologically identical with the Greek Hestia (*q.v.*), and the two deities are of similar cult. Vesta's worship, if not primitive, is very ancient. The lack of an easy source of fire in the early community placed a special premium on the ever-burning hearth fire, both publicly and privately maintained, and thus from the earliest times Vesta is assured a prominent place in both family and state worship. The private worship of Vesta, as deity of the family hearth, was observed in every household along with that of the Penates and the Lares, and her image is sometimes encountered in the household shrine (lararium). A wreath was placed on the family hearth by the chief female slave (*vilica*) on the Kalends, Nones and Ides of each month (Cato, De agricultura, 143, 2).

The state worship was much more elaborate. The sanctuary of Vesta was traditionally a circular building, in imitation of the early Italian round hut. Symbolic of the public hearth, it was not strictly speaking a temple, although popularly called such. The shrine of Vesta in the Roman forum was of great antiquity, traditionally going back to Romulus or Numa, although it should be remembered that the forum area was not a part of the earliest Rome. The structure underwent many restorations and rebuilding in both republican and imperial times. There burned the perpetual fire of the public hearth attended by the vestal virgins and renewed annually on March 1 (the Roman new year). The innermost sanctuary (*penus;* cf. PENATES) was not open to the public, and only the vestals might enter it. Once a year, however, on the occasion of the Vestalia (June 7–15), it was opened to matrons who visited it barefooted. The days of the festival were unlucky. On the final day occurred the ceremonial sweeping out of the building, and the period of ill omen did not end until the sweepings were officially disposed of by placing them in a particular spot along the Clivus Capitolinus or by throwing them into the Tiber.

The public worship of Vesta was in the care of the vestal virgins. If the state cult is merely the extension of the worship in the king's household (a questioned viewpoint), these priestesses originally were the king's daughters who, ceremonially at least, attended the hearth. They were two or four in number at first, entering service when they were from six to ten years old and continuing as vestals for five years; *i.e.,* until they were old enough for marriage or at least betrothal. In historical times they were six in number, chosen by the pontifex *maximus* (who assumes the religious functions of the king), and they served for 30 years under a vow of chastity. There was nothing that forbade marriage after that, but by custom and superstition they rarely married. Those chosen had to be of the required age, freeborn of freeborn and respectable parents (although later daughters of freedmen were eligible), having both parents alive (patrimae et *matrimae*) and free from physical and mental defects. The pontifex took the candidate by the hand, pronouncing the formula of admission, te, Amata, capio. Her hair was cut and the cuttings hung on a certain tree and she was dressed in an ancient costume identical with that of a bride (not that the maiden became the bride of some deity, as many suppose; rather both the bride and the vestal wore garments symbolic of virginity). The vestals enjoyed many honours and privileges not accorded other Roman women. They were, for example, free from the tutelage (*manus*) of either a father or a husband, although they were in the charge of the pontifex *maximus,* who could punish them if they were remiss in their duties.

Their obligations involved keeping the sacred fire (the punishment for letting it go out was a beating) and maintaining their vow of chastity (breaking this was a capital offense, punishable with burial alive). Other duties included fetching water from a sacred spring (Vesta would have no water from the city system); the preparation of sacred foodstuffs (*muries* or brine, and mola salsa, coarse meal mixed with salt) for ritual purposes; and custody of the sacred objects of the *penus*. These last were a secret, but there was much conjecture as to what the *penus* contained; *e.g.,* the sacred objects brought by Aeneas, the Palladium (*q v.*).

In addition to the shrine itself and between it and the Velia stood the magnificent Atrium Vestae, a name which originally related to the whole sacred area comprising the shrine, a sacred grove, the Regia (headquarters of the pontifex *maximus*) and the house of the vestals, but ordinarily designates the home or palace of the vestals. This was an elaborate structure of two or three stories built around an open peristyle lined with statues of former vestals. The extensive remains, excavated in modern times, date for the most part from the empire, and the fragments of the numerous statues of the vestals belong largely to the 3rd century A.D. When Augustus became pontifex *maximus* he transferred his headquarters to his own home on the Palatine, turning over the Regia to the vestals. He also constructed a second shrine of Vesta either within or close to his palace.

As the shrine of Vesta contained no cult statue, it is perhaps not surprising that images of Vesta are rare. When she appears, however, she is a fully draped woman, sometimes accompanied by her favourite animal, an ass. As goddess of the hearth fire, Vesta was the patron deity of bakers. hence her connection with the ass, usually used for turning the millstone, and her association with Fornax, spirit of the baker's oven. She is found also allied with the primitive fire deities Cacus and Caca, whose worship goes back to the time of the Palatine settlement.

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VESTINI, an ancient Sabine tribe which occupied the eastern and northern bank of the Aternus in central Italy. It entered into the Roman alliance, retaining its own independence, in 304 B.C. A northerly section around Amiternum near the passes into Sabine country probably received the Caerite franchise soon after. The local dialect, which belongs to the north Oscan group, survived certainly to the middle of the 2nd century B.C. (see LATIN LANGUAGE). The Latin first spoken by the Vestini was not that of Rome but that of their neighbours the Marsi and Aequi (*qq.v.*). See also PAELIGNI; SABINI.

VESTMENTS, ECCLESIASTICAL, are ceremonial garments worn by bishops, priests, deacons, ministers and others in performing the offices of religion, as distinct from clerical clothing worn in everyday life. This article, dealing with Christian and Jewish liturgical dress, is organized as follows:

I. EVOLUTION OF CHRISTIAN ECCLESIASTICAL VESTMENTS

The liturgical vestments of the Christian Church, as modern archaeological research has shown, are not derived from the sacerdotal ornaments of the Jewish ritual, as was once thought; rather, they developed from articles of dress worn in the Roman empire, the basic forms being inspired by classical Greek attire. Christian archaeology indicates conclusively that ecclesiastical apparel from the 1st century onward consistently follows the Greco-Roman pattern and manner of wearing the tunic and the mantle.

1. Greco-Roman Origins.--Since ecclesiastical attire is based ultimately on clothing forms developed in classical Greece. understanding of the Greek attitude toward clothing is basic to a study of vestments. This closely resembled their attitude toward and understanding of architecture. Solid forms are produced either about a point or about a line. In architecture a building may either centre about a single pivotal point, such as a dome, or may be developed from two points that are tied together by a beam. In clothing, the body may be encircled horizontally with the head as pivotal point, or it may be draped vertically from the shoulders. The Greeks perceived that the tunic, like all form-fitting types of clothing that drape from the shoulders, was essentially expressive of the body and its movements; while the enveloping cloak, draped around the body with the head as centre, expressed spiritual and intellectual perfection. In the Greco-Roman world of the 1st century A.D., then, there were two fundamental types of clothing: (1) the tunic (Greek *chiton;* Latin *tunica*), adapted to the body by clasps at the shoulders and held at the waist by a cord or belt; and (2) the mantle or cloak (Greek *chlamys* or *himation;* Latin *palla* or *pallium*), a rectangular piece of cloth of varying length and width, wrapped around the body. The tunic was essentially an undergarment, the mantle an outer garment. (For descriptions, see DRESS: Mediterranean World.) Some customs connected with the wearing of these that particularly affected ecclesiastical vesture are discussed below.

A man at work wore only a tunic, but no Roman of any standing appeared in public without a toga, the more elaborate Roman form of the *pallium* or mantle. Even when the tunic was hidden by the toga, ho ever, good form required it to be belted. The tunic of the ordinary citizen was made of plain white wool. On the tunics of knights and senators stripes of garnet colour (perhaps woven into the material) descended, one from each shoulder, to the bottom of the tunic, both front and back. The mantle of the poorer classes, the *byrrhus,* was gradually supplanted by the *paenula*, or casula ("little house"), a semicircular piece of cloth whose ends were brought together and sewn partially up the front, allowing enough room for the passage of the head, forming a conical or bell-shaped garment. Originally worn only by slaves, soldiers and others of low station, it was adopted during the 3rd century by persons of fashion as a convenient riding or traveling cloak, and finally. by a sumptuary law of the emperor Theodosius in 382. it was prescribed as the proper everyday mantle of senators, the toga being reserved for state occasions.

Another garment that was to affect ecclesiastical usage came into fashion in the Roman world during the 2nd century. This was the dalmatic, a loose, unbelted tunic. with very wide sleeves, worn as an outer garment over the long white tunic (tzmica alba) now worn by the better class of citizens. The bands or stripes that were found on the tunics of knights and senators were transferred to the dalmatic, frequently being given greater importance on the latter.

The *lacerna,* introduced into the Roman army by Lucullus as an article of luxury worn only by the higher officers, was another mantle. fastened in front by a *fibula* ("pin" or "brooch"). It was often described by the generic name *amictus,* "wrapped around," but is distinct from and not to be confused with the neckcloth also called *amictus,* which has survived as the amice. The *lacerna* was used by early Christian artists, aptly enough, in depicting Melchizedek and the Jewish high priests (as in the apsidal mosaics of SS. Cosmas and Damian in Rome and of San Vitale in Ravenna), and according to the Vulgate (Ecclus. 1, 12) the high priest Simon, son of Onias, wore the *amictus.* Jewish priests of the New Testament were also depicted as wearing it, as is the high priest at the judgment of Christ before Pilate in the nave mosaic of San Apollinare Nuovo in Ravenna. As a military costume the *lacerna* is worn by the emperor and his attendants in the superb offertory mosaic at San Vitale in Ravenna.

2. Development of Ecclesiastical Vesture: 6th to 13th Centuries. — As late as the 6th century the under tunic (*linea*), the upper tunic (tunica dalmatica) and the chasuble (paenula, casula) were common to both clergy and laity. and were used both in the liturgy and in everyday life. By the 4th century, however, the garments worn at liturgical functions had been separated from those in ordinary use, though they were still identical in form. The major development of specifically ecclesiastical vestments took place between the 6th and 9th centuries. Secular fashions altered with changes of taste and because of the barbarian invasions; the church retained the dress of the Roman empire of the 4th century, which still conserved the modified classicism of a vertically draping undergarment (indutus) in the tunic, and an enveloping outer garment (amictus) in the chasuble.

One of the most important questions concerning ecclesiastical vestments is why the church chose to retain these modsfied forms rather than the more perfect garments of classical Greek times. The early Christian writers approached the subject of clothing by referring to the book of Ecclesiasticus, which, speaking of the creation of man, declares that God clothed him with divine power (Ecclus. xvii, 2). Understanding this literally, they considered the attributes of the state of innocence to be the "clothing" of the first parents. Since they consistently tried to clarify the Old Testament by comparison with the New, they related these words of the Ecclesiast with those of St. Matthew, which refer to the vestments of Jesus as becoming white as snow on Mt Tabor (Matt. xvii. 2), or with those of St. Luke, which describe the angels of the resurrection clothed "in dazzling apparel" (Luke xxiv. 4). In this dazzling apparel was seen a replica, so to speak, of the garment of glory with which Adam was clothed at creation. St. Basil approached the problem from a more positive point of view by noting that man should receive more fitting gifts than natural clothing because of the love he bears to God. Thus Jesus recalled the life of Paradise when he said, "Do not be anxious about your life, what you shall eat or what you shall drink, nor about your body what you shall put on" (Matt. vi. 25). Man should not have possessed clothing, either natural or fabricated. Should he give proof of his virtue, another clothing mas reserved for him. the splendour of the gift of God, the robe of light similar to that of the angels.

For this reason, perhaps, the early church chose to temper the intellectual perfectionism of Greek classicism in clothing, leaving room for the eternal "robe of glory," and chose the chasuble of the peasant instead of the toga or *pallium* of the free Roman citizen. That this was done intentionally, not as a result of mere historical accident, is indicated by the fact that in all iconography, from the early Christian centuries till modern times, Jesus himself is invariably clothed in tunic and toga or *pallium*, never in a chasuble. Very often the saints in early frescoes and mosaics, as well as in medieval manuscripts, are also so portrayed. On the other hand, living churchmen of priestly rank are invariably clothed in tunic and chasuble. The church chose to accept the inspiration of classical Greece without being bound by its proud rigour or intellectual formalism The tunic or alb continued to express the bodily nature of man, and the enveloping, circular chasuble continued to express the fallen spirit of man healed by redemption but not yet in possession of the robe of glory. In this respect it is interesting to note that in the full liturgy of the Western rites only the celebrant is perfectly clothed, up to and including the encircling chasuble: he is the complete man.

During the 4th and 5th centuries the first distinctive vestments, the sacred pallium and stole, made their appearance as ensigns of office or dignity. It was the period between the 9th and 13th centuries, however, that marked the final development of eucharistic vestments in the West. Since by this time the clothing worn in the liturgy was almost completely distinguished from secular dress, vestments came to symbolize a special dignity. In the second quarter of the 9th century bishops, when fully vested wore a *camisia* or shirt, girdled; a neck cloth or amice (analolaium); an alb (linea), girdled; a tunicle (*dalmatica* minor); a dalmatic (dalmatzca *major*); stole (*orarium*); chasuble (*planeta* or *casula*); and the sacred pallium. This is especially observable on the ivory covers of a 9th-century missal, preserved at Frankfurt am Main.

In an age when costume was becoming a symbol of the status of the wearer, it was natural that in the church official vestments should undergo a similar process. Canonical legislation began to prescribe as a rule many actions that had previously been hallowed by custom and religious association, and also put a check upon the discretion or caprice of individuals. Until this time, the ancient garments had no significance beyond the meaning that had been attributed to them from the time of classical Greece and the early Christian writers; by the 11th century, symbolic meanings and prayers were attached to all major garments used in the liturgy.

In the 9th century appeared the pontifical gloves; in the 10th, the mitre; in the 11th, the use of liturgical shoes and stockings was reserved to cardinals and bishops. By the 12th century, mitre and gloves were worn by all bishops. Until the 9th century vestments had been very plain; what splendour they had was the result of material and colour and the ample folds of their drapery. But from this time onward they tended to become more and more elaborately decorated.

3. Final Determination of Ecclesiastical Usage: **13th** to **16th** Centuries. — The only significant development of the late middle ages and the Renaissance was the extension of various forms of choir habit. The eucharistic vestments became more ornate and colourful, with the addition of apparels and brocades; they also deteriorated in form. The black choir cape or cope developed into various types of cloaks, ornamental copes, gowns and hoods; the white rochet and surplice came to the fore in noneucharistic usage. These developments are treated in detail below.

II. VESTMENTS IN THE WEST

A. Four Major Vestments

Four types of vestments, three of which are eucharistic (alb, dalmatic and chasuble) and one noneucharistic (cope), constitute the basic forms of Christian ecclesiastical vesture. These vestments are treated here as structural or architectural, as distinguished from derivative forms and secondary and symbolic items of apparel. The dalmatic, however, proper to deacons in Western rites, must be designated as a major Christian vestment because of its usage rather than its structure; in form it is similar to the alb, in usage it is employed as an outer robe rather than an undervestment.

1. Alb.—The alb derived from the white linen tunic (*tunica alba*), especially those forms that were sewn up the sides and provided with sleeves. In its modern form it is a sacklike, full-length, white, usually linen garment with long, narrow sleeves, secured at the waist by a cincture (*cingulum*) or girdle of white linen. silk or cotton cord. Albs were originally plain. but about the 10th century the custom arose of ornamenting the hem and cuffs with embroidery, and this became common in the 12th century. Such ornamentation at first encircled the whole hem and cuff, but soon it became customary to substitute rectangular patches of embroidery or fabric. These "parures," "apparels" or "orphreys" were usually four in number, one being sewn on the back and another on the front just above the hem, and one on each cuff. A fifth was occasionally added just below the neck opening. Apparels fell into disuse during the 16th century, although they are retained in the Roman Catholic Church in certain localities and according to wish, and they are favoured by many Anglican authors. The use of lace, prevalent since the 16th century. denoted a marked decadence, at times virtually destroying the character of the alb. The vestment symbolizes purity.

2. Dalmatic.—This is a more elaborate tunic (colour and fabric the same as those of the vestments of the officiating priest) whose form has remained almost identical to the original, with open sides, wide sleeves with bands about the cuffs, and *clavi* or coloured bands descending from the shoulders. As in early Christian times, it is worn without cincture or girdle. The dalmatic became the distinctive garment of the deacons of the city of Rome during the 5th century, and it has been retained as the diaconal vestment in the Roman Catholic and Anglican churches. By extension, a shorter dalmatic with narrower sleeves, called the tunic, or tunicle, has become the characteristic vestment of the subdeacon. Dalmatic and tunicle are never worn by priests, except when officiating as deacons (*e.g.*, as deacon and subdeacon assisting at Mass). but both are worn, under the name of tunicles, by bishops under the chasuble (never under the cope) on certain occasions. A silk dalmatic forms one of the English coronation robes.

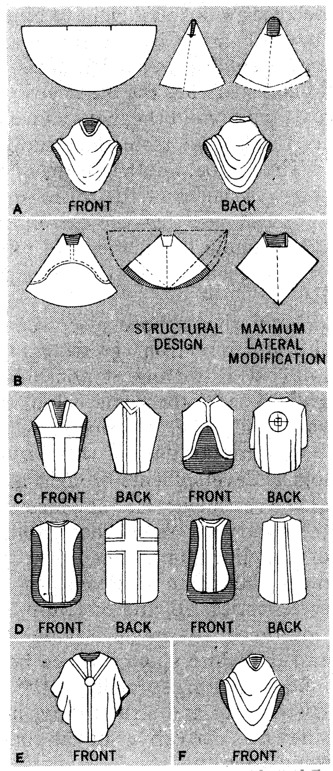
3. Chasuble. — The chasuble, the outermost eucharistic vestment, is the distinctive priestly garment and the Mass vestment par excellence. It retained for hundreds of years in both East (as the phelonion) and West the classical form of its ancestor, the Roman *paenula*. But in modern times no vestment is so difficult to recognize as descending from the earlier Christian centuries.

The early chasuble was worn in three ways: (1) The right side was elevated over the shoulder in order to free the right arm, as in classical Roman times and as shown in the great majority of mosaics and frescoes of the 5th to 9th centuries (2) Both sides were elevated equally, leaving the forearms moderately free; this style was exceptional at the beginning, but became common during the 9th century and throughout the middle ages. (3) The front of the chasuble was gradually elevated over the forearms and chest, a usage which became typical of the Byzantine and Russian churches after the 14th century. These various ways of draping the chasuble did not greatly affect its structure until motives of convenience began to affect usage from the 15th to the 19th centuries, during which period the vestment underwent drastic structural violations.

Ornamentation was the first element that began to alter the appearance of the chasuble. In order to strengthen the single front seam, it was covered by a band, as seen in the 13th-century sculptures at Chartres; the neck opening was also strengthened, and a transverse band became common. This "T" form led to the placing of crosses on the chasuble. The medieval custom was to add oblique side bands to the central column, forming a "Y" or fork; this is typical of chasubles from the 13th to the 16th centuries. As the sides of the chasuble came to be cut down in later centuries, the fork was correspondingly squared off to form the Latin cross, which for the sake of symbolism was transferred to the back of the vestment. Even today, however, there is no requirement for the placing of a cross or any other decoration on the chasuble.

The conical form of the chasuble does not permit lateral diminution over the arms beyond the 90° angle without destroying its essential structure. Beyond this point the front and back become panels draping from the shoulders in the manner of the alb or tunic, rather than retaining the architectural quality of an enveloping garment centring about the head and drawn around the body. This development occurred at the end of the medieval period and during the Renaissance, when the use of brocades and other heavy, stiff materials caused the vestment to hang badly and led to the gradual reduction of the material that extended over the arms; eventually front and back became panel surfaces for weighty baroque decoration. This occurred little by little, without the support of any text and by tolerance of the authorities. St. Charles Borromeo did his best to stem the tide during the high Renaissance, but in spite of his efforts the original structure of the chasuble disintegrated beyond recognition until by the end of the 18th century there existed so-called national models—the French or Gallican, Spanish and Italian chasubles.

The 19th-century renewal of interest in the medieval period, which was felt in both the Roman Catholic and Anglican churches, led to efforts to restore the chasuble to its traditional form. Working on the French side of the Alps, the neo-Gothic reformers adopted as their fundamental model the style that may be called Gallican or French (though the same type was used in Germany), and contented themselves with loosening and enlarging this style in the hope of recovering the medieval or "Gothic" model. They neglected the form known as the Italian model, and, unfortunately, the Gallican chasuble was not a diminution of the medieval chasuble but rather a deformation of the Italian; the latter is truly a reduction of the traditional chasuble and has retained its fundamental structure. This error of the Gothic revivalists has produced indescribable confusion and has delayed the restoration of the true chasuble even in the 20th century.



DEVELOPMENT OF THE CHASUBLE
(A) Ancient model, a semicircle sewn in the form of a cone and modified at the collar and base; (B) Eastern-rite frontal modification after the 16th century; (C, left) Italian model after the 16th century; (C, right) Eastern-rite model frequently used in recent centuries; (D, left) French or Gallican model, (D, right) Spanish model; (E) Neo-Gothic model, a false amplification of French or Gallican model, resulting in two amplified panels rather than a cone; (F) amplification of Italian model (C, left), or Eastern rite frontal modification (B, left) resulting in a vestment similar to the ancient chasuble

In the matter of usage, the chasuble was originally worn by all ranks of clergy. The first Roman *ordo* (an 8th-century document which describes the liturgy of 6th-century Rome) notes that the clergy wore the chasuble over their other garments as they entered the stational church. Only the pontiff, however, retained his chasuble throughout the whole rite of which he was celebrant. On the occasion of his visit to Rome in 831, Amalarius of Metz notes that the deacon who read the Gospel retained his chasuble until the *Alleluia* verse just before his reading. At that moment he removed his chasuble, rolled it on his left shoulder, passed its two ends together with the stole, across and under his right arm and fastened them there. This was done to free the arms. The custom of the deacon wearing a folded chasuble in this fashion during Lent and Advent continued until the usage became obsolete by a new code of rubrics promulgated on July 26, 1960, although in most instances the so-called "broad stole" was unfortunately substituted for the folded chasuble. The clergy are also shown wearing the chasuble on the covers of the 9th-century Frankfurt missal. As late as the 17th century the Ceremonial of Bishops published by Pope Clement VIII directs that presbyters who assist the bishop at solemn vespers wear the chasuble; and even today the priests who assist the bishop of the Roman rite on Maundy Thursday, when the oils for the anointing of the sick and other sacramental uses are blessed, are vested in chasubles. The chasuble symbolizes Christ's love.

In the Eastern churches the equivalent of the chasuble is the phelonion, or phenolion, reserved exclusively to priests; the sakkos is substituted by the higher clergy (see below, Eastern Orthodox *Church*).

4. Cope.—The cope (Med. Lat. *cappa*) is a mantle reaching the heels and worn when the chasuble is not used. The word was in its origin identical with cape; the garment was a hooded outdoor cloak worn by both men and women. *Pluviale* ("rain cape"), the Latin name for the cope in the Roman Catholic Church, is parallel in meaning. When spread out the cope forms a semicircle. Along the straight edge there is usually a broad band or orphrey, and at the neck is attached the hood or cowl. The usage of an actual hood attachment is being restored; in the past four centuries it was replaced by a shield-shaped piece of material (*clypeus*) that was sewn onto the back or attached as an appendage, often rounded or fringed. The cope is secured in front by a broad tab sewn onto one side and fastened to the other with hooks, or by means of a brooch (morse, or fibula).

The use of the cope as a liturgical vestment can be traced to the end of the 8th century. Before this time the so-called *cappa choralis* ("choir mantle"), a black, hooded vestment with no special liturgical significance, had been worn by the secular and religious clergy at choir services and processions. In the Anglican Church it is still worn as the "cloth cope" or *cappa* nigra ("black cope") for funerals in bad weather, when taking communion to the sick and sometimes for general use. In reality, the choir mantle is identical with the cowl, such as was prescribed by St. Benedict (c. 530) for his monks. In the 10th century, partly under the influence of the community of Cluny, the use of an ornamental choir mantle or cope became widespread, and by the 11th century it was universally worn. By the 13th century the cope, as an ornamental, coloured garment of finer material, had supplanted the chasuble in all noneucharistic functions. It came to be used for choral and processional services not only by bishops and priests but also by cantors and others.

In form the original chasuble and cope have remained identical, with the major exception that the cope is open at the front and the chasuble is sewn; this front seam, of course, produces an entirely different appearance (see fig. [A]).

B. Secondary, Derivative and Symbolic Vestments

1. Amice.—The amice (*amictus*, "wrapped around") may have originated in a scarf wrapped around the neck and shoulders to protect the outer garments from soil. It was not strictly a part of ancient Roman dress, and like the loincloth (which served a similar purpose) was scarcely considered a real garment. The medieval amice, similar to the cowl, was simply a hood to cover the head and ears when the church was cold, and this hood form became the basis for the amice's development as a distinctly ecclesiastical vestment in the West. The hood form is retained by monks of various religious communities (*e.g.*, the Benedictine), but among the secular clergy, more in accord with ancient usage, the amice is a rectangular piece of linen cloth, about 24 by 36 in., secured about the neck and shoulders by two long narrow bands. In correlation with the apparels used upon albs, the upper border of the amice was often appareled during the late middle ages, and the practice continues in many instances. The amice symbolizes the helmet of salvation.

2. Pallium.—The pallium (or pall), which symbolizes the fullness of the pontifical power, belongs to the pope but is conferred by him on archbishops (and occasionally other bishops) to indicate their participation in this authority. Since the 9th century no archbishop may exercise his metropolitan jurisdiction until he has received the pallium. He must apply for it, personally or by deputy, within three months after his consecration, and it is buried with him at his death. Though the pallium is thus a vestment distinctive of bishops having metropolitan jurisdiction, it may be worn by them only within their jurisdiction, on certain solemn occasions The pope alone has the right to wear it everywhere and at all times.

Early Christian art, following an invariable convention, clothed Jesus and the apostles in a pallium. and this tradition prevailed even when the pallium in its original form of a long, rectangular cloth. wrapped around the body as a mantle. had ceased to he a cominon article of dress. In ancient times, the pallium was often folded up and thrown over the shoulder when not needed for warmth. By this process (contabulatio, "folding") the sacred pallium was also folded into a band, which finally appeared only as an ornamental scarf of white wool, morn on the shoulders over the chasuble; in this form it is seen in mosaics of the 6th to 12th centuries. Later it gained its present form of a yoke. made of white lamb's wool, with ends hanging down before and behind. so that when seen from either front or back it resembles the letter "Y." It is decorated with six crosses, one on each pendant and four on the loop.

The Eastern equivalent of the pallium is the bishop's omophorion. a long, white, embroidered scarf of silk or velvet, about ten inches wide. worn over the shoulders at celebration of the Holy Liturgy.

3. Stole.—This ensign began to enter into liturgical usage as early as the 4th or 5th century. Its origin is obscure. The word stola did not appear until the Carolingian period, and until that time all Christian writers used the word *orarium* to designate this vestment, indicating that the stole was originally intended for wiping the mouth (os, *oris*). It was morn about the neck and is frequently seen on pagan monuments and in the catacombs. As a vestment, however, it may have originated from the consular toga (the only form that survived the 4th century), a sumptuous garment so heavily embroidered in gold that it had to be folded in broad bands that showed only the ornament; after it had been drawn around the body in the usual manner of the toga, it was passed around again with the decorative pattern fully displayed, the end resting on the left arm. This article survived in the Byzantine court as an ensign of imperial dignity, but by that time it had become a mere scarf.

In its present form it is a relatively narrow (two to four inches) band of silk, about eight feet in length, harmonizing in colour with the major vestments. It is the distinctive diaconal vestment but is also a regular vestment of the priest. The deacon wears it over the left shoulder with the ends joined under the right arm; the priest wears it around the neck, the ends crossed (if worn over the alb) or hanging down It symbolizes immortality.

The counterparts of the stole in the Orthodox Church are the epitrachelion (peritrachelion) of the priests and the orarion of the deacons.

4. Maniple.—This ensign (Lat. *manipulus,* "handful"), which assumed its present general form and purely ceremonial character about the 11th century, is a narrow (about two to four inches) strip of silk, three to five feet in length, worn over the left forearm with the ends hanging down on either side. It corresponds in colour with the major vestments and is ornamented with three crosses, one in the centre and one at each end, that in the centre being obligatory; it is often elaborately embroidered. The maniple is the special ensign of the office of subdeacon (though proper to all orders above). It is worn only at Mass, by the celebrant and the ministers assisting.

The maniple may have originated in a cloth in practical use as a napkin during the liturgy, or it may have been a diminutive stole proper to the subdeacon. The earliest extant specimen of the bandlike maniple is that found in the grave of St. Cuthbert (early 10th century). It was carried originally in the left hand or hung over the left arm near the wrist, and it is represented this way in the iconography of the 9th. 10th and 11th centuries. By the 12th century the rule according to which it is worn over the left arm had been universally accepted. The maniple symbolizes work and service.

5. **Humeral** Veil.—The humeral veil is mentioned, under the name of *sindon,* in the 8th-century Roman *ordo,* when it was worn by acolytes who had charge of the sacred vessels. It was used as a shoulder (*humerus*) support to lighten the burden of the heavy chalices. The humeral veil did not make its appearance in the Rituale Romanum until the latter part of the middle ages, when it was used principally by the subdeacon at high Mass; general adoption for other uses came in the 19th century. It has become a silk scarf, eight to nine feet in length by two to three feet in width, worn by the priest at benediction and processions and by the subdeacon at high Mass. Its normal colour is white, but at Mass it matches the other vestments. The ends (usually fringed) are used to hold the monstrance or paten; thus the veil still retains its function of a shoulder support.

The vimpa, another form of veil, ordinarily white in colour, is worn by clerks of the mitre and crosier at pontifical ceremonies. It is believed that the extremities of the surplice were formerly used to hold the crosier and mitre, and that the vimpa came into existence only when the surplice was reduced in size (see Cotta, below).

Latin rite bishops also wear a form of apron or veil, called the gremial (from *gremium,* "lap"), which is placed over the knees while sitting at pontifical Mass or when anointing. The gremial is of the same colour as the vestments and ornamented with gold or silver fringe.

6. Derivatives of the Cope.—With the Reformation, theological developments brought about a reaction against the wearing of the vestments used at Mass, such as the alb and chasuble. Contemporary excess in ornamentation also led to a reaction in favour of simplification. The cope, as the original black choir vestment, thus came to serve as the principal noneucharistic model for ecclesiastical apparel of late medieval, Renaissance and Reformation times. As modifications of the choir mantle, the black gown and the white choir surplice became major religious garments in modern times. especially in the Protestant and Anglican churches. Historically and structurally. however, all of these must be considered as derivatives of the cope and of choir costume used in the middle ages.

Chimere, Mantelletta and Mantellone.—The chimere, worn as part of the ceremonial dress of Anglican bishops, has as its counterpart in the Roman Catholic Church the mantelletta ("little mantle"), worn by cardinals, bishops, abbots and other prelates of rank. Both vestments are long. sleeveless mantles of silk or satin, open at the front but fastened at the neck, worn over the rochet (see below) as a cape. The chimere was more immediately derived from the medieval tabard, an upper garment worn in civil life by all classes of people, including the clergy. In the Anglican form for the consecration of bishops the newly consecrated prelate, hitherto vested in rochet, is directed to put on "the rest of the episcopal habit"; *i.e.,* the chimere. The robe has thus become in the Church of England symbolic of the episcopal office and is in effect a liturgical vestment. The mantellone (of purple silk or wool). worn by lesser prelates at the papal court. and the academic robe of the master's degree closely resemble the chimere, except that the streamers pendant from the shoulders of these garments indicate vestigial remnants of former sleeves.

Cappa Magnu.—At what date the choir mantle developed into the cappa magna, a nonliturgical garment of state peculiar to the pope, cardinals, bishops and certain privileged prelates. is not known, but mention of it is found as early as the 15th century. This vestment is a loose mantle, with a large hood lined with fur in winter and silk in summer, and a long train. Its colour varies with the hierarchical rank of the wearer.

Mozzetta—The name is derived from the Italian *mozzare,* "to cut off," which points to its being an abbreviated *cappa* It is a short cape of silk or wool with a miniature hood, fastened down the front with buttons. It is worn over the rochet by the pope (red), cardinals (red), bishops (purple) in their dioceses, abbots (colour according to habit) in their abbeys and certain privileged prelates.

Black Gown—For the sake of convenience in freeing the forearms, the ancient black choir mantle was somewhat modified in the middle ages, but its basic copelike form was retained The first modification was the opening of slits at the sides for passage of the arms, as seen in the chimere. A fundamental structural change, however, consisted in the addition of sleeves. long and either flowing or tucked in at the wrists. In this manner, the original enveloping quality of the cope was altered into that of an open-fronted dalmatic or kimono, architecturally becoming an under-garment or tunic. The gown is worn by both civil and ecclesiastical magistrates: as academic apparel, as formal costume for judges and lawyers, as preaching gown for ministers and as costume for vergers and other functionaries. Coloured bands, similar to those on copes, sometimes enliven the otherwise sombre black gown, and at court and academic functions coloured gowns may be worn (See also ROBES: Academical Dress.)

Almuce.—From the hood of the *cappa* was developed the almuce, a hooded cape of fur, or fur-lined, worn occasionally as a choir vestment, although almost superseded by the mozzetta. In the late 13th century two types of almuce were distinguished. (1) a cap coming donn just over the ears; (2) a hoodlike cape falling over the back and shoulders, reserved to more important canons and worn over surplice or rochet in choir. The square cap and biretta. in common use by the 16th and 17th centuries, tended to replace the almuce as a head covering. Its hood then became smaller. and the cape was enlarged and the fur lining introduced. In England the almuce was known as "gray amice" (from the colour of the fur; the word amice, or amess, in this connection is derived independently from the eucharistic vestment called amice). By the 16th century the almuce had become definitely established as the distinctive choir vestment of canons; but it had ceased to have any practical use, and was only carried over the left arm as a symbol of office. A form of almuce survives among the canons of some churches in Rome and elsewhere.

Academic Hood and Black Tippet.—The choir habit peculiar to the Anglican Church consists of a long surplice (see below), the academic hood (according to the wearer's degree) and the black scarf or tippet. The short cape vith hood. structurally identical with the full cape or rain cape. was worn by all classes during the middle ages and developed into various styles, among them the academic hood. Until the 17th century this was a real hood attached to a shoulder cape, but the fashion for large wigs made it necessary to enlarge the neck opening. so that. by the reign of George III, the hood became a rather shapeless garment, hanging down very far at the back and almost completely cut away in front and over the shoulders. Use of the original type of academic hood with cape is encouraged in modern times.

The black scarf or tippet developed out of the liripipe, a piece of fabric attached to the point of the hood. The liripipe gradually grew longer until it could be wrapped around the throat. Eventually it mas separated from the hood and worn by itself around the shoulders, becoming a scarf.

Hood and tippet are worn over the surplice for matins and evensong and other nonsacramental services, and the tippet is also worn with cassock and gown as the formal dress of the Anglican clergy. The tippet is a wide piece of black cloth (silk for doctors and masters. stuff for others), gathered together about the neck and worn in the manner of a priest's stole.

7. White Choir **Vestments.**—*Surplice.*—The most commonly used choir vestment in the Roman Catholic Church (in which it is proper to all clerics) is the surplice (Lat, *superpellicium*, "over the fur coat"); in the Anglican Church it is the normal eucharistic vestment in parish churches, and it is worn by the ministers of some Lutheran and Free churches. But the surplice does not possess an ancient and venerable tradition. Until as late as the middle of the 13th century the alb was not only the undervestment of the priest at the altar but also the proper choir attire of all clerics. The first use of the surplice seems to have occurred in England or France about the 11th century, and it is mentioned in an ordinance of King Edward the Confessor; its adoption in Rome was delayed until the 13th century. Its Latin name derives from its use over fur-lined tunics during the cold winter months in order to give the choirs a more uniform appearance. and this likewise accounts for the ampleness and the full sleeves of this garment Such an outer garment should traditionally be an enveloping one, like the chasuble or cope. Though the surplice, in white linen, is used in place of the alb in choir and at other functions, its classical structure is indeed almost identical with that of the chasuble, with the major exception that it is provided with sleeves, which alters the draping and destroys the effect of the encircling folds. The surplice reached the apex of its development during the 14th and 15th centuries, when it is depicted by the artists of the Florentine and Sienese schools. It has no counterpart in the Eastern churches.

Cotta—The mistaken notion that the surplice was derived from the alb led to the introduction of a diminutive, jacketlike garment named the cotta, which even today is used and named indiscriminately as a surplice. The cotta is a square-necked chemise, often pleated about the shoulders and descending to the waist or a little lower; its shoulder draping places it beyond all question in the category of the tunic. This article of clothing is a most unhappy development, since it partakes of the qualities of neither the alb nor the surplice.

Rochet.—This garment is in reality a substitute for the alb or surplice; in form it is more closely related to the alb. The alb requires the use of an amice and cincture, and thus involves some care in vesting; the rochet, which may be sleeveless or tight-sleeved, can be put on and carried about easily. It is usually made of linen and falls to within a foot to six inches of the ground. The rochet, with wide lawn sleeves, is worn under the chimere by Anglican bishops; in the Roman Catholic Church it is worn under the mozzetta by bishops, abbots and occasionally other dignitaries.

8. Head Coverings.—The most important liturgical head covering is the bishop's headdress, the mitre. which, in its customary form, is a sort of folding cap consisting of two halves, which. when not worn, lie flat upon each other, and. when worn, rise in front and in back into pointed arches. (See MITRE.)

The square cap which is used in various forms in many of the Christian churches was originally the medieval "barret cap." When the word *biretum* was first used in the 13th century. it meant little more than the pileum (pileolus) or skullcap, used as a protection against the cold and by clerics to cover the tonsure. By the 16th century it had developed through various forms and mas the common headgear of all people of substance. The academic cap is a direct descendant of its form as a "square cap" (see ROBES: *Academical* Dress). One of the most attractive forms is found during the reign of Edward VI, depicted in the famous portrait of Archbishop Thomas Cranmer in the National Portrait gallery, London. This is one of the forms preferred by the Anglican clergy. The pileum, later designated by the diminutive form pileolus, became a round skullcap of silk, lined with red leather. called the zucchetto, worn by bishops under biretta or mitre. By a brief of June 17, 1868, Pope Pius IX granted to all patriarchs. archbishops and bishops the privilege of wearing this skullcap at home. in church and even when celebrating Mass. except from the Sanctzrs until after communion. The biretta, whose form is peculiar to the Roman Catholic Church. was devised in the 17th century, and its liturgical usage, strictly post-Reformation. is quite limited (see BIRETTA). From the point of view of both history and appearance, the episcopal usage of both pileum and biretta at the same time is anomalous.

III. USAGE IN THE CHRISTIAN CHURCHES

A. ROMAN CATHOLIC CHURCH

Ecclesiastical vestments may be divided into two categories. liturgical and nonliturgical. Liturgical vestments are again divided into three classes: (1) those worn at the celebration of Mass; (2) those never worn at Mass, but worn at other liturgical functions; (3) those used at both Nonliturgical vestments are those (*e.g.*, cappa magna, rochet) that have no sacred character but have come into use from motives of convenience or as ensigns of dignity and are worn at secular as well as ecclesiastical functions

1. Eucharistic Vestments.—As the sacrifice of the Mass is the central mystery of the Catholic faith, the vestments worn by the priest when celebrating Mass are the most important. The cassock. which must always be worn under the vestments, is not itself a liturgical garment (see CASSOCK). Over this the priest, robing for Mass, puts on, in order, the amice, alb, cincture, maniple, stole and chasuble. Deacons wear amice. alb, cincture, maniple, stole and dalmatic; subdeacons wear amice, alb, cincture, maniple and tunicle. The vestment proper to the minor orders, formerly the alb with amice and cincture, is now the surplice. The pontificating bishop, as belonging to the order of the fullness of the priesthood, wears the same vestments as the priest. with the addition of the pectoral cross, pontifical gloves and ring, liturgical sandals and stockings, tunicles which replace and symbolize the dalmatic and tunicle and which are worn over the stole and under the chasuble, and the mitre. Archbishops. on solemn occasions, wear the pallium over the chasuble. Bishops also carry a pastoral staff as a symbol of their office as shepherd (see CROSIER). Finally, the pope, when celebrating Mass, wears the same vestments as an ordinary bishop, with the exception of the *fanon* or *orale,* a specially designed and ornamented cloak which, put on after the alb and then placed over his head, is allowed to fall over the chasuble like a cape, and the *subcinctorium,* an ornament that is the Western version of the epigonation (see below, Eastern *Orthodox* Church). The liturgical headdress of the pope is the mitre, not the tiara. which is the symbol of his supreme office and jurisdiction (see TIARA).

2. Others.—Of the liturgical vestments not immediately or exclusively associated with the sacrifice of the Mass, the most conspicuous are the cope and the surplice. In addition to the strictly liturgical vestments there are also numerous articles of costume worn at choir services, in processions or on ceremonial occasions in everyday life, which have no sacral character; such are the almuce. the cappa magna, the mozzetta, the mantelletta, the mantellone, the rochet and the pileum or small skullcap, worn under mitre and tiara.

3. Colour.—The custom of marking the seasons of the ecclesiastical pear and the more important feasts by the colour of the vestments dates approximately from the 12th century. Certain rules, already established by Pope Innocent III (c. 1200), are still in effect. Late medieval and Renaissance paintings and tapestries show that a wide profusion of colours was used in the liturgy, so much so that a need for simplification and systematization of some sort became apparent.

In modern times five liturgical colours are used in the Roman rite, together with two alternate colours. (1) White is used at Christmas. Epiphany, Easter, most of the feasts of Christ and the Blessed Virgin, and at other feasts and name days of virgins and confessors. (2) Red is used for Pentecost, or Whitsuntide. feasts of martyrs and on certain other occasions. (3) Green is used for ordinary Sundays from Epiphany to Septuagesima, and after Pentecost. (4) Violet is the distinctive colour of Advent and Lent; a violet stole is also worn by the priest in the administration of the sacraments of penance and extreme unction or anointing. (5) Black is used at Masses for the dead and for funeral ceremonies of adults. as well as on Good Friday. (6) On two Sundays of the year—Gaudete. the third Sunday in Advent, and Laetare, the fourth Sunday in Lent—rose-coloured vestments may be substituted for violet. (7) Gold is tolerated as a substitute, particularly in churches which are unable to afford complete wardrobes, for white, red and green. In Spanish countries blue or azure is used for certain feasts of the Virgin Mary.

B. EASTERN ORTHODOX CHURCH

The vestments of the great historical churches of the East are derived from the same Greco-Roman originals as those of the West. Between the patriarch Germanus of Constantinople in the 8th century and Simeon, archbishop of Thessalonica in the 15th century, there is scarcely any essential distinction between Eastern and Western liturgical clothing. All colours may be used, the differentiation lying only in the fact that dark colours characterize the penitential seasons! light colours the festive seasons. Black is used in many churches at Masses for the dead and on Good Friday, but this has been borrowed from the Latin Church through Poland. A tendency toward the use of heavy ornamentation has prevailed during the past few centuries.

The phelonion (phenolion), or chasuble. the outermost and chief vestment of the priest, suffered the most serious alteration of all the vestments after the 16th century. The entire front of the cone-shaped garment was cut out in the form of an ellipse, so that the phelonion as it is used in certain rites now resembles a *cappa* and no longer encircles the body with horizontal folds. A reaction to this alteration has occurred: however, and a return is being made to the encircling form. The phelonion is not so specifically a eucharistic vestment as the chasuble is in the West, but is worn at solemn functions other than the Liturgy—*e.g.,* at marriages and processions.

The sakkos, a short, tight-fitting tunic with half-sleeves, similar in form to the dalmatic, was adopted by Greek metropolitans in 1433 and by all Russian bishops from the time of Peter the Great. It is widely believed that this was the tunic of the Byzantine emperors, who conceded its use first to the patriarchs, then to bishops whom they wished to honour in a special manner. It may, however, be a vestige of the deacon's dalmatic, over which the bishop assumed the phelonion; and it may have been influenced by the sleeveless tunic (*me'il*) of the Jewish high priest. The wearing of the sakkos (which substitutes for the phelonion) is unfortunate, since it is not an enveloping outer vestment and the ancient classical relationship of under and outer garments is lost.

The amice, maniple and cope are not employed in the Eastern churches.

1. Episcopal Vestments.—An Orthodox bishop, vested for the Holy Liturgy, wears over his cassock: (1) the sticharion; (2) the epitrachelion (peritrachelion), or stole; (3) the zone, which fastens the sticharion about the waist as the cincture fastens the alb; (4) epimanikia or liturgical cuffs, which fasten the sticharion at the wrists (originally, perhaps, like the maniple, a napkin worn on the arm); (5) the epigonation, a lozenge-shaped piece of stiff material about 12 by 10 in. and embroidered, hanging at the right side from the zone or shoulders, to the level of the knee; (6) the sakkos; and (7) the omophorion, or pallium.

In addition to these, the bishop wears one or two enkolpia, images of Christ or of the Virgin, suspended from the neck; a pectoral cross; and carries the bakteria (dikankion) or crosier, which ends in two serpents facing one another, symbolizing prudence in guiding the flock. (Archimandrites and higumens having actual jurisdiction in a monastery are also entitled to use a crosier, of which the upper endings are not turned upward—as is the case with bishops' crosiers—but downward.) For blessings he holds the dikerotrikera, a double candelabrum, one of two branches (dikerion) representing the two natures in Christ, the other of three branches (*trikerion*) representing the three Persons of the Trinity. The mitra, or mitre, is believed to be a copy of the imperial crown of the Byzantine emperors, with a cross on top and adorned with various religious emblems, though it may owe some derivation to the Jewish mitre. (See MITRE.) In Russia archimandrites and higumens by right and certain secular clerics by special favour wear a mitre.

Two other garments are worn before formal vesting for the Holy Liturgy: (1) the epikalymmauchion (or epanokalymmauchon), a black veil of monastic origin worn over the kamelavkion, or ordinary round black headdress of the priest or monk; and (2) the mandyas, also of monastic origin and assumed at the threshold of the church, is likewise worn on less solemn occasions. The mandyas is a long, full cloak, blue or purple in colour and open down the front, its edges caught together under the chin and at the bottom by hooks or small bells. At these points the cloak is adorned with squares of some richly embroidered material, called pomata ("beverages"), from which issue red and white stripes, called potamoi ("rivers"). The pomata typify the Old and the New Testaments, the sources whence the bishop should draw the doctrine he pours out upon his flock. Neither of these is a distinctive episcopal garment—bishops wear the epikalymmauchion because they are monks, and the mandyas is also worn by archimandrites and higumens, though without the potamoi.

2. Priests' and Deacons' Vestments.—The vestments of the priest are the sticharion, epitrachelion, zone, epimanikia and phelonion. He wears all of these only at the celebration of the Eucharist and on other very solemn occasions. A dignitary in priests' orders is distinguished by wearing the epigonation; and in

Russia the use of the mitra was formerly sometimes conceded to distinguished priests by the tsar.

The deacon wears the sticharion without zone, the epimanikia and the orarion (deacon's stole, counterpart of the priest's epitrachelion) hanging over his left shoulder. The deacon's epimanikia cover the sleeves of the cassock rather than the sticharion, which in tlie case of the deacon does not reach the wrists. Acolytes wear a shorter sticharion and a tunicle. The phelonion has only in modern times come to be reserved exclusively to priests. It is still conferred on deacons and lectors at their ordination, but once the ordination ceremony is over, the lower orders may not wear this vestment. During the 10th century it was worn by cantors at Hagia Sophia, and even in the late middle ages was worn by deacons.

C. Protestant Churches

In the Protestant churches custom in regard to vestments differs widely. corresponding to a similar divergence in tradition and teaching. At the Reformation two tendencies became apparent. Luther and his followers regarded vestments among the adiaphora — matters of indifference, that might be either retained or abolished—and in the churches that afterward came to be known as Lutheran many of the traditional vestments were retained. Calvin, on the other hand, laid stress on the principle of the utmost simplicity in public worship. At Geneva the traditional vestments were absolutely abolished, and the Genevan model was followed by the Calvinistic or Reformed churches throughout Europe.

In modern times the Lutheran churches of Denmark and Scandinavia retain the use of alb and chasuble in the celebration of the Eucharist (stole, amice, cincture and maniple were not used after the Reformation), and bishops retain the cope and mitre. The surplice is not used, the ministers conducting the ordinary services and preaching in a black gown, of the 16th-century type, with white bands or ruff.

In the United States, Lutheran pastors are under no obligation in the matter of vestments. The custom of wearing a plain black gown is gradually diminishing in favour of cassock, surplice and stole. This tendency, however, is disapproved by many leading American Lutheran scholars for Holy Communion, matins, vespers, "preaching services," processions and noneucharistic devotions, although the stole may properly be worn by ordained clergymen in the administration of baptism, matrimony, orders and penance.

> Official pronouncements of other Lutheran bodies in this country notwithstanding, the present widespread vogue among us of surplice plus stole . . . is an ill-considered importation into the Lutheran Church of an Anglican compromise that even Anglican liturgiologists disapprove and that is without real warrant in historic Lutheran practice . . . The next step for a Lutheran parish beyond the simple white vestment is not surplice and stole, but the combination of surplice (or sleeveless rochet) and chasuble . . . The acquisition of a chasuble as the next step after the surplice thus has a number of advantages. It is simple and convenient. It adds the specifically Eucharistic vestment, the chasuble, to the general service vestment, the alb (A. C. Piepkorn. "What About Vestments for Pastors?", in *Concordia Theological Monthly,* vol. xxx, no. 8, pp. 587–588, 591; Aug. 1959).

The fullest Lutheran usage would include eucharistic vestments for Holy Communion, cope for processions and solemn offices, surplice and stole for noneucharistic services and surplice for choir offices. There is also no reason why dalmatics and tunicles should not be revived; they were in actual use in the church of the Augsburg Confession at least until the end of the 18th century.

The Evangelical Church in Germany has, in general, discarded the old vestments. In isolated instances the surplice is still worn, but pastors now wear a barret cap, a black gown of the type worn by Luther himself, and white bands. Superintendents in Prussia wear the pectoral cross.

In the Reformed churches the minister wears the black Geneva gown with bands. This use has been largely discontinued in the modern Free churches, but some of these have in comparatively recent times adopted the surplice, and in the Irvingite or Catholic Apostolic Church the traditional vestments have been revived. In the United States, a tendency toward changes in worship and liturgy frequently affects the wearing of vestments at services. For instance, the Book of Worship (1948) of the Congregational Christian churches indicates that the vestments worn by the minister include a cassock, surplice and stole, which "is the sign of an ordained clergyman" and may be of various colours. (E. J. Su.)

D. Anglican Church

In the matter of vestments the Reformation in England passed through several stages. Under Henry VIII no alterations were made. In the first Prayer Book of Edward VI (1549) the priest at Holy Communion is directed to wear "a white alb plain with a vestment or cope," while the assisting priests or deacons are to wear "albs with tunicles." In the medieval period the word vestment was generally used as a collective noun to cover what is now called "a set of vestments." Elsewhere there are directions for the wearing of surplice and hood at choir services in cathedrals and collegiate churches, and bishops are directed to wear, besides a rochet, a surplice or alb and a cope or vestment, with a pastoral staff.

The intention of the framers of this book, among whom was Bishop Nicholas Ridley, was to substitute the Holy Communion for the Mass as a sacrifice as this had been understood in the middle ages. It was soon found. however, that the conservative clergy took advantage of the retention of so much of the old liturgy to celebrate it as "a verie niasse." To guard against this the second Prayer Book of Edward VI (1552), in addition to changing the phraseology and order of the prayers, prescribed as the sole vestment of the minister the surplice, which had previously been associated with the daily prayer offices and sacramental administration but which was free of association with the sacrifice of the Mass. They did this against the Puritan wish to reject all ecclesiastical vestments and to wear lay dress, generally in some academic form, to conduct all services of the church. The Prayer Book of 1552 was of course suppressed during the reign of Queen Mary, but in 1559, after the accession of Elizabeth I, parliament once more adopted it, and passed the Act of Uniformity, which made its use obligatory on all.

In the Prayer Book ordered by the Act of Uniformity of 1559, no explicit directions were given as to the vestments to be worn, but the act ended with a section directing that the ornaments of the church and its ministers were to be "retained and had in use" as they were "by authority of Parliament in the second year of the reign of King Edward VI." An act of parliament is dated from the day it is introduced, not the day it is passed. Although the Prayer Book of 1549 was not issued until the third year of the king's reign. the act imposing it would be referred to as of the second year. Lawyers would naturally read that the Act of Uniformity imposed the "ornaments" ordered by that book, in which at least the most conspicuous of the Mass vestments had been retained. Nothing is historically clearer, however, than the fact that these vestments were not retained long after 1559. The "Reformation Settlement" of the 16th century attempted to settle on an ecclesiastical vesture acceptable to both traditionalists and to the Puritans. The difficulty seems to have been not to suppress the chasuble, which fell into almost complete disuse after 1559, but to save the surplice, which the more zealous Puritans looked on with scarcely less disfavour. More practical directions had been put out by the archbishop of Canterbury, Matthew Parker, in the *Interpretations* of 1560 and the *Advertisements* of 1566. The latter required the clergy to wear "a four-cornered cap, a scholar's gown priestly and in the church a linen surplice." It was impractical to order the use of the chasuble as most of them had been destroyed and contention was too strong, but the cope was ordered as the normal eucharistic vestment for cathedrals and collegiate churches. In practice copes came to be used only on occasions of high ceremony such as the coronation or funeral of the sovereign. The instructions of the *Advertisements* on clerical garments were incorporated into the fully authorized Canons of 1604. Despite this, the Ornaments Rubric, with minor verbal changes, was repeated in the 1662 book. These formularies still govern the Church of England in the matter of vestments. The ordinary costume of the bishop consists of rochet, chimere and square cap, which formerly had been the "undress" uniform of the bishop when going about his business outside the church building. Great liberty with regard to the colour of vestments is also legitimate under the strictest interpretation of the Ornaments Rubric.

With the revival in the 19th century of high sacramental doctrine and of belief in the sacrifice of the Mass, there was a natural tendency to restore the usage of the vestments that symbolized these doctrines (see ENGLAND, CHURCH OF: 20th-Century History *and* Development: Anglo-Catlzolicism). Opposition was aroused, and the judicial committee of the privy council in two cases (1870 and 1877) decided that the usage of the Advertisemeats overruled what seemed to many the natural interpretation of the rubric. This judgment did not at all settle the question. The "ritualistic" clergy refused to obey it on the ground that it was not delivered by a spiritual court, and after 1877 usage became varied even according to parishes. A subcommittee of five bishops was finally appointed to investigate the matter, and their report—"On the Ornaments of the Church and Its Ministers"—was presented in 1908. This document concluded that under the Ornaments Rubric the vestments prescribed in the first Prayer Book of Edward VI are permitted, if not enjoined.

Parliament, by the Enabling act of 1919 (officially Church of England Assembly [Powers] act), gave the Church of England powers of self-government; measures passed by the convocations and the newly established church assembly were subject only to the veto of parliament. Early in 1927 an alternative Prayer Book, drawn up by a committee of bishops and intended, among other things, to regularize practices of doubtful legality under the old book, was adopted by both convocations and by the church assembly; but it was rejected by the house of commons later that year.

The rubrics contained in the new Prayer Book directed that the minister at Holy Communion is to wear either a surplice with stole or scarf, or "an alb plain with a vestment [i.e., chasuble] or cope." The former directive is followed among strong Evangelicals in England and in Canada; the latter is freely interpreted to permit the entire gamut of eucharistic vestments in the liturgy. (W. A. P.; B. G. F. M.)

IV. JEWISH VESTMENTS

1. Old Testament **Priests.**—According to the Pentateuch God commanded Moses to prepare special garments for Aaron and his sons to be worn by them during their services in the Tabernacle. One set of vestments was prescribed for the common priests and two sets for the high priest. These were considered obligatory for the priests of all future generations (cf. Mishnah Yoma 7, 5).

Common Priests.—The vestments of the common priests consisted of four pieces: coat, girdle, cap and breeches. The coat and cap were made of fine linen, the breeches of fine twined linen and the girdle of fine twined linen and of blue, purple and scarlet stuff, embroidered with needlework (Ex. xxviii, 40, 42; xxxix, 27–29).

High *Priest.*—The vestments of the high priest consisted of eight pieces. In addition to the four pieces of the common priest, the high priest had to wear during the services at the Tabernacle: (1) a coat called ephod (*q.v.*); (2) a breastpiece called *hoshen* or *hoshen ha-mishpat;* (3) a *me'il* or robe of blue; and (4) a *ziz* or diadem.

The *hoshen,* in the form of a pouch, was adorned with precious stones. It was "square and double, a span its length and a span its breadth." Four rows of stones were set in it: a row of sardius, topaz and carbuncle; a row of emerald, sapphire and diamond; a row of jacinth, agate and amethyst; and a row of beryl, onyx and jasper. They were enclosed in settings of gold filigree. There were 12 stones "with their names according to the names of the sons of Israel: they shall be like signets, each engraved with its name, for the twelve tribes" (Ex. xxviii, 16–21; xxxix, 8–14). The breastpiece contained the divine oracle called Urim and Thummim (q.v.).

The *me'il,* woven all of blue, is described as follows:

> The opening of the robe in it was like the opening in a garment, with a binding around the opening, that it might not be torn. On the skirts of the robe they made pomegranates of blue and purple and scarlet stuff and fine twined linen. They also made bells of pure gold, and put the bells between the pomegranates upon the skirts of the robe round about, between the pomegranates; a bell and a pomegranate, a bell and a pomegranate round about upon the skirts of the robe for ministering (Ex. xxxix, *22–26; cf.* xxviii, 31–35).

The *ziz,* or diadem of gold, worn by the priest on his forehead, was inscribed. "like the engraving of a signet, 'Holy to the Lord.' And they tied to it a lace of blue. to fasten it on the turban above" (Ex. xxxix, 30–31; cf. xxviii, 36–37). The headgear of the high priest, or his mitre (*miznefet*), was different in form from the cap (*migba'at*) of the common priest, but no description is given in the Pentateuch.

On the Day of Atonement, the most solemn day in the Jewish calendar, the high priest was dressed in pure white from head to foot. These were the "holy vestments;" and before putting them on he had to bathe in water. The ritual bath was repeated when, after his dismissal of the goat (the scapegoat) which was sent away into the wilderness to Azazel, he laid the vestments aside. After the subsequent sacrifices of the day, the high priest resumed his sacerdotal vestments (Lev. xvi).

Levites.—The Levites, who performed various services and were the hymn singers of the Temple, were also dressed in distinctive robes (I Chron. xv, 27; II Chron. v, 12). Flavius Josephus, the Jewish historian of the 1st century A.D., relates that the Levites, who during the time of the Second Commonwealth were degraded by the priests to the position of lower servants (c. 200 B.C.), persuaded King Herod Agrippa II in A.D. 63 to convene the supreme religious council, the Sanhedrin, and to seek from it permission for the Levites to wear linen garinents; the permission was granted (*Antiquities* xx, 9. 6).

2. Second Commonwealth.— In the literature of the time of the Second Commonwealth the vestments of the high priest are described by some authors with great pride (*see* Ecclus. [Sirach] xlv, 6–24; l, 11; Letter of Aristeas, 96–99). The Hellenistic Jewish philosopher Philo of Alexandria (*Vita Mosis* ii, 109–135; De *specialibus legibus* i, 82–97) interpreted the vestments symbolically, as representing the world and its parts: the robe is an image of the air, the ephod a symbol of heaven, the stones at the breast signify the zodiac cycle, and so on. Josephus (*Antiquities* iii, 179–187; *The* Jewish *War* v, 231–237) gives a similar though independent allegorical interpretation of the vestments: The high priest's tunic signifies the earth. being of linen; its blue represents the arch of heaven, its pomegranates the lightning, the sound of its bells the thunder. His upper garments, too, denote universal nature, the breastpiece being set in the midst of the garments after the manner of the earth. Sun and moon are indicated by the two sardonyxes with which the high priest's robe is pinned. The talmudic scholars emphasized the power of the priestly garments to procure forgiveness of sins.

3. Roman **Period.**—In the Roman period of Jewish history, the vestments of the high priest, as symbols of political power. became involved in the struggle between Jewish and Roman authorities. During A.D. 6–36 the vestments were held all year in custody of the Roman authorities and were given out to the high priest only before a holiday, but in 36 the Roman legate Vitellius returned them to the custody of the high priests. In A.D. 44 the procurator Fadus demanded that the vestments be placed under his control, but the emperor Claudius decided against him and they remained in the custody of the high priests until the destruction of the Temple in A.D. 70. After this, animal sacrifices ceased, the high priesthood was abolished and there were no more sacerdotal vestments in Judaism.

4. Nonpriestly **Vestments.**—The synagogue (q.v.) antedates the destruction of the Temple by many centuries, but the scholar, the predecessor of the rabbi, is not the historic heir of the priest and his garments have not the holiness of the high priest's garments. The scholar in the house of learning or in the synagogue wore the same garments as other people. The only demand put on him was that his garments be clean and neat and that all his body be covered by them; it was expected, however, that he would observe the commandment of the fringes, or tassels (*zizit;* Num. xv, 37–40). All Jews, however, endeavoured to reserve a special suit for use in the synagogue, particularly on the Sabbath and holidays.

In course of time. however, a class of scholars developed, and the scholar and later the rabbi could be recognized by his outward appearance. The Talmud already mentions "the overcoat of the scholar" (Baba Batra, 57b), and it prohibits a nonscholar from dressing in the manner of a scholar (*ibid,* 98a). In the middle ages it became customary for a rabbi to wear black velvet or silk, even on weekdays. Rabbis were also exempted from the sumptuary laws in order to add to and strengthen their dignity. Some scholars with mystic inclinations preferred white for their garments. because white symbolizes forgiveness of sins (cf. Isaiah i. 18: Eccles. ix, 8). As early as Josephus (*The Jewish War* iii, 123) the Essenes made a point of always being dressed in white. and in the middle ages even nonscholars dressed in white on the high holidays. A survival of the medieval mystical movements in Judaism, which penetrated deep into Jewish life and left an indelible imprint, is the *kittel* (called *sargeness* by German Jews), the white robe worn by many Jews on the high holidays, on Passover eve at the Seder. and by ultra-Orthodox Jews at the wedding ceremony.

Mysticism became the dominant spiritual power in Judaism with the rise of Hasidism in the 18th century. The *zaddik* ("righteous one") in Hasidism was considered as the sacrificing priest; hence his garb had to be white, like the clothing of the high priest on the Day of Atonement. The conception of the *zaddik* as a surrogate for the high priest. rooted in the cabalistic literature of the middle ages could be traced to some statements in the Talmud The hasidic *zaddikim* dressed in white silk or velvet garments They also wore a distinctive headgear, a round fur cap nith tails, called the *shtreimel* (of Tatar origin). which became the characteristic part of hasidic attire in eastern Europe and was worn not only by the *zaddikim* but also by many of their adherents, especially on the Sabbath and holidays.

In the middle ages certain rabbis wore special kinds of overcoats, but alnays in the style of the country in which they lived. Generally speaking in the early middle ages, as in ancient times, the Jews did not wear distinctive Jewish garments. The fact that the Christian church in the 13th century had to resort to special signs. as the yellow badge and the "Jew hat." imposed upon the Jews by the fourth Lateran council (1215). prove that at that time there was no distinctive Jewish dress. A study of Jewish garments mentioned in the Talmud shows that all their names are of Greek or Latin origin. The *tallit* (prayer shawl) worn by men in the synagogue during the morning service is not of sacred origin. It is an outgrowth from the desire to fulfil the commandment of the fringes To the same category belongs the *arba kanfot*, or small *tallit*, worn by Orthodox Jews under the upper garment all day. Not until later times did the *tallzt* come to be considered as a liturgical garment for the divine service.

A part of Jewish religious attire in modern times is the *yarmulke* or skullcap, which is worn by Orthodox and Conservative male Jews in the synagogue; Reform Jews. however. pray with uncovered heads. The *yarmulke*, like the *shtreimel*, is of non-Jewish origin.

The modern rabbi of all denominations in Judaism adapts his official attire to his environment—in Protestant countries his vestments resemble those of the Protestant clergy, in Catholic countries those of the Catholic clergy. Even the most Orthodox rabbis in western Europe and America, who at the beginning of the 19th century opposed all innovations on principle. have yielded to the natural processes of acculturation and adopted the clerical garments of the Christian clergy. The first Jew to officiate in Protestant clerical garb was Israel Jacobson at the dedication service of the temple in Seesen am Harz. Ger.. in 1810. Only the ultra-Orthodox rabbis and hasidic *zaddikim* remain loyal to the rabbinic attire of the late middle ages. (J. M. RL.)

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VESTRIS, AUGUSTE (MARIE JEAN AUGUSTIN) (1760–1842), French virtuoso dancer of unusual brilliance, was a star of the Paris Opéra from his debut in 1772 until his retirement in 1816. Born in Paris on March 27, 1760. he was the son of Marie Allard and Gaetan Vestris (*q.v.*), and was sometimes called Vestr'Allard. Vestris, who inherited the vivacity of his ballerina mother and the technical aptitude of his father. was especially noted for his prodigious leaps. His greatest roles were in *Télémaque* and as Amour in Pierre Gardel's *Psychk*.

His later years mere devoted to teaching, his pupils including Auguste Bournonville, Fanny Elssler (*qq.v.*) and his son Armand Vestris. In 1835 he reappeared for one performance. dancing a minuet with Marie Taglioni. He died in Paris on Dec. 5, 1542. (LN. ME.)

VESTRIS, GAETAN (GAETANO) (1729–1808), French dancer who was the finest male dancer of his time. was noted for his lightness. precision, strength and versatility, Born in Florence, Italy, April 18, 1729. he entered the Paris Opéra ballet school at the age of 19 and studied under Louis Dupré. He danced briefly in the ensemble. was appointed soloist in 1751 and for the next 30 years enjoyed a succession of triumphs in the ballets of Jean Barthélemy Lany, Pierre Gardel and Jean Georges Noverre. He died in Paris. Sept. 23. 1808. Enormously conceited. Vestris declared that the century had produced only three great men: Voltaire, Frederick the Great and himself. He was called. half ironically. "the god of the dance." (LN. ME.)

VESTRIS, MADAME (LUCIA ELIZABETH MATHEWS, née BARTOLOZZI) (1797–1856). English actress and opera singer. was born in London on Jan. 3. 1797, the daughter of Gaetano Stefano Bartolozzi and granddaughter of Francesco Bartolozzi. both engravers. In 1813 she married Auguste Armand Vestris, who deserted her four years later. Madame Vestris made her first appearance in Italian opera in the title role of Peter Winter's *Il ratto di Proserpina* at the King's theatre in 1815. She had an immediate success in both London and Paris, where she played Camille to F. J. Talma's Horace in *Horace*. Her first hit in English was at Drury Lane in James Cobb's *Siege* of *Belgrade* (1820). Because of her beautiful figure, she was a particular favourite in "breeches parts," like Cherubino in *The Marriage of Figaro*, and in *Giovanni in London*. In 1831 she became lessee of the Olympic theatre, and began the presentation of a series of burlesques and extravaganzas for which she made that house famous. She was the first to inaugurate tasteful and beautiful stage décor and to set a standard in stage costumes. She married Charles James Mathews (*q.v.*) in 1838. accompanying him to the United States and aiding him in his subsequent managerial ventures. She died in London on Aug. 8. 1856.

See C. E Pearce, *Madame Vertris and Her Times* (1923). (W J M.-P.)

VESUVIANITE: *see* IDOCRASE.

VESUVIUS, a volcano rising from the eastern margin of the Ray of Naples in Italy about 7 m. E S E. of Naples The height of the mountain varies from time to time within limits of several hundred feet. but averages about 4.000 ft above sea-level (in June 1900, 4.275 ft., but after the eruption of 1906

3.668 ft., 4,190 ft. in the 1950s). Vesuvius consists of two distinct portions. On the northern side a lofty semicircular cliff, reaching a height of 3,858 ft., half encircles the present active cone, and descends in long slopes to the plains. This precipice, Monte Somma, forms the wall of a vastly greater prehistoric crater.

At the beginning of the Christian era, and for many previous centuries, no eruption had been known. Strabo, however, detected the probable volcanic origin of the cone and drew attention to its fire-eaten rocks. The sides of the mountain were richly cultivated, as they are still, the vineyards being of extraordinary fertility. Pompeian wine jars are frequently marked with the name *Vesuvinum* (*vinum*). (The wine is now known as *Lacrima Christi.*) On the barren summit lay a wide flat depression, walled by rugged rock festooned with wild vines. The present crater-wall of Monte Somma is doubtless a relic of that time. It was in this lofty rock-girt hollow that the gladiator Spartacus was besieged by the praetor Claudius Pulcher (73 B.C.): he escaped by twisting ropes of vine branches and descending through unguarded fissures in the crater-rim. A painting discovered when excavating in Pompeii in 1879 represents Vesuvius before the eruption (*Notizie degli scavi*, 1880, pl. vii.).

After centuries of quiescence the volcanic energy began again to manifest itself in a succession of earthquakes, which spread alarm through Campania. For some sixteen years after 63 these convulsions did much damage to the surrounding towns. On Xug. 24, 79, the earthquakes, which had been growing more violent, culminated in a tremendous explosion of Vesuvius. A contemporary account of this event has been preserved in two letters of the younger Pliny (Epist. vi. 16, 20) to the historian Tacitus. He was staying at Misenum with his uncle, the elder Pliny, who was in command of the fleet. The latter set out on the afternoon of the 24th to attempt to rescue people at Herculaneum, but came too late, and went to Stabiae, where he spent the night, and died the following morning, suffocated by the poisonous fumes. Three towns are known to have been destroyed — Herculaneum at the western base of the volcano, Pompeii on the south-east side, and Stabiae, which was situated farther south on the site of the modern Castellamare.

For nearly fifteen hundred years after the catastrophe of 79 Vesuvius remained in a condition of less activity. Occasional eruptions are mentioned, in A.D. 202, 472, 512, 685, 993, 1036, 1049, 1139. At length, after a series of earthquakes lasting for six months and gradually increasing in violence, the volcano burst into renewed paroxysmal activity on Dec. 16, 1631. So swiftly did destruction come upon them that 18,000 people are said to have lost their lives.

Since this great convulsion, which emptied the crater, Vesuvius has never again relapsed into a condition of total quiescence. At intervals, varying from a few weeks or months to a few years, it has broken out into eruption, sometimes emitting only steam, dust and scoriae, but frequently also streams of lava. The years 1766–67, 1779, 1794, 1822, 1872, 1906 and 1929 were marked by special activity. The extensive eruption of 1906 completely altered the cone, considerably reducing its height.

The modern cone of the mountain has been built up by successive discharges of lava and fragmentary materials round a vent of eruption, which lies a little south of the centre of the prehistoric crater. The southern segment of the ancient cone has been almost concealed, but is still traceable among the younger accumulations. The numerous deep ravines which indented the sides of the prehistoric volcano have on the south side served as channels to guide the currents of lava from the younger cone. On one of the ridges between these radiating valleys an observatory for watching the progress of the volcano was established by the Neapolitan government (1844). Since 1880 a funicular railway has carried tourists almost to the crater's mouth.

(A. GEI.; T. A.)

VETCH (*Vicia*), a genus of leguminous (pod-bearing) herbs widely distributed in temperate regions of North America and Eurasia. Of approximately 150 known species, a few are cultivated as important food, fodder and cover crops and green manure. Like other legumes, they add nitrogen, by means of nitrogen-fixing bacteria, to the soil and thus are particularly valuable as a soil-enriching crop. The plants are from one to four feet high with trailing or climbing stems. compound leaves with several pairs of leaflets and magenta, bluish-white, white and yellow flowers borne singly, in clusters and in racemes. There are from two to ten smooth, usually varicoloured seeds in a pod.

Species and Distribution. — Most perennial vetches are wild. The wild annual form, sometimes regarded as a distinct form of *Vicia angustifolia*, is common in dry soils. Bitter vetch (*V. ervilia*) and wood vetch (V. *sylvatica*) are indigenous British species. The name vetch is applied to plants of a few genera other than *Vicia* of the family Leguminosae, including kidney vetch (*Anthyllis vulneraria*); the yellow-blossomed horseshoe vetch (*Hippocrepis*) with its characteristically shaped curved pods; milk vetch (*Astragalus*); and crown vetch (*Coronilla*).

Common or spring vetch (*V. sativa*). a winter annual also known as tares, is native to Eurasia and naturalized in North America, where it is cultivated in the northern and Pacific states of the U.S. and in southern Canada. Hairy or winter vetch (V. *villosa*), also introduced from Eurasia, is grown in states along the southeastern seaboard and the Gulf of Mexico. inland in Oklahoma, Arkansas, Missouri and Nebraska, and in Oregon and Washington. Common vetch, while widely used as a soil-improving crop, is grown in western Oregon and Washington for hay, silage, green feed, pasture and seed; hairy vetch is utilized mainly for seed and green manure. Other species grown to a limited extent are Hungarian vetch (*V. pannonica*) and purple vetch (*V. atropurpurea*), in the Pacific coast states; monantha (*V. monantha*), in the Gulf states; and smooth vetch, a less downy variety of the hairy species, grown in both regions and gradually replacing the pubescent variety. Seeds of the hairy and smooth varieties often are mixed and sold as hairy vetch. Woollypod (*V. dasycarpa*),, similar to smooth vetch, is of increasing importance in southern states, but seed supplies are limited.

In Britain, spring varieties do best; they are cultivated for fodder, silage or seed, or plowed under as green manure. The pod of V. *faba*, known as Windsor, horse or broad bean, is the bean grown for human and animal consumption since early times; it remains an important crop in Europe and southeast Asia.

Cultivation. — Vetches are adaptable to a wide range of soil conditions but yield the greatest bulk of forage on fertile. heavy, well-drained soil. Barnyard or artificial manure should he supplied where the soil is in poor physical condition. Like other legumes, vetches require the presence of certain symbiotic bacteria for successful development; such bacteria must be introduced when planting the crop for the first time.

By alternating winter and spring varieties of vetch with clover or grass, each crop of vetch can be utilized as cattle food when at its peak. When used for forage the crop generally is cut in the flowering or early-seeding stage. For seed it generally is mowed and swathed when the majority of pods are mature, and threshed when dry. Shattering varieties should be cut earlier to reduce seed losses. Vetches may be cultivated with rye for early spring grazing; grown in association with oats, they form a useful mixture for hay, silage or green fodder. When winter vetch is required it is important to obtain seed from a crop sown in the autumn.

When intended for seed production, vetches commonly are grown in association with companion crops that will reduce lodging. For silage, typical mixtures for, autumn sowing on light lands are two bushels of tares and one-half bushel of rye per acre; and on heavy lands, two bushels of tares, one-half bushel of beans and one-half bushel of winter oats. On rich lands lighter seedings of tares are required to avoid lodging, the difference being made up by increased quantities of beans and oats. Lighter seedings of tares are required in the U.S. than in Europe, especially when grown for hay or seed. Vetch seed in demand in the southern states, primarily for cover-crop and green-manure purposes, formerly was imported from Europe. By the late 1950s, however, the seed was supplied largely from states of the Pacific northwest and from Texas, Arkansas and Oklahoma.

In Britain about. 60% of the crop is cut for green fodder or silage, about 25% harvested ripe for seed and about 15% cut for hay. The amount of hay and green fodder sold to horse and cow owners in towns is small. About 70% of the seed is used for reseeding or for feeding of stock; the remainder is sold. usually for pigeon and poultry mixtures.

See also BEAN; CATCH CROP; LEGUMINOSAE. (H. A. SCH.)

VETERANS ADMINISTRATION, U.S. The Veterans administration (VA), an independent agency of the United States government charged with administering benefits created by law for U.S. veterans and their families, was created by executive order no. 5398, dated July 21, 1930, issued under authority of a law enacted on July 3, 1930.

The purpose of the VA, as stated in that law, was to "consolidate and coordinate Governmental activities affecting war veterans," which, up to that time, had been carried on by three separate agencies: the veterans bureau, the pension bureau of the interior department and the national home for disabled volunteer soldiers.

The VA, headed by an administrator of veterans affairs, maintains a central office in Washington, D.C., as well as regional offices, hospitals, domiciliary homes and district offices located in various parts of the United States and its possessions.

By the end of Aug. 1958 there were more than 22,700,000 veterans of all wars in the United States. Together with their families, they made up two fifths of the nation. Of the veterans. 67%, or more than 15,308,000, served in World War II. About 5,300,000 saw service following the outbreak of hostilities in Korea in June 1950. Of these, 917,000 were World War II veterans who had gone back on active duty during the Korean conflict.

Early History.—Veterans' benefits first took the form in Europe of war pensions (*q.v.*) in the late 16th century; the concept of community responsibility for those who served in battle was brought over to the American colonies by the Pilgrims. Early medical benefits were provided by such military hospitals as the Kilmainham hospital in Dublin (1679), the Invalides in Paris (1670) and the Royal hospital at Chelsea, Eng. (1692). (*See* CHELSEA, THE ROYAL HOSPITAL.)

The United States took its first steps in caring for ill and disabled ex-servicemen in 1811. when congress authorized the secretary of navy to build a permanent naval home for disabled and decrepit officers, seamen and marines. The home, built in Philadelphia, was not occupied until 1831. The National Home for Disabled Volunteer Soldiers was established after the Civil War, and its first branch at Togus, Me., opened in 1867. Others later were established for domiciliary care of veterans! and all became part of the VA when that agency was formed in 1930.

With World War I came a new concept of benefits for veterans in the U.S., encompassed in an amendment of Oct. 6, 1917, to the War Risk Insurance act. The program included compensation for injuries received in military service; allotments for the support of close dependents; a system of life insurance; medical, surgical and hospital treatment; and vocational rehabilitation for the service disabled. Administration of the first four benefits was assigned to the bureau of war risk insurance; the fifth was given to the federal board for vocational education. Functions of the two agencies were consolidated with the establishment of the veterans bureau on Aug. 9, 1921. The veterans bureau became part of VA in 1930.

World War II Veterans' Benefits.—World War II was in progress in Europe, but had not pet involved the United States. when two laws were enacted which were to affect U.S. veterans. The first, the Selective Training and Service act of Sept. 16, 1940, provided for the draft as well as for benefits after discharge, such as re-employment rights. The second, passed Oct. 8, 1940, established a low-cost system of National Service life insurance for servicemen and veterans. At the end of 1958 nearly 5,400,000 World War II veterans were holding $35,400,000,000 worth of National Service life insurance. At the same time there were approximately 351,000 veterans of World War I who held insurance policies valued at $1,500,000,000.

When the war was at its height two more veterans' measures came into being. One was the Vocational Rehabilitation act of March 24, 1943 (public law 16, 78th congress), furnishing training to veterans who needed it to overcome the handicap of service-connected disabilities. By the time this program ended for virtually all veterans on July 25, 1956, more than 610,000 disabled World War II veterans had received training.

The other law mas the far-reaching G.I. Bill of Rights (public law 346. 78th congress) of June 22, 1944. Under this lam, eligible veterans could receive education and training at government expense, readjustment allowances for unemployment and guaranteed or insured loans for homes, farms and businesses.

The G.I. bill benefited millions of veterans in their efforts to readjust successfully to postwar living. Under the readjustment allowance program, which ended for most veterans in July 1949, nearly 9,000,000 veterans received a grand total of $3,800,000,000, which they used to tide them over during periods when they were looking for work. Only one out of ten of the veterans stayed on the allowance rolls for the maximum period of 52 weeks.

The education and training program, in turn, reached its end for nearly all World War II veterans on July 25, 1956. Under this program, a World War II veteran could go to school or college! or obtain on-the-job or on-the-farm training, with the government paying all his training expenses and in addition paying him a living allowance of up to $120 a month.

More than half of the nation's World War II veterans, or 7,800,000, availed themselves of the educational opportunities of the G.I. bill during the 12 years the program was in effect. Of these, 2,300,000 attended college; 3,400,000 attended schools below the college level; 1,400,000 received on-the-job training and 700.000 had taken on-the-farm training. The program cost $14,500,000,000. Only five cents out of every dollar was spent for administration.

By 1957 the guaranteed and insured loan program of the G.I. bill was the only one of the "big three" G.I. benefits still in force. World War II veterans then had until July 25, 1958. to apply for loans and up to a year later to complete the transaction. By later legislation. however. World War II veterans had until July 25, 1960, to apply for G.I. loans and up to a full year after that to close the transaction.

Under the G.I. loan program, the veteran usually made his own arrangements for a loan through such lending channels as banks. building and loan associations or builders. Then. VA was empowered to guarantee home loans up to 60% of the amount, with a top guaranty of $7.500. Other real estate loans were guaranteed up to 50%, with a $4,000 top. Nonreal estate loans. such as business loans, could be guaranteed for 50%, with a $2,000 guaranty ceiling.

About 5,395,000 veterans had obtained G.I. loans, valued at nearly $43,800,000,000, by the end oi Feb. 1958. About 95% of the loans were for homes. Veterans proved to be excellent loan risks, for it was found that less than 1% of the total defaulted on their payments to the point where VA had to pay lenders the guaranteed portions of the loans.

Benefits for Korea Veterans.—On June 27. 1950, the president ordered U S. troops into action in Korea. Men nere subsequently called into service in increasing numbers. At first. the veterans' benefits to which this new group of servicemen would be entitled were limited to those that any peacetime veteran could get—disability compensation at peacetime rates, hospitalization under certain limited conditions and a few others. Wartime benefits could not be authorized because the United States was not officially at war.

On Dec 27, 1950, vocational rehabilitation training was extended to disabled Korea veterans—the first of a stream of benefits designed to assist Korea veterans in readjusting to civil life. While in training and for two months afterward. the veterans received a subsistence allowance from the government, in addition to their monthly disability compensation payments. About 56,000 disabled Korea veterans had received vocational rehabilitation training by the end of 1958.

On April 25, 1951, a new system of G.I. insurance was created for Korea veterans under the Servicemen's Indemnity and Insurance acts. Without cost, U.S. Korea veterans were insured against death in service and for 120 days after discharge. They also were given the right to apply for low-cost nonparticipating (nondividend paying) G.I. policies after they left service. The free coverage, as well as the right to apply for G.I. insurance. ended for Korea veterans on Dec. 31, 1956. At that time there went into effect the Servicemen's and Veterans' Survivor Benefits act (public law 881, 84th congress); which generally increased benefits to widows and children of deceased servicemen and veterans who died of service-connected causes by partially relating benefits to the military pay of the deceased. It also placed the armed forces under social security, on a contributory basis, and revised the six-month death gratuity paid to veterans' survivors by the armed forces. so that payments ranged from $800 to $3,000. Death payments to widows and children of veterans who died of non-service-connected causes were not changed by the act.

By the end of 1958 about 685,000 Korea veterans had G.I. term insurance totaling $6,200,000,000. Under a law passed in 1958, these veterans obtained the right to convert their term insurance to permanent plans beginning Jan. 1. 1959.

On July 16, 1952, a new Korean G.I. bill was enacted, providing five benefits for veterans who served in the armed forces during the Korean conflict. The benefits included education and training, G.I. loans. unemployment compensation, mustering-out pay and job-finding assistance.

Under this G.I. training program, a veteran is entitled to one and one-half days of education or training for each day spent in service during the Korean conflict period, with a maximum of 36 months. While in training, he is entitled to receive an allowance from the government of up to $160 a month, to help meet the cost of his studies. By the end of 1958 more than 2,000,000 veterans had taken training under the Korean G.I. bill: half had attended college; one third had gone to schools below the college level, and the rest had received on-the-job or on-the-farm training.

In 1958 VA regulations were liberalized to permit many veterans who had been obliged to drop out of training to resume their education. This program was to remain in effect through Jan. 31, 1965.

The Korean G.I. loan program operates in exactly the same manner as the program for World War II veterans. About 550,000 Korea veterans obtained G.I. loans by the end of Feb. 1958; the program extends until 1965. VA administers both the training and loan provisions of the Korean G.I. bill.

Unemployment compensation for Korea veterans—$26 a week for a maximum of 26 weeks—is handled through the individual state governments by the U.S. department of labour. The mustering-out program administered by the armed forces provides payments. at time of discharge, ranging from $100 to $300. depending on length and type of military service. Another G.I. bill program consists of job counseling and placement services offered by the U.S. employment service. Under a law passed in 1958 unemployment compensation was made available to servicemen released from the armed forces after Oct. 27. 1958.

Other Veterans Benefits.—At the close of 1958, VA operated a network of 171 hospitals for the treatment of ill and disabled veterans of all wars and the peacetime service. It also used beds in civil. state and other federal hospitals on a contract basis. Veterans with service-connected disabilities received first call for VA hospitalization. Then came war veterans and those with post-Korean service, who needed treatment for conditions having nothing to do with their military service. Veterans in this latter class were required to state that they were unable to pay for private hospital care. and to wait until a bed became available.

VA administers programs of compensation and pensions for veterans and the families of deceased veterans. Compensation is payable to those with service-connected disabilities resulting either from war or peacetime service. Wartime rates—also paid to disabled Korea veterans—range from $19 to $225 a month, depending upon the severity of the disability. Peacetime rates are 80% of the wartime scale. Pensions are paid to World War I, World War II and Korea veterans. who are totally and permanently disabled for reasons not traceable to service. and whose income falls below certain levels. Rates are $66.15 a month. increased to $78.75 after 10 years or when the veteran reaches the age of 65.

More than 3.700.000 veterans and dependents of deceased veterans were on VA's pension and compensation rolls in Feb. 1958. Nearly 900,000 were drawing payments as a result of the Korean conflict.

VA administers a number of other benefits. mostly designed to help disabled veterans readjust successfully to peacetime living despite their handicaps. A grant of $1.600 toward the purchase of an automobile may be provided to those who lost, or lost the use of. one or both hands or feet, or who were blinded. The disabilities must have resulted either from World War II service or from service after the Korean conflict began.

Also, VA may furnish a grant of up to $10,000 toward the purchase of a specially-equipped "wheelchair home" to veterans of either war or peacetime service who were entitled to VA compensation because of the loss, or loss of use of, both of their legs. The disability must be so severe that the veteran cannot get about without the aid of crutches. cane or a wheelchair.

War Orphans Education.— In June 1956 congress enacted a War Orphans Education program for the sons and daughters of World War I. World War II and Korea veterans who died as a result of service-connected conditions. Veterans' children. generally between 18 and 23 years of age, may receive up to 36 months of schooling. with VA paying them an allowance of up to $110 a month for those enrolled full time.

Approximately 150.000 young men and women were eligible for the educational grants. Some still were expected to be in school when the 20th century drew to an end. (S. G. W.)

VETERANS DAY (Armistice Day), the anniversary of the cessation of hostilities in World War I (Nov. 11, 1918) and of the signing of an armistice between the Allies and Germany. Immediately after the war, Nov. 11 was set aside in the U.S., Great Britain and France as a day of remembrance for those who had given their lives in the war and was generally called Armistice day. After World War II the day was recognized as a day of tribute to the dead of that conflict as well as of World War I. In Canada it came to be known as Remembrance day. In Great Britain the Sunday nearest Nov. 11 was proclaimed as Remembrance Sunday and was devoted to honouring the dead of both world wars. After the Korean war the president of the U.S. signed a bill (June 1, 1954) designating Nov. 11 as Veterans day and proclaiming it as an occasion for honouring veterans of all mars. The day is usually observed with parades, speeches and the placing of floral tributes on the graves of servicemen. In the U.S., group naturalization ceremonies have come to be an important part of the day's activities. Special services are held at the Tomb of the Unknowns in Arlington National cemetery, Arlington, Va., and at similar shrines in other countries.

VETERANS OF FOREIGN WARS, a U.S. organization created in 1913–14 by the merger of three national societies of overseas war veterans that were founded shortly following the close of the Spanish-American War in 1899. These societies were the American Veterans of Foreign Service, chartered by the state of Ohio on Oct. 11, 1899; the Colorado Society of the Army of the Philippines, organized in Denver: Colo., Dec. 1, 1899; and another society also known as the American Veterans of Foreign Service, formed in Altoona, Pa. These organizations merged in a convention in Pittsburgh, Pa., to become the single nationwide association that has been known since then as the Veterans of Foreign Wars of the United States (V.F.W.). The organization received a congressional charter in 1936.

Membership in the V.F.W. is restricted to "Any male officer or enlisted man, or any honorably discharged male officer or enlisted man, who is a citizen of the United States of America and who has 'served' in the Military or Naval Service of the United States of America in any foreign war, insurrection or expedition, which service shall be recognized by the authorization of the issuance of a campaign medal by the Military or Naval Service of the United States of America."

The basic aims of the V.F.W. are as follows: to ensure the national security through maximum military strength; to speed the rehabilitation of the nation's disabled and needy veterans; to assist the widows, orphans and other dependents of disabled and needy veterans; to promote Americanism through education in patriotism and constructive service to individual communities.

The V.F.W. legislative service maintains its office in the V.F.W. Memorial building in Washington, D.C., dedicated Feb. 1, 1960, by Pres. Dwight D. Eisenhower. The V.F.W. also maintains the central office of its national rehabilitation service in Washington, D.C. This nationwide program serves all disabled veterans of all wars, members and nonmembers alike, in matters of government compensation and pension claims: hospitalization, civil service employment preference, etc. Another important function of the organization is the community-service and youth-activities programs. The organization annually completes more than 500.000 individual community service projects through its 10,000 individual units, known as "posts." The V.F.W. also supports a youth program in which about 5,000,000 youths annually participate in events such as bowling tournaments, rifle meets, marble tournaments and baseball tournaments.

At Eaton Rapids: Mich., the V.F.W. maintains a national home for orphans of deceased or totally disabled overseas veterans. The home campus includes more than 30 family-size dwellings, each housing a typical family group of children under the care of a trained housemother.

In addition to its Washington office! the V.F.W. maintains its national headquarters in Kansas City, Mo. From this office the 50 state departments of the organization and the department of the Panama Canal Zone are serviced. (J. L. SM.)

VETERINARY SCIENCE deals with the anatomy, physiology and pathology of animals other than man. It includes the diagnosis, prophylaxis and treatment of their diseases and infirmities; their relationship to man with regard to intercommunicable diseases and to the use of their flesh and other products; and their scientific breeding, feeding and handling. In North America and to a lesser extent in Europe, however, the breeding, feeding and handling of normal animals is largely in the hands of persons trained in the field of animal husbandry.

This article surveys the general field of veterinary science, while the following articles discuss specific aspects: ANIMAL BREEDING; ANIMAL HEAT; FEEDS, ANIMAL; POULTRY AKD POULTRY FARMING. *See* also CAT; CATTLE; DOG; HORSE; PIG; SHEEP; and other articles on various animals.

Many specific diseases are treated in individual articles, as ANTHRAX; BACTERIAL AND INFECTIOUS DISEASES; BRUCELLOSIS; CANCER; DISTEMPER, CANINE; ENCEPHALITIS; FOOT-AND-MOUTH DISEASE; GLANDERS; IMMUNITY; PATHOLOGY; PLEUROPNEUMONIA; PSITTACOSIS; RABIES; RINDERPEST; SWIKE FEVER; TULAREMIA; VACCINE THERAPY; VIRUSES.

HISTORY

Persons known as animal doctors have existed since earliest times. Veterinary science flourished in ancient India, where separate treatises on the diseases of horses and elephants were written, and there were hospitals for various species of animals. The legal code of the Babylonian king Hammurabi (c. 1800 B.C.) prescribed the fees for "doctors of asses and oxen," and the Egyptian papyrus of Kahun (c. 1900 B.C.) gave prescriptions for diseases of dogs and cattle. The ancient Greeks had a class of *hippiatroi* (literally, "horse-doctors"), and a number of writers (Hippocrates, b. 460 B.c.; Xenophon, b. c. 430 B.C.; Aristotle, b. 384 B.c.) gave consideration to the treatment of animal diseases. The Romans took little interest in medicine, leaving this to the Greek physicians in Rome, but several writers on husbandry (Cato, b. 234 B.C.; Varro, b. 116 B.C.; Columella, fl. A.D. 60), gave good descriptions of animal disease and treatment. The word veterinary comes from the Latin *veterinarius,* "pertaining to beasts of burden," and the armies of the later Roman empire had a *veterinarium* or "hospital for sick and wounded horses." The physician, Galen (c. A.D. 130–c. 200), wrote on animal physiology.

The Greek veterinarians of the Roman armies during the Byzantine period demonstrated a high level of proficiency! superior in some respects to that of medical practitioners. Chief among these Byzantine veterinarians was Xpsyrtus (fl. A.D. 330), whose writings mark him as the "father" of veterinary medicine. The *Hippiatrika,* compiled in the 10th century under the direction of Constantine Porphrygenitus from these Byzantine writings, has preserved the best account of veterinary practice prior to the fall of the eastern empire. Better known is the *Artis Veterinariae* of the Roman, Vegetius (fl. A.D. 450), the last important veterinary writing for nearly 1,000 years and the first influential veterinary work to be printed (Basel, 1528). Vegetius demonstrated an understanding of the importance of segregating sick animals as well as other principles of hygiene and preventive medicine. He also deplored the already lowered status of the veterinary art and ridiculed the tendency to attribute animal disease to supernatural influences. However, this superstition long remained a deterrent to the development of animal medicine.

From the middle ages until modern times, persons called farriers, who in Roman times were merely horseshoers, were attached to the cavalry of most countries to treat sick and wounded horses. Practice upon the animals of the civilian population also became firmly entrenched in their hands. However, they contributed little to the general knowledge of animal diseases, and their mean status was a factor in deterring educated persons from taking up the profession. Practitioners upon cattle, called cow leeches, were even more ignorant in their methods, and were looked down upon even by farriers. A standstill in veterinary knowledge extended from late Roman times to the 18th century. A major exception. however. was Carlo Ruini's excellent treatise. *Anatomia del Cavallo* ("Anatomy of the Horse." 1598), the first completely original work on the horse in more than 1.000 years, which included a section on diseases.

The depredations caused by animal plagues during the 18th century in Europe forced a reappraisal of the methods of dealing nith animal disease. Most significant was the establishment of veterinary schools throughout Europe in the late 18th and early 19th centuries. With veterinary medicine once again in the hands of educated men, the profession rapidly regained its lost status and its development closely paralleled that of medicine. The methods and techniques of one were readily adapted to the other, and with the recognition of the close interrelationship of many human and animal diseases. human and animal medicine came to be regarded as complementary.

In the Cnited States and Canada. because of the scarcity and isolation of domestic animals during the colonial period. which was thus characterized by a relative freedom from major animal diseases. veterinary science as a profession developed somewhat belatedly.

ECONOMIC ASPECTS

Preventive veterinary medicine and control measures are of great economic importance to animal breeders, farmers and the general populace. A precise figure for the losses from animal disease cannot be given, but conservative estimates place this at about $2,000,000,000 annually in the U.S., or about 10% of the total value of livestock. The major causes of loss are parasitism of all species. and the complex of conditions resulting in impaired fertility of cattle, which probably account for about half the total. All poultry diseases, together with mastitis and brucellosis of cattle. account for about 25%. Other diseases of major importance are: swine fever (hog cholera), tuberculosis of cattle and swine. swine erysipelas and anthrax and leptospirosis in all species. Losses from diseases of dogs and cats cannot be determined reliably. The loss of animals from rabies is not great. but the cost of rabies control is high.

Methods of control include rigid sanitation and the segregation of sick animals to prevent the spread of disease, and optimal nutrition to increase natural resistance of animals to disease and to parasites. Vaccination is employed'to create an artificial immunity against such infectious diseases as anthrax, brucellosis. canine distemper, rabies and swine fever. Quarantine is imposed to prevent spread of highly contagious diseases once their presence is known. Imported animals are regularly quarantined to prevent introduction of disease. X regular program of testing cattle for tuberculosis and brucellosis is carried out nationally. and infected animals are slaughtered. The addition of antibiotic substances to feedstuffs has markedly decreased losses from swine and poultry diseases.

PUBLIC HEALTH ASPECTS

This discipline requires the attention of many veterinary and medical practitioners, research workers and administrators. Traditionally it has included eradication and control of the zoonoses (diseases communicable betaeen animals and man) and food hygiene — primarily the inspection of food products of animal origin. To these have been added industrial hygiene, including prevention of air and water pollution and occupational diseases of handlers of animal products; radiological health, concerned with the biological effects of radiation; space medicine. involving research on the effects of high altitudes on the animal body; and animal cancer research as a means of attacking the problem of cancer in man and animals.

Of the more than 80 animal diseases transmissible between animals and man. the more common include: tuberculosis. brucellosis, anthrax, rabies. psittacosis, encephalomyelitis (several kinds), typhus, plague, Q fever, trypanosomiasis, amoebic dysentery. leptospirosis and salmonellosis. In the U.S. bovine tuberculosis in man has been virtually eliminated by the work of veterinarians in the eradication of the disease in cattle, and much progress has been made in the eradication of brucellosis. In many countries of the world the zoonoses are a major deterrent to economic development.

In the U.S , nations of the British Commonwealth and most of continental Europe veterinary inspection of foods of animal origin is a major safeguard to consumers of these products. In most countries the various aspects of veterinary public health are administered on local and state levels as well as by national governments.

VETERINARY SCIENCE AS A PROFESSION

In the United States persons trained in veterinary science are usually known as veterinarians; in British Commonwealth nations the usual designation is veterinary surgeon. To qualify for membership in the profession in many parts of the world, candidates must complete an educational program of from five to six or more years of work at the university level, after which they must obtain a licence to practise the profession from some duly constituted governmental authority. In Great Britain this authority is invested in the Royal College of Veterinary Surgeons. In the United States a licensing board consisting of veterinarians appointed by the government of each state examines the credentials of graduates, gives examinations and recommends those to be licensed.

About 1950 a national board of veterinary examiners was set up, and a number of states accepted the examinations of this board in lieu of their own. In both the U.S. and Britain. the qualifications for the profession are set and maintained by the profession itself.

Schools. — Formal veterinary education had its beginnings in France. The first school was organized at Lyon in 1762 and the second at Maisons-Alfort. a suburb of Paris, in 1765. During the half-century following 1765, schools were established in Berlin, Copenhagen and London and eventually in nearly every important city of Europe. The veterinary schools of other parts of the world appeared considerably later. The veterinary schools of Great Britain were established in London (1792), Edinburgh (1823), Glasgow (1863), Dublin (1900), Liverpool (1904), Bristol (1949) and Cambridge (1949). Each is affiliated with the university of the city where it is located. Those of the G.S. are affiliated with Iowa State college (veterinary school established 18793, University of Pennsylvania (1884), Ohio State university (1885), Cornell university (1896), Washington State college (1899), Kansas State college (1905), Alabama Polytechnic institute (1907), Colorado State university (1907), Michigan State university (1909), Texas Agricultural and Mechanical college (1916), Tuskegee institute (1945). University of Georgia (1946), University of Missouri (1946). University of Minnesota (1947), Oklahoma Agricultural and Mechanical college (1947), University of California (1948), Cniversity of Illinois (1948) and Purdue university (1958).

There are tno veterinary colleges in Canada: the Ontario Veterinary college (1862), affiliated with the University of Toronto. and the École de Mkdecine Vétérinaire (1894). affiliated with the University of Montreal. Instruction in the latter is in French. Veterinary schools in other English-speaking countries include Makerere, in British East Africa; Onderstepoort, affiliated with the University of Pretoria, Union of South Africa; and those affiliated with the Universities of Queensland and of Sydney, in Australia, and with the University of the Philippines. By the second half of the 20th century there were about 180 veterinary schools in the world.

In the U S and some European countries the veterinary schools award the degree of Doctor of Veterinary Medicine (D V.M.). Graduates of veterinary colleges in Great Britain do not receive the doctor's degree, but upon admittance to membership in the Royal College of Veterinary Surgeons are entitled to append the letters M.R C.V.S. to their names.

Curriculum.—The fundamental disciplines common to most veterinary schools require preliminary training in chemistry, physics, zoology, animal husbandry, botany and languages, as in premedical education. The preclinical subjects include: anatomy, the study of the normal structure of domestic animals, and histology, the microscopic anatomy of tissues; physiology, the study of function of organs and systems of the body; pharmacology, the study of drugs and their actions; microbiology. including bacteriology and virology, the study of bacteria and viruses and their immunological reactions, and parasitology, pertaining to both ecto- and endoparasites and the means of their control; and pathology, the study of the effects of disease upon the body.

The clinical subjects can be divided broadly into: medicine, surgery, preventive medicine and clinical practice. Internal medicine includes the diagnosis, treatment and prophylaxis of diseases as they affect animals. Preventive medicine and public health concern the broader aspects of disease prevention and control, especially of diseases transmissible between animals and man or affecting human welfare, like the contagious diseases of food-producing animals. Surgery includes wound treatment, fracture repair, the excision of body parts and the related techniques of radiology, anesthesiology, obstetrics and treatment of lamenesses. A clinic is operated to enable students to observe and assist with actual cases of disease or other conditions requiring attention. In both medical and surgical treatment the same techniques are employed as in human practice.

Growth of Profession. — In the late 1950s the Directory of the American Veterinary Medical association listed more than 19,000 veterinarians in the United States and more than 1,400 in Canada. The Register of the Royal College of Veterinary Surgeons listed about 6.300 members, of which more than 4.000 were working in the British Isles. The world supply of veterinarians in the late 1950s was in excess of 90,000, about one-third of them in western Europe. The remainder of the world was generally undersupplied.

In both Great Britain and North America the veterinary population rose steadily from late in the 19th century until the end of World War I. During this time a large part of the profession had been concerned primarily with horses. There followed a period of readjustment to the mechanization of transportation and agriculture in which pessimism about the future of the profession was reflected in declining numbers of practitioners and of students entering veterinary schools.

After 1935, however, a decided upturn was noted; schools were forced to limit enrollments, and after World War II several new schools were established to accommodate the pressures for admission. Growth of the veterinary profession was a reflection of increasing demand.

Vocational Trends. — Graduates in the 1950s who had a broad cultural and scientific education found many outlets for their talents. Surveys showed that only about 60% of graduates in the U.S. and 50% in Canada went into private practice; the rest were employed in salaried positions. A substantial proportion of those who chose to enter practice did so as specialists in one or more species, or in such subspecialties as the breeding diseases of cattle. In the U.S. the federal department of agriculture was the largest single employer of veterinarians. Of these, many were engaged in meat inspection; others were in various field activities such as enforcing quarantine laws and regulations designed to prevent importation of diseased animals and disease-harbouring materials from abroad, the enforcing of interstate shipping laws and the supervision of production of serums, vaccines and other biological products. Many were engaged in research and diagnostic work. All of the state governments employed veterinarians for similar duties. Others were in the federal public health service and the food and drug administration, or the armed services. Some were employed as teachers in veterinary and agricultural schools. Many others were privately employed in zoological parks, food processing concerns, large dairy companies, pharmaceutical and biological manufacturing companies and animal feed manufacturers.

VETERINARY ORGANIZATIONS

Veterinary associations exist in practically all countries, their purpose being to advance the standards and improve the services of the profession.

The *Veterinary Record* is a weekly publication of the British Veterinary association; the *Journal of the American Veterinary Medical Association,* a biweekly, and the *American Journal of Veterinary Research,* a quarterly, are publications of the American Veterinary Medical association. The International Veterinary congress is organized at approximately four-year intervals, with about 60 countries sending delegates.

TRENDS IN VETERINARY SCIENCE

An increased emphasis on public health and animal disease research is evinced by the increasing number of graduates entering these areas. Specialization in practice, alnays more or less characteristic, is increasingly evident. In the U.S. many small-animal practitioners own hospitals comparable in many respects to hospitals for humans. The extension of contract farming to livestock raising. whereby individual stock owners are affiliated with a marketing corporation, has placed increased emphasis upon maintenance of herd or flock health, and proportionately less on the treatment of individual sick animals.

A major challenge to veterinary science is the supplying of adequate service to underdeveloped areas of the world. The plains of Africa, for example. could produce vast quantities of much needed meat once the problems of animal diseases, such as tsetse fly infection, peculiar to this region have been mastered. Except for most of the countries of western Europe, the supply of veterinarians has not been adequate to meet the demand. To meet these needs, a greatly increased output of broadly trained veterinarians by existing or new schools will be required.

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VETO, a negative upon a course of action, preventing or impeding its execution. (Latin. *veto,* "I forbid"). A veto is a means of self-protection exercised by a unit of government against encroachment by other units of government. A veto may be absolute, in which case it cannot be reversed by other governmental units; or it may be qualified, or subject to being overriden, under certain conditions, by other units.

The president of the United States is given a strong veto power by the constitution (art. i, sec. 7). All bills, passed by both houses of congress, must be submitted to the president. To veto a bill, he declines to sign it and returns it to the house of origin with his objections. The bill is then of no effect unless each house votes by a two-thirds majority to pass it over his veto. In such case, the bill becomes law without presidential approval. Under the constitution. if the president does not return a bill within ten days. excluding Sundays, it becomes law without his signature. If, however, congress adjourns before the ten days have elapsed, the president may kill the bill simply by failing to act upon it. This is the pocket veto, and it is absolute.

Early presidents employed the veto chiefly to object to legislation which they considered unconstitutional. Andrew Jackson was the first president to use the veto as a means of appealing to the public on matters of general policy. Jackson's veto of legislation to recharter the second Bank of the United States was in effect a campaign document which figured prominently in the presidential election of 1832. Of all presidents. Franklin D. Roosevelt vetoed the most bills, 584 in all. His closest competitor was Harry S. Truman, who vetoed 101 bills. The overriding of vetoes is highly infrequent.

American governors are given the veto power in every state except North Carolina. Governors in 38 states are empowered to exercise the item veto in respect to appropriation bills, but the president does not possess this power. The item veto gives the executive power to strike out specific sections while signing the remainder of the bill.

The striking down by courts of statutes on constitutional grounds is sometimes termed the judicial veto. *(See* JUDICIAL REVIEW).

The veto is also important in the United Nations. The UN charter requires that votes on nonprocedural matters be taken in the Security council by concurrence of 7 of the 11 members, provided that all 5 of the permanent members of the council be among the 7. The charter provision has the effect of granting a veto on UN action to each of the five permanent members — the Soviet Union, the United States, Great Britain, France and China. Serious dissatisfaction has been expressed with the arrangement. (See UNITED NATIONS.)

For a discussion of the Polish *liberum veto,* an absolute power of veto enjoyed by individual members of the Polish diet in the 17th and 18th centuries, *see* POLAND: *History.*

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VETTER, a lake of south Sweden, 81 mi. long and 19 mi. in extreme breadth, 733 sq.mi. in area, 420 ft. maximum depth and at an elevation above sea level of 289 ft. It drains by the Motala river to the Baltic. Its waters are transparent and blue, its shores picturesque and steep on the east side, where the Omberg (863 ft.) rises abruptly, with furrowed flanks pierced by caves. The lake is subject to sudden storms. Its northern part is crossed from Karlsborg to Motala by the Gota canal route. At the southern end is the important manufacturing town of Jonkoping.

VETULONIA, an ancient town of Etruria, Italy. It lies 1,130 ft. above sea level, about 10 mi. directly northwest of Grosseto, on the northeast side of the hills which project from the flat Maremma and form the promontory of Castiglione. In Etruscan times there was a bav there. Silius Italicus tells us that it was hence that the Romans took their magisterial insignia (fasces, curule chair, purple toga and brazen trumpets), and it was undoubtedly one of the 12 cities of Etruria. There are remains of the acropolis walls and also of houses and a street of the Roman period. The earliest tombs found belong to the Villanovan period (First Benacci to late Second Benacci stage). Next come transitional tombs (in some of which hut urns are foundj surrounded by a ring of stones, and a few graves which are very early Etruscan: and then a group of important palaeo-Etruscan tombs (850–700 B.C.), most of them circle graves.

VEUILLOT, LOUIS (1813–1883), French journalist and leader of the extreme conservative wing of French Roman Catholicism, was born of poor parents at Boynes, near Orléans, Oct. 11, 1813. He had little schooling and at 13 was working as a clerk in a Paris law firm. An incessant reader, he began to write for periodicals at 18 and developed his talents in provincial journalism. Without interest in religion until 1838. he was converted on a visit to Rome and immediately became involved in polemics. He violently attacked the July monarchy on the school issue. Quickly disillusioned with the Republic in 1848, he mas a champion of Louis Napoleon until the emperor threatened the papal temporal sovereignty by his Italian campaign (1859). In 1870. at the peak of his influence from his support of the doctrine of papal infallibility during the Vatican council, Veuillot turned to the Bourbon restoration as the hope of the church. His health failed in 1878, but his influence persisted in the French Church. He died in Paris on March 7, 1883

Veuillot was an enemy of all conciliation and accommodation Pessimistic about human progress, filled with hatred for bourgeois institutions and all that stemmed from the Revolution, despising industrialism and its agents Veuillot wrote precisely, popularly and satirically. He knew the poner of public opinion and was adroit in its manipulation. Merciless toward opponents, including all he chose to call liberal Catholics, he finally drew a rebuke from his admirer, Pope Pius IX, for his "bitter zeal." His collected works, *Oeuvres Complètes* (1927–38), comprise 38 volumes one of poetry, 11 of correspondence, 12 of short pieces and 13 of full-length books. (J. N. M.)

VEVEY, a small town in the Swiss canton of Vaud near the eastern extremity of Lake Geneva. Population (1960) 16.269, of whom most were French-speaking and Protestant. Vevey was a Roman settlement (Viviscus) and later formed part of the barony of Vaud, that was held by the counts and dukes of Savoy till 1536 when it was conquered by Berne. In 1798 it was freed from Bernese rule and became part of the canton du Léman (renamed canton de Vaud in 1803) of the Helvetic republic. Vevey is 12 mi. S E. of Lausanne at the mouth of the Veveyse and commands fine views of the mountains. The surrounding country is covered with vineyards. Every 20 years or so the *Fête des Vignerons* is held here by an ancient guild of vinedressers.

VÉZELAY, a village of France, in the *département* of Yonne, 10 mi. W.S.W. of Avallon by road. Its population, which was over 10,000 in the middle ages, was 412 in 1954. The history of Vézelay is bound up with its Benedictine abbey, which was founded in the 9th century under the influence of the abbey of Cluny. The acquisition of the relics of St. Magdalen, soon after its foundation, began to attract crowds of pilgrims, whose presence enriched both the monks and the town which had grown up round the abbey and acknowledged its supremacy. In the 12th century the exactions of the abbot Artaud and the refusal of the monks to grant political independence to the citizens resulted in an insurrection in which the abbey was burned and the abbot murdered. During the 12th century Vézelay was the scene of the preaching of the second crusade in 1146 and of the assumption of the cross in 1190 by Richard Coeur de Lion and Philip Augustus.

Vézelay stands on a hill on the left bank of the Cure and still preserves most of its ancient ramparts, notably the Porte Neuve. consisting of two massive towers flanking a gateway. The church of La Madeleine dates from the 12th century.

VIANNEY, SAINT JEAN BAPTISTE MARIE (1786–1859). known as the CURÉ D'ARS and famous for the supernatural powers ascribed to him, was born on May 8, 1786, at Dardilly, near Lyons. Though not without talent, he encountered almost insuperable difficulties when at the age of 18 he started to learn Latin. for he had received only the most elementary education. When scarcely begun, his studies were interrupted for two years while he went into hiding to avoid conscription. After some private coaching in theology he was ordained in 1815 and was made assistant priest at Écully. In 1818 he became parish priest of Ars, 22 mi. from Lyons. Religion was at a low ebb in the village, but by his prudence and gentleness, his daily catechizing and the example of his life, the cur6 made it a model parish. Reports of his holiness and his supernatural powers soon spread abroad. Nocturnal molestations by the devil (le *grappin*) often troubled him. By 1827 people flocked to Xrs from every part of France. Every year from 1845 until his death in Ars on Aug. 4, 1859, some 20,000 persons of every age and condition visited Ars to see a saint, to speak to him, to ask his prayers, but above all to make their confession to him, so that the holy curé daily spent as many as 12 or even 15 hours in his confessional at all seasons of the year.

The curé d'Ars was canonized in 1925 and his feast day falls on Aug. 9.

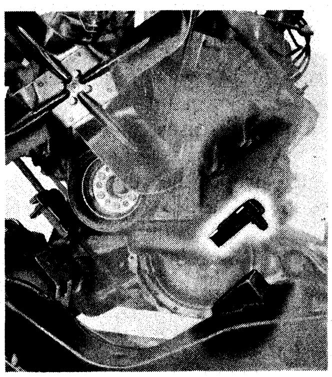
BIBLIOGRAPHY.—His sermons were ed. by M. A. Delaroche, 4 vol. (1928). *See* also F. Trochu, The *Cure' d'Ars,* Eng. trans. by E. E. Graf (1927); L C Sheppard, *Portrait of a Parish Priest* (1958). (ER G.)

VIAREGGIO, a maritime town and sea-bathing resort of Toscana, Italy, in the province of Lucca, on the Mediterranean. 13 mi N W of Pisa by rail. 7 ft above sea level. Pop. (1957 est.) 45,134 (commune). Being sheltered by dense pine-woods on the north, it is frequented as a winter resort, and in summer by some thousands for its sea bathing. In 1740 the population was only 300, and in 1841. 6,549. The body of Shelley was burned on the shore near Viareggio after his death by drowning in 1822. At Varignano near Viareggio is a large oil refinery.

VIATICUM, a Latin word meaning "provision for a journey" (Gr. τὰ ἐφόδια), is used by early Christian writers to denote anything that gave spiritual comfort to the dying. Ultimately it came to be restricted to the last communion given to the dying. In extreme cases the viaticum may be given to persons not fasting. and the same person may receive it frequently if his illness be prolonged. The ritual administration is that prescribed for the communion of the sick, except in the formula "Accipe, frater (soror), viaticum corporis Domini nostri Jesu Christi, qui te custodiat ab hoste maligno, et perducat in vitam aeternam. Amen." The viaticum is given before extreme unction, a reversal of the medieval practice due to the importance of receiving the Eucharist while the mind is still clear.

VIBORG, a town of Denmark, capital of the amt (county) of its name, in the district of Jutland, on Viborg lake. Pop. (1960) 23,253. The most notable building is the cathedral (1130–69. restored 1864–76). It has paintings by Joachim Skovgaard. The Black Friars' church is of the 13th century, and the museum has specimens of the Stone, Bronze and Iron Ages. The industries embrace distilleries, iron foundries and manufactures of cloth.

VIBRATION CONTROL. The study of mechanical vibrations is the study of the oscillatory motion of a mechanical part about some equilibrium, or neutral, position. Every structure or machine exhibits this phenomenon to some extent when subjected to a shock or an oscillating force. There are some cases where the vibration is essential to the operation of machines; examples are musical instruments, vibratory grain separators and vibrating conveyor belts. Often, however, vibration produces undesirable effects and must be reduced. For example, vibration may produce structural failures, excessive wear of rubbing surfaces, disturbances of delicate instruments and noise or other discomforts. This' article will discuss only cases involving undesirable vibrations. Thus vibration control will mean vibration reduction.



BY COURTESY OF BUICK MOTOR DIV., GENERAL MOTORS CORP

FIG. 1.—VIBRATION ISOLATOR FOR AUTOMOBILE ENGINE: ISOLATOR (OUTLINED IN WHITE) AND ENGINE ARE SHOWN LIFTED AWAY FROM CHASSIS

Good examples of vibration-control methods are found in automobiles. Without proper design of the suspension system, shocks and vibration caused by road irregularities would be transmitted directly from the wheel and axle assemblies to the chassis. Automobile suspension systems comprise two primary components—an elastic member, consisting of a steel or air spring, and a shock absorber, to damp out the motion of the elastic member.

(See SHOCK ABSORBER.)

Vibration in automobiles is caused also by unbalance in the engines. For this reason, engines are elastically mounted on the automobile chassis (see fig. 1). Used in this way. the elastic members are called vibration isolators. Their purpose is to insure that only a minimal part of the unbalanced forces in the engine are transmitted to the frame of the automobile.

Principles of Vibration Isolation.—The choice of vibration-isolation systems depends upon the mass of the part to be isolated and the character of the shock or oscillating force. Fig. 2 indicates the essential parts of a simple vibrating system under the influence of an oscillating force. This system approximates that of the automobile engine supported on the chassis by vibration isolators. The force is a result of the unbalance in the engine and is represented by Fsinwt. This force, the maximum value of which is indicated by F, varies in magnitude with time t at a frequency of ω radians per second (depending on the speed of the engine). If the engine were bolted directly to the frame, the entire force would be transmitted to the chassis.

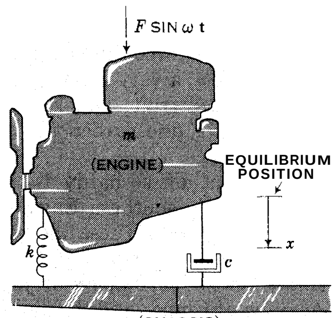
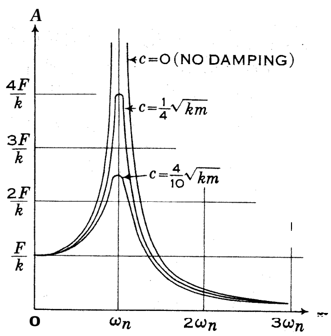


FIG. 2—SCHEMATIC DRAWING OF ESSENTIAL COMPONENTS OF AUTOMOTIVE ENGINE ISOLATED FROM CHASSIS

The purpose of the isolators is to diminish the force that is transmitted to the frame.

The isolators have two functions—to act as springs supporting the mass m of the engine and to dissipate energy as dampers and thereby restrict the magnitude of the vibration.. In the case of the automobile wheel-suspension system these two functions are performed separately by two components, springs and shock absorbers. However, in the engine suspension, these two functions are performed by single units, usually made of rubber. The springs exert a force on the engine and the chassis which is proportional to their deformation. This force will always tend to return the engine to its nonvibrating (equilibrium) position. The stiffness of the springs is indicated as k pounds per inch of deformation. Dampers exert a force on the engine and the chassis which is dependent on the speed of the relative motion of the engine with respect to the frame. Since this force is always opposite to the motion, it dissipates energy, and its magnitude is determined by multiplying the velocity by the damping coefficient c.



FROM J. P DEN HARTOG, "MECHANICAL VIBRATIONS," 4TH ED. (1956), MCGRAW-HILL BOOK CO INC

FIG. 3.— AMPLITUDE OF VIBRATION AS RELATED TO VIBRATION FREQUENCY FOR VARIOUS AMOUNTS OF DAMPING

(Natural frequency $= \omega_n = \sqrt{k/m}$)

In terms of the displacement x from the equilibrium position (see fig. 2), the differential equation describing the motion of the engine with respect to the frame of the automobile is

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F\sin\omega t \qquad (1)$$

The solution of this equation indicates that, after transient vibrations caused by starting die out, the engine will vibrate with a frequency equal to the exciting frequency (frequency of the force Fsinwt) and with an amplitude A (maximum displacement from the equilibrium position) given by the expression

$$A = \frac{F}{\sqrt{(k - m\omega^2)^2 + (c\omega)^2}} \qquad (2)$$

A plot of this amplitude in relation to frequency appears in fig. 3, when the exciting frequency equals the value given by

$$\omega_n = \sqrt{k/m} \qquad (3)$$

the amplitude approaches a large value. This condition is known as resonance, and the frequency ω_n is called the natural frequency or resonant frequency.

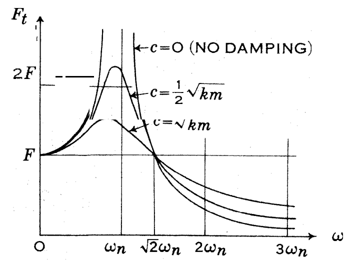
It is apparent also from fig. 3 that increased damping (shown by increased values of c for two of the curves) reduces the amplitude of vibration of the engine.

The force transmitted to the chassis through the isolators, F_t, is equal to the sum of the spring force and the damping force, and it also will vary with a frequency equal to the exciting frequency.

The maximum value of this force can be shown to be

$$F_t = \frac{F\sqrt{k^2 + (c\omega)^2}}{\sqrt{(k - m\omega^2)^2 + (c\omega)^2}} \qquad (4)$$

A plot of transmitted force in relation to frequency (see fig. 4) shows that this force is large in the vicinity of resonance. In fact, it is apparent that only when the exciting frequency is larger than the natural frequency ω_n by a factor of at least $\sqrt{2}$ times is the transmitted force less than F (that is, less than what it would be if no isolators were used at all). It is also apparent that using no isolators at all nould be better than using isolators that give a natural frequency so high that the exciting frequency can not exceed it by at least $\sqrt{2}$ times. In general, then, isolators must be chosen so that, when applied to a particular mass, they produce a natural frequency $\omega_n = \sqrt{k/m}$) which is substantially lower than the frequencv of the vibration to be 'isolated. Since the mass of the machinery usually cannot be increased, the isolators must be chosen so that their stiffness k is low.



FROM J. P. DEN HARTOG, "MECHANICAL VIBRATIONS 4TH ED (1956) MCGRAW HILL BOOK CO, INC

FIG 4.—TRANSMITTED FORCE IN RELATION TO VIBRATION FREQUENCY FOR VARIOUS AMOUNTS OF DAMPING

(Natural frequency $= \omega_n = \sqrt{k/m}$)

Another conclusion to be drann from fig 4 concerns the proper amount of damping It can be seen that in the region where the isolators are effective (*i.e.*, for an exciting frequency greater than $\sqrt{2}\omega_n$), damping increases the magnitude of the transmitted force. It might appear, therefore, that the best situation would be to have no damping at all. However, this is not true, for in most practical cases the applied force must be brought up from zero speed to the operating speed, and during this time the system will be operating in the resonant region. In this region damping is desirable.

Therefore, it may properly be concluded that for these conditions the isolators should have as little damping as possible but not so little that excessive vibration will result when the machinery is brought up through resonance to operating speed.

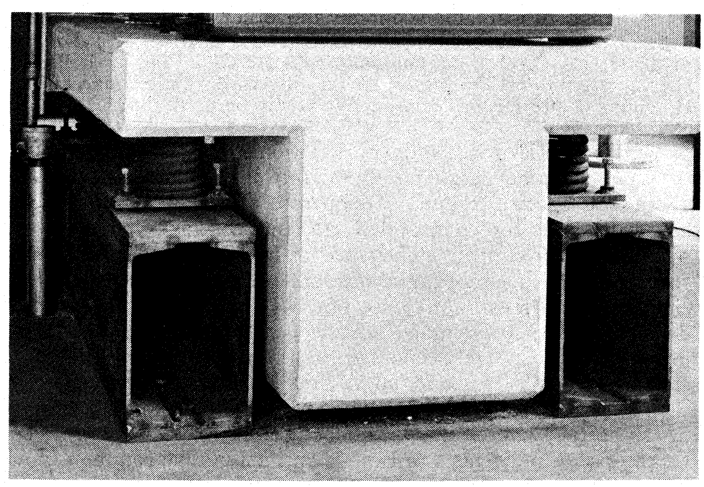
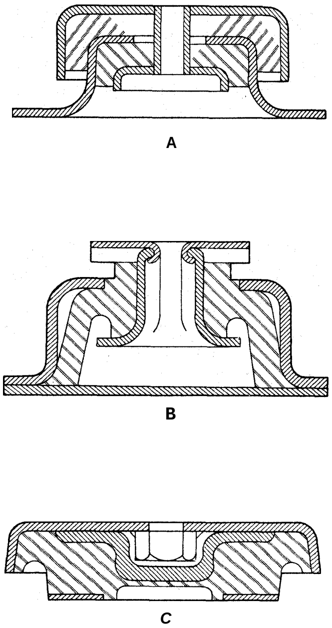


FIG. 5.— MACHINERY SUPPORT WITH COIL-SPRING VIBRATION ISOLATORS. T-SHAPED CONCRETE BLOCK INCREASES THE MACHINE MASS, REDUCING NATURAL VIBRATION FREQUENCY

In the case just cited and in all cases of isolation from steady vibration, the effectiveness of the isolators does not depend primarily on their damping characteristics; rather, it depends upon their ability to produce a low natural frequency which allows the equipment to move in a natural way in response to the applied exciting forces and its own inertia.

The case of isolation from shocks is more difficult to discuss, partly because the term shock encompasses many different kinds of phenomena. However, any use of the term shock implies a sudden force or motion. For this reason isolation from shock requires suspension systems which store energy rapidly and then release it slowly or dissipate it quickly in the form of heat. In either case, the damping characteristics usually play a more important part in the isolation systems than they do in the case of isolation from steady vibration. This is the reason for the special shock absorbers on the automobile wheel-suspension system in addition to the suspension springs.



FROM "MACHINE DESIGN," VOL. 26, AUG. 1954

FIG. 6.— SELF-CONTAINED RUBBER ISOLATORS FOR VARIED MOUNTING CONDITIONS AND SPRING RATES

Vibration **Isolators.**—Vibration isolators are made up of many different materials and in many shapes and sizes. They may be classified in three general categories: (1) self-contained isolators; (2) metallic springs; and (3) resilient pads.

Self-contained rubber isolators are made of natural or synthetic rubber bonded to metal parts with appropriate mounting holes or other means of attachment. Cross-sectional views of some of the common types are shown in fig. 6.

Metallic springs, in either leaf or coil form, are often used as isolators by attaching them directly to the machinery, and coil springs are also used in self-contained vibration isolators in place of rubber.

When the latter is done, additional damping devices are often provided in the isolators because of the small damping characteristic of the coil springs.

Resilient pads, often used under the bases of heavy machinery. are available in a variety of materials and in many shapes and sizes. Some of the more common materials are cork, glass fibre. felt, sponge rubber and neoprene and other synthetic materials.

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(RA. C.)

VIBURNUM, a genus of handsome shrubs (rarely small trees) of the honeysuckle family (Caprifoliaceae, *q.v.*), comprising about 120 species, found in temperate and subtropical regions, especially in eastern Asia and North America, many of which are planted for ornament. They are usually upright, rather large shrubs with opposite, simple, medium-sized leaves and numerous small flowers, mostly in large umbellike clusters, the marginal Bowers often showy, much enlarged and sterile. The fruit (a drupe), is often highly coloured, with a single, usually flattened stone. Two species are found in Great Britain: V. *lantana* (wayfaring tree), found widely also in Europe and Asia, and naturalized in the eastern United States; and V. *opulus* (cranberry tree; *see* CRANBERRY), indigenous to Europe and Asia. The common snowball of the gardens is a floral variant of the latter (*see* GUELDER-ROSE), while the Japanese snowbali is V. *tomentosum sterile* (or *V. t. plicatum).* In the United States and Canada 15 or more species occur, several of which are widely distributed. Four species attain the size of small trees: V. *lentago* (nanny berry; *q.v.*), V. *prunifolium* (black haw; *q.v.*), V. *rufidulum* (southern black haw) and V. *obovatum* (small viburnum). Well-known shrubby species are V. *trilobum* (high-bush cranberry), *V. alnifolium* (hobblebush), *V. dentatum* (arrowwood) and *V. acerifolium* (dockmackie). Beside the foregoing many other species are cultivated for ornament, and several American species yield medicines. The finest cultivated sorts comprise V. *carlesi* of Korea, grown both outdoors and forced in the greenhouse for its fragrant bloom; V. *carlcephalum,* a very fragrant hybrid; V. *dilatatum* of Japan, with persistent red fruit; and V. *burkwoodi,* a semi-evergreen hybrid. All these are fine garden plants, hardy in regions of reasonably mild winters.

Finer, but not so hardy as the above species, are the evergreen sorts hardy in southern England and northwestern and southeastern coastal U.S. These include the laurestinus (*q.v.*), V. *tinus,* with white, winter-blooming flowers; the fragrant V. *odoratissimum* and *V. japonicum* of Japan; the large-flowered V. *rhytidophyllum* of China; and the pinkish-flowered V. *suspensum* of Hong Kong. Viburnums may be propagated by seed or by cuttings.

(N. TR.)

VICAR, a title, more especially ecclesiastical, describing various officials acting in some special way for a superior. Cicero uses *vicarius* to describe an under-slave kept by another slave as part of his private property. The *vicarius* was an important official in the reorganized empire of Diocletian. It remained as a title of secular officials in the middle ages, being applied to persons appointed by the Roman emperor to judge cases in distant parts of the empire or to wield power in certain districts or, in the absence of the emperor, over all the empire. In the early middle ages the term was applied to representatives of a count administering justice for him in the country or small towns and dealing with unimportant cases, levying taxes, etc. Monasteries and religious houses often employed a vicar to answer to their feudal lords for those of their lands which did not pass into mortmain.

The title of "vicar of Jesus Christ," borne by the popes, was introduced as their special designation during the 8th century, in place of the older style of "vicar of St. Peter" (or *vicarius principis apostolorum*).

All bishops were looked upon as in some sort vicars of the pope, but the title *vicarius sedis apostolicae* came especially to be applied as an alternative to *legatus sedis apostolicae* to describe papal legates to whom in certain places the pope delegated a portion of his authority. Pope Benedict XIV tells us in his treatise *De synodo dioecesana* that the pope often names vicars-apostolic for the government of a particular diocese because the episcopal see is vacant or, being filled, the titular bishop cannot fulfil his functions. The Roman Catholic Church in England was governed by vicars-apostolic from 168j until **1850,** when Pope Pius IX re-established the hierarchy. Vicars-apostolic at the present day are nearly always titular bishops taking their titles from places not acknowledging allegiance to the Roman Catholic Church.

Sometimes the pope appointed a neighbouring bishop as the vicar of a church which happened to be without a pastor. A special vicar was appointed by the pope to superintend the spiritual affairs of Rome and its suburbs, to visit its churches, monasteries, etc., and to correct abuses. It became early a custom for the prebendaries and canons of a cathedral to employ "priest-vicars" or "vicars-choral" as their substitutes when it was their turn as hebdomadary to sing High Mass and conduct divine office. In the English Church these priest-vicars remain in the cathedrals of the old foundations as beneficed clergy on the foundation; in the cathedrals of the new foundation they are paid by the chapters. "Lay vicars" also were and are employed to sing those parts of the office which can be sung by laymen. The incumbent of a parish where the tithes are impropriate is entitled vicar.

In the Anglican Church a vicar-general is employed by the archbishop of Canterbury and some other bishops to assist in such matters as ecclesiastical visitations. In the Roman Catholic Church bishops sometimes appoint lesser vicars to exercise a more limited authority over a limited district. They are called "vicars-forane" or rural deans. They are entrusted especially with the surveillance of the parish priests and other priests of their districts, and with matters of ecclesiastical discipline. They are charged especially with the care of sick priests and in case of death with the celebration of their funerals and the charge of their vacant parishes. In canon law priests doing work in place of the parish priest are called vicars. Thus in France the *curé* or head priest in a parish church is assisted by several *vicaires*.

VICENTE, GIL (c. 1465–1536?), sometimes called the Portuguese Shakespeare, was born in the latter part of the reign of King Alphonso V. The first half of his life is vague. He was of humble birth and almost certainly spent his boyhood in some mountain village of the north of Portugal. He was perhaps apprenticed later to his father or uncle, Martim Vicente, goldsmith of Guimarães, and first came to the court at Evora, with many other provincials, on the occasion of the marriage of King João II.'s young son and heir to a daughter of the Catholic king in 1490. His work as goldsmith attracted the attention of Queen Lianor, and after the death of her son in 1491, and her husband four years later and the accession of her brother Manuel, Vicente retained her favour. It was at her request that he contributed (in 1509) a few verses to a poetical contest printed in the *Cancioneiro Geral* (1516). On the evening of June 7, 1502, the day after the birth of King Manuel's heir, the future João III., Vicente with a few others, dressed as herdsmen, entered the queen's chamber and recited a rustic monologue of 114 lines in Spanish. This primitive *Auto da Visitaçam* pleased Queen Lianor, and for the following Christmas Vicente had ready a longer but equally simple *Auto Pastoril Castelhano*.

For the next 34 years he was a kind of poet laureate, accompanying the court from Lisbon to Almeirim, Thomar, Coimbra or Evora and staging his plays to celebrate great events and the solemn occasions of Christmas, Easter and Maundy Thursday. The departure of a Portuguese fleet on the expedition against Azamor in 1513 turned his attention to more national themes, and in the *Exhortação da Guerra* (1513) and *Auto da Fama* (1515), inspired by the splendid victories of Albuquerque in the East, he wrote fervent patriotic verse which still stirs the hearts of his countrymen. Vicente's first wife, Branca Bezerra, may have died at about this time, and it seems that he was a widower when in 1514 he produced the charming *Comedia do Viuvo*.

His career as goldsmith kept pace with his growing success as dramatist. In 1509 he was appointed overseer of works in gold and silver at Thomar and elsewhere; in 1512 he was elected to the Lisbon Guild of Goldsmiths, and in Oct. 1513 he became one of their four representatives on the Lisbon town council. On Feb. 4 of this y'ear he was appointed master of the Lisbon mint. a post which he resigned on Aug. 6, 1517, in favour of Diogo Rodriguez, whose sister Melicia he married, perhaps in the same year. After the death of King Manuel in 1521 and of Queen Lianor four years later, Vicente frequently complains of poverty, but he received various pensions in the new reign; his accomplished daughter Paula won the favour of Princess Maria (1521–77); and he enjoyed the personal friendship of King Joio III.

On the occasion of the departure by sea of King Manuel's daughter Beatriz to wed the duke of Savoy in Aug. 1521, Vicente's *Cortes de Jupiter* was acted in a large room "adorned with tapestry of gold," a fact chronicled by his friend, the poet Resende. The *Fragoa de Amor* (1524) was also written for a court occasion, the betrothal of King João III. to the. sister of the Emperor Charles V. In the *Auto Pastoril Portugues* (1523), the farce *O Juiz da Beira* (1525), the *Tragi-comedia da Serra da Estrella* (1527) and the satirical *O Clerigo da Beira* (1529–30) he returned to the people, to the peasants and shepherds of the Beira mountain country which he knew so intimately.

He devoted himself more and more to the stage and multiplied himself in answer to the critics of Sá de Miranda's school. In 1526 came the *Templo de Apolo,* followed in rapid succession by the biblical play *Sumario da Historia de Deus,* the *Nao de Amores,* the *Divisa da Cidade de Coimbra,* and the *Farsa dos Almocreves*. These last three plays, with the *Serra da Estrella,* were all produced before the court in 1527 at Lisbon and Coimbra. On the other hand the *Auto da Festa* appears to have been acted in a private house at Evora. The elaborate *Auto da Feira* (1528), with its living popular types, contains some exceedingly caustic satire against Rome (personified on the stage): "You remit the sins of the whole world and forget to shrive yourself." It must be remembered that this was not a question of religion but of national politics: the relations of the devout João III. with the Vatican were often as troubled as those of his equally pious and even more regalist nephew Philip II. of Spain.

Vicente was now over 60, but he retained his vigour and versatility. The brilliant scenes of two of his last plays, the *Romagem de Agravados* (1533) and the *Floresta de Enganos* (1536), are loosely put together, and may well be earlier work; but the lyrical power of the *Triunfo do Inverno* (1529) and the long, compact *Amadis de Gaula* (1532) prove that his hand had lost none of its cunning and that his mind remained alert and young. The *Auto da Mofina Mendes* (1534), partly a religious allegory, partly a version of "Pierrette et son pot au lait," shows his old lightness of touch and penetrating charm. The *Auto da Lusitania,* which was acted in the presence of the court in 1532, may with some plausibility be identified with the *Caça de Segredos* at which Vicente tells us he was at work in 1525. It was the last of his plays to be staged at Lisbon in his lifetime; in Lent of 1534, by request of the abbess of the neighbouring convent of Odivelas, he produced there his religious *Auto da Cananea,* but the remainder of his plays were acted before the king and court at Evora; and it was probably at Evora that Vicente died in the year of his last play (1536).

Vicente's 44 plays admirably reflect the tragi-comedy of his age of change and upheaval in all its splendour and its squalor. Eleven are written exclusively in Spanish, 14 in Portuguese; the rest are bilingual; scraps of church or medical or law Latin, of French and Italian, of the dialect or slang of peasants, gipsies, sailors, fairies and devils frequently occur. His drama may be divided into religious plays, foreshadowing the Calderon *autos*, court plays, pastoral plays, popular farces and romantic comedy. They were often elaborately staged: a ship was rowed on the scene, or a tower opened to display some splendid allegory; here too he forestalled the later Spanish drama.

The various plays of the years 1513–19, composed when he was about 50, show Vicente at the height of his genius. He possessed a genuine comic vein, an incomparable lyric gift, and the power of seizing touches of life or literature and transforming them into something new by the magic of his phrase and his satiric force, under which lay a strong moral and patriotic purpose.

A far-sighted patriot and imperialist, and intensely national, he was also a devout son of the church; but he belonged to the more outspoken days before the Reformation, and his satire of priests and of the abuses of Rome was frank and merciless; so that when in 1531 one of his plays, the *Jubileu de Amores* (which some critics would identify with the *Auto da Feira)* was acted at Brussels, the papal nuncio, Cardinal Aleandro, who was present, felt "as if I were in mid-Saxony listening to Luther or in the horrors of the sack of Rome." As a lyric poet Vicente is first seen at his best in the wonderful poems of the *Auto da Sibila Cassandra* (1513?) in Spanish. This poet, who goes to the very heart of the Portuguese people, can as a lyric poet occasionally rival and even excel Camões, who, as Prof. W. P. Ker remarked, is "less of a miracle than Vicente" and owed more to the Renaissance. Vicente was over 50 when Sá de Miranda brought the new forms and metres from Italy; in their rivalry Vicente remained faithful to the indigenous octosyllabic verse. He had to meet growing criticism, and, in answer to the taunts of pedants, borrowed from Gomez Manrique the proverb, "Better an ass that carries me than a horse that throws me," and, building on it the *Farsa de Ines Pereira,* turned the tables on the "men of good learning."

It is Vicente's originality that he is an artist of the Renaissance untainted by its pedantry. He is at once the most imitative and the most original of poets; we continually find him working up his borrowed material, like gold in the hands of an artist of genius, into concrete figures; and his rapidly sketched portraits of peasant, priest and courtier will last as long as literature. Even in his rudest plays, and when the execution is at its roughest, his bold plastic genius makes itself felt. His plays are rich in folklore, and in his love of all that was popular and indigenous he seized on the essential and eternal elements of art. His knowledge of the French language was small, the influence of France came to him through Spain, and his *Barcas* were inspired by the Spanish version of the Dance of Death. The Spanish influence is always strong in this most national poet; he even quotes from the Book of Job, not direct but through Garci Sanchez de Badajoz. He had studied very carefully the work of the early Spanish playwrights Gomez Manrique and Encina, although he soon surpassed them. No other country produced so inspired a dramatic poet before the second hali of the 16th century. Actor, stage manager and author, Vicente was also a goldsmith and musician; he wrote the settings for some of his own lyrics, delightful popular romances and *cossantes* interspersed in his plays, which often end and open with a song, and are sometimes, as in the *Auto da Alma,* one long lyric.

Vicente is no exception to the general rule that Portuguese literature is mainly lyrical, in prose and verse; but in his many-sidedness he delineated life in its various aspects with the skill of a master, and he is the true forerunner of writers so different as Molière, Lope de Vega, Calderon and Shakespeare.

BIBLIOGRAPHY.—The only collected editions of Vicente's plays, a few of which were printed separately in his lifetime (seven of these were placed on the Portuguese Index of 1551), are the folios of Lisbon (1562, 1j86); 3 vol. of Hamburg (1834) and Lisbon (18jz); and the modern edition by Mendes dos Remedios, 3 vol. (1907–14). The critical edition of the 1562 text prepared by Michaelis de Vasconcellos immediately before her death has not yet seen the light. The only English translations are A. F. G. Bell, *Lyrics of Gil Vicente* (1914; 3rd ed. 1921) and *Four Plays of Gil Vicente* (1920). *See E*. Prestage, "The Portuguese Drama in the 16th Century; Gil Vicente," in the *Manchester Quarterly* (July, Oct. 1897); M. Menéndez y Pelayo, *Antologia de Poetas Liricos,* vol. vii; *T*. Braga, *Gil Vicente e as origens do theatro nacional* (1898); J. I. de Brito Rebello, *Gil Vicente* (1902, 1912); C. Michaelis de Vasconcellos. *Notas Vicentinas,* 4 vol. (Coimhra, 1912–22); A. Braamcamp Freire, *Vida e Obras de Gil Vicente* (Porto, 1919); and A. F. G. Bell. *Gil Vicentr* (1921).

For a fuller bibliography see *Four Plays of Gil Vicente* (1920). *A* new Vicente play, the *Auto da Festa,* was published from his library in 1906 by the Conde de Sabugosa. (A. B.)

VICENTE LÓPEZ, Argentine city and suburb of greater Buenos Aires, is 8 mi. N.W. of the federal district on the estuary of the Rio de la Plata. Pop. (1960) 250,823. Its name commemorates the author of the Argentinian national anthem, Vicente López y Planes. Vicente López was incorporated as a city in 1905. Engulfed by the growth of the capital in the 20th century, it still has many attractive homes which dominate the bank of the Rio de la Plata. During and after World War II numerous industrial enterprises were established in the city. (Js. R. S.)

VICENZA (anc. VICETIA), a town and episcopal see of Veneto, Italy, capital of the province of Vicenza, 42 mi. W. of Venice. Pop. (1957 est.) 87,856 (commune).

It lies at the northern base of the Monti Berici, on both sides of the Bacchiglione, at its confluence with the Retrone. It was surrounded by 13th-century walls, mostly demolished. The town has many buildings by Andrea Palladio (*q.v.*). The best is the basilica (1549–1614), one of the finest works of the Renaissance, replacing the exterior of the Palazzo della Ragione, a Gothic building (1444–77), which the colonnades of the basilica enclose. Close by is the Torre di Piazza (12th–15th century) 270 ft. high, the Loggia del Capitanio, by Palladio (1571) and the long Lombardesque Monte di Pietà (16th century). He also designed many of the fine palaces which give Vicenza its individuality; only two, the Porto Barbaran and Chiericati palaces (the latter containing the picture gallery), have two orders of architecture, the rest having a heavy rustica basis with only one order above it. Many palaces attributed to him are really the work of Scamozzi (the architect of the fine Palazzo del Municipio, 1588) and others of his successors. The famous Teatro Olimpico begun by him, but finished in 1583, is a remarkable attempt to construct a theatre in the ancient style. and the stage, with the representation of streets ascending at the back, is curious.

The Italian Gothic cathedral (mainly 13th century), consists of a nave with eight chapels on each side, and a very high Renaissance domed choir. The churches of S. Lorenzo (1280–1344) and S. Corona (1260–1300), both .of brick, are better examples of Gothic; both contain interesting works of art — the latter a very fine "Baptism of Christ," by Giovanni Bellini. The church of SS. Felice e Fortunato was restored in 975, but has been much altered, and was transformed in 1613. The portal is from 1154, and the Lombardesque square brick tower from 1166. Under it lies a mosaic pavement with the names of the donors, belonging to the original church of the Lombard period (?). Of the Palladian villas in the neighbourhood, La Rotonda, 1½ mi. S.E., is a square building with Ionic colonnades and a central dome which has been more than once copied in England and France. Nearby is the Villa Valmarana, with fine frescoes by G. B. Tiepolo (1737), and the new Piazzale della Vittoria, behind which is the baroque church of Monte Berico, with good works of art, from which porticoes lead down to the tower. Vicenza also has Venetian Gothic palaces.

The ancient Vicetia was of less importance than Verona and Patavium. It was for some time during the middle ages an independent republic, but was subdued by the Venetians in 1405. Toward the end of the 15th century it became the seat of a school of painting strongly influenced by Mantegna, of which the principal representatives were Bartolomeo Montagna, its founder, his son Benedetto Montagna, more important as an engraver, Giovanni Speranza and Giovanni Buonconsiglio. Andrea Palladio (1518–1580) was a native of Vicenza, as was also a contemporary, Vincenzo Scamozzi (1552–1616), who was largely dependent on him, but is better known for his work on architecture (Architettura *universale,* 1615). Palladio inaugurated a school of followers who continued to erect similar buildings in Vicenza even down to the French Revolution. Other natives of Vicenza were Giangiorgio Trissino (1478–1553) (see ITALIAN LITERATURE; PALLADIO, ANDREA), Antonio Pigafetta (1491–1534) and Antonio Fogazzaro (1842–1911) (*q.v.*). (T. A.)

VICHY, the chief spa of France, lies on the east bank of the Allier river (there nearly 1.000 ft. wide) in the Allier *département*, 365 km. (227 mi.) S.S.E. of Paris and 174 km. (108 mi) W.N.W. of Lyons by rail. Pop. (1954) 30.099. The town. largely modern and with a profusion of hotels, is separated from the river by gardens surrounding the extensive bathing establishments. Known to the Romans as Vicus Calidus, Vichy acquired fame for its hot and cold alkaline springs in the 17th century and was patronized by the families of successive French sovereigns, and notably by Napoleon III himself. The waters have a high reputation for alleviating liver and stomach complaints and are bottled for export. With more than 130,000 visitors annually, Vichy has extensive recreational amenities (casino, theatres, golf, lawn tennis, regattas and horse racing) and its airport at Charmeil provides links with London and Lyons. Following the Franco-German armistice of 1940, the collaborationist government under Marshal Pétain was established at Vichy until 1944.

VICIA: see VETCH.

VICKERY, HOWARD LEROY (1892–1946), U.S. naval officer and outstanding merchant shipbuilder of World War II, was born in Bellevue, O., April 20, 1892. He graduated from the U.S. Naval academy, Annapolis, Md.. in 1915 and later took graduate work in naval architecture. From 1921 to 1937 he served in various technical posts in the U.S. navy and, in 1937, was a technical adviser to a senate technical committee on safety of life at sea.

In 1937 he was selected as assistant to the chairman of the U.S. maritime commission, in full charge of the shipbuilding program under the Merchant Marine act of 1936; was appointed a commissioner in 1940; and vice-chairman of the commission in 1942, in which year he became a rear admiral. Vickery was a vigorous and unswerving administrator who demanded full performance and set an indefatigable example. Under his leadership more than 5,500 ocean-going ships were built — an unprecedented production record and a contributing factor in winning the war in spite of shipping losses inflicted by German U-boats. In 1944 he was made a vice-admiral. Among many awards, he received the army distinguished service medal; in 1948, posthumously, he was made, by King George VI, a knight commander of the Order of the British Empire. Vickery died at Palm Springs, Calif., March 21, 1946. (E. L. C.)

VICKSBURG, a city of the state of Mississippi situated about halfway between Memphis and New Orleans on the Mississippi river. It is historically famous as the site of one of the most decisive campaigns of the American Civil War (see below). On the landward side the city is almost completely surrounded by the 1,323-ac. Vicksburg National Military park and the Vicksburg National cemetery to the north fronting on the river where lie the graves of 16,653 Union soldiers, three-fourths of them marked "unknown." The park includes the battle lines of the opposing armies during the siege of the city. May 18 to July 4. 1863. Hundreds of bronze markers tell the story and observation towers afford comprehensive views of the field: Scores of busts and statues. state memorials and a bronze statue of Jefferson Davis are all further testimony of its historic importance.

Geography- *and History.*— Vicksburg owes its importance in peace and war to its geographic location. For miles above the city the Mississippi river meanders through an alluvial plain many miles wide. bounded on the east by a range of high land rising in some places more than 200 ft. The city was established at a point where a hairpin-shaped bend carried the river to the base of a 230-ft. bluff and then abruptly turned away, leaving a narrow peninsula of land across the river. Eight miles upstream the Tazoo river flowed into the Mississippi.

BY COURTESY OF VICKSBURG CHAMBER CF COMMERCE

BRONZE STATUE OF JEFFERSON DAVIS BY HENRY KITSON, IN THE VICKSBURG NATIONAL MILITARY PARK

In 1718 a few Frenchmen settled on the bluff and the next year built Ft. St. Pierre, but the settlement was wiped out by Indians ten years later. In 1790 Spaniards established an outpost there and in 1791 built Ft. Nogales on the highest hill. naming it for the many walnut trees growing there. Flatboatmen and other voyagers later called the place Walnut Hills

The Rev. Nenitt Vick, a Methodist minister from Virginia. established a mission in a clearing 6 mi. E. of the present city in 1811. Foreseeing the coming of settlers and river traffic, he then acquired a tract of land on the river front and prepared to lay out a town. Yellow fever killed him and his nife in 1819, but his son-in-law. John Lane. established the town, which was incorporated in 1825 as Vicksburg It was a lusty frontier river town, warring with river gamblers and claiming five heroic and individualistic newspaper editors dead by violence in a period of 22 years. It rapidly became the commercial centre of a cotton-groaing region with gins, compresses and warehouses dominating the business scene.

Commercial activity ceased and the city became an armed camp during the American Civil War. In 1876, before it had recovered from the effects of the war, another disaster struck. The Mississippi river broke through the narrow peninsula in front of the city making a new channel and leaving Vicksburg high and dry. But by closing the mouth of the Yazoo and diverting its waters through a canal past the bluffs the city lived again to become a great river port. Competition of railroads reduced river traffic to a mere trickle, but it revived in 1917 when the U.S. government started a barge line to relieve the wartime pressure on the railroads. This line was so successful that private enterprise started other lines. Harbour improvements later made it a growing centre of transportation and water-integrated industries. About 140,000 freight cars a year pass over its railroad bridge, the only such bridge spanning the Mississippi between Memphis and Baton Rouge. Cattle, livestock, lumber and cotton come to Vicksburg from the surrounding countryside. The U.S. government maintains at this strategic location the river fleet and general headquarters for flood-control research and for work on the blississippi and its tributaries.

The seat of Warren county, Vicksburg has a commission form of government and owns and operates an airport, a gas system and a waterworks. Sixty-two churches representing 16 denominations serve the community. The Illinois Central railroad, river craft and a highway system that includes a bridge across the Mississippi bring people and goods to the city. An estimated one-third of a million tourists visit the city and the national military park each year. For comparative population figures ***see*** table in MISSISSIPPI: *Population.*

Military Campaigns, 1862–63.—Vicksburg became a key point in the defense of the Confederacy in the spring of 1862. The fall of Forts Henry and Donelson in Tennessee in February and of New Orleans in April. meant further Union action from above and below the city to clear the river and cut the Confederacy in half. Vicksburg was ideally situated for defense purposes. Beyond the point where the Yazoo entered the Mississippi just above the city was a maze of swampy bayous, backwaters and side channels. Thus the only approach on high land was from the east or south.

The Confederates moved immediately to take advantage of these natural features. They laid out and constructed batteries to command the river approaches and fortified the river front. They were none too soon, for before the end of June. Adm. David G. Farragut's fleet arrived from New Orleans to be joined shortly by the upper fleet under flag officer C. H. Davis. Naval bombardment proved futile. The ironclads could run the batteries but could do no damage to the city. After a month they withdrew.

Anticipating attack by land the Confederates began the construction of a line of defenses in the rear using mostly Negro labour hired or impressed from nearby plantations. They also fortified Haynes's bluff, 11 mi. N. on the Yazoo, and Warrenton, 6 mi. below the city, and prepared to face attack from any or all quarters. On Oct 14, Gen. John C. Pemberton assumed command of the Department of Mississippi and East Louisiana and established headquarters at Jackson, 50 mi. to the east, and connecte l to Haynes's bluff by railroad. During the winter the Confederates also fortified Grand Gulf, the first bluff south of Vicksburg on the east side of the river about 50 mi. below the city, and Port Gibson several miles east of the river, the starting point of roads to Grand Gulf. Vicksburg and Jackson.

The winter witnessed a series of movements, usually remote from Vicksburg and none of them successful, to reach the high ground north of the city. The first of these was made at the end of November when Grant sought to move from Memphis and Grand Junction on Grenada. The outnumbered Confederates fell back without fighting but their cavalry under Maj. Gen. Earl Van Dorn and blaj Gen. Sterling Price destroyed most of Grant's supplies and communications and forced him to abandon the effort. Meanwhile Maj. Gen. William T Sherman had come downriver with a flotilla and about 30,000 men to attack Vicksburg simultaneously from the water side. Sherman attacked the Yazoo bluffs above Vicksburg. unaware that Grant had been turned back by the same troops now aiding the defenders, and met with defeat. Retreating from the upland. Grant sailed down the river and joined Maj Gen. John A. McClernand and Sherman at Milliken's bend above Vicksburg, with Maj. Gen. James B. McPherson's making three corps at Grant's disposal. Three other efforts followed. He attempted to cut a channel across the narrow neck of land in front of Vicksburg, hoping to isolate the fortress. to gain a water connection nith the lower river and to land an army on the bluffs beyond Pemberton's left flank. Kext he tried to make a channel from the Mississippi to the upper Yazoo and so to turn Pemberton's right flank, but the Confederates erected a fort where Grant's force had to emerge from the bayous and thwarted him in the effort.

Grant was about to lose his reputation for effectiveness. Several months and a half-dozen futile tries had brought him no nearer to Vicksburg Criticism and doubts of his leadership were freely expressed. Finally. not to be outdone and showing some of that doggedness and resourcefulness that was to make him famous. Grant decided on a bold move that succeeded probably beyond his wildest expectations. On April 16, 1863, a part of the upper fleet non commanded by flag officer David D. Porter ran the batteries at Vicksburg. JJ'hereas ironclads had previously run back and forth many times, this was the first time that ordinary steamers had done so Two nights later four more boats towing barges of large capacity passed down the river. Meanwhile Grant had crossed the river at Milliken's bend and made his way southward across the peninsula to meet the fleet at Bruinsburg. He had abandoned his line of communications by rail or river and had even sent his wagon train by a somewhat safer route. The fleet on the 29th unsuccessfully attacked Grand Gulf, but that night ran past the batteries for the rendezvous with Grant and put the army across 10 mi. below. At the time Grant was greatly outnumbered by the Confederates around Vicksburg, principally at Grand Gulf, Haynes's bluff and Jackson. He had to move rapidly to beat the enemy in detail outside the fortifications of Vicksburg before they could concentrate their forces. On the 30th Grant reached the high ground 2 mi. from Bruinsburg and moved quickly toward Port Gibson where roads led to Grand Gulf, Vicksburg and Jackson. He took Port Gibson on May 2 and moved toward Grand Gulf. Since his wagon train had not yet caught up with him, he had collected a motley train from the countryside and moved ahead. On May 3, Grant reached Grand Gulf abandoned by Confederates withdrawing to Vicksburg to await attack there. Whereupon Grant decided to abandon the idea of using Grand Gulf for a base and to hurry to Jackson before reinforcements could arrive for Gen. Joseph E. Johnston there and before they could join Pemberton who had gone to see to the defenses of Vicksburg. On May 12 McPherson took Raymond and two days later Grant drove Johnston from Jackson where he had arrived the night before to take command.

At this point the Confederate high command made fateful contradictory decisions. President Davis had wired Pemberton to hold Vicksburg at all costs. Johnston, on the other hand, favoured abandoning the city until the Confederate forces could be concentrated and then attack Grant there. Pemberton came out of Vicksburg on the way to Johnston's aid. but met Grant moving westward at Champion's hill and was forced back into the city. Thus on May 18 Grant was in the rear of Richmond, having meanwhile brought up more men and supplies, and Pemberton was isolated in the city. When assault proved futile, Grant settled down to siege tactics. By July 3 the besiegers were close to the Confederate lines, and Johnston had been prevented from coming to Pemberton's relief, nor could the latter escape across the river to Louisiana. Short of ammunition, almost completely without food and with his limited manpower approaching exhaustion, Pemberton surrendered on July 4, with approximately 30,000 men. The Mississippi river was open; the Confederacy was divided. A turning point had been reached, and Lincoln had found a new general. See also AMERICAN CIVIL WAR.

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VICO, GIAMBATTISTA (1668–1744), Italian philosopher of law and of cultural history, renowned as the exponent of a "new science of humanity," was born in Naples on June 23, 1668. The son of a poor bookseller, he attended various schools for short periods but was largely self-taught. For nine years he was tutor to the nephews of the bishop of Ischia, in the castle of Vatolla in the Cilento, south of Salerno. He received his law degree from the University of Naples in 1694 and was professor of rhetoric there from 1699 until 1741, when he was succeeded by his son Gennaro. He had aspired to a chair of law, but made no further attempt after an unsuccessful candidacy in 1723. He was appointed royal historiographer in 1735. He died in Naples in the night of Jan. 22–23, 1744.

One of the duties of the professor of rhetoric was to open the academic year with a Latin oration, and Vico's first professional publication. "On the Method of the Studies of Our Time" (De nostri *temporis* studiorum ratione, 1709), was expanded from such an inaugural oration. Six of his earlier orations, concerned with the several ends of university studies, he revised to form a companion volume but did not publish.

After a metaphysical essay "On the Ancient Wisdom of the Italians" (De *antiquissima Italorum* sapientia, 1710) and a biography of Marshal Antonio Carafa (De *rebus gestis A.* Caraphaei, 1716), he published in the three volumes of his "Universal Law" (De uno *universi iuris principio* et fine uno, etc.. 1720–22) a first version, or more precisely the first three versions, of his "new science of the common nature of nations" or "principles of humanity" as he later called it. All the works so far mentioned were in Latin, but from then on he wrote in Italian. After an unpublished intermediate version "in negative form," there appeared in 1725 the first published version to bear the name Scienza *nuova* in its title. A completely rewritten second edition appeared in 1730, and a much revised third edition in 1744, after his death.

Among disciplines familiar to the 20th century, perhaps the nearest in intent to Vico's new science is the history of civilization. But what he laboured to bring about may be more accurately described as the convergence of history from the one side and the more systematic social sciences from the other and their interpenetration to form a single science of humanity. In language closer to his own, the new science unites philology as ascertainment of particular historic fact and philosophy as demonstration of general truth.

Vico approached his new science through a new theory of knowledge, announced in his publications of 1709 and 1710. We know in mathematics because. by abstraction and definition, me have made the objects of our knowledge. We have a quasi-knowledge of the world of nature just so far as we are able to carry the experimental method by which, as it were, we make what we know; but, to speak more strictly and as a whole, the world of nature is known only by God, who made it. On the other hand, we can know the civil world or world of nations, the institutions of human culture, because we have made that world and "its principles are therefore to be found within the modifications of our own human mind."

The root formula for these modifications is not far to seek. "Men at first feel without observing; then they observe with a troubled and agitated spirit; finally they reflect with a clear mind." The recovery of the origins of civilization from the surviving fragments of antiquity by a new critical art guided by this formula is a more difficult matter, and it cost Vico "the research of a good twenty years." The best examples of this research are (1) his critique of "the fiction that the law of the Twelve Tables came to Rome from Greece" and (2) his "discovery of the true Homer" as the Greek people of the heroic or poetic age, mythological in thought, barbaric in manners and completely ignorant of the "recondite wisdom" of later philosophers.

The principal aspects of the new science, as formulated in the edition of 1744, are: (1) a rational civil theology of divine providence; (2) a philosophy of authority; (3) a history of human ideas; (4) a philosophical criticism; (5) an ideal eternal history; (6) a system of the natural law of nations; and (7) the principles of universal history.

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VICQ-D'AZYR, FÉLIX (1748–1794), French physiologist and pioneer in comparative anatomy, was born at Valognes, Normandy, on April 23, 1748, the son of a physician. He went to Paris in 1765 to study medicine and from 1773 gave courses at the Jardin des Plantes that opened up an entirely new approach to the study of anatomy. He compared the structures of the arms and legs in man with the limbs of other vertebrates, and demonstrated the similarity of the muscular systems and their function. His description of the structure of the brain was the most exact up to that time. In 1774 he was elected a member of the Académie des Sciences. The following year he was appointed to study an epizootic in the south of France, and partly as a result of his experiences during that investigation, encouraged the creation of a new society for the study of epidemic diseases: La Société Royale de Medicine, founded in 1776 with Vicq-d'Azyr as permanent secretary. He became consulting physician to the queen and on the death of G. Buffon in 1788 was elected to his seat in the Académie Française.

His many studies dealing with vertebrate comparative anatomy and physiology were published in the *Mémoires de l'Académie des Sciences* and other scientific journals. An annotated edition containing most of these memoirs was prepared by Moreau: *Oeuvres complètes de Vicq-d'Azyr,* 6 vol. (1805). Besides these he wrote La *Médicine des bêtes à cornes* (1781). He died at Paris on June 6, 1794. His *Système anatomique des quadrupèdes* was left unfinished, but was completed by Hippolyte Cloquet and published in the *Encyclopédie me'thodique,* vol. 3 (1819). (ED. HE.)

VICTOR, the name of three popes and two antipopes.

VICTOR I. SAINT, pope in the last decade of the 2nd century, an African. succeeded Eleutherius in 189. His pontificate. which lasted 10 years. is memorable for a great enhancement of Rome's authority in the church. He treated the Quartodecimans harshly in the controversy about fixing the date of Easter.

VICTOR II (Gebhard), pope from 1055 to 1057, was the son of the Swabian count Hartwig of Calw (Kalw). At the instance of Gebhard. bishop of Regensburg. a relative of the emperor Henry III, he was appointed bishop of Eichstadt in 1042, when he was still very young. His talents soon enabled him to render important services to the emperor. whose chief adviser he eventually became. His nomination to the papacy. in succession to Leo IX. by the emperor at Mainz in the autumn of 1054, was made on the demand of the Roman deputation headed by Hildebrand (the future Gregory 1-11). After his consecration at St. Peter's (April 13. 1055) Victor rejoined the emperor at Florence in May. There, in June, they held a council which again condemned clerical marriages, simony and the alienation of the estates of the church. In the following year he was summoned to Germany to the side of the emperor and was with him when he died at Botfeld in the Harz on Oct. 5, 1056. As guardian of the infant Henry IV and adviser of the empress regent Agnes, Victor now wielded enormous power, which he began to use with much tact for the maintenance of peace throughout the empire and for strengthening the papacy against the aggressions of the barons. He died shortly after his return to Italy, at Arezzo, on July 28,.1057.

VICTOR III (Dauferius), pope from 1086 to 1087, was born in 1027, a member of the ducal house of Benevento. After studying in various monasteries he entered the cloister at Monte Cassino, where his name was changed to Desiderius. In 1058. on the death of Pope Stephen X (who had retained the abbacy of Monte Cassino throughout his pontificate). Desiderius succeeded him as abbot. His rule there marks the golden age of that great monastery: he promoted literary activity and established an important school of mosaic. Desiderius was created cardinal priest of Sta. Cecilia by Nicholas II in 1059 and as papal vicar in southern Italy conducted frequent negotiations between the Normans and the pope. Among the three or four men suggested by Gregory VII on his deathbed as most worthy to succeed him was Desiderius, who was favoured by the cardinals because of his learning, his connection with the Normans and his diplomatic ability. The abbot, however, declined the papal crown. and the year 1085 passed without an election. The cardinals at length proclaimed him pope against his will on May 24. 1086. but he was driven from Rome by supporters of the emperor Henry IV before his consecration was complete. Laying aside the papal insignia at Terracina. he retired to his beloved Monte Cassino. In 1087, as vicar of the Holy See he convened a synod at Capua early in March, resumed the papal insignia on March 21 and received tardy consecration in St. Peter's on May 9; but imperial support for the antipope Clement III (Guibert of Ravenna) made it impossible for Victor to spend more than a few weeks in Rome. He sent to Tunis an army that defeated the Saracens and compelled them to pay tribute to the papal see. In Aug. 1087 he held a synod at Benevento, which renewed the excommunication of Guibert; banned Archbishop Hugo of Lyons and Abbot Richard of Marseilles as schismatics; and confirmed the prohibition of lay investiture. Falling ill at the synod. Victor returned to Monte Cassino. where he died on Sept. 16. 1087.

While abbot of Monte Cassino, Victor III contributed personally to the literary activity of the monastery. His *Dialogi de miraculis S. Benedicti* and his *Epistolae* were printed by J. P. Migne (ed.), in *Patrologia latina,* vol. cxlix (Paris, 1853); his short account of two miracles of Leo IX is in the Bollandist *Acta Sanctorum,* under April 19 (Paris, Rome, 1866).

VICTOR IV (Gregory, sometimes surnamed Conti), the first antipope to take the name. had since 1122 been cardinal priest of SS. Dodici Apostoli when he was chosen by a party opposed to Innocent II in succession to the antipope Anacletus II. about March 1j, 1138. St. Bernard of Clairvaux. however. prevailed on him to make his submission to Innocent on May 29.

VICTOR IV (Octavian of Monticelli), second antipope of the name, had since 1138 been cardinal priest of Sta. Cecilia when he was elected successor to Adrian IV by a minority of cardinals in the course of a series of indecisive scrutinies in the three days following Sept. 4, 1159. He was put up in opposition to Alexander III by those who desired a *rapprochement* with the emperor Frederick I Barbarossa and was the first of the series of antipopes that Barbarossa was to support in his struggle against Alexander. After a scandalous scene in which Octavian snatched the scarlet mantle from his rival. his armed supporters burst into St. Peter's and enthroned him. forcing Alexander to withdraw. Victor was consecrated at Farfa by Imarus, cardinal bishop of Tusculum, on Oct. 4. Despite Frederick's diplomatic efforts and his attempt at the council of Pavia (Feb. 1160) to consolidate ecclesiastical opinion on Victor's behalf, the rest of Europe had no desire to see a revival of imperial control over the papacy. and even in Germany a section of the clergy remained loyal to Alexander. Victor died on April 20, 1164, at Lucca. whither he had been conducted by the imperial arch-chancellor, Rainald of Dassel. He was succeeded by the antipope Paschal III. Pope Gregory VIII had his hones disinterred in 1187.

VICTOR, SEXTUS AURELIUS, prefect of Pannonia about 360 (Amm. Marc., xxi, 10), possibly the same as the consul (jointly with Valentinianj in 373.and as the prefect of the city who is mentioned in an inscription of the time of Theodosius. Four small historical works have been ascribed to him on more or less doubtful grounds: (1) *Origo Gentis Romanae,* (2) *De Viribus Illustribus Romae,* (3j *De Caesaribus,* (4) *De Vita et Moribus Imperatorum Romanorum excerpta ex Libris Sex. Aur. Victoris* The four have generally been published together under the name *Historia Romana,* but the fourth is a *réchauffé* of the third.

The first edition oi all four was that of A. Schottus (Antwerp, 1579). A good modern edition of the De *Caesaribus* is by F. Pichlmayr (Munich, 1892).

NICTOR AMADEUS II (1666–1732), duke of Savoy and king first of Sicily and then of Sardinia: is famous for his aggrandizement of the house of Savoy as a European power and also for his astute changes of alliance in wartime. He was born at Turin on May 14. 1666. the son of Charles Emmanuel II of Savoy. His mother. Marie Jeanne Baptiste of Savoy-Nemours. became regent for him on his father's death in 1675 and pursued a pro-French policy: and in 1684. when \-ictor Amadeus began to rule in person. he married Anne Marie of Orléans (1669–1728), niece of Louis XIV of France. In 1687. however. he went to Venice for a secret conference with representatives of the German powers then coalescing against Louis. When the War of the Grand Alliance (*q.v.*) broke out. the French tried to ensure that he would not be against them. but in 1690 he settled terms with the .Austrian and Spanish Habsburgs. refused to allow the French to garrison Turin and entered the war on the side of the allies. England and Holland ratified the terms accorded to him by the Habsburgs. while insisting on guarantees for his Waldensian subjects. As the war went against him (battles of Staffarda [1690] and Marsaglia

[1693]), he demanded the government of Milan from his Spanish ally and. on being refused this, negotiated for a separate peace with France. The treaty of Turin (1696) gave Savoy very favourable terms and increased territory; and it stipulated the neutrality of Italy for the rest of the war, which ended with the peace of Ryswick (169;). His daughter Marie-Adelaide was married to the French dauphin's eldest son.

In the War of the Spanish Succession (*q.v.*) Victor Amadeus allied himself first with the French (1701). Then, in 1702 he began negotiations with the Holy Roman emperor; and late in 1703 he finally changed sides, after the suspicious French had disarmed a contingent of his troops. The French defeat at Turin (1706) secured his position in Italy; and the treaties of Utrecht and Rastatt (1713–14) gave him the royal title as king of Sicily. The quadruple alliance of 1720 made Victor Amadeus take Sardinia instead of Sicily, which he had lost to the Spaniards in 1718, though he would have preferred a state on the Italian mainland, such as Parma.

In 1730 Victor Amadeus abdicated his crown in favour of his son, Charles Emmanuel III, and retired to Chambéry with his newly married second wife, Anna, the nidowed contessa di San Sebastiano. When he tried to revoke his abdication, Charles Emmanuel eventually had him arrested (1731) and confined first at Rivoli and then at Moncalieri, where, on Oct 31, 1732, Victor Amadeus died.

Bibliography —D. Carutti, *Storia del regno di Vittorio Amadeo II,* 3rd ed (Turin, 1897), the marchesa Vitelleschi, *The Romance of Savoy,* Eng trans, 2 vol (London, 1905); various authors, *Studi su Vittorio Amadeo II* (Turin, 1933)

VICTOR **EMMANUEL II** (1820–1878), king of Sardinia and first king of Italy, was born at Turin on March 14, 1820, and was the son of Charles Albert, prince of Savoy-Carignano. Brought up in the bigoted and chilling atmosphere of the Piedmontese court, he received a rigid military and religious training, but little intellectual education. In 1842 he married Adelaide, daughter of the Austrian Archduke Rainer. Victor Emmanuel played no part in politics during his father's lifetime, but took an active interest in military matters. When the war with Austria broke out in 1848, he was delighted at the prospect of distinguishing himself, and was given the command of a division. At Goito he was slightly nounded and displayed great bravery, and after Custozza defended the rearguard to the last (July 25, 1848). After the defeat at Novara on March 23, Charles Albert, having rejected the peace terms offered by the Austrian field-marshal Radetzky, abdicated in favour of his son. Victor Emmanuel was received by Radetzky with every sign of respect and the field-marshal offered not only to waive the claim that Austria should occupy a part of Piedmont, but to give him an extension of territory, provided he revoked the new Piedmontese constitution granted by Charles Albert in March 1848, and substituted the old blue Piedmontese flag for the Italian tricolour, which savoured too much of revolution. But the young king rejected the offer, and had to agree to the temporary Austrian occupation of part of his territories and of half the citadel of Alessandria, to disband his Lombard, Polish and Hungarian volunteers, and to withdraw his fleet from the Adriatic; but he secured an amnesty for all the Lombards compromised in the recent revolution, having even threatened to go to war again if it were not granted. It was the maintenance of the constitution in the face of the overwhelming tide of reaction that established his position as the champion of Italian freedom and earned him the sobriquet of *Rè Galantuomo* (the honest king). But the task entrusted to him was a most difficult one. Parliament having rejected the peace treaty, the king dissolved the assembly; in the famous proclamation from Moncalieri he appealed to the people's loyalty, and the new Chamber ratified the treaty (Jan. 9, 1850). This same year, Cavour (q *v.*) was appointed minister of agriculture in D'Azeglio's cabinet, and in 1852 became prime minister.

In having Cavour as his chief adviser Victor Emmanuel was most fortunate, and but for that statesman's astounding diplomatic genius the liberation of Italy would have been impossible. The years from 18jo to 1859 were devoted to restoring the shattered finances of Sardinia, reorganizing the army and modernizing the antiquated institutions of the kingdom. Among other reforms the abolition of the *foro ecclesiastico* (privileged ecclesiastical courts) brought down a storm of hostility from the Church both on the king and on Cavour, but both remained firm in sustaining the prerogatives of the civil power. When the Crimean War broke out, the king strongly supported Cavour in the proposal that Sardinia should join France and England against Russia so as to secure a place in the councils of the great powers and establish a claim on them for eventual assistance in Italian affairs (1854). In 1855, while the allied troops were still in the East, Victor Emmanuel visited Paris and London, where he was warmly welcomed by the Emperor Napoleon III and by Queen Victoria, as well as by the peoples of the two countries.

Victor Emmanuel's object now was the expulsion of the Austrians from Italy and the expansion of Sardinia into a North Italian kingdom, but he did not regard the idea of Italian unity as coming within the sphere of practical politics for the time being, although a movement to that end was already beginning to gain ground. With this end in view he entered into communication with some of the conspirators, especially with La Farina, the leader of the *Società Nazionale,* and even communicated with Mazzini and the republicans. In 1859 Cavour's diplomacy succeeded in drawing Napoleon III into an alliance against Austria, although the king had to agree to the cession of Savoy and possibly of Nice and to the marriage of his daughter Clothilde to the emperor's cousin Prince Napoleon. These conditions were very painful to him, but he was always ready to sacrifice his own personal feelings for the good of his country. He had an interview with Garibaldi and appointed him commander of the newly raised volunteer corps, the *Cacciatori delle Alpi.* Even then Napoleon would not decide on immediate hostilities, and it required all Cavour's genius to bring him to the point and lead Austria into a declaration of war (April 1859). Although the Franco-Sardinian forces were successful in the field, Napoleon, fearing an attack by Prussia and disliking the idea of a too powerful Italian kingdom on the frontiers of France, insisted on making peace with Austria, while Venetia still remained to be freed. Victor Emmanuel, realizing that he could not continue the campaign alone, agreed to the armistice of Villafranca. When Cavour heard the news he hurried to the king's headquarters at Monzambano, and in violent, almost disrespectful language implored him to continue the campaign at all hazards. But the king on this occasion showed great political insight and saw that by adopting the heroic course proposed by the latter he ran the risk of finding Napoleon on the side of the enemy, whereas by waiting all might be gained. Cavour resigned office, and by the peace of Ziirich (Nov. 10, 1859) Austria ceded Lombardy to Sardinia, but retained Venetia; the central Italian princes who had been deposed by the revolution were to be reinstated, and Italy formed into a confederation of independent states. But this solution was most unacceptable to Italian public opinion, and both the king and Cavour determined to assist the people in preventing its realization, and consequently entered into relations with the revolutionary governments of Tuscany, the duchies and of Romagna. As a result of the events of 1859–60, those provinces were all annexed to Piedmont, and when Garibaldi decided on the Sicilian expedition Victor Emmanuel secretly assisted him. He had considerable influence over Garibaldi, who, although in theory a republican, was greatly attached to the bluff soldier-king. When Garibaldi having conquered Sicily was determined to invade the mainland possessions of Francis II. of Naples, Victor Emmanuel, foreseeing international difficulties, wrote to the chief of the red shirts asking him not to cross the straits; but Garibaldi, although acting throughout in the name of his majesty, refused to obey and continued his victorious march, for he knew that the king's letter was dictated by diplomatic considerations rather than by his own personal desire. Then, on Cavour's advice, King Victor decided to participate himself in the occupation of Neapolitan territory, lest Garibaldi's doubtful entourage should proclaim the republic or create anarchy. When he accepted the annexation of Romagna offered by the inhabitants themselves the pope excommunicated him, but, although a devout Catholic, he continued in his course undeterred by ecclesiastical thunders, and led his army in person through the Papal States, occupying the Marches and Umbria, to Naples. On Oct. 29 he met Garibaldi, who handed over his conquests to the king. On Feb. 18, 1861, the parliament proclaimed him king of united Italy.

The next few years were occupied with preparations for the liberation of Venice, and the king corresponded with Mazzini, Klapka, Türr and other conspirators against Austria in Venetia itself, Hungary, Poland and elsewhere, keeping his activity secret even from his own ministers. The alliance with Prussia and the war with Austria of 1566, although fortune did not favour Italian arms, added Venetia to his dominions.

The Roman question yet remained unsolved, for Napoleon, although he had assisted Piedmont in 1859 and had reluctantly consented to the annexation of the central and southern provinces, and of part of the Papal States, would not permit Rome to be occupied, lest he should lose the support of the French clericals, and maintained a French garrison there to protect the pope. When war with Prussia appeared imminent Victor Emmanuel was anxious to assist the man who had helped him to expel the Austrians from Italy, but he could not do so unless Napoleon gave him a free hand in Rome. This the emperor refused to do until it was too late. Even after the first French defeats the chivalrous king, in spite of the advice of his more prudent councillors, wished to go to the rescue, and asked Thiers, the French representative who was imploring him for help, if with 100,000 Italian troops France could be saved, but Thiers could give no such assurance and Italy remained neutral. On Sept. 20, 1870, the French troops having been withdrawn, the Italian army entered Rome, and on July 2, 1871, Victor Emmanuel made his solemn entry into the Eternal City, which then became the capital of Italy.

The pope refused to recognize the new kingdom even before the occupation of Rome and the latter event rendered relations between church and state for many years extremely delicate. The king himself was anxious to be reconciled with the Vatican, but the pope, or rather his entourage, rejected all overtures, and the two sovereigns dwelt side by side in Rome until death without ever meeting. Victor Emmanuel devoted himself to his duties as a constitutional king with great conscientiousness, but he took more interest in foreign than in domestic politics and contributed not a little to improving Italy's international position. On Jan. 9, 1878, Victor Emmanuel died of fever in Rome, and was buried in the Pantheon.

Bluff, hearty, good-natured and simple in his habits, he always had a high idea of his own kingly dignity, and his really statesmanlike qualities often surprised foreign diplomats, who were deceived by his homely exterior. As a soldier he was very brave, but he did not show great qualities as a military leader. He had a great weakness for female society, and kept several mistresses; one of them, the beautiful Rosa Vercellone, he created Countess Mirafiori e Fontanafredda and married morganatically in 1869; she bore him one son.

Bibliography.—Beside the general works on Italy and Savoy, *see* V. Bersezio, *Il Regno di Vittorio Emanuele II.* (Turin, 1869); G. Massari, *La vita ed il Regno di Vittorio Enzanuele II.* (Milan, 1878); N. Bianchi, *Storia della Diplomazia Europea in Italia* (Turin, 1865); *Il Carteggio Cavour Nigra 1858–61* (Bologne, 1926); C. S. Forester, *Victor Emmanuel II.* (1927). (L. V.)

VICTOR EMMANUEL III (1869–1947), king of Italy, son of King Humbert I and Margherita of Savoy-Genoa, was born at Naples on Nov. 11, 1869. He entered the army and soon after attaining his majority, was appointed to the command of the Florence Army Corps, and in 1896 to that of the Naples Army Corps. His formal accession to the throne took place on Aug. g and 11, 1900, after the assassination of his father (July 29).

When in 1915 Italy declared war on Austria, the king at once went to the war zone, remaining there until the armistice, appointing his uncle Ferdinand, duke of Genoa, regent of the kingdom to act in his stead. At the front he lived in a most unassuming manner at the "Villa Italia" near Udine, and after Caporetto near Padua, constantly visiting the trenches and the most exposed positions, as well as the military hospitals, and leading to a very large extent the life of the soldiers. Although nominally commander-in-chief he never interfered with the conduct of operations, or in the matter of appointments.

After Caporetto he multiplied his activities a thousand-fold, and his proclamation of Nov. 19, 1917, sounded like a trumpet-call to the whole people. After the armistice, King Victor Emmanuel returned to Rome on Nov. 14, 1918.

On the night preceding the fascist "march on Rome" (Oct. 28, 1922) the cabinet had decided unanimously to proclaim martial law, of which Marshal Badoglio said in those days that the simple fact of its proclamation would have been sufficient to disperse at once the rabble of the so-called "march." The prime minister, Facta, went with the decree at midnight to the villa Savoia, out of Rome, to have it signed by the king. At two in the morning back he went with the decree not signed by the king. Official fascist propagandists wrote later on that the king had "nobly" refused to sign. Others, the first of whom was Count Sforza in his *Makers of Modern* Europe, asserted that Facta had accepted reluctantly the decision of the cabinet; that he had been induced by Mussolini into believing that a new Facta-Mussolini cabinet might be formed; and that he secretly suggested that the king not sign the decree. The fact is that the king's rule had always been to obey the prime minister in any political matters. He went too far with this rule under fascism, because he signed and welcomed, or feigned to nelcome, decrees which violated his oath as a constitutional king, as when he ratified the complete suppression of the freedom of the press, the suppression of the chamber of deputies, etc. Under Mussolini's rule, the king's prerogatives existed nominally but not in fact, so that by the time of World War II he was taking a small part indeed in the Italian affairs of state. On June 5, 1944, the day after the Allies entered Rome, he named his son, Crown Prince Humbert, lieutenant general of the realm, relinquishing all power for himself but retaining his title of king. On May 9, 1946, he abdicated in favour of Kumbert. On June 2, 1946, however, the Italian people voted to end the monarchy and to set up a republic. Victor Emmanuel died Dec. 28, 1947, in Alexandria, Egypt.

Victor Emmanuel married Princess Elena Petrovich-Niegosh, daughter of the first and last king of Montenegro; she bore him four daughters: Yolanda Margherita (June 1, 1901), Mafalda (Nov. 19. 1902), Giovanna (Nov. 13, 1907) and Maria (Dec. 26, 1914); and a son and heir, Humbert, prince of Piedmont (Sept. 15, 1904). Princess Yolanda was married in 1923 to Count Giorgio Calvi of Bergolo, Mafalda in 1925 to Prince Philip of Hessen and Giovanna in 1930 to King Boris of Bulgaria.

See L. Morandi, *Come fu educato Vittorio Emmanuele III* (1901); and B. Astoni and P. Rost, *Il Re alla guerra* (1918). (L. V.; X.)

VICTORIA (1819–1901), queen of the United Kingdom of Great Britain and Ireland, and from 1876 empress of India, was born at Kensington palace on May 24, 1819, the only child of Edward, duke of Kent, fourth son of King George III. With the death in 1817 of the prince regent's daughter. Princess Charlotte, there was no surviving legitimate offspring of George III's 15 children. In 1818, therefore, three of his sons, the dukes of Clarence, Kent and Cambridge, married to provide for the succession. The duke of Kent's wife was Princess Mary Louisa Victoria of Saxe-Coburg-Gotha, the widow of Prince Ernest Charles of Leiningen. The duke of Kent died when his daughter (who was christened Alexandrina Victoria) was eight months old; accordingly, on George IV's accession she became heir to the throne next after the duke of Clarence (subsequently William IV) whose own children died in infancy.

Victoria, by her own account, "was brought up very simply," principally at Kensington palace where her closest companions, other than her homely and impoverished mother, were her half-sister Féodore and her governess Louise (afterward the Baroness) Lehzen, a native of Coburg. Her mother's nearest adviser was her brother, Victoria's uncle Leopold, widower of Princess Charlotte. Until he became the first king of the Belgians in 1831 he lived at Claremont, near Esher, Surrey, where Victoria would visit him. From her father's family she was virtually isolated, growing up to regard herself as a Coburg rather than as a member of the house of Hanover. Her mother's morbid fear of Victoria's uncle, the duke of Cumberland, and after the death of George IV, her pretentiousness on her daughter's behalf, led to an estrangement from Victoria herself and to friction with William IV. Early in life Victoria learned caution in her friendships; she also revealed a liking for her own way; nor did her retentive memory allow her to forgive readily.

The legend (upon which the queen herself was to cast some doubt) ran that she was unaware until she was 12 that she would one day succeed to the throne. "I will be good" she is reported to have responded to the news. Not long afterward she began the detailed and highly characteristic Journal which she kept throughout her life.

If in Great Britain at mid-20th century the crown is at the centre of society and but rarely concerned with political decisions, at Victoria's accession in 1837 it was almost the reverse. Society in the conventional sense revolved not so much around the court as around the great houses whose owners might still look down upon, or at least askance at, the palace. Politics, however, still revolved around the throne. As recently as 1834 the Melbourne ministry had been dismissed by the crown, and prime ministers such as Sir Robert Peel who had served their political apprenticeship before the Reform act of 1832 were still likely to hold "the confidence of the crown" to be a political necessity to an administration. The political role of the crown when Victoria first came to wear it was thus by no means clear; neither was the permanence of the throne itself. When she died and the new king moved from Marlborough house to Buckingham palace the change was one of social rather than of political focus: nor was there any doubt of the monarchy's continuance. That was the measure of her long reign.

Accession.—In the early hours of June 20, 1837, Victoria received the archbishop of Canterbury and the lord chamberlain to learn of William IV's death. Later that morning the privy council was impressed by the graceful assurance of the new queen's demeanour. The accession of a young woman was romantically popular; moreover. because of the so-called Salic law, which prevented succession by a woman, it entailed the separation of the crowns of Great Britain and Hanover, the latter of which passed to William IV's surviving brother, Ernest, the unpopular duke of Cumberland.

The new queen, who had never before had a room to herself, exiled her mother to a distant set of apartments when they moved into Buckingham palace. Sir John Conroy, her mother's major-domo. was pensioned off; only Lehzen, of whom she was still in awe, remained close to the queen. Even her beloved uncle Leopold was politely warned off discussions of English politics. "Alone" at last, she enjoyed her new-found freedom. "Victoria," wrote her cousin, Prince Albert (*q.v.*) who was later to marry her, "is said to be incredibly stubborn and her extreme obstinacy to be constantly at war with her good nature; she delights in Court ceremonies, etiquette and trivial formalities . . . She is said not to take the slightest pleasure in nature and to enjoy sitting up at night and sleeping late into the day." It was, in retrospect, "the least sensible and satisfactory time in her whole life"; but at the time it was exciting and enjoyable, the more so because of her romantic friendship with Lord Melbourne, the prime minister.

Together with the threat of Cumberland as heir apparent, two episodes in 1839, revealing that if she had too little in her head she had perhaps too little in her heart also, may explain why "those who had her welfare most at heart were anxious," as she wrote long afterward, "to secure for her without delay a husband's guidance and support." Lady Flora Hastings, a maid of honour with Tory connections, was forced to undergo a medical examination for suspected pregnancy. The gossip, when it was discovered that the queen had been mistaken, became the more damaging when later in the year Lady Flora died of a disease not diagnosed by the physician whom the queen had thrust upon her earlier. The brief enthusiasm of the populace over the coronation (June 28, 1838) swiftly dissipated.

Between the two phases of the Hastings case "the bedchamber crisis" intervened. Lord Melbourne had proved a delightful and devoted mentor to the young queen; but, by surrounding the queen with Whig ladies, he had allowed her to become a Whig partisan. When he resigned in May 1839 Sir Robert Peel, the Conservative leader, stipulated that the Whig ladies of the bedchamber should be removed. The queen imperiously refused, not without Melbourne's encouragement. "The Queen of England will not submit to such trickery," she said. Peel therefore declined to take office which Melbourne rather weakly resumed. "I was very young then," wrote the queen long afterward "and perhaps I should act differently if it was all to be done again." Denunciation of her conduct became a popular item in Chartist propaganda.

For a short time after Albert's arrival at Windsor the queen wrestled with her desire for continued and enjoyable independence until on Oct. 15, 1839, she proposed to him. Her letters became ecstatic; his were more circumspect. They were married on Feb. 10, 1840, the queen dressed entirely in articles of British manufacture.

The "Albertine Monarchy."—At first the queen was insistent that her husband should have no share in the government of the country. Within six months, on Melbourne's repeated suggestion, the prince was allowed to start seeing the despatches, then to be present when the queen saw her ministers. The concession became a routine and, during her first pregnancy, the prince received a "key to the secret boxes." Quickly, too, she learned from her husband to dislike London and to abandon late parties. His was the stronger personality. It was the "Prince who insisted on spotless character, the Queen not caring a straw about it," the duke of Wellington (*q.v.*) told Charles Greville, the diarist—the prince was "extremely strait-laced and a great stickler for morality whereas she was rather the other way." The royal dinner parties became a conspicuous model of decorum: and not very amusing.

Blissfully happy herself, the queen settled down to have children while the prince busied himself with the administration of the royal properties. The "mere amusement" of the gossipy days with Melbourne was past. Later she recorded talking them over with her husband and of her "unbounded affection and admiration for Lord Melbourne which I said to Albert I hardly knew from what it arose excepting the fact that I clung to someone and having very warm feelings. Albert thinks I worked myself up to what really became rather foolish."

It is convenient to summarize here the growth of the royal family. The princess royal (the "Vicky" of the *Letters)* was born in Nov. 1840; in 1858 she married the crown prince of Prussia and later became the mother of the emperor William II. The prince of Wales (Edward VII) was born in 1841. Then followed Princess Alice, afterward grand duchess of Hesse, 1843; Prince Alfred. afterward duke of Edinburgh and duke of Saxe-Coburg-Gotha, 1844; Princess Helena (Princess Christian), 1846; Princess Louise (duchess of Argyll), 1848; Prince Arthur (duke of Connaught). 1850; Prince Leopold (duke of Albany), 1853; Princess Beatrice (Princess Henry of Battenberg), 1857. The queen's first grandchild was born in 1859, her first great-grandchild in 1879. There mere 37 great-grandchildren alive at her death.

The prince came into his own to negotiate a compromise on the bedchamber question with Peel after the Melbourne government had been defeated in the general election of 1841. The queen's first interview with Peel went well, eased by Melbourne's advice to his successor: "the Queen is not conceited—she is aware there are many things she cannot understand and she likes to have them explained to her elementarily—not at length and in detail but shortly and clearly." If, as Lady Lyon once noted, "there was 'a vein of iron' which ran through the Queen's extraordinary character," her personal happiness as wife and mother evoked a less willful humility. Peel's very real distress when in the summer of 1842 an attempt was made to assassinate the queen—together with the affinity between the prince and the new prime minister—soon converted the "cold odd man" of the queen's earlier comment into "a great statesman, a man who thinks but little of party and never of himself." Lord Aberdeen, the foreign secretary, also became a great favourite. "We felt so safe with them both," she told King Leopold. It was under Albert's influence that she came to adopt what she later called "the obvious but up to that time much neglected doctrine that it is the paramount duty of a constitutional monarch to maintain a position of neutrality towards the leaders of party on both sides." At' the election of 1841 the queen had subscribed, through Lehzen, £15,000 to the Whig cause.

By the autumn of 1842 Lehzen had left for Germany forever and the prince could reorganize the palace. He became effectively the queen's private secretary: according to himself. "her permanent minister": using his own staff. George Anson and Gen. Charles Grey, for the purpose. There are. perhaps, three significant aspects of what has been called the "Albertine monarchy": apart from the intense happiness in which it enclosed the queen. In 1842 she had made her first railway journey. Railway travel made an important contribution to the queen's contentment, for it enabled her to spend much of the year in the Isle of Wight and in Scotland, ministers taking turn in "doing service" (as Lord Palmerston came to call it). by residing in attendance. An estate at Osborne in the Isle of Wight was purchased on Peel's advice, and the residence — "our island home" — built in 1846 out of the queen's savings from her income once the prince had got her properties into shape. She had already paid off her father's debts. The lease of the original Balmoral house near Ballater was taken in 1848 after three previous visits to Scotland. In 1852 the estate was bought and in 1855 a great castle in "Scotch baronial" was almost completed. At Balmoral she was happiest: there it was possible to form a new establishment without the difficulties which the prince had encountered in organizing the palace or Windsor castle. In Scotland. moreover, he did not have to face the unpopularity so frequently his experience in England. At Balmoral the royal pair and their family were able to live "with the greatest simplicity and ease." wrote Greville. The queen soon came to hold the Highlanders in more esteem than any other of her subjects. She liked the simpler life of the Highlands, as her published *Journal* was to reveal: she came to make the most of the thin stream of Scottish blood in her veins; also, so long as the sermons were short enough, to prefer the Scottish form of service. "You know," she was to tell Gladstone, "I am not much of an Episcopalian": and she developed a comfort in the consolations of the Rev. Norman MacLeod. as also a delight in the plain speech of John Brown, the Highland servant who stalked with Albert.

The political circumstances within which the monarchy operated in the prince's lifetime are peculiarly worth remarking. After the repeal of the corn laws there was a period not ending until the election of 1568 when politics tended to consist of a series of temporary alliances between splinter groups and no single group (one may perhaps hardly use the word "party" in the modern sense so early) could guarantee its extended control over the house of commons: a condition rendering active political intervention by the crown not only possible but sometimes even necessary. There was a role for the cabinet maker: especially in helping to compose coalitions. Its significance must not, however, be overemphasized, since (as C. H. Stuart reminds us: *Trans. Roy. Hist. Soc., Fifth Series,* vol. 4 [London, 1954]) "the initiative in politics in the twilight years between the decline of royal government and the dawn of purely parliamentary rule still lay mith the official men of ministerial standing or ambition." 'and the queen's share "though substantial was always secondary." It may be doubted. however, whether she herself saw matters in this light.

Again. the tradition persisted that in foreign affairs the crown had a special part to play, and could continue to "do it alone with a Secretary of State." Victoria and Albert had relatives throughout Europe and were to have more. Moreover, they visited and were visited by other monarchs: the tsar. Nicholas I, and Louis Philippe, for example, and later by Napoleon III. Albert was determined that this personal intelligence should not be disregarded and that the queen should never become (as his own mentor the Baron Stockmar had indicated) "a mandarin figure which has to nod its head in assent or shake it in denial as its Minister pleases." The result was a clash mith Lord Palmerston who could look back on a career of high office beginning before the royal couple mas born. Confident in his parliamentary skill and in his capacity to solve every problem of foreign policy on the spur of the moment, shrewd, bold, instinctive, contemptuous of foreign potentates, diplomatic amenities or his ministerial colleagues, in every respect save industry he was Albert's antithesis. The prince distrusted Palmerston's character, disapproved of his methods, thought his policy shallow, and. prompted by Stockmar, disagreed with his concept of the constitution.

In the ensuing contests Victoria, as Albert's disciple, outran her lord and master in her vehemence and in 18jo thought "it right in order to avoid any mistakes for the future. to explain what it is she expects from the foreign secretary. She requires: (1) that he distinctly state what he proposes in a given case in order that the Queen may know as distinctly to what she has given her royal sanction; (2) having once given her sanction to a measure, that it be not arbitrarily altered or modified by the minister." Palmerston's habits did not change and n-hen without consultation he expressed his approval of Louis Napoleon's *coup d'état* in 1851, Lord John Russell at once dismissed him. using the occasion to make public the queen's memorandum just quoted. Within a few months Palmerston was back in office. however, as home secretary. and on the eve of the Crimean War the royal pair encountered a wave of unpopularity such as they had endured in 1846–47. There was however a marked revival of royal sentiment as the war wore on. The queen personally superintended the committees of ladies who organized relief for the wounded and eagerly seconded the efforts of Florence Nightingale: she visited crippled soldiers in the hospitals, and instituted the Victoria Cross for gallantry.

Widowhood. — The importance of the Albert period lay in the training the queen received: in orderly ways of business, in hard work (which she certainly never learned from Melbourne). in the expectation of royal intervention in ministry-making at home; and in the establishment of a private (because royal) intelligence service abroad. The English monarchy had changed. "In place of a definite but brittle prerogative it had acquired an undefinable but potent influence." (G. M. Young, *Victorian England,* 2nd ed., Oxford University Press. London, 1953.)

The queen had played with Albert a "substantial" (if "secondary") part in choosing and putting into office Aberdeen's ministry when Derby resigned in Dec. 1852. The habit died hard, for after the nervous breakdown—the "two dreadful first years of loneliness" — after the prince consort's death (Dec. 1861), she sought, on her recovery, to behave as he would have ordained. Her testing point was, then, her "dear one's" point of view; and this she had known at a particular and thereafter not necessarily relevant period in English political life. Her training and his influence were ill suited to the "swing of the pendulum" politics which better party organization and a wider electorate enjoined after the Reform bill of 1867. She was a widow of 42 with nine children when Albert died. And since she blamed her son and heir for his death — the prince consort had come back ill from clearing up an indiscretion of Albert Edward's at Cambridge— she did not hesitate to vent her loneliness upon him. "It quite irritates me to see him in the room." she startled Lord Clarendon by saying. The breach was never really healed. The Hanoverians —and in this, at least, she was a Hanoverian—were never able to get on to terms with their heirs. Hating ceremonial herself, although she had much talent for it, as time went on the queen was clearly envious of the popularity of the prince and princess of Wales. She liked to be, but she took little trouble to see that she was, popular.

To Balmoral (to which telegraphic communication with London was established in the 1860s) and to Osborne, for four months in the year. she came to retreat in turn. giving the impression to shrewd observers like Walter Bagehot (whose *English Constitution* was published in 1867) that she was "a retired widow" because he could not read her *Letters;* and. although his division between the dignified or "theatrical" and the efficient or "business" parts of the constitution. came to grow truer in her case, the *Letters* exist to reveal that, so far as she was concerned, she mas determined to remain, as Albert had taught her, very much one of the efficient parts of the constitution: although, from the point of view of the populace and those tradespeople who needed a more splendid court, carrying into effect all too few of the "theatrical" aspects of the task. She had been an adoring wife and, if Albert had left her prejudices less narrow, he had not, of course, been able to alter her temperament: as she herself realized. "My nature is too passionate," she told an old friend, "my emotions are too fervent; he guided and protected me, he comforted and encouraged me." Not only was Albert gone but the advisers of earlier days were dead too — Melbourne. Peel, Wellington and Aberdeen — and Stockmar had retired in Coburg. "Uncle Leopold" died not long afterward. And the old men who survived. she had never liked: Palmerston, Derby or Russell to whom there soon came a black-edged reproach from Osborne warning him not to take up Palmerston's habit of sending off drafts "without the Queen's having first seen them." (Jan. 14, 1862). Moreover, there were to be changes, because of retirement, in the next few years, in the household, and one of them was of some moment. "Good, excellent General Grey." who had been Albert's secretary, stoutly resisted her attempt to make herself a recluse. It was he who urged ministers to press her to appear in public. He realized what an infliction it was to ministers that she stayed so long at Balmoral and Osborne nursing her grief; he advised "a strong — even a *peremptory* tone." Grey had been prepared to lose his temper with her — and survive. After he retired nobody dared, except, till 1883. John Brown. Henry (later Sir Henry) Ponsonby. Grey's successor, mas too young to try. He might soften her asperities, or take the blame on her behalf, but he could not, indeed (despite his wife's prompting) did not try to, stand up to her prejudices as Grey had done. No longer restrained. her *Letters* became more forcefully characteristic, and, as Lady Ponsonby told Sir Henry, "When she is disagreed with. even slightly, she thinks nothing too bad to say of the culprit."

It was despite, yet because of, Albert that she succumbed to Disraeli. Albert had thought him insufficiently a gentleman and remembered what he had done to Peel; the prince had approved of Gladstone. Yet Disraeli was able to enter into the queen's grief. flatter her, restore her self-confidence and make the lonely crown an easier burden. Behind all the calculated attack on her affections there was a bond of mutual loneliness, a note of mystery (which she had already found of interest in Napoleon III): and the return to good gossip. Moreover, Disraeli told the queen in 1868 that it would be "his delight and duty, to render the transaction of affairs as easy to your Majesty, as possible." Since the queen was only too ready to consider herself overworked, this approach was especially successful. Gladstone, on the other hand. would never acknowledge that she was, as she put it, "dead beat": perhaps because he never was himself; whereas Disraeli tired easily. The contrast between Disraeli's gay. often malicious, gossipy letters and Gladstone's 40 sides of foolscap is obvious. And there was no Albert to give her a neat précis. Moreover, Gladstone held the throne as an institution in such awe that it affected his relations with its essentially feminine occupant. His "feeling" for the crown, said Lady Ponsonby. was "always snubbed." There was a lack of personal understanding between the queen and Gladstone fairly early which was accentuated by Disraeli's willingness that such should be so. Later, this was to grow into political differences; but they began, it would seem, on the psychological and personal level. Dean Wellesley, her favourite cleric, took considerable trouble to warn Gladstone in 1868 before he took office, that "everything depends upon your manner of approaching the Queen. Her nervous susceptibility has much increased since you had to do with her before and you cannot show too much-regard, gentleness, I might even say tenderness, towards Her."

Gladstone took the advice to heart, and although they might differ on a particular issue, such as the disestablishment of the Irish church in 1869, it did not prevent the queen's active co-operation: in that particular issue, certainly. when her intervention with the bishops was decisive, to avoid clashes between the two houses. Friction began in 1871 when Gladstone, alarmed at the wave of republican feeling, tried to persuade the queen to reappear in public and postpone her departure to Balmoral. She threatened abdication, and Disraeli made matters worse for Gladstone by defending the queen's seclusion in a speech savouring of what Gladstone called his "usual flunkeyism." When Gladstone subsequently appeared at Balmoral he noted "the repellent power which she so well knows how to use has been put in action towards me . . . I have felt myself on a new and different footing with her."

Over Ireland. their paths separated ever more widely. Whereas "to pacify Ireland" had become the "mission" of Gladstone's life, the queen (like the majority of her subjects) had little understanding of, or sympathy for, Irish grievances. She disliked disorder and regarded the suggestion of Irish Home Rule as sheer disloyalty. The proposal of an Irish "Balmoral" was repugnant to her, especially when it mas suggested that the prince of Wales might go in her place. To avoid the Irish sea, she claimed to be a bad sailor; yet she was willing in her later years to cross the English channel almost every year. In all, she made but four visits to Ireland, the last in 1900 being provoked by her appreciation of the gallantry of the Irish regiments in the South African War; she never forgot that she was herself a soldier's daughter.

Constitutional **Position.**—News of Gladstone's defeat in 1874 found the queen in delight. "What an important turn the elections have taken." she wrote to Sir Theodore Martin (Albert's biographer). "It shows that the country is not *Radical.* What a triumph, too, Mr. Disraeli has obtained and what a good sign this large Conservative majority is of the state of the country, which really required (as formerly) a strong Conservative party!" If. years before. Melbourne, almost despite himself. had made her a good little Whig: if Albert had left her, in general, a Peelite, temperamental and subsequently doctrinal differences with Gladstone made it easy for Disraeli to turn her into a stout supporter of the Conservative party. And he took an artist's pleasure in doing so (as his *Letters to Lady Bradford and Lady Chesterfield* make evident). By 1878 we find Lady Ponsonby writing to her husband "I *do* think Dizzy has worked the idea of personal government to its logical conclusion and the seed mas sown by Stockmar and the Prince. While they lived, the current of public opinion, especially among the Ministers, kept the thing between bounds, but they established the superstition in the Queen's mind about her own prerogative. and we who know her, know also perfectly how that superstition. devoid as it is of even a shadow of real political value, can be uorked by an unscrupulous Minister to his own advantage."

Lady Ponsonby went on to hint at a future clash with Gladstone. When in Sept. 1879 a dissolution seemed imminent, the queen wrote to the marchioness of Ely (who was, after the duchess of Argyll. perhaps her most intimate friend):

Dear Janie,—I wish it were possible for Sir Henry Ponsonby to *get at some* of the Opposition and to point *out* the *extreme* danger of binding themselves by foolish, violent declarations about their policy beforehand I hope and trust the Government will be able to go on after the Election, as change is so disagreeable and so bad for the country; but, if it should *not,* I wish the *prtnctpal* people of the Opposition should *know* there *are certain* things which I *never can* consent to.

1. Any lowering of the position of this country by letting Russia have her way in the East, or by letting down our Empire in India and in the Colonies. This *was* done under Mr. Gladstone, quite *contravy* to Lord Palmerston's *policy,* which, whatever faults he had, *was always* for *keeping up England* which of late years had *quite* gone down, so that we were *despised* abroad.
2. That I would never give way about the *Scotch Church* which is the real and true stronghold of Protestantism.

These are points which I *never* could *allow* to be *trifled with,* and *I* could have *no* confidence in any men who attempted this. Our position in India, and in the Colonies, *must* be *upheld.* I wish to *trust my* Government w-hoever it is, but they should be *well aware* beforehand I never could if they intended to *try* and *undo* what has been done.

In the same way I never could take Mr. Gladstone or Mr. Lome as my Minister again, for I never could have the slightest *particle* of confidence in Mr. Gladstone *after* his violent, mischievous and dangerous conduct for the last three years, nor could I take the *latter* after the very offensive language he used three years ago against *me.*

Sir Henry Ponsonby has so many Whig friends that he might easily *get* these things *known.* In former days much good was done by Baron Stockmar and Mr. Anson paving the way *for* future arrangements and *preventing* complications at the moment. like Sir Robert Peel's failure in 1839 about the Ladies. Ever yours affectionately, V.R. and I. I never *could* take Sir C. Dilke as a *Minister.*

After the blow fell with the Conservative party's defeat in 1880 she sent for Lord Hartington. "Mr. Gladstone *she* could have nothing to do with, for she considers his whole conduct since '76 to have been one series of violent, passionate invective against and abuse of Lord Beaconsfield and that *he caused* the Russian war." Nevertheless, as Hartington pointed out, it was Gladstone whom she had to have. She made no secret of her hostility, she hoped he would retire, and she remained in correspondence with Lord Beaconsfield (as Disraeli had become). Gladstone. indeed, said he himself "would never be surprised to see her turn the Government out, after the manner of her uncles." Over the abandonment of Kandahar, in 1881, for example, Ponsonby had never seen her so angry: "The Queen has never before been treated." she told him, "with such u-ant of respect and consideration in the forty three and a half years she has worn her thorny crown . . . ." Over the Franchise bill of 1884 she nas able to intervene usefully, and it would seem that it was Lord Salisbury who was the more difficult; nevertheless she blamed Gladstone. "The Lords." she said, "are *not* in disharmony with the people, but unfortunately Mr. Gladstone's government leans so much to the extreme Radical side, instead of to the sound and moderate portion of his following. that measures are presented to the House of Lords which the Conservatives and moderate Liberals do not feel they can with safety agree to. No one is more truly Liberal in her heart than the Queen, but she has aluays strongly deprecated the great tendency of the present Government to encourage instead of checking the stream of destructive democracy which has become so alarming. This it is that. she must sap justly, alarms the House of Lords and all moderate people. And to threaten the House of Lords that they will bring destruction on themselves is in fact, to threaten the Monarchy itself Another Sovereign but herself must acquiesce in any alteration of the House of Lords. She will not be a Sovereign of a Democratic Monarchy." She "was under the impression," said Ponsonby's son, that "she was holding the scales evenly between the two parties."

Of the three great rights (to be consulted. to encourage and to warn) which Walter Bagehot had awarded the crown in his *English Constitution* she had come to make partisan use. Nothing escaped her "drill eye." She insisted on consultation whoever was in power—and over the most trivial details. As time went on, she came, to encourage the Conservatives and to warn the Liberals. The considered view of the Radical Joseph Chamberlain, not notably a friend of royalty, is of interest: "The Queen does interfere constantly," he wrote; "more, however. when Liberal Ministers are in power than when she has a Conservative Cabinet, because the Conservatives on the whole do what she likes, as she is a Conservative; whereas the Liberals are continually doing and indeed exist for the purpose of doing the things she does not like. But it is very doubtful how far her interference is unconstitutional. and it would be quite impossible to prove it . . . The Queen is a woman of great ability . she writes to the Prime Minister about everything she does not like, which when he is a Liberal means almost everything that he says or does . . . she insists that administrative acts should not be done nithout delay for the purpose of consulting with regard to them persons whose opinions she knows will be unfavourable . . . her action to my mind is strictly speaking constitutional . . . it would be difficult to maintain that uith her immense experience the Queen is not justified in asking for time in order that men of distinction should be consulted upon various acts." Her warnings in 1884 about General Gordon passed unheeded. and when he was killed at Khartoum she sent her reproof (Feb. 5. 1885) *en clair.*

"The lengthening experience of the Queen. laid up in the most retentive and faithful memory, was making her an excellent person to talk things over with; if she had mastered the nervous horror of London which drove her to Balmoral or Osborne, and had kept her Ministers under the charm at Buckingham Palace, her influence would have groan with her experience. . . . On three occasions after the Prince's death she intervened with decisive effect: in checking the hysterical fussiness with which Palmerston and Russell were behaving over Schleswig-Holstein under the grim contemptuous eyes of Bismarck; in promoting the passage of the Reform Bill of 1867; in releasing the deadlock of the Houses over Reform and Redistribution in 1884. But Disraeli had made her a partisan: the hoarded experience which might have been freely at the disposal of all her Ministers was reserved for such favourites as Salisbury and Rosebery, and the influence was dissipated in reprimands and injunctions, often shrend, always vigorous, but sometimes petulant and sometimes petty. . . . Now that her relations with her ministers are known with some degree of intimacy, it is permissible to say that if she never overstepped the limits of her admitted powers, she did not alnays behave well within them: she did her duty but often with a reluctance and temper which in a more critical age might have been even dangerously resented." (G. M. Young, *Victorian England,* and ed., Oxford University Press, London, 1953.) She never acclimatized herself to the effects of the new electorate on party organization. No longer was the monarchy normally necessary as cabinet maker—but she still had an obscure desire to have a coalition (Aberdeen had become her favourite minister in Albert's day) and she had been brooding, since 1880, over getting "the moderate men of both parties," as she called them, into a coalition together as an anti-Radical bloc. Irish Home Rule provided her with a solution.

In 1885 Ponsonby explained to Sir William Harcourt that "her idea was that 'extremes' (meaning Gladstone and R. Churchill) should be got rid of, that Hartington should be Prime Minister and Salisbury Foreign Secretary under him, the whole of the rest of the Cabinet being Liberal and Whig." She had already sounded the duke of Argyll in the matter and she pressed G. J. (afterward Lord) Goschen to act as go-between. "Out of this," she said. "might grow a Coalition in time." In this she was right: and in the Salisbury administration (1895–1902) with which her long reign ended she was eventually to find not only the sort of ministry with which she felt comfortable. but one which lent a last ray of colour to her closing years by its alliance, through Joseph Chamberlain, with the mounting imperialism which she had so greatly enjoyed in Disraeli's day when he had made her empress of India. Before that, however. she mas to have two more rounds of bickering with Gladstone and the shortlived administration of Lord Rosebery whom she herself chose unadvised in 1894 as her prime minister.

Last Years.—Victoria absorbed a great deal of the time of her ministers, especially Gladstone's, but after 1868 it may be doubted whether, save in rare instances, in the longer run it made a great deal of effective difference, politically. She may have postponed an occasional evil day; she certainly hampered an occasional career. And sometimes. that "continuous political experience" which Bagehot remarked as a long-lived monarch's greatest asset, was invaluable: in stopping "red tapings," as the queen called them, or in breaking a log jam. Meanwhile—"a comparatively late growth"—she had gained the affection of her subjects. Lord Salisbury observed in the lords (Jan. 25, 1901) after her death that: "She had an extraordinary knowledge of what her people would think—extraordinary, because it could not come from any personal intercourse. I have said for years that I have always felt that when I knew what the Queen thought, I knew pretty certainly what views her subjects would take, and especially the middle class of her subjects." Bagehot had emphasized the fact that the court stood aloof from the rest of the London world and had "but slender relations with the more amusing part of it." The court, was, then, unfashionable: but the queen herself, as the two Jubilees of 1887 and 1897 showed. was popular. Gone were the days when pamphlets were circulated asking what she did with her money. More and more fully with advancing years. she was able to satisfy the imagination of the middle class—and the poorer class—of her subjects.

Many of the movements of the day passed the aged queen by, many irritated her. but the stupendous hard work which Albert had taught her went on—the meticulous examination of the boxes, the regular signature of the papers. "Wiggings" (as her scoldings of family and ministers were familiarly called) grew more infrequent. When in 1896 the prince of Wales wanted her to give the kaiser a "good snubbing," she replied, "Those sharp answers and remarks only irritate and do harm and in Sovereigns and Princes should be most carefully guarded against. William's faults come from impetuousness (as well as conceit); and calmness and firmness are the most powerful weapons in such cases." She had mellowed. She had come into calmer, if lonely, waters. Those who were nearest to her came completely under her spell; yet all from the prince of Wales down stood in considerable awe. A breach of the rules could still make a fearsome change in the kindly, managing great-grandmother, in black silk dress and white cap. The eyes began to protrude, the mouth to go down at the corners. Those who suffered her displeasure never forgot it; nor did she. She lived surrounded by mementoes, photographs, miniatures, busts and souvenirs: at the end of long corridors down which one tiptoed past Indian attendants to the presence. Nobody knocked; a gentle scratching on the door was all that she permitted. Every night at Windsor Albert's clothes were laid out on the bed, every morning fresh water was put in the basin in his room. She slept with a photograph--over her head—taken of his head and shoulders as he lay dead.

Queen Victoria had fought a long rearguard action against the growth of "democratic monarchy": yet, in some ways, she had done more than anyone else to create it. She had made the monarchy respectable and had thereby guaranteed its continuance: not as a political power but as a political institution. Her long reign had woven a legend and, as her political power ebbed away. her political value grew. It lay, perhaps, more in what the electorate thought of her, indeed felt about her, than in what she ever was or certainly ever believed herself to be. Paradoxically enough, her principal contribution to the British monarchy and her political importance lay in regard to those "dignified" functions which she was accused of neglecting rather than to the "business" functions which, perhaps, sometimes, she did not neglect enough.

The queen died at Osborne on Jan. 22, 1901, after a short and painless illness. She was buried beside Prince Albert in the mausoleum at Frogmore near Windsor. Her essential achievement was simple. By the length of her reign, the longest in English history, she had restored both dignity and popularity to a tarnished crown: an achievement of character, as well as of longevity. Historians may differ in their assessment of her political acumen, her political importance or her role as a constitutional monarch. None will question her high sense of duty as wife, mother and queen, or the transparent honesty, the massive simplicity, of her royal character.

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VICTORIA, TOMAS LUIS DE (TOMMASO LUDOVICO DA VITTORIA) (*c.* 1540–1611), Spanish composer. was born at Avila. He was ordained and in 1571 was appointed choirmaster to the Collegium Germanicum at Rome. In 1578 he became chaplain to the empress Maria, sister of Philip II of Spain, and probably returned to his native country in 1583. From 1586 he was choirmaster to the convent of the Descalzas Reales. In 1603 he composed for the funeral of the empress Maria the greatest requiem of the golden age of vocal polyphony. This *Officium defunctorum* (published 1605) is his last-known work. He died in Madrid on Aug. 27, 1611.

Victoria was not ostensibly Palestrina's pupil, but Palestrina had the main influence upon his art, and alike personally and artistically the relations of the two were close. The work begun by Christobal Morales and perfected by Palestrina left no stumbling blocks in Victoria's path, and he was able from the outset to express the purity of his ideals of religious music without having to sift the good from the bad in that Flemish tradition which had entangled Palestrina's path while it enlarged his style. From Victoria's first publication in 1572 to his last requiem there is practically no change of style, all being pure church music of unswerving loftiness and showing no inequality except in concentration of thought. Like his countryman and predecessor Morales. he devoted himself entirely to sacred music; yet he differs from Morales, perhaps more than can be accounted for by his later date, in that his devotional spirit is impulsive rather than ascetic. He strikes the note of aspiration rather than that of renunciation.

Victoria's work is the crown of Spanish music: music which has been regarded as not constituting a special school, since it absorbed itself so thoroughly in the Rome of Palestrina. In any extensive anthology of liturgical polyphony, such as the *Musica* Divina of Karl Proske, his work stands out as impressively as Palestrina's and Orlando Lasso's; and the style, in spite of a resemblance to Palestrina which amounts to imitation. is as individual as only a successful imitator of Palestrina can be. That is to say, Victoria's individuality is strong enough to assert itself by the very act of following Palestrina's path. When he is below his best his style does not become crabbed or harsh, but overfacile and thin, though never failing in euphony. If he seldom displays an elaborate technique it is not because he conceals or lacks it. His mastery is unfailing, but his methods are those of direct emotional effect; and the intellectual qualities that strengthen and deepen this emotion are themselves innate and not sought out. The emotion is reasonable and lofty, not because he has trained himself to think correctly, but because he does not know that anyone can think otherwise. (See also MASS; MOTET; ORATORIO.)

(D. F. T.; X.)

VICTORIA, a state of the commonwealth of Australia occupying a triangular area of 87,884 sq.mi. in the extreme southeast of the continent. After Tasmania it is the smallest Australian state, with an area only 2.96% of that of the commonwealth.

Victoria is marked off from New South Wales by the river Murray from near its source to the South Australian border and by a straight boundary line from Forest Hill near the Murray source east-southeast to Cape Howe. On the west the border with South Australia extends from Discovery bay about 2jo mi. N.. running about 2 mi. W. of the meridian 141° E. which had been designated the boundary but was not correctly located when the boundary was marked in 1847. The coast line, about 680 mi. in length, extends in a generally east-west direction from 141° E. to 150° E. The most northerly corner of the state is at latitude 34° S. and the most southerly, Wilson's promontory. which is also the most southerly point of the Australian mainland, extends to 39° 8' S.

PHYSIOGRAPHY

For the main divisions of the state see map in Fig. r.

Central Highlands.—Official maps of Victoria still apply the name "Great Dividing range" to the main water-parting dividing north-flowing from south-flowing rivers and often represent it in a way suggesting a sharp-crested ridge. The highlands of Victoria in no way justify the term "range" and in parts of them the water-parting traverses level upland surfaces. The eastern highlands may be taken as extending from the border of New South Wales to a north-south line through hlelbourne. In this extensive area considerable diversity of structure and rock types occurs and distinctive subregions may be distinguished. The eastern highlands as a whole form part of the main eastern highland belt of Australia and are a complex of blocks bounded by intersecting fractures and flexures. The eastern section includes massive plateau areas from which peaks such as Mounts Cobboras. Feathertop. Hotham, Bogong, Fainter and Cope rise to over 6,000 ft. as blunted elevations. The area is strongly dissected and many of the valleys cut as much as 3.000 ft. below the intervening plateau surfaces, locally known as "high plains." The Bogong high plains, an extensive plateau at 5,500 ft between Mounts Bogong and Hotham. are the site of an extensive construction program for storages for the Kiewa hydroelectric scheme. Somewhat to the west Mounts Buffalo, Hoaitt and Buller exceed 5,500 ft. Still farther west the highlands become lower and narrower. The highest point within 50 mi. of Melbourne is Mt. Donna Buang (4,077 ft.). The southwestern corner of the eastern highlands includes the Dandenong ranges. The maximum elevation is only 2,078 ft. but since these hills lie less than 20 mi. from the centre of Melbourne and are, for census purposes, actually included in the metropolitan area. they provide a recreation area of great local importance. North of Melbourne, along the junction between the eastern and western highlands, the main route to the north and northeast crosses through the Kilmore gap at only 1,145 ft. No railways cross the highlands east of this line.

Western Highlands.—These are of generally lower elevation. only a few points attaining 3,000 ft. Toward the western end are

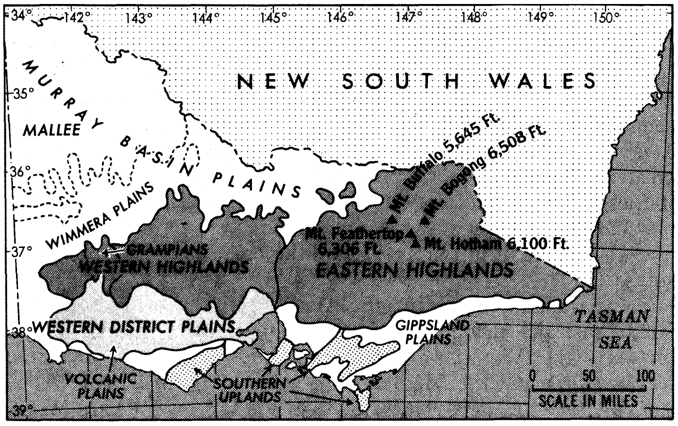

FIG. I. —VICTORIA: PHYSIOGRAPHIC DIVISIONS

the Grampians, prominent ridges of Upper Palaeozoic sandstone (Mt. William 3.828 ft.). Between these and the Kilmore gap the highlands form a rough upland zone from which rise peaks, including domes of Palaeozoic igneous rocks, such as Mounts Lar Ne Gerin. Buangor and Macedon, all of which exceed 3,000 ft., ridges of older Palaeozoic sediments and Tertiary volcanic cones. Within this zone occurred much of Victoria's gold mining and the relief is such that only in a few places was serious difficulty encountered in developing routes in and through the area.

Southern *Uplands.*—In the south lies a discontinuous series of higher areas reaching maximum heights of about 2,000 ft. The Otway ranges and the South Gippsland hills consist of Jurassic sandstones and mudstones overlain by Tertiary sands, the ranges being due to faulting and flexuring along lines with a generally northeast trend. With this group may be included the Mornington peninsula between Port Phillip and Westernport bays and Wilson's promontory, a granitic mass rising to 2,475 ft.

Southern Plains.—Between the central highlands and the southern uplands extends east-west a series of lowlands for which J. W. Gregory popularized the graphic term "great valley." While this term is useful in emphasizing the fact that one may move east or west from Port Phillip bay without encountering obstruction, the term "valley" strictly applies only to the east Gippsland plains where the Latrobe valley lies between the central and southern highlands. This section is reached from the low land at the head of Westernport bay across a low divide (500 ft.). To the west of Port Phillip bay extend the Western district plains. of which large tracts are covered by lava flows of late Tertiary to recent age. Around the western end of the highlands these plains join with the plains of the Murray basin.

Murray Basin Plains.—These include the plains of the Wimmera, Mallee and Northern districts. The map in Fig. 3 shows the boundaries of these districts as adopted for many official purposes, but these boundaries do not follow precisely the limit of the characteristic Mallee type of soil (alkaline sandy loam) and vegetation (see below). The surface is undulating and bears sand in east-west ridges or irregular dunes. The Wimmera and Northern district plains are both built up of the flood-plains of streams flowing to the Murray. They are flat except where occasional residuals of bedrock rise through the alluvium.

Climate.—Since Victoria extends through only 5° of latitude the differences in climate between districts depend principally on relief and distance from the sea. The highlands form a considerable area cooler and wetter than the rest of the state and only in the higher parts of the eastern highlands is winter snow regularly received. The highlands also form a climatic divide between the coastal zone and the interior plains, and the rainfall decreases toward the interior. It is also less reliable and, at irregular and unpredictable intervals: years with rainfall far below average have occurred. The droughts of 1902, 1914, 1927, 1938 and 1945 were among the most disastrous. Within the higher rainfall areas of the south occur two dry strips—one across the Western district to Port Phillip bay and the other around Sale in Gippsland. The seasonal distribution of rainfall reflects the position of Victoria at the southeastern corner of the continent. Toward the west there is a clear winter maximum of rainfall. This becomes less marked toward the east and at Melbourne the monthly rainfall figures are nearly uniform. Since, however. the winter rainfall is more frequent and gentle and the summer rainfall more intense and erratic. with falls on about half as many days as in winter, and since the higher summer temperatures reduce the effectiveness of the rainfall, it can be said that Melbourne has a dry summer. Toward the east there is a less distinct dry season. Average annual temperatures fall below 45° F. only on the higher parts of the eastern highlands and exceed 60° F. only in the northern parts of the Mallee and Northern districts. Except in the highlands the mean temperatures of the winter months show general uniformity throughout the state (July av.: Melbourne, 48.8° F.; Mildura 49.5° F.) though daily range and frost risk are greater in the interior. The higher annual means of the north are due to the higher temperature of the summer months. The hot spells characteristic of the Victorian summer are more severe and more prolonged in the interior. During a typical hot spell in the south the temperature reached on several successive days will rise to values nearing or exceeding 100° F. (absolute maximum, Melbourne: 114° F.). The spell is ended by the arrival of a southerly change. The effect of such a change may stop at the divide or it may extend over the whole state.

Water Supply.—Compared with the other mainland states Victoria is fortunate in the small proportion of its area which receives deficient rainfall. Nevertheless there are considerable areas in which settlement depends on the provision of water for domestic supply and for cattle and where intensive agricultural development is possible only with irrigation. The main source of water for irrigation is the Murray system. This is by far the largest river system in Australia, but the main stream and many of its major tributaries show great variations of flow from season to season and from year to year. Thus in the drought of 1914 the discharge of the river Goulburn fell to one-quarter of the average and three years later it rose to three times the average value. Obviously no large-scale development in. the use of this water could succeed without the provision of extensive storage. The Irrigation act of 1886 vested in the crown the right to the use of all water in any stream, lake or swamp, provided for the extinction of riparian rights which might prevent this and authorized the construction of national works. Even these revolutionary provisions proved inadequate since expansion under local irrigation trusts tended to be unregulated and outstripped the provision of storage. By 1905 it became necessary to abolish all but one of the trusts and to vest the state-wide control of irrigation in the State Rivers and Water Supply commission. Since the Murray itself forms the boundary between two states and then flows into a third, agreement on the use of its waters was reached only after prolonged negotiation. In 191j legislation by the interested states and the commonwealth incorporated an agreement about Murray waters and created a commission to give it effect. Subject to a specified delivery to South Australia. Victoria controls its own tributaries and shares equally

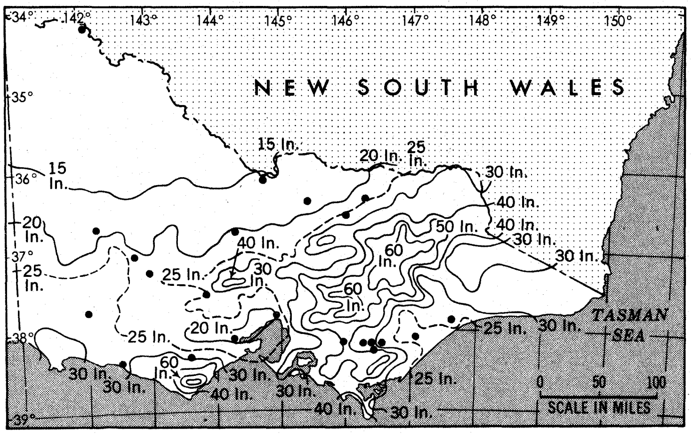

FIG. 2.— AVERAGE ANNUAL RAINFALL IN VICTORIA. PRINCIPAL CITIES ARE SHOWN WITH LARGE DOTS; FOR IDENTIFICATION SEE FIG. 3

with New South Wales the flow of the Murray. In 195j the total storage available to Victoria was 5,500,000 ac.-ft. (1 ac.-ft. = 272,-250 gal.j. The largest single contribution to this total is that of the Big Eildon storage (2,750,000 ac.-ft., completed 195j; cf. 310,000 ac.-ft. of the earlier dam on the same site). At the Goulburn weir 1jo mi. downstream from the Eildon reservoir water is diverted, the main channel to the northeast supplying irrigation districts around the town of Shepparton and the main western channel supplying other irrigation and filling the Waranga reservoir (330,000 ac.-ft.). This serves irrigation districts in the north of the state and contributes, through a long western channel, to the extensive Wimmera-Mallee domestic and stock supply. This system, which fills farmers' storages and provides town supply over an area of 11,000 sq.mi., also receives water from storages in the Grampians to which was added in 1953 water diverted from the south-flowing river Glenelg by the Rocklands reservoir (270,000 ac.-ft.). This is the first diversion of a coastal river for inland supply to be completed in Australia. On the river Murray itself the works constructed under the River Murray agreement include the Hume reservoir at Albury which. under an amendment to the agreement in 1954, is to be enlarged to 2,500,000 ac.-ft., and a series of weirs along the river (Yarrawonga, Torrumbarry, Euston, Mildura, Wentworth) which increase storage and permit diversion to irrigation districts along the river. Enormous works in progress in 19j6 in the Snowy mountains of New South Wales were planned to divert to the Murray system water from the headwaters of the Snowy river. While irrigation in the south of Victoria is obviously less widely needed than in the interior, the dry area of Gippsland mentioned above is irrigated with water from the Glenmaggie reservoir on the Macallister river. Town supply for Melbourne and a few of the other cities is still controlled separately from the state system. Storages on tributaries of the river Yarra supply Melbourne. Storage construction on its headwaters undertaken after World War II was designed to treble the capacity of the reservoirs and maintain for an increasing population the advantages of an unusually good metropolitan supply from strictly controlled catchments.

Flora and Fauna. — Both the central highlands and the southern uplands were originally mostly forested. The plains on either side of the central highlands included considerable areas of native grassland. The Mallee district includes wide tracts of scrub composed of small eucalypts to whose characteristic habit of growth the name mallee originally referred. It also contains considerable tracts of heathland and, in the area subject to flooding by the river Murray, red gum occurs as a fringing forest.

The forests proper lie chiefly on the highlands. On the high plains (see above) trees are sparse or absent. At lower elevations snow gums occur. Between 3,500 ft. and 4,500 ft. alpine ash (*Eucalyptus* gigantea) extends as pure forest. At still lower elevations on those parts of the southern slopes of the main highlands and in the southern uplands where the rainfall exceeds 40 in. a year. *Eucalyptus regnans* forms extensive stands of pure forest. These mountain forests are exceeded in area by the drier forest (25 in.–40 in. a year) which extends across the state and includes various associations of eucalypts. notably of species covered by the popular names stringybark. messmate. peppermint, box and gum. These forests are best developed at elevations of 500 ft. to 2.000 ft. above sea level and! with the mountain forests; they form the principal sources of commercial timber. On the lower rainfall areas on the inland foothills of the highlands and the northern plains the forests tend to be open and the trees smaller. Eucalypts of various species (ironbarks and boxes) are the principal trees. The control of forests was made the responsibility of a state department in 1907 and in 1919 the department was reconstituted as the Forests commission. Increasing private investment in the establishment of softwood plantations, principally of *Pinus radiata,* had led to the establishment of more than 20,000 ac. by 1956. Sawn hardwood remains the principal product.

Of the two mammals found only in Victoria, Leadbeater's possum may be now extinct and the smoky mouse is very rare. The smallest carnivorous marsupial in Victoria is the fat-tailed pouched mouse, found in the open plains, and the largest is the tiger cat, re-established recently in the east and south. Many once-common small marsupials have become extinct and the dark rat-kangaroo is now only found locally, but the gray kangaroo is common in the open forest of the coastal belt and a variety of it is found in the Mallee. The largest gliding possum is the greater glider; there are echidnas. platypuses, bandicoots, one species of wombat, the gray-headed fruit bat (a visitor). other bats, rats and mice. Deer were introduced in 1870–73, the fox and hare in 1870, the rabbit in 1840. Around the coast are whales, dolphins and seals.

The peculiar avifauna of the Mallee country of Victoria and South Australia includes the eastern mallee fowl (*Leipoa* ocellutu *rosinae*), the Victorian coachwhip bird (Psophodes *olivaceus* seryncgeourij and the Victoria emu wren (*Stipiturus malachurus mallee*). (A. A. W.)

HISTORY

The Victorian community was founded by groups of pastoral pioneers who crossed Bass strait from Launceston in the 1830s in search of fertile grazing land. The occupation of the area was made in defiance of a British government edict forbidding settlement in the territory, which was then part of the colony of New South Wales.

In Nov. 1834 the Henty brothers landed stock and stores at Portland, on the south coast. and established the first settlement. In 1835, John Batman, backed by a Launceston syndicate. landed at Port Phillip. Batman's venture led the way to the pastoral occupation of Victoria. In the same year John Pascoe Fawkner established a small colony of settlers on the banks of the river Yarra. From Batman's colony grew Victoria's capital city, Melbourne.

The Port Phillip settlement developed rapidly. In 1836 the British government authorized the settlers, but gave them no title to their land. In Dec. 1836 the New South Wales governor sent Capt. William Lonsdale to act as resident magistrate in the new settlement.

Before its pastoral settlement in the 1830s Victoria had been sketchily explored by sea and land and unsuccessfully occupied by several groups. Capt. James Cook sighted the coast at Cape Everard on April 19, 1770, shortly before his landing at Botany bay. In Dec. 1797 George Bass, naval surgeon, sailed a whaleboat south from Botany bay and explored Western Port. In 1798, accompanied by Matthew Flinders, he circumnavigated Van Diemen's Land (now Tasmania), and established its identity as a separate island. In 1802, Lieut. John Murray sailed into Port Phillip.

Two abortive attempts were made at founding convict settlements in the area in the early years of the 19th century. The first, in 1803, near Sorrento, on Port Phillip, lasted seven months. The second was in 1826, at Settlement point on the coast of Western Port. It was abandoned after two years.

The extent and nature of Victoria's hinterland was revealed in a series of probing expeditions in the 1820s and 1830s. In 1824, Hamilton Hume and W. H. Hovell led a party south from Lake George to reach the south coast on the western arm of Port Phillip. In 1829 Charles Sturt explored the full reach of the Murray river. In 1836 an expedition led by hlaj. Thomas L. Mitchell opened up a large area of western and central Victoria. and between 1834 and 1840 a number of parties penetrated the eastern portion of the territory, the mountainous Gippsland district.

During the 1840s and 1850s Victoria became a prosperous pastoral community. The squatters extended their grazing runs to the boundaries of the territory. The population rose rapidly as British migrants arrived and more settlers crossed from Van Diemen's Land or drove their flocks and herds south from New South Wales. By 1850 Victoria had 76,000 people and 6,000,000 sheep. Melbourne (pop. 23,000), Geelong and Portland were its main urban centres.

Dissatisfied with their limited representation on the legislative council of New South Wales. the Port Phillip pastoralists agitated for separation. In 1851 Victoria became a separate colony. with an executive council appointed by the crown and a legislative council, partly elected and partly nominated, effectively dominated by conservative landed interests.

Victoria's establishment as a separate colony coincided with the discovery of gold. An early find at Warrandyte, 16 mi. from Melbourne, led to a dramatic rush. By the end of 1851 half the men of the colony were working on the gold fields. In ten years, more than £105,000,000 worth of gold was won from these fields. For five years gold-seeking migrants poured into the colony. Over 200,000 came from Britain and 25,000 from China. By 1860 the population of Victoria had passed the 500,000 mark.

The gold rushes produced a spectacular, but short-lived, boom. By 1854 Melbourne was suffering from a severe depression and the treasury faced a deficit of £1,000,000 sterling. Financial stringency aggravated discontent on the gold fields. The miners strongly resented the fee demanded for a mining licence and the brutal fashion in which it was collected by the gold fields' police. This discontent culminated in a minor rebellion at Eureka, near Ballarat. Mining licences were burned and a republican flag hoisted. On Sunday, Dec. 3, 1854, police and troopers stormed the rebels' stockade. In a brief battle the miners were overwhelmed. Thirty miners and five soldiers were killed. But the incident hastened the redress of the miners' grievances and the movement for democratic reforms in the colony.

Victoria, along with New South Wales, attained self-government in 18jj. The new constitution set up two houses of parliament—a legislative council of 34 members, elected on a limited property franchise. and a legislative assembly, elected on a wider property and income franchise. The assembly was entrusted with exclusive powers of initiating all money bills. In 1856 an act providing for secret ballots was passed. In 1857 manhood suffrage was introduced for elections to the legislative assembly, and the property qualifications for membership of the assembly were reduced. The payment of members of the legislative assembly was first introduced in 1870.

The legislative council remained the stronghold of the rich, conservative landowners; throughout the 19th century it was a major obstacle to radical demands for effective land reform. Until the late 1850s Victoria depended on imports of flour from South Australia, California and Chile. During the 1860s the grazing leases of the pastoralists were thrown open to agriculture. In keeping with a policy designed to "unlock" the land, a series of land acts was passed to encourage the development of small freeholds. These opened up the Mallee and Wimmera to the small wheat farmers. and by the end of the century Victoria was Australia's largest wheat producer. But in other districts the wealthy pastoralists managed by guile and financial manipulation to evade the acts. And very many of them acquired freeholds to large estates at low prices, especially in the fertile Western district.

The period between 1860 and 1890 was one of general prosperity and economic progress. Significant industrial development occurred, partly under the stimulus of high protective tariffs. Between 1855 and 1880 the number of factory hands employed in Melbourne rose from 4,000 to 40,000. During the 1860s and 1870s the population of the state steadily increased. There was a considerable expansion in public works. By 188;. 20,000 ac. of land had been irrigated, mostly in wheat areas. And between 1870 and 1890, 3,000 mi. of railways were laid down.

Responsible government, mounting industrialization, growing prosperity and population and the rapid expansion of trade unionism produced a period of economic, social and political reform, despite the political dominance of the legislative council. The growing conflict between the assembly and the council over questions affecting protection. taxation, land policy and the reform of the constitution reached a climax. Although the upper house retained its basic powers, a number of significant reforms were secured.

In 1871 the property qualification for the council was reduced and the tenure of seats shortened. In 1888 further electoral reforms for both houses were passed. With a few exceptions, single-member constituencies became the rule for the assembly. In 1899 plural voting for the assembly was abolished and in 1900 postal voting introduced. Significant progress was also made in the field of social and industrial reform. An act of 1872 introduced a system of free, compulsory and secular primary education. The successful fight of the Melbourne stonemasons for the eight-hour day in 1856 heralded a series of industrial reforms, culminating in the factory acts of 189j–96, which laid down standards for hours and conditions in shops and factories, and set up tribunals to fix minimum wages.

By the end of the 1880s the state's growing prosperity had expanded into a speculative boom. The crash came in 1891 and was considerably aggravated by a sharp fall in the prices of Victoria's main exports, wool and wheat. In 1891–92 21 finance societies and land banks collapsed and in 1893 all but 3 of the trading banks closed their doors. Most resumed payment, but three were liquidated. The depression which followed was marked by high levels of unemployment and considerable industrial unrest. It took almost 20 years to work itself out.

In 2891 the first Australian national convention met in Sydney to consider proposals for the creation of an Australian federation (see also AUSTRALIA). Ten years later, on May 9, 1901, the first commonwealth parliament mas opened in Melbourne. The federal parliament continued to sit in Melbourne till 1927, when it moved to Canberra, the new commonwealth capital.

Following federation there was an immediate need to rationalize the constitutional structure of the states. In Victoria, an act of 1903 provided for a reduction in the number of members of both houses. The franchise for the legislative council was further liberalized and the property qualifications for membership extended. Adult suffrage was introduced in 1908, when women were given full voting rights for the assembly and equal voting rights with men for the council. In 1923 women candidates were admitted for election to both houses. Preferential voting was introduced for the assembly in 1923 and for the council ten years later. Voting was made compulsory for the assembly in 1926 and for the council in 193j. The upper house was gradually reformed over the years until full adult suffrage was finally introduced in 1950.

Political developments in Victoria in the first 50 years after federation were marked by the rise of the Labour and Country parties. leading to the creation of a three-party pattern in place of the former Liberal-Conservative two-party system. The existence of three political parties partly accounts for the instability of Victorian government. Between 1901 and 1950 there were 27 different ministries. Many of these were composite governments, or ministries based on minority support. Labour first won office, as a minority government, under G. A. Elmslie in 1913. It formed minority governments on five subsequent occasions. and only succeeded in winning effective political power in 1952, when it gained an electoral majority under the leadership of John Cain.

In 1914 the Victorian Farmers' union was founded. Three years later four of its members were elected to parliament and in 1926 it formally changed its name to the United Country party. From 193j the Country party. led by Albert Dunstan, governed for eight years with the support of the Labour party, and again from 1943 to 1945.

The Country party's influential role in Victorian politics is partly explained by the unequal size of rural and urban electoral districts. The original design of the legislative assembly provided for electoral equality, but subsequent redistributions considerably reduced the value of an urban vote. Between 1924 and 1945 the unequal size of electorates meant each rural vote mas worth more than twice an urban vote. In 1953–54 an electoral redistribution, planned by a section of the Liberal party and carried through by a Labour government. restored comparative parity between rural and urban electorates.

Successive Victorian governments in the first half of the 20th century were mainly concerned with the problems of administering those functions retained by the state under the distribution of powers involved in the creation of a federal system. These functions included the administration of the police force and of justice, education. health services. agriculture (including marketing boards), transport and the utility and development services associated with electricity, irrigation and water supply, ports and harbours. sewerage, forestry and country roads. A distinctive feature of this period was the development and application of a policy of state socialism, begun in 1902 by a Liberal government, and adopted and extended by all subsequent governments, regardless of party. Government departments or agencies have been vested with responsibility for the regulation of primary production. industry and commerce. labour, professional and occupational standards, education. social welfare and public health. The most significant developments in public enterprise were associated with the conservation and development of community resources.

The development of Victoria during this period was marked by two main trends. First. an increasing proportion of the population became urbanized. At the beginning of the century only 58 out of every 100 persons in Victoria lived in urban areas. By 1947 the percentage had risen to 70, of which 60 lived in or around the capital city. Melbourne. Second. Victoria became increasingly industrialized. In just under jo years the proportion of the total work force of the state engaged in primary industry dropped from 30% to 14%, while that engaged in secondary industry rose from 27% to 37%, and in tertiary industry from 43% to 49%. In 1901 Victoria had 66,000 factory workers. In 1951 there were five times as many, and they produced more wealth than wool. agriculture, mining and forestry combined. (C. L. Bs.)

POPULATION

At the census of June 1954 the population of Victoria was 2,452,341 (males 1,231,099, females 1,221,242), forming 27.29% of the population of the commonwealth. The average density, 27.90 persons per sq.mi., is higher than that of any other state in Australia. Since first settlement the people of Victoria have been nearly all of British stock. Australian-born persons formed more than half the population by the 1870s and more than 90% by World War II; then a vigorous immigration policy led to a rapid increase in the numbers born elsewhere. Between the censuses of 1947 and 1954 the number of overseas-born more than doubled, the principal increases in such numbers being Italians (34,124), English (33,485), Germans (17,465) and Polish (17,396). These additions reduced the Australian-born part of the population to 85% by mid-1954. Of the other 15% born outside Australia, about half were born in Great Britain and many were residents of long standing. The new feature of the postwar migration was the great increase in numbers from continental Europe. By mid-1954 this had brought the European-born proportion to 6.6% of the Victorian population and the Victorian community faced, for the first time in its history, the problem of assimilating a rapidly increasing population element which was not dominantly British.

The outstanding feature of the distribution of Victoria's people is the concentration in the metropolitan area. At the 1954 census the population of metropolitan Melbourne, defined for census purposes as an area of 27; sq.mi. embracing the city and its suburbs, was 1,524,111; *i.e.*, 62.15% of the population of Victoria. The city itself has a population of 93,172. Each phase in Victoria's development has tended to increase Melbourne's lead. Pastoral occupation

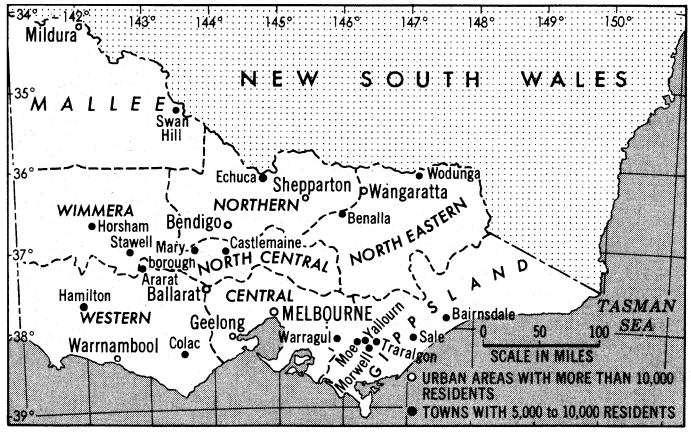

FIG. 3.—STATISTICAL DISTRICTS AND PRINCIPAL CITIES OF VICTORIA

(183j on) rapidly produced a wide sparse spread and tended to support towns at the ports rather than in the interior. Of these Melbourne was best placed to serve, and profit by. the pastoral expansion. It was the inevitable choice as capital. The discovery of gold in 1851 led to a rapid influx of people. largely through the colony's best port, and the road. and later the rail, pattern was focused on Port Phillip. With the decline of gold began the rise of manufactures, aided to an extent which cannot be precisely determined by Victoria's tax policy and protective tarifi. No coal field offered any inducement to establish them away from the labour. the market and the port which Melbourne offered. % further factor favouring metropolitan concentration was a tradition of centralized administration. Partly because of the smallness of provincial populations, many activities elsewhere carried on by private enterprise or by local government have in Victoria fallen to the central government. The financial and administrative strength of hlelbourne may also have been increased by its position as temporary federal capital (1901–27).

Of the 37.85% of the population not resident in Melbourne in 1954 slightly more than half were classed as urban. Only three cities exceeded 15,000 in population and the total number in all three was just over one-tenth of Melbourne's. The largest. Geelong (1954: city 20,034; urban area 72,595), as a port of Port Phillip bay shared some of the advantages of position noted for Melbourne but was too close to Melbourne to profit by them when the railway (1857) permitted the use of Melbourne's port and business facilities rather than encouraged the development of its,own. Its present growth is aided by the availability of port facilities and industrial sites. Ballarat (city 39,945; urban area 48,050) and Bendigo (city 28.726; urban area 36,918) were founded by the discovery of gold and in 1954 contained as many people as in the 1870s and 1880s. Four other cities exceeded 10,000 in 1954. Mildura and Shepparton are centres of irrigation districts. The other two are Warrnambool. long established as an important centre in the Western district, and Rangaratta, a district centre and the see of an Anglican bishop, in the northeast which passed 10,000 between the censuses of 1947 and 1954 with the assistance of a rayon-spinning factory established there. In the postwar years government encouragement was offered to the establishment of industries away from Melbourne and some success in decentralizing industry was claimed. The most significant change in Victoria's urban pattern is in the Latrobe valley. There, because of development based on brown coal. town populations greatly increased.

Education. — Attendance at school is compulsory for all children between the ages of 6 and 14. Of the 382,000 children attending in 1952, 73% were in government schools. Other schools, without state aid. included the system under the Roman Catholic Church (19.3% of pupils! and other nongovernment schools, the majority under the sponsorship of Protestant churches, with 7.7%

of all pupils but a much higher percentage of the secondary pupils.

Government and Administration. — The Victorian legislative council consists of 34 members and the legislative assembly of 65 members. The state is represented in the federal parliament by 10 senators and sends 33 members to the house of representatives.

ECONOMICS

Agriculture. — At the census of 1954 the working population of Victoria mas just over 1,000,000. Of these 111,300 were engaged in agriculture, grazing and dairying. This may be contrasted with the number engaged in manufacturing—341,400. These numbers reflect not only the great expansion of secondary industry but also the extent to which farming in Victoria is a mechanized undertaking with high output per man. The subdivision of this 111,300 between agriculture (52,690), grazing (23,060) and dairying (35,-550) follows a traditional distinction very important in Victorian social history, but tends to obscure the fact that nearly all cereal farms carry sheep and on some the flock returns a larger income than the crops. In 1953–54 there were 4,400,000 ac. under crop and 2,200,000 ac. in fallow, making a total cultivated area of 6,600,-000 ac.

Wheat has always been the principal crop and the area sown to it first passed 1,000,000 ac. in the season 1883–84. After that the area fluctuated. reaching a maximum of 4,600,000 ac. in 1930–31 when an unsuccessful attempt was made to counter economic depression by expansion in production. By the end of the 19th century the practice of fallowing was universal, the use of artificial fertilizers mas established and the breeding of wheat varieties suited to local conditions was in progress. All these features of the industry are still evident. In 1954–5j, 2,390,000 ac. were sown to locally developed wheat varieties. 78,000 tons of superphosphate were used on the crop and most of the fallow was in the wheat-growing districts. The yield of 20.3 bu. per acre mas very good but not exceptional. Generalizations about yield are made difficult by extreme fluctuations from year to year. Average yields for the whole state have been as low as 1.3 bu. per acre in the drought of 1902–03, and as recently as 1944–45 drought reduced the average to 1.63 bu. per acre. There is, however, no doubt about the general increase in yield. A more recent advance has been an increase in lea farming. The introduction of a year or two of grazing on clover benefits the soil and the yield of the crop which follows and permits an increase in the number of sheep carried.

Of the wheatlands of Victoria 95% lie in the Wimmera, Mallee and Northern districts. These three divisions contain between them over 85% of the cultivated land of the state and wheat occupies most of the cropped land in each. Most of the wheat is produced within a triangle bounded on the west by a line from Mildura to Horsham, on the north by the Murray and on the south by a line from about Horsham to Corowa. In the Northern district the expansion of irrigation has led to the subdivision of some holdings formerly devoted to wheat. The wheat acreage in 1954–55 was divided between districts thus: Mallee 46% of Victorian acreage, Wimmera 32% and Northern 17.5%; but the higher yields of the Wimmera enable this smaller area to produce almost the same contribution to the total crop, nearly 40%. In the ten years following the drought of 1944–45 the total Victorian wheat crop exceeded 50,000,000 bu. in four seasons and 45,000,000 bu. in five others. This decade included an exceptional run of good seasons and the crop of 3,498,000 bu. in 1944–45 stands as a reminder that, despite all improvements, Australian wheat farming still' depends on the seasons. The rail pattern of the northern wheat areas was designed to open them to cultivation and a series of almost parallel lines extended across them in successive advances between 1890 and 1925. Bulk handling of wheat began in 1938–39 and by 1955 just over 200 railway stations in the wheat belt had structures (153 of them concrete silos) for receiving and loading wheat. For the export crop the terminal silos and other storage are at Geelong.

Other Crops. — The areas sown to oats show less concentration in the three northwestern districts than the wheat areas do, though the largest acreages are in these districts. The total area varies from year to year and in the decade after the end of World War II ranged between 454,000 ac. and 676,500 ac. Hay has always ranked among the principal arable crops of Victoria. Because of the unsuitability of native grasses for hay the practice early developed of sowing cereal crops and cutting them as hay. In the year of greatest production (191j–16) almost 1,000,000 ac. of oats and one-third of this area of wheat were cut for hay. With increase in the use of auperphosphate as top dressing came changes in the species composing pastures and the possibility of cutting meadow hay. Oaten hay fell to about 220.000 ac. with smaller areas of other cereals and lucerne. and meadow hay rose (1953–54: 476,600 ac.). The two remaining principal arable crops are barley (1954–55: 280,000 ac.) and potatoes (45,000 ac.). Potatoes are grown mainly on the volcanic soils of the Central district (45% of total crop), North Central (17%) and Western (20%). Victoria is the chief potato-producing state, though the yields per acre are not as high as those of Tasmania. Victorian maize production has never been comparable with that of the other eastern states and the acreage (about 5,000 ac.) in eastern Gippsland is only about 3% of the Australian maize acreage. Grass grown for seed by specialized suppliers occupies an area which in 1954–5j reached 11,700 ac. Other minor crops are tobacco and flax. Fruit growing is widely distributed and its diversity gives an indication of the range of Victorian climates. In the Murray valley, particularly toward the west, grapes, principally for drying, and oranges are important. The irrigation areas of the Goulburn valley produce peaches and apricots. Pears are grown both there and east of Melbourne. East and southeast of Melbourne and at Harcourt, south of Bendigo, apples are grown. For the whole state vineyards occupy about 46,-000 ac. and orchards nearly 68,000 ac. (apples. 20.000; peaches 14,000; pears 12,000). Vegetables other than potatoes accounted for 36,000 ac. in 1954–5j.

Irrigation. — Reference has been made above to water supply and to fruit growing under irrigation. Considerably greater areas are occupied by other forms of irrigated production but, since the intensity of watering differs in different districts, acreage alone provides an incomplete comparison. In 1953–54 the irrigated area was 821,000 ac., of which 81.7% was in pasture or fodder crops compared with 5.4% in vineyards and 4.4% in orchards. In value, the aggregate production from the livestock carried on the much greater area of irrigated farm exceeds, though by a much smaller margin. the production from the horticultural holdings; *e.g.* (1952–53) livestock total £19,600,000, including milk and milk products (£9,100,000), wool, lamb and mutton (F5,800,000). Production from orchards and vineyards was valued at £9,200,000; including dried vine fruits (£5,600,000), canning fruits (£1,900,000). Vegetables contributed £3,900,000.

Pastoral Industries. — Sheep remain the principal form of livestock. In 1955 Victoria's total number exceeded 22,000,000 for the first time. The number first reached 20,000,000 in 1941 and was sharply reduced by the drought of 1944–45. The rebuilding of the flocks after this was encouraged by high wool prices and by 1951 the total again passed 20,000,000. The Western district with 32.7% (1955) continues in its traditional role as the principal Victorian producer of fine-woolled sheep. The Wimmera (15.2% of total sheep) and Northern (15.5%) have similar sheep populations but more attention is given in the Wimmera to fine-woolled breeds and in the Northern district a much higher proportion of ewes are mated to rams of British breeds for the production of fat lambs. The three districts named account for more than 63% of Victoria's sheep. The smallest district totals are found in the North Eastern (7.8%), Gippsland (5.8%) and Mallee (5.7%). In much of the two former districts rugged topography or excessive rainfall exclude sheep raising. The lower number in the Mallee reflects the larger size and lower carrying capacity of the Mallee farms. In wool production Victoria stands second to New South Wales which usually produces more than twice as much, but in lamb and mutton production Victoria is the leading state. The total number of cattle in Victoria in 1955 was 2,456,000; only in the first year of the previous decade had it been below 2,000,000. In the second half of this period the proportion of beei cattle rose somewhat to just over one-third of the total number. If the districts are arranged in order according to the number of beef and dairy cattle, the first four districts in each class are found to aggregate more than 80% of the state total, three districts figuring in the first four of both lists. Dairy cattle (1955). 1.613 000; Gippsland 25.6%, Western 23 8%, Central 18 1% arid Northern 15.7%. Beef cattle. 843,000; Western 25.9%, North Eastern 21 8%, Gippsland 18.5% and Central 15.1%. Dairying in the irrigation areas of the Northern district contrasts with the importance of beef cattle in the adjacent North Eastern district where many of the cattle. like some of those in Gippsland. spend part of the year on upland grazings. In dairying Victoria is the leading state. producing about 40% of Australia's milk and a somewhat higher proportion of product manufactured from milk. Progress in the pastoral industries is indicated by the fact that in 1955 more than 8.200.000 ac. were under sown pasture and nearly six times as much superphosphate was used on pasture as on the wheat crop.

Mining and **Industries.**—The gron·th oi population in Victoria and the establishment oi several of its more important provincial cities was largely the result of the discovery of gold. After 1851 more than 75,000,000 oz. of gold (£333,000,000) were won but production declined (1954: 52,665 oz.; £820.179) and the most valuable mineral product of the state became brown coal. of which over 9,000,000 tons were produced in 1954. Even black coal. with which the state is poorly endowed. exceeded in value the gold produced. After gold come, in order of value. limestone (1954: 694,684 tons; £464.833) and clay. The black coal is mined in Gippsland where the state mines at Wonthaggi produce small quantities (141,000 tons in 1954). The main seam has an average thickness of about 4 it. and the area is extensively faulted. Black coal is largely used by Victorian government railways. The great. and expanding. mineral resource of Victoria is brown coal. The most extensive deposits lie in the Latrobe valley in Gippsland. There are smaller basins west of Melbourne. Reserves are enormous. From Yallourn eastward the belt is practically continuous for 40 mi. and ior much of the distance it is irom 4 to 10 mi. wide. Boring has revealed, at one point. a seam 757 ft. thick lying only 89 ft. below the surface. The proved reserves suitable for open-cut working exceed 20,000,000,000 tons. In extent. thickness and shallowness of overburden the deposits are admirably suited to large-scale working by specialized machinery for cutting and handling. Thirty years of mining at Yallourn have produced an open cut already about $1\frac{3}{4}$ sq.mi. in area and about 200 ft. deep.

Manufacturing in Victoria greatly increased and diversified during and after R'orld War II. In 1938–39 an average of 201.800 persons were engaged in manufactures in 9,250 iactories. By 1953–54 the numbers had increased to 331,300 persons in 15,533 factories. Roughly three times as many Yictorians work in factories as on iarms and in mines and forests. In the following paragraphs the numbers cited are taken from the census of 1954 and give the number of persons, including working proprietors. engaged in the industrial groups mentioned. Certain groups require little comment. The processing of local raw materials — bricks. cement. timber, flour, butter and soap manuiacture — is to be expected. A somenhat higher degree of industrial development is implied by the existence of woollen mills. with Geelong as an important centre. supplying about half Australia's needs. The manufacture of clothing was established earlier than in the other states and in some parts of the field Victoria (with 56,000 engaged) retains a lead; e.g., in the case of boots and shoes. hosiery and knitwear. and women's outer clothing. The largest industrial group is classified as founding, engineering and metal working with 75,200 workers (*cf.* agriculture and grazing, total 75,700). The manufacture. assembly and repair of ships. vehicle parts and accessories engaged 43,200 (cf. dairying, 35.600). Since Yictoria has no industrial metals thic growth rests entirely on imported raw materials. The trend has been from repair and assembly to the construction of completed machines. In some types of agriculturul machinery. design and construction were entirely local as early as 1890. Motor-car assembly plants were established in the 1920s and the first mass production oi an Australian car began in 1948. World War II stimulated great expanaion in heavy general engineering and electrical engineering. The manufacture of chemicals. dyes, explosives, paints, etc. (14,300), began in the 19th century n·ith sulphuric acid and superphosphate. The manufacture of explosives was begun during World War I. The range of fine chemicals made increased during World War II.

Electricity Supply.—The main producing authority is the State Electricity commission which generates about 99% of the electricity used. transmits it over two-thirds of the area of the state and thereby caters ior four-fifths of the population. At Yallourn a generating station using raw brown coal generates about 40% of the electricity produced in Victoria. Yallourn is the base-load station of an interconnected system comprising three steam stations in Melbourne. two in Ballarat. two in Geelong, several hydro stations and three provincial diesel stations. Brown coal, either raw or briquetted at the commission's Yallourn iactory (producing 630,000 tons a year). provides a subctantial part of the fuel for the steam stations so that about three-quarters of all the electricity produced in Victoria is derived from brown coal. After World War II a vigorous construction program trebled electricity production in a decade. At S-allourn the addition of two 100-megawatt extensions. one completed in 1955. the second planned for 1957–58, represented a doubling of capacity. At Morwell, six miles away, construction aimed at the installation by 1960 of a 91-megawatt power station and two briquette factories with a combined capacity of 1,500,000 tons a year. As well as meeting Victoria's need for solid fuel these briquettes are used in a gas-making plant which began production in 1956 using the Lurgi process and supplying gas to Melbourne through a 102-mi. pipeline. Victoria's hydroelectric potential is relatively small. At the Big Eildon reservoir a 135-megawatt station was nearing completion in 1956. The largest hydro del-elopment is on the Kiewa river. 160 mi. S.E. of Melbourne, where the first of a series of stations began operation in 1944. The total installation planned exceeds 300 megawatts. By 1955 generators with a capacity of 80 megawatts were in service.

Communications. — In the development of railways private companies played a brief and insignificant part. The construction and operation of railways has always fallen to the government and the strict economics of operation have always been modified by public policy. As elsewhere. railways sutiered from road competition and the route mileage open in 1954, 4.482 mi.. represented a reduction of about 300 mi. on the 1939 figure. Post-World War II re-equipment included an increased use of diesel traction and electrification of the line between Melbourne and the brown-coal centres in Gippsland. The gauge is 5 ft. 3 in. and the break to "standard" gauge at the New South Wales border is a major source of inefficiency. The rail pattern is largely radial from Melbourne. The Melbourne suburban lines (174 route mi.) are electrified.

In 1913 the country roads board was constituted to construct and maintain main country roads. A system of state highways exists. but martime deterioration and the increasing size of road transport pose problems. In particular. interstate road transport makes heavy demands on the roads and the problem of ensuring that it makes. as the government railways must. a fair contribution to the maintenance of the roadway it uses is complicated by constitutional difficulties.

Melbourne is outstandingly the most important port in Victoria. From the point of view oi port construction its site offered little beyond shelter. The port in 1956 had 20 berths at piers on Hobson's bay, 63 at wharves along the Yarra river and 24 in Victoria dock excavated alongside the river. Xbout four-fifths of the seaborne commerce of Victoria and a greater proportion of passenger traffic pass through the port. Geelong ranks second and Portland handles minor amounts of the trade of the Western district.

(X. A. W.)

VICTORIA, Brazil: see VITÓRIA.

VICTORIA, capital and second largest city of the province of British Columbia. Can., is situated on the southeastern tip of Vancouver Island. One of the oldest centres in the province, Victoria was founded in 1843 as a nen- fur-trading headquarters for the western department. Hudson's Bay company. In anticipation of the Oregon boundary settlement of 1846, Ft. Victoria was located well to the north of the former headquurters near Vancouver. Wash.. U.S.

In 1849 Victoria became capital of the new crown colony of Vancouver Island and in 1868 was made capital of the united colony of British Columbia. It remained the largest business and commercial centre in the province until about 1900 when rapidly growing Vancouver, about 70 mi. N., on British Columbia's mainland. eclipsed the older city. The pleasant climate and attractive surroundings continue to draw people and Victoria has become primarily an administrative, residential and tourist centre noted for its fine homes and beautiful gardens. Public buildings include an imposing provincial legislative building, a large federal astrophysical observatory, United Services college (Royal Roads), which trains cadets for the army, navy and air force, and Victoria college, nhich is affiliated with the University of British Columbia. The port is small but well equipped and is important in both coastwise and deep-sea traffic. Victoria has the main Vancouver Island termini and repair yards for the Canadian Pacific and Canadian National railways and is the island terminus of Trans-Canada Air Lines. Manufacturing is mainly sawmilling, other wood processing and shipbuilding and repair. The federal government dry dock at Esquimalt is capable of holding the largest vessels afloat. Since earliest times Esquimalt has been linked with the navy and is Pacific coast headquarters of the Royal Canadian navy. The population of Victoria in 1961 was 54,941, that of the metropolitan area, including Oak Bay, Esquimalt, Saanich and Central Saanich, was 154,152. (A. L. Fy.)

VICTORIA, LAKE (Victoria Nyanza), the largest lake in Africa and chief reservoir of the Nile. lies mainly in Tanganyika and Uganda but borders on Kenya. The quest for the Nile sources led to the discovery of the lake by J. H. Speke in 1858. Formerly known to the Arabs as Ukerewe, the lake was named Victoria by Speke, in honour of the queen of England. He. with A. J. Grant, visited it again a few years later and mapped part of it. It was more thoroughly explored by H. hi. Stanley in 1875. A detailed survey was made of the lake by Sir William Garstin in 1901 and the possibility of using the lake as a vast reservoir for Egypt was considered for many years. Plans for the gradual raising of the level of its waters were completed in 1954. An associated project was the building of the Owen Falls dam on the Nile at Jinja, to provide electricity on a large scale.

Among the fresh-water lakes of the world it is exceeded in size by Lake Superior only and has an area of 26,828 sq.mi. In shape it is an irregular quadrilateral but its shores, save on the west, are deeply indented. Its greatest length from north to south is 200 mi., its greatest breadth 150 mi. Its coast line exceeds 2,000 mi. It fills a shallow depression in the central part of the great plateau which stretches between the western and eastern rift valleys *(see* Africa: *Physical Geography),* and has an elevation of 3,717 ft. above the sea. Its greatest ascertained depth is 270 ft. It contains many archipelagoes, the majority being near the coast line.

The lake is full of reefs, many just below the surface of the clear water. It is abundantly stocked with fish. The land surrounding the lake consists of gneiss, quartz and schistose rocks, covered with marl and red clay and in the valleys with loam. The basin area covers 92,240 sq.mi.

Shores and Islands.—The shores of the lake present varied aspects. The western coast, which contains no large indentations, is, in the south, backed by precipices 300 ft. high, behind which uplands rise to three times the height of the cliffs. To the north the hills give way to papyrus and ambach swamps, which mark the delta of the Kagera. Beyond the delta the hills reappear, and increase in height, till at the northwest corner they rise about 500 ft. above the water. This western shore is marked by north to south faults which run parallel to the lake at a short distance inland. The northern coast is deeply indented and is marked by rocky headlands jutting into the waters. There is a rim of high land near the shore, and streams which rise on its northern face drain north away from the lake. On a promontory about 30 mi. E. of the Katonga is Entebbe *(q.v.),* a port and the administrative centre of the Uganda protectorate. At Jinja is the outlet of the Nile. the water there forcing its way over the Ripon falls through the rock-bound shore of the lake. The northeast corner of the lake is flat and bare. A narrow channel leads into Kavirondo gulf, which, with an average width of 16 mi.. extends for 45 mi. to Kisumu. the terminus of the railway from Mombasa on the east coast of Africa. Hills dominate the south shore of the gulf and behind them are the Kisii highlands. To the south the shore trends generally southwest and is marked by many deep inlets with bold bluffs. At the southeast corner is Speke gulf, and at the southwest corner Emin Pasha gulf. There the coast is barren and hilly, while long ridges of rock run into the lake.

Ukerewe, north of Speke gulf, is the largest island—almost a peninsula. Its wooded hills rise 650 ft. above the lake. It is densely populated. At the northwest corner of the lake is the Sese archipelago, consisting of 62 islands. The largest island in the group is Bugala. Most of these islands are forested, and some of them attain considerable elevation. Their scenery is of striking beauty. Buvuma Island is at the entrance to the channel leading to Jinja. There are numerous other islands: most being of ironstone formation overlying quartzite and crystalline schists.

Rivers.—The Kagera *(q.v.),* the largest and most important of the lake affluents, rises east of Lake Kivu, and enters the west side of the lake just north of lat. 1° S. It is the most remote headstream of the Nile *(q.v.)* and is navigable for 80 mi. The only other river of note entering Lake Victoria from the west is the Katonga, north of the Kagera. Between the Katonga and the Nile outlet: the rivers which rise near the lake drain away northward, the watershed being close to the lake shore. On the northeast several streams reach the lake—notably the Sio, Nzoia and Yala. On the east the Mara enters the lake between lat. 1° and 2° S. It is, next to the Kagera, the largest of the lake tributaries. On the southern shores a number of short rivers drain into the lake. The only outlet of the lake is the Nile.

Population.—The Lake Victoria region is one of the most densely populated in Africa and within 50 mi. of its shores live several million people. These are nearly all of the Bantu race, the better-known tribes being the Ganda in Buganda, the Kavirondo in Kenya and the Sukuma and Haya in Tanganyika. Other tribes, some of which are not Bantu in origin, are the Soga in Uganda, the Luo and Tende or Kuria in both Kenya and Tanganyika, and the Girango, Kerewe and Zinza in Tanganyika. Considerable anthropological study, organized by the East African Institute for Social Research, was done in that area, which was the scene. of much tribal change and movement with pronounced Hamitic, Nilo-Hamitic and Nilotic intrusions.

Fishing.—Most of the tribes living on the shores are skilled fishermen and adept at handling canoes. The importance attached to the fishing industry is shown by the establishment of the East Africa Fisheries Research organization at Jinja, where, under the aegis of the East Africa high commission, research is conducted into the habits and distribution of the fish in the lake (there are more than 200 varieties) and into the economic and other problems connected with the industry.

At Kisumu are the headquarters of another high commission service, the Lake Victoria Fisheries board, with branches at Entebbe and Mwanza. The board has made a survey of fishing in the lake to determine the best methods of developing and controlling it.

Steamer Services.—The East Africa Railways and Harbours administration runs weekly steamer services round the lake from Kisumu in both directions, calling at Port Bell, Entebbe, Bukakata, Busungwe, Bukoba, Mwanza and Musoma. There are weekly services to the Sese Islands, a tug and lighter service round the Kavirondo gulf ports, and local services from Mwanza to Nansio, Karumo, Katunguru, Nyamirembe, Buchenzi and Nyamtukusa. The lake is connected with Mombasa by rail from Kisumu, with Dar es Salaam by rail from Mwanza and with the Nile steamer service by rail from Jinja to Namasagali, thence by steamer to Masindi Port, and from there by road to Butiaba on Lake Albert.

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VICTORIA FALLS, on the boundary betneen Southern and Sorthern Rhodesia, form the most remarkable feature of the Zambezi river. central Africa. The falls are about midway in the course of the Zambezi in 17° 51′ S. ,25° 41′ E. For a considerable distance above the falls the river flows over a level sheet of basalt. its valley bounded by low and distant sandstone hills. Its clear blue uaters are dotted with numerous tree-clad islands. These

CENTRAL AFRICAN PRESS FROM BLACK STAR

VICTORIA FALLS SEEN FROM THE AIR

islands increase in number as the river, without quickening its current. approaches the falls. whose nearness is indicated only by a veil of spray. At the spot where the Zambezi is at its widest—more than 1,500 yd.—it falls abruptly over the edge of an almost vertical chasm with a mighty roar and a cloud of sunlit spray. From 4,000,000 to 75,000,000 gal. a minute fall over the edge (minimum flow, April-May; maximum, Tovember-December). The mist that rises hundreds of feet gave the falls their native name of *Mosi-oa-tunya* ("the smoke that thunders").

The chasm, extending over the whole breadth of the river, is wider than Niagara, though broken, and it is more than twice the depth, a measurement varying somewhat, but attaining 35j ft. in the centre. Unlike Niagara the water does not fall into an open basin but is arrested at a distance of from 80 to 240 ft. by the opposite wall of the chasm. Both walls are of the same height, so that the falls appear to be formed by a huge crack in the bed of the river. The only outlet is a narrow channel cut in the barrier wall at a point about three-fifths from the western end of the chasm, and through this gorge, not more than 100 ft. wide, the whole volume of the river pours for 130 yd.—the Boiling Pot—before emerging into an enormous zigzag trough (the Second, Third, Fourth and Fifth gorges) which conducts the river past the basalt plateau.

The fall is broken by islands on the lip of the precipice into four parts. Close to the right bank is a sloping cataract 36 yd. wide, called the Leaping Water; beyond Cataract (formerly Boaruka) Island is the Main fall in two parts, 1,719 and 975 ft. wide, beyond which is Livingstone Island and the Rainbow falls, 1,800 ft. wide. At both these falls the rock is sharp cut and the river maintains its level to the edge of the precipice. At the left bank of the river is the Eastern Cataract, a millrace resembling the Leaping Water. From opposite the western end of the falls to Danger point, which overlooks the entrance of the gorge, the escarpment of the chasm is covered with great trees known as the Rain forest; looking across the gorge the eastern part of the wall (the Knife Edge) is less densely wooded. At the end of the gorge the river has hollowed out a deep pool, named the Boiling Pot. It is about 500 ft. across; its surface, smooth at low water, is at floodtime troubled by slow, enormous swirls and heavy boilings. Thence. the channel turns sharply westward. beginning the great zigzag mentioned. This grand and gloomy series of gorges is more than 40 mi long. Its almost perpendicular walls are more than 400 ft. high, the level of the escarpment being that of the lip of the falls. A little below the Boiling Pot, and almost at right angles to the falls. the gorge is spanned by a rail and road bridge (completed in April 1905). This bridge. 657 ft. long, with a main arch of 500 ft. span, is slightly below the top of the gorge. The height from low-water level to the rails is 420 ft.

The volume of water borne over the falls varies greatly. The maximum flow is 12.000.000 cu.ft. a minute. the minimum 594,000 cu.ft. a minute. Every foot rise in the river above the rapids gives a 6-ft. rise in the gorge. The highest known rise of water in the gorge is j6 ft.

The falls were discovered by David Livingstone on Nov. 16, 18jj, and by him named after Queen Victoria of England. Livingstone approached them from above and gained his first view of the falls from the island on the lip now named after him. In 1860 Livingstone, with Dr. (afterward Sir John) Kirk, made a careful investigation of the falls, but until the opening of the railway from Bulauayo (Sept. 12, 1905) there were few visitors. The land in the vicinity of the falls was made a public park by the Rhodesian government.

Livingstone's theory of the origin of the falls (that they were the result of volcanic action) was disputed by later geographers, who claimed that they were caused by the check to erosion of the bed of the river by the resisting sheet of basalt over which they flow. The latter claim has been accepted.

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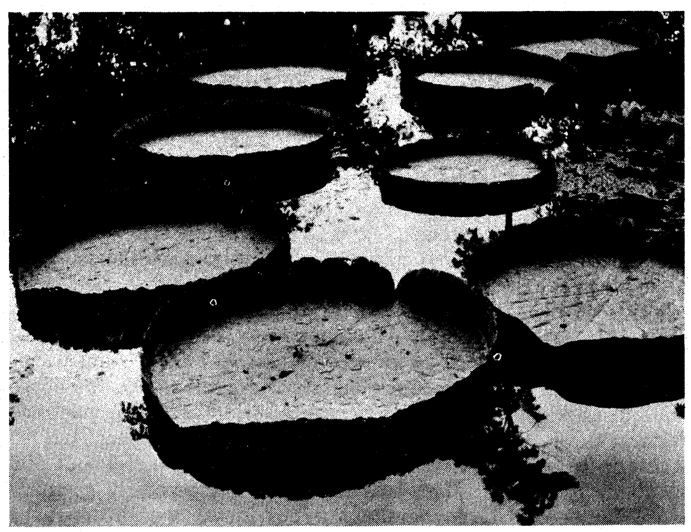
VICTORIA REGIA, a giant, showy water lily, native to British Guiana and the Amazon region of Brazil, hence the oldest scientific name, *Victoria amazonica*. It is a perennial with a thick, erect rhizome, usually growing in four to six feet of water. The huge. peltate leaves are from four to seven feet across, with upturned margins three to eight inches high. The leaves are green above but usually purple underneath, with veins bearing



EDGAR AUBERT DE LA RUE

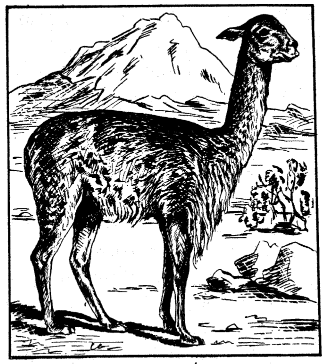
GIANT WATER LILIES (VICTORIA REGIA) OF THE AMAZON

horny prickles.

The fragrant, floating blossoms measure from 6 to 18 in. across and bear numerous white, pink or red petals. When cultivated in temperate regions the plant is treated like an annual and raised from seed.

See also WATER LILY. (T. K. J.)

VICUÑA (VICUGNA), one of the two wild South American representatives of the camel family still surviving (*see* TYLOPODA). From its relative the guanaco (*q.v.*), the vicuña (Lama *vicugna*) differs by its inferior stature, more slender build, shorter head, and the absence of bare callosities on the hind limbs. The colour is orange-red. Vicuñas live in herds on the bleak and elevated parts of the mountain range bordering the region of perpetual snow, in various parts of Peru, Ecuador, and Bolivia. Its fine, silky wool is highly valued for weaving.



CABRERA AND YEPES, MAMÍFEROS SUD-AMERICANOS

VICUÑA (LAMA VICUGNA)

VICUÑA, a term applied both to a distinctive variety of wool, and also to a special kind of "finish" given to certain varieties of woolen textures.

Vicuña wool is the fleece obtained from the vicuña (*q.v.*), a wild relative of the llama (*q.v.*) inhabiting the mountainous districts of Bolivia, Chile and Peru. This type of wool is distinguished for its remarkably long, fine, soft and lustrous character for which it is greatly prized. These properties adapt it eminently for the production of woolen and worsted textures that require a soft and full "handle" or "feel," and also for the development of "nap."

Vicuña fabrics comprise several varieties of woolen and worsted textures, which are of the character of serge (*q.v.*), excepting that they are more supple, softer and fuller and of a more subdued lustre than true serge textures. These qualities partly result from the different character of wool employed in their manufacture and partly from the method of finishing. Like serges, also, vicuña fabrics are usually based on the simple twill weave structures and employed as dress and costume materials and suitings.

Vicuña fabrics comprise two distinct types of textures: (1) simple structures for the lighter and medium textures suitable for women's wear and light suitings and coatings for men's summer wear; and (2) double-cloth structures for the heavier and stronger textures suitable for men's overcoatings. (H. N.)

VIDAL DE LA BLACHE, PAUL (1845–1918), founder of the French school of human geography, was born in Pézenas, Hérault, on Jan. 22, 1845. He was educated at the Ecole Normale Supérieure in Paris and entered upon the study of geography by way of that of history. He made a life study of the interrelations of the terrestrial environment and the activities of man.

Rejecting the theory of absolute geographical "control," Vidal de la Blache held that man's role is not passive, since he can within limits modify his environment to advance his own ends. His interpretation of the geographical personality of France in his *Tableau de la géographie de la France* prefixed to E. Lavisse's Histoise de *France* (1903) is a notable exposition of his approach. Vidal de la Blache joined the French school at Athens in 1867. From 1898 to 1909 he held the chair of geography in the Faculté des Lettres at Paris. He died at Tamaris-sur-Mer, Var, on April 5, 1918.

BIBLIOGRAPHY.—He founded in 1891 and edited until his death the periodical *Annales de Géographie*. His *Atlas général; histoire et géographie* was first published in 1894, and his uncompleted work *Principes de géographie humaine* appeared posthumously in 1922 (Eng. trans. reprinted 1950). *See* also biographical notice by L. Gallois in *Ann. Géogr.* 23:*161–73* (1918). (G. R. CE.)

VIDAME, a French feudal title. Originally, like the *avoué*, the vidame (*vice-dominus*) was a layman charged with representing an ecclesiastical institution in the domain of temporal affairs (war, money, etc.), which clerics were forbidden by the canon law to handle. The office applied in particular to the abbeys and sees to which the king had granted immunity and in which the vidame used to deal with questions that elsewhere would devolve upon the count.

When feudalism had attained its full growth and ecclesiastical seigniories were created, the vidame came to represent the bishop as a vassal, the *avoué* assuming the same office in the abbeys whose protector he was. In the 12th century the office of vidame had become an hereditary fief. As a title, however, it was less common and less dignified than that of *avoué*. The *advocati* were often great barons; the vidames were usually petty nobles, who exercised their office in strict subordination to the bishop. Their chief functions were: to protect the temporalities of the see, to represent the bishop at the count's court of justice, to exercise the bishop's temporal jurisdiction in his name and to lead the episcopal levies to war.

See A. Luchaire, *Manuel des institutions françaises* (Paris, 1892); A. Villien, *Dictionnaire de droit canonique* (Paris, 1924), *s.v.* "Avoué."

VIDIN (formerly written WIDIN or WIDDIN), a fortified river port and capital of Vidin district in the extreme northwest of Bulgaria; on the right bank of the Danube, near the Yugoslav frontier. Population (1956) 23,932, including descendants of refugees who fled thither from the Inquisition in the 16th century.

Vidin is an episcopal see and the headquarters of a brigade. A steam ferry connects it with Calafat, on the Rumanian bank of the Danube, and there is a branch railway to the main line Sofia-Lom. The old town, containing several mosques and synagogues and a bazaar, preserves its oriental appearance. There is a modern cathedral, a school of viticulture and a high school, besides an ancient clock-tower and the palace (*Konak*) formerly occupied by the Turkish pashas. Vidin exports cereals and fruit, and is locally celebrated for its gold and silver filigree. It has important fisheries and manufactories of spirits, beer and tobacco.

Vidin stands on the site of the Roman town of Bononia in Moesia Superior. It is a fortress of great natural strength owing to the marshes which surround it. In the 14th century it was the seat of an independent tsardom, which was overthrown by the Turks in 1396. Under the Turks it was the seat of a pashalik, which under Pasvanoglu (1794–1807) was practically independent.

VIDOCQ, FRANÇOIS EUGENE (1775–1857), French detective, was born at Arras in 1775 (or possibly 1773). After an adventurous youth he joined the French army, where he rose to be lieutenant. At Lille he was sentenced to eight years' hard labour, and sent to the galleys at Brest, whence he escaped twice but was recaptured. For the third time he escaped, and lived for some time in the company of thieves and other criminals in Paris and elsewhere, making a careful study of their methods. He then offered his services as a spy to the Paris police (1809). Eventually Vidocq was made chief of the reorganized detective department of the Paris police, with a body of ex-convicts under his immediate command. Vidocq possessed unbounded energy and a real genius for hunting down criminals. In 1827 he retired and started a paper-mill, the work-people in which were drawn entirely from ex-convicts. The venture was a failure, and in 1832 Vidocq re-entered the police service and was employed mainly in political work. Anxious to get back to his old detective post he himself foolishly organized a daring theft. His real part in the matter became known, however, and he was dismissed from service. He died in poverty. Several volumes have been published under his name, the best known of which is *Mémoires de Vidocq* (1828). It is, however, extremely doubtful whether he wrote any of them.

See Charles Ledru, La Vie, la mort et *les* derniers moments de *Vidocq (1857)*.

VIDYASAGAR, ISWAR CHANDRA (1820–1891), writer and social reformer of Bengal, was born at Birsinha in the Midnapur district in 1820, of a Kulin Brahman family. He was removed to Calcutta at the age of nine, was admitted into the Sanskrit College, and carried on his studies in the midst of privations and extreme poverty. In 1839 he obtained the title of *Vidyasagar* (="Ocean of learning") after passing a brilliant examination, and in 1850 was appointed head pundit of Fort William College. In 1846 appeared his first work in Bengali prose, The Twenty-Five Tales *of* a *Betal*. This was succeeded by his *Sakuntala*, 1855, and by his great work, The Exile of Site, 1862.

As a social reformer and educationist, too. Iswar Chandra made his mark. He associated himself with Drinkwater Bethune in the cause of female education; and the management of the girls' school, called after Bethune, was entrusted to him in 1851. And when Rosomoy Datta resigned the post of secretary to the Sanskrit College of Calcutta, a new post of principal was created. and Iswar Chandra mas appointed to it. He simplified the method of learning Sanskrit; and thus rendered a great service to Sanskrit learning of that ancient tongue among his countrymen. Under the education scheme of 1854 he established aided schools in Bengal. In 1858 he resigned his appointment under government and became manager of a private college at Calcutta.

But he then turned to practical reform. He had discovered that the ancient Hindu scriptures did not enjoin perpetual widowhood. and in 1855 he startled the Hindu world by his work on the *Remarriage of Hindu Widows*. Such a work, from a learned and presumably orthodox Brahman, aroused a storm of indignation. He appealed to the British government to declare that the sons of remarried Hindu widows should be considered legitimate heirs. The act was passed in 1856. and some years after, Iswar Chandra's own son was married to a widow. In the last years of his life Iswar Chandra wrote works against Hindu polygamy. He was as well known for his lavish charity and wide philanthropy as for his educational and social reforms. He was appointed companion of the Order of the Indian Empire in 1880. He died on July 29, 1891. (R. C. D.)

VIEIRA, ANTÓNIO (1608–1697), Portuguese Jesuit. diplomat, writer and orator, a great master of classical Portuguese prose. Born at Lisbon on Feb. 6, 1608, his life span coincided with a critical period in the history of Portugal and Brazil, and he played an active and at times a leading role on both sides of the Atlantic. His sermons, letters and state papers form the best collective source for the understanding of the climate of opinion in 17th-century Portugal and Brazil. In an age when the pulpit had great power in forming public opinion, Vieira's sermons were among the most famous and influential, "being bought up as fast as they are printed, and sent for out of all parts of Spain. Italy and France," as a contemporary Englishman noted. He was a prolific letter writer, and his correspondence is the more valuable in that he was a well-placed, intelligent and critical observer who frequently wrote at white heat and without reserve. His state papers on such varied subjects as diplomatic negotiations with the Dutch. Portugal's economic ills and their remedies, toleration for the crypto-Jews, or "New Christians," and freedom for the Indians of Brazil are models of clear and incisive reasoning and exercised great influence in the councils of the crown. A great historical as well as a great literary figure, Vieira may be considered the most remarkable man in the 17th-century Luso-Brazilian world.

Vieira went with his parents to Brazil in 1614. He was educated by the Jesuits at Bahia and entered the Society in 1623, being ordained as a priest in 1634. He became the most popular and influential preacher in the colony. Many of his sermons were calls to battle against the Dutch invaders who occupied northeast Brazil from 1630 to 1654, and others contained devastating criticisms of the colonial authorities. He also worked among the Amerindians and the Negro slaves. though he was not allowed by his superiors to devote his whole life to ministering to them as he had hoped to do. He returned to Portugal in 1641, as a member of a Brazilian mission sent to congratulate King John IV on his accession. The king fell under the spell of Vieira's self-assured and magnetic personality, and soon came to regard the tall, lean, dynamic Jesuit as "the greatest man with the world." Vieira repaid him with a passionate devotion which, after John's death (1656), became a hallucination that he would rise from the dead to inaugurate the fifth biblical universal monarchy under Portuguese leadership.

Between 1646 and 1650, Vieira was employed on confidential diplomatic missions to Holland, France and Italy, but none of them was successful, and he made himself unpopular with many Portuguese by his outspoken advocacy of toleration for the persecuted crypto-Jews and of peace at any price with the Dutch. The Jesuit general at Rome, embarrassed by Vieira's multifarious activities, resolved to dismiss him from the Society. but the king intervened and the matter was dropped. At the end of 1652 he was sent to the Maranhão and the Amazon delta mission fields, where he remained for the next nine years, except for a brief visit to Portugal (1654–55). During this time he displayed as much energy and ardour in work among the savages of the South American rivers and jungles, as he had shown in his political activities in the European capitals and courts. He learned several of the local languages of the Amazon delta, in addition to the Tupí-Guarani, or lingua franca, of the Brazilian littoral and the Kimbundu of the Negro slaves from Angola. His caustic criticism of the colonists' enslavement of the Indians led to his expulsion and deportation to Portugal in Sept. 1661. He was first received sympathetically by the court, but a palace revolution in June 1662 brought his enemies to power, and the Inquisition. which had long disliked him. arrested and tried him for his messianic beliefs concerning the future of Portugal and the resurrection of Ring John IV. Luckily for him, his sentence coincided with another palace revolution which brought the prince regent Dom Pedro and his own friends to power, and he was released in 1668. But his old influence at court was gone, and he spent the years from 1669 to 167j at Rome trying to secure the annulment of his sentence and a degree of toleration for the crypto-Jews. He did secure the partial revision of his sentence, and a papal brief exempting him from any further molestation by the Portuguese Inquisition, but he ultimately failed to attain his second object, though securing the suspension of the Inquisition's anti-Jewish activities for five years (1676–81).

He returned to Bahia in 1681 with the intention of ending his days in Brazil, and there he died on July 18, 1697, a paralyzed physical wreck. but mentally active and a fighter for the freedom of the Indians to the last.

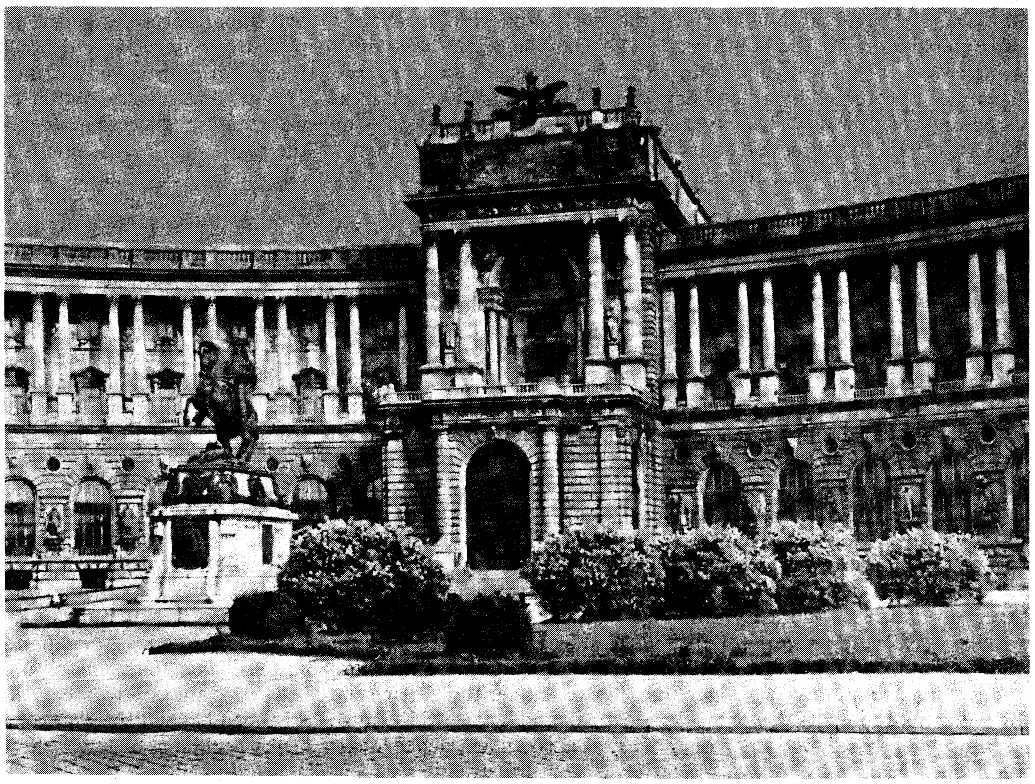
BIBLIOGRAPHY.—The standard biography is by J. L. d'Azevedo, *Historia de Antdnio Vieira*, 2 vol. (1918–20). He has also edited the best edition of correspondence, *Cartas do Padre Antdnio Vieira*, 3 vol. (1925–28). For a definitive bibliography of works hy and on Vieira, *see* Serafim Leite, *S.J., Histdria da Companhia de Jesus no Brasil*, 10 vol., vol. ix, pp. 192–363 (1938–50). *See* also *Padre Antdnio Vieira. Obras Escolhidas*, ed. by António Sérgio and Hernâni Cidade, 12 vol. (1951–54); C. R. Boxer, *A Great Luso-Brazilian Figure. Padre António Vieira S.J.* (1957). (Cs. R. B.)

VIENNA (German WIEN, Czech VIDEŇ, Hungarian BÉCS), the capital and a *Bundesland* (federal state) of Austria, extends from the eastern slopes of the Wienerwald (Vienna woods) in the west and northwest to the plains of the Danube basin in the east and south. It lies mainly on the right bank of the Danube, with only 2 of its 23 districts on the left bank. It is situated between 515 ft. and 790 ft. above sea level and has a changeable climate liable to rapid falls of temperature and gusty winds. The mean annual temperature is 49° F. and the mean rainfall 27 in. a year. Area 160 sq.mi. Pop. (1961) 1,619,668.

The layout of Vienna resembles a star. While many of its main streets, extending radially from the centre, follow the courses of covered brooks where once the old villages stood, the inner city itself is encompassed by the beltlike wide boulevard, the Ringstrasse, built in 1858–60, around which are inner districts encircled by the Giirtel, built in 1894. Both these circular road systems replace the old fortifications.

The very centre of the city is the Stephansplatz with the cathedral of St. Stephen. measuring 361 ft. in length and with a nave 114 ft. wide and 95 ft. high. The cathedral is one of the chief Gothic buildings in Europe, incorporating remnants of the original Romanesque edifice, probably built between 1137 and 1147, but soon destroyed by fire. The choir and nave were built between 1304 and 1450, simultaneously with the southern tower (446 It.). while the northern tower, never finished; was finally completed with a Renaissance spire in 1578. Burned out during the battle of Vienna in April 1945, its reconstruction was completed by 1952; and even the 20-ton bell, founded from captured Turkish cannons in 1711, was recast. Other Gothic churches include the Augustinerkirche, the Maria am Gestade church and the Church of the Friars Minor, all dating from the 14th century. St. Ruprecht, dating from the 13th century with parts from the 11th century, is

Vienna's oldest church and is believed to have been originally built in 740. St. Peter's, standing on the site of a church allegedly founded by Charlemagne in 792, was built chiefly by J. L. von Hildebrandt in 1702–33. Other fine examples of baroque art are the richly frescoed University church (1627–31) and the Capuchin church (1622–32), the latter containing the imperial crypt, the vault in nhich 140 members of the house of Hapsburg. 12 emperors and 1j empresses among them, repose. The Church of the Scots, founded in 11jj. together with a monastery of Scottish and Irish monks, was rebuilt in late Italian Renaissance style in 1638–48. Most of the noteworthy secular buildings are baroque, for example the Harrach and Kinsky palaces and the Winter palace of Prince Eugene of Savoy (now the ministry of finance).



BY COURTESY OF THE AUSTRIAN INFORMATION SERVICE, N.Y.

THE HOFBURG, VIENNA. FORMERLY THE IMPERIAL PALACE

Thoroughfares of the city are the Graben, nith the magnificent Plague of Trinity column (1682–86), and the Karntnerstrasse, both of which issue from the Stephansplatz and are lined with Vienna's most fashionable shops. The vast complex of the imperial palace. the Hofburg, adjoins the Ring. It consists of a number of buildings of various periods and styles, enclosing several courtyards. the oldest part dating from the 13th, the latest from the end of the 19th century. It abounds in magnificently appointed private and state apartments, and also houses the imperial treasury of the Holy Roman and Austrian empires; the National library containing about 1,620.000 volumes, 35,000 manuscripts, 85,000 autographs. 125,000 maps, 100.000 papyri, etc.; the Albertina and several other museums; and the Spanish Riding school. founded in the 16th century. The state apartments of the Hofburg wing adjoining the Ballhausplatz are now the offices of the president of the republic of Austria. Opposite is the edifice of the federal chancellery, built in 1717–19, where the congress of Vienna took place in 1814–1j and where Chancellor Engelbert Dollfuss was assassinated in 1934. The magnificent Ringstrasse, 2 mi. long and 160 ft. wide, is planted with four rows of trees. It is lined with splendid buildings, monuments and parks.

Facing the Hofburg to the southwest are the museums of natural history and fine arts, two domed Renaissance-style buildings dating from 1872–81, identical in construction but separated by gardens containing the Maria Theresa monument. Adjoining the museums to the west is the palace of justice (1881), burned during riots in 1927, and the houses of parliament (1883) in modified Grecian style. Beyond these, to the north. stands the new Rathaus (city hall. 1872–83), a very large and lavishly decorated building in modern Gothic style. Farther to the north stands the university, an imposing building of Neo-Renaissance style (1873–83). It is the oldest German university in existence. Founded in 1365, it has contributed much to building up Vienna's high cultural reputation in Europe. Its library contains 1,463,000 volumes.

Other important buildings are, opposite the Rathaus. the Burgtheater. built in 1874–88. and the Opera (1861–69) at the intersection of Ring and Karntnerstrasse. both in Neo-Renaissance style. Heavily damaged by bombs and fire in 1945, these two largest theatres of Vienna were reopened in 1955. On the eastern side of the inner town lies the Stadtpark, rich in monuments. The inner town with its immediate neighbourhood is still, unlike the older parts of most European towns, the fashionable quarter, containing the government offices. the principal hotels, embassies and legations and many handsome buildings. Located at some distance outside the Ring to the south are the beautiful baroque Charles church (begun in 1716 by Johann Fischer von Erlach the Elder, completed in 1739) and, farther to the south, the Belvedere palace (1714–23), a perfect example of secular baroque style. Here the state treaty of Austria was signed in 19j;. The imperial summer palace of Schonbrunn with splendid rooms in rococo taste, and its large park of 18th-century style, lie to the southwest in the suburb of Hietzing.

The town as a whole has preserved its general character of the period prior to 1914, although in World War II it suffered heavy damage. The Southern and Eastern Railway stations near the Belvedere, and the Western station adjoining the Mariahilferstrasse. were rebuilt in modern style after their wartime destruction. Some residential areas are dominated by large new buildings containing workers' flats, many of them built with the aid of public funds; these social housing schemes were first introduced in 1923. On the contrary, some of the outer districts, such as Grinzing or Sievering, still keep their picturesque 18th- or early 19th-century village atmosphere.

Vienna is rich in museums, art collections and libraries. It possesses two big concert halls and 10 major theatres. In addition to the University of Vienna, there are technical, commercial, veterinary and agricultural colleges and three art academies. Vienna also possesses a great number of monasteries and convents.

Vienna is a city of open green spaces and parks. The largest ones are the Prater (2,000 ac.), situated between the Danube river and the Danube canal, and the spacious Lainzer Tiergarten (a zoological garden) at the western end of the town. Most of the industrial plants are situated in the southern and eastern precincts.

Communications and Industry.— Vienna has been a centre of cominunications since its foundation and many roads intersect there, linking north and south. east and west. Five main railway lines link the city to nearly all European capitals. From the main airport of Schwechat. 10½ mi. from the city, there are air services to most of the major towns of the world.

The northeastern limit of the inner town is not the Danube proper but the Danube canal. It is 10.7 mi. long; it branches from the Danube river at Nussdorf to the north and rejoins it near Kaiserebersdorf to the southeast. The Danube itself flows in a course 866 ft. wide regulated in 1870–84. The left bank of the Danube is protected by a flood dam built behind a high-water area, about 1,500 ft. wide. The river is navigable for 340–350 days of the year. In the three harbours (Freudenau, Albern and Lobauj almost 2,000,000 metric tons of goods were loaded or unloaded in 1956.

In spite of losses in population and trade during World Wars I and II, Vienna remained the focus of industrial life in Austria. The most important branches of industry are the manufacture of foodstuffs. the electrical and chemical industries, machine manufacture, the making of iron and metal goods, clothing and textiles.

The Vienna fair, founded in 1921, is one of the most popular trade exhibitions in central Europe.

History. — Vienna's position in central Europe is marked by the crossing of two immemorial routes of trade and migrations: the waterway of the Danube river, linking the west with the east, and the road from the Adriatic to the Baltic, connecting south and north. Thus the city's geographical situation has enabled it to rise from the nucleus of a nameless settlement in the mists of prehistory to the rank of an imperial capital.

Traces have been found in Vienna of the Neolithic and Bronze Ages, and more of the early Iron Age. In the later Iron Age the dwellings of Veneto-Illyrian tribes in this area were superseded, in successive Celtic inroads. by the first organized settlement. When the Romans advanced to the Danube, they took over the Celtic settlement, retaining its name of Vindobona, and enlarged it into a frontier station (*castrum*) bounded. on a small eminence near the Hoher Markt. by today's Salzgries. Rotenturmstrasse. Graben and Tiefer Graben. Soon public life developed in connection with the rising importance of the fortress. which temporarily served as the command post of Marcus Aurelius (who died there in A.D. 180).

In the middle of the 5th century Vindobona was raided by Attila, moving westward with his Huns, and tradition relates a conquest at the end of the 8th century by Charlemagne. A definite mention occurs only later, in annals of 881. under the heading *Primum bellum* cum *Ungaris* ad *Weniam* ("first war with the Hungarians at Vienna"), and in annals of 1030, in connection with the ill-fated Hungarian campaign of the Frankish emperor Conrad II, whose army was captured in "Viennis." After the battle on the Lechfeld (955), in which Otto the Great decisively defeated the Hungarians, the Vienna area was settled from the west, and the margraves of Babenberg, originating' from Franconia, set up an effective administration, expanding Ostarrichi, the core of the future Austria (see AUSTRIA, EMPIRE OF), as far as the March and Leitha rivers. Shortly before the House of Babenberg moved its residence to Vienna, Wienne is referred to for the first time as a *civitas* (city) in a document of 1137. With Duke Henry II Jasomirgott establishing his court at the square today called Am Hof. and the foundation of St. Stephen's cathedral, ever since known as the city's symbol. Vienna began to grow. At about 1200, already ranking among the major German cities. it expanded beyond its original boundaries and was surrounded by a system of ramparts which determined its size for nearly six centuries and is still reflected in the beltlike shape of the Ringstrasse. A decree of Duke Leopold VI, of 1221, conferred municipal privileges on the city. Further legislation, of the Emperor Frederick II in 1237 and the Babenberg Duke Frederick II in 1244, defined and secured the status of the prospering city in which also the Jewish population was granted special privileges by both the emperor and the duke in relevant decrees of 1238 and 1244. With Duke Frederick, the last of the Babenberg dynasty, killed in action against the Hungarians in 1246, and the death of Emperor Frederick II in 1250, a period of chaos followed. The city had temporarily to accept the reign of King Ottokar (Otakar) II of Bohemia (1251) until in 1278 the victor in the fateful battle on the Marchfeld. Rudolf I of Hapsburg (German king from 1273), established the new ruling house of Austria with its seat in Vienna.

In the 14th century, after the city had struggled through critical epochs under the new dynasty but continued to enlarge its wealth and importance, the generous activities of Rudolf IV initiated a period of enterprise and prosperity in Vienna, marked by his extension of St. Stephen's cathedral, his foundation of the university (1365), and his promotion and organization of many municipal institutions. Increasing social tensions between the patriciate and the craftsmen led to serious rifts in the political structure of the city under the reign of Frederick III (crowned as emperor in 1452), when Vienna was torn between weakened imperial authority and ambitious moves for power of Archduke Albert (Albrecht) VI. In the outcome of the strifes, the craftsmen obtained a share in the civil government. At the end of the century; troubled times recurred in the conquest of the city by the Hungarian king Matthias Corvinus (1485–90).

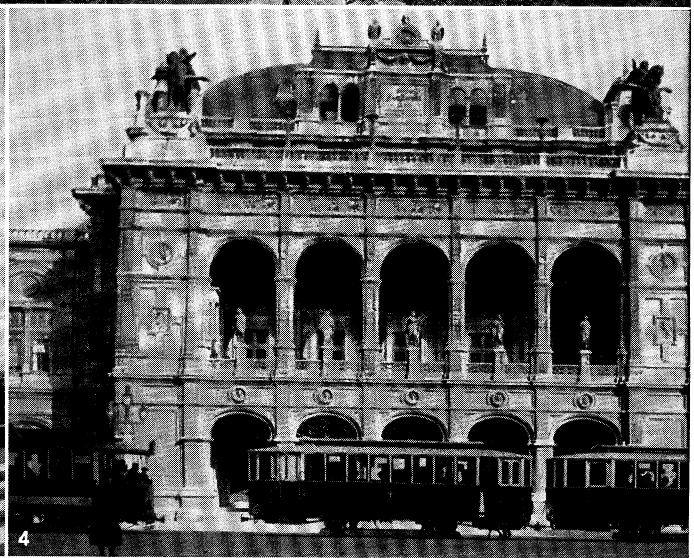
The independence and determination of the citizens, which had overcome political setbacks as well as continual afflictions by devastating epidemics of plague and conflagrations, stood its historical test on the European scene in the Ottoman invasion marked by the two sieges of Vienna under Suleiman II in 1529 and Mohammed IV in 1683. Between the two Turkish inroads, continental political developments, reflected in the religious struggles of the 17th century, brought insecurity and distress to Vienna: for the Thirty Years' War broke the imperial power and initiated the rise of France at the expense of Austria and Spain. But a century later, the statesmanship of Emperor Charles VI (1711–40) and the fortunate reign of his daughter Maria Theresa (1740–80) gave new brilliance to the metropolis.

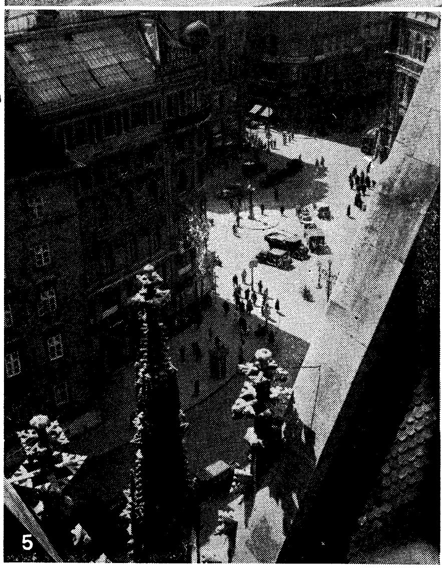
Toward the end of the 17th century, the suburbs of Vienna had expanded beyond the ramparts protecting the city in the past, and in the beginning of the 18th century new fortified walls were constructed to enclose the built-up area which today is marked by the Gürtel. In 1754 the population amounted to 1 j5,400. The new spirit in public activities and imperial promotion attracted artists, scholars, architects and musicians as well as patrons. Adding to the mainly ecclesiastical buildings of the 17th century. palaces, governmental edifices, academies. richly decorated cathedrals, festival halls and theatres. magnificent squares and streets mere built. Treasures of art accumulated in the imperial collections! and operatic and theatrical tradition gained national importance. Even today the Viennese baroque has retained its specific appeal in the architectural appearance of the city centre.

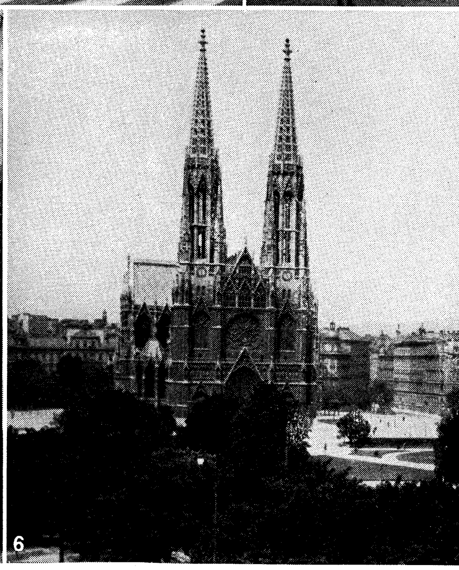
At the dawn of the 19th century, the reign of Francis I was troubled by the Napoleonic wars, during which the French twice seized the capital. But the city soon revived to witness the congress of Vienna (1814–15). The revolution of 1848 finally destroyed the ancient "rock of order" of Metternich's conservative state. The accession of Emperor Francis Joseph I (1848–1916) inaugurated a new period, with the right of self-government by elective bodies, and the advancing middle class eventually achieved permanent successes under the determined leadership of the great mayor of Vienna of the "Christian Social era," Karl Lueger (1897–1910). The development of the city. whose population had nearly quadrupled within half a century (reaching 2,031,498 in 1910), was marked by the razing of the old ramparts in 1858 and the subsequent reconstruction of the inner centre, while the outskirts freely extended into the green belt and the surrounding vineyards, blending the urban area with the open landscape.

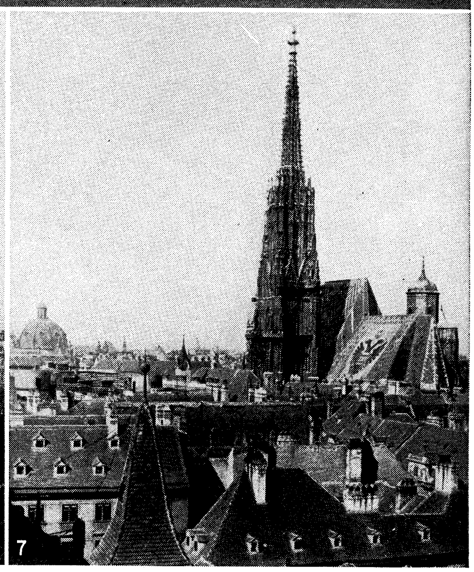
Vienna emerged from World War I as the capital of a federal state of nine provinces. It covered one two-hundredth part of the new Austrian territory while containing more than one-fourth of its total population (1,841,326 in 1920). But Vienna surmounted the difficulties caused by this unbalanced situation which were partly alleviated by the aid of foreign relief organizations. The city's initiative. guided by a Socialist majority in the municipal administration. became visible in modern building projects, social housing settlements, effective welfare institutions. well-planned highways and industrial expansion. The achievements of this period are inseparably linked with the untiring efforts of mayor Karl Seitz (1923–34), the outstanding counterpart to Lueger in this decade.

Developments were interrupted by repercussions of Hitler's rise to power which culminated in March 1938 in the invasion by the German *Reich,* known as the *Anschluss*. Essential elements of









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SCENES IN VIENNA

1. The centre of the city — Kartnerstrasse at the corner of Ringstrasse
2. General view of the Ring, showing the old Parliament building at the left, the Rathaus with the high tower, the Votive church with twin towers in the distance, and the Hofburg theatre (right) with part of the Volksgarten in front
3. A section of the Parliament building, facing the Ring
4. The Opera house, built during 1861 and 1869
5. View of the Graben and Stefansplatz
6. The Votive church
7. Spire of St. Stephen's cathedral, 450 ft. high, regarded as one of the finest of Gothic spires. It was rebuilt in 1860–64. The roof was completely destroyed and the vaulting of the apse partially destroyed in World War II

Viennese' life were stamped out not only by the Nazi system, but also by the hail of bombs and shells at the end of World War II which severed Austria's connection with Germany.

Vienna's faculty of combining conservative and creative power once again proved a vital factor in the postwar years, which were to begin with a ten-year quadripartite occupation. Careful planning and imaginative improvisation made it possible to overcome the first difficulties of reconstruction which was soon substantially helped, especially by the U.S. Three symbols of Vienna, St. Stephen's cathedral, the opera house and the Burgtheater, all seriously damaged during World War II, rose again to testify to the joint determination of the Viennese population to revive and maintain the city's famous tradition.

Vienna still retains the stamp of its multiple development, the traces of the Latin, Slavonic, German and Magyar elements that have intermixed to form this metropolitan centre.

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VIENNA, CONGRESS OF (1814–1815). The fall of Napoleon left the disposition of his empire to the four powers who had overthrown him—Austria, Prussia. Russia and Great Britain. Other countries, of which Spain, Portugal and Sweden were the most important had shared in this task and had signed the treaties of Paris (*q.v.*) in 1814, but the four greater powers were bound together by a special alliance (treaty of Chaumont. March 1. 1814) Thus. though the treaties with France stipulated that all countries that had taken part in the war should send plenipotentiaries to a congress at Vienna, the four powers meant to make the decisions themselves, and, as they could not agree at Paris. bound France by a secret article of the treaties to recognize these decisions at a future date.

The Delegates.—Thus the meeting at Vienna, where representatives began to arrive toward the end of September, was meant to be merely a convenient assembly to ratify the decisions of the "four." Nevertheless, all Europe sent its most important statesmen. Metternich, principal minister of Austria since 1809, naturally represented his Emperor Francis II. a stubborn man who sometimes had a policy of his own. The brilliant, but wayward and emotional, Alexander I of Russia directed his own diplomacy. The weak Frederick William III of Prussia had as his principal minister Prince von Hardenberg. who had lost credit owing to physical infirmities. Great Britain was represented by the foreign minister, Lord Castlereagh, the creator of the alliance of Chaumont. When Castlereagh had to return to his parliamentary duties the duke of Wellington replaced him and Lord Clancarty was principal representative after the duke's departure. The restored Louis XVIII sent the astute diplomatist. Prince Talleyrand. Spain, Portugal and Sweden had only men of moderate parts to represent them, in Don Pedro Gomez Labrador, the duke of Palmella and Count von Lovenheilm. Count Miinster, who represented the British prince regent as ruler of Hanover, had much influence on German questions. Many of the rulers of the minor states of Europe put in an appearance. With them came a host of courtiers, secretaries and ladies to enjoy the magnificent hospitality of the almost bankrupt Austrian court. The social side of the congress made a great impression on the age, and on history. It was one of the causes of the long and unexpected delay in producing a result, for Metternich at least sometimes subordinated business to pleasure.

Procedure of the Congress.—This was determined by the difficulty and complexity of the problems to be solved. First there was the problem of the organization of the congress. for which there was no precedent. The "four" were determined to keep the management of the main problems entirely in their own hands; but since they had rather rashly summoned a congress they had to pay some attention to it. The ministers of the "four" assembled early to discuss this problem, and finally agreed on Sept. 22 that the "four" should have the "initiative." by which they meant the "decision" of the future of all the conquered territories. They were then to "communicate" with France and Spain. The "congress" was to be summoned only when all was ready.

This was the situation which Talleyrand found when he arrived on Sept. 24. He refused to accept it and was supported by Labrador. He denied that either the "four" or the "six" were legally constituted bodies, and desired that the congress should be summoned to elect a directing committee. If there was any other body which had any rights it was the "eight" powers who had signed the Paris treaties. The "four" were much disturbed, for they knew that all the smaller powers would support Talleyrand if they gave him the chance of appealing to them. But they had no intention of giving way, and refused to summon a meeting of all the plenipotentiaries. A notice was issued that the opening of the congress was postponed till Nov. 1. No solution could be found, however, and after a meeting of the "eight" on Oct. 30 the opening was again postponed.

Meanwhile the work of the congress proceeded without the sanction of the main body of plenipotentiaries. The "four" discussed the main territorial problems informally among themselves. The "eight" assumed the formal direction of the congress; a committee of German states met to draw up a constitution for Germany, and a special committee on Switzerland was appointed by the "four." Talleyrand was thus excluded from the main work of the congress. but his protests on behalf of the smaller powers grew fainter as he realized that the "four" were not in agreement, Castlereagh and Metternich gradually won his confidence and at last insisted on France being admitted to the "four." The "four" thus became the "five" and it was this committee of five which was the real Congress of Vienna. Between Jan. 7 and Feb. 13 it settled the frontiers of all territories north of the Alps and laid the foundations for the settlement of Italy. Meanwhile the committee of "eight" dealt with more general matters. The congress as a representative body of all Europe never met.

Poland and Saxony.—The great difficulty which nearly produced war was the disposition of Poland and Saxony. By treaties signed in 1813 Alexander had promised that the sovereigns of Prussia and Austria should rule over as many subjects as they had done before they were reduced in size by Napoleon. He had also promised that the duchy of Warsaw. which Napoleon had constituted out of the Prussian and Austrian shares of the Polish partitions, should be divided among the three powers. After the battle of Leipzig, however, he claimed practically all Poland for Russia, and suggested that Austria could find compensation in Italy, and Prussia by annexing all Saxony, whose king had been the most faithful of Napoleon's vassals. In this plan he was moved by a sincere wish to give the Poles an opportunity for the expression of their nationality; but. of course, he intended to keep Russian sovereignty over all Poland. Metternich was much alarmed. and Hardenberg, while very desirous of Saxony, was not anxious to see Russia's frontier extended so far. Castlereagh was also, as a true disciple of Pitt. afraid of Russian expansion. Accordingly Castlereagh encouraged Austria to agree to the sacrifice of Saxony to Prussia so that the three powers could oppose Russia's demands on Poland. With great difficulty he eventually succeeded in so doing. But the plan. which included an offer of constituting an entirely independent Poland, which it was known Alexander must reject, failed because Frederick William III. who was grateful to the tsar for his help in the overthrow of Napoleon, refused to support Hardenberg when the crisis came. Metternich and Hardenberg were, therefore, estranged, and the former withdrew his consent to Prussia's absorption of all Saxony. Prussia then went altogether on to Russia's side. and a complete deadlock resulted. Meanwhile Talleyrand had been advocating the principle of "legitimacy" which had brought Louis XVIII back to France, so as to support the king of Saxony and the return of the Bourbons to Naples.

Castlereagh's Diplomacy.—Castlereagh had been much chagrined at the failure of his first plan. Moreover. his cabinet were alarmed at his activity in European matters. and he was warned against going too far. The difficult negotiations with the United States, with whom Britain was still at war! also made caution necessary. Nevertheless, Castlereagh saw that if a European war broke out both France and Britain would certainly be involved before it was over. He had already prepared the way with Talleyrand, and in December both he and Metternich promised Talleyrand that the Bourbon house should be re-established in Naples instead of Joachim Murat (*q.v.*). Secure of Talleyrand's support they insisted that France should be admitted to the committee of the "four." When Hardenberg threatened war, Castlereagh drew up a secret treaty of defensive alliance which Talleyrand and Metternich signed on Jan. 3, 1815. For a few days the issue was doubtful, but the tsar, who had already obtained most of Russia's demands, inclined to peace, and eventually Prussia gave way. With Castlereagh acting as mediator, a compromise was arranged on the question of Saxony, and then the rest of the territorial settlement was comparatively easy, especially as Castlereagh reduced the demands of both Hanover and the Netherlands, whose policy was ultimately controlled by Britain.

Decisions of the Congress.—Alexander gave back Galicia to Austria. Thorn and a region round it to Prussia, while Cracow was made a free town. The rest of the duchy of Warsaw was incorporated as a separate kingdom under the tsar's sovereignty. Prussia got two-fifths of Saxony, and was compensated by extensive additions in Westphalia and on the left bank of the Rhine. It was Castlereagh who insisted on Prussian acceptance of this latter territory, with which it was suggested the king of Saxony should be compensated, for he wanted Prussia to guard the Rhine against France and act as a buttress to the new kingdom of the Netherlands, which Holland had formed by incorporating Belgium. Austria was compensated by Lombardy and Yenice, and also got back most of the Tyrol. The south German states on the whole did well. Hanover was also enlarged. The outline of a constitution, a loose confederation, was drawn up for Germany. It was a triumph for Metternich and a defeat for the Prussiaa statesman, Baron von Stein. Denmark lost Norway to Sweden hut got Lnuenberg, while Smedish Pomerania went to Prussia. In Italy, Piedrnont absorbed Genoa; Tuscany and Modena went to an Austrian archduke; Parma was given to Marie Louise, though the young Napoleon's claims to succeed failed to win British and French approval. The papal territory was restored to the pope. Murat's fate was decided even before his rash attempt after Napoleon's return from Elba, and the Sicilian Bourbons restored to Naples. Switzerland was given a new constitution. Valuable articles were included on the free navigation of international rivers and diplomatic precedence. (*See* DIPLOMACY.) Castlereagh's great efforts on behalf of the abolition of the slave trade were only rewarded by a pious declaration.

The final act, which included all these agreements in one great instrument, signed on June 9, 1815, by the "eight" (except Spain, who refused as a protest against the Italian settlement) was afterwards acceded to by all the other Powers, and was the most comprehensive treaty which Europe had ever possessed.

As a result the lines laid down by the Congress of Vienna lasted, except for one or two changes, for over 40 years. The statesmen had successfully worked out the principle of a balance of power. But the idea of nationality had been almost entirely ignored—necessarily so because it was not yet ready for expression. Territories had been bartered about without much reierence to the wishes of their inhabitants. Until an even greater settlement took place at Versailles after World War I it was customary for historians to condemn the statesmen of Vienna. It is now realized how difficult their task was, and the fact that they secured for Europe a period of peace, which was its cardinal need, is fully recognized. But the statesmen failed to give to international relations any organ by which their work could be adapted to the new forces of the 19th century, and it was ultimately doomed to destruction.

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VIENNE, a department of west-central France, formed in 1790 out of Poitou (four-fifths of its present area), Touraine (one-seventh), and Berry, and bounded by Deux-Sèvres on the west, Charente on the south, Haute-Vienne on the southeast, Indre on the east, Indre-et-Loire on the northeast and north and Maine-et-Loire on the northwest. Pop. (1946) 313,932. Area 2,720 sq.mi. The department includes the basin of the Vienne from the point at which it emerges from the Plateau Central down to its junction with the Creuse, while its extreme southwest corner includes a small part of the course of the Charente. It contains the famous gate of Poitou (Seuil du Poitou) between the Plateau Central and the Gâtine, the historic southwest entry into the Paris basin. The winter average temperature is 39° to 41° F., the summer average temperature being 66° to 68° F. The prevailing winds are from the southwest and west. The annual rainfall is 24 in. in the north to 32 in. in the south.

Wheat, oats and barley are the principal cereals grown, other important crops being lucerne, sainfoin, clover, mangel-wurzels and potatoes with some colza and hemp. The district of Poitiers produces good red wine, and the white wine of Trois-Moutiers near Loudun is well known. The breeding of livestock is fairly active. Poitou is famous for its mules, and the geese and turkeys of the department are highly esteemed. Among the fruit trees are the chestnut, walnut and almond. In the forests a small number of wild boars and other wild game survives. Freestone is quarried. There are mineral springs at La Roche-Posay. The most important industrial establishments are the national arms manufactory at Châtellerault and the cutlery works near that town. The capital of Vienne is Poitiers, and the department is divided into 3 arrondissements (Poitiers, Châtellerault, Montmorillon), 31 cantons and 298 communes. The chief towns are Poitiers, Châtellerault, Loudun, Chauvigny (*qq.v.*) and Montmorillon. Sanxay has ruins of a theatre and other Gallo-Roman remains nearby. Vienne is rich in megalithic monuments.

VIENNE, the chief town of an arrondissement of the department of the Isère, France. Pop. (1946) 23,519. Vienne stands on the left bank of the Rhône just below the junction of the Gère with the Rhône, between the river and low hills, and about 20 mi. by rail S. of Lyons. Its site is an immense mass of ancient *débris*, which is constantly yielding interesting antiquities. On the bank of the Gère are traces of the ramparts of the old Roman city, and on the Mont Pipet (E. of the town) are the remains of an amphitheatre, while the ruined castle there was built in the 13th century on Roman substructures. Several of the ancient aqueducts (one only is now actually in use) are still to be seen.

Vienne, originally the capital of the Allobroges, became a Roman colony about 47 B.C. under Caesar, who embellished and fortified it. A little later these colonists were expelled by the Allobroges; the exiles then founded the colony of Lyons (Lugdunum). It was not till the days of Augustus and Tiberius that Vienne regained all its former privileges as a Roman colony. Later it became the capital of the Provincia Viennensis. In 257 Postumus was proclaimed emperor here, and for a few years Vienne was the capital of a short-lived provincial empire. It is said to have been converted to Christianity by Crescens, the disciple of St. Paul. There were Christians here in 177, as in the Greek letter (preserved to us by Eusebius) addressed at that date by the churches of Yienne and Lyons to those of Asia and Phrygia mention is made of "the" deacori of Yienne. The first bishop certainly known is Verus, who was present at the Council of Arles in 314.

About 450 Vienne became an archbishopric and continued one till 1790, when the see was suppressed. The archbishops disputed with those of Lyons the title of "Primate of all the Gauls." Vienne was conquered by the Burgundians in 438, and in 534 was taken by the Franks. Sacked in 558 by the Lombards and in 737 by the Saracens, the government of the district was given by Charles the Bald in 869 to a Count Boso, who in 879 was proclaimed king of Provcnce, and was buried in 887 in the cathedral church oi St. Maurice. Vienne then continued to form part of the kingdom of Provence or Arles till in 1032 it reverted to the Holy Roman empire. Vienne was sacked in 1562 by the Protestants under the Baron dcs Adrets, and was held for the Ligue 1590–95, when it was taken by Montmorency. The fortifications were demolished between 1589 and 1636. In 1790 the archbishopric was abolished, the title "Primate of all the Gauls" being attributed to the archbishops of Lyons.

Ancient Monuments.— The town possesses two fine Roman monuments. One is the temple of Augusta and Livia, a building of the Corinthian order, built by the emperor Claudius, and inierior only to the Maison Carrée at Nîmes. From the 5th century to 1793 it was a church (Notre-Dame-de-Vie), and the "festival of reason" was celebrated in it at the time of the Revolution. The other is the Plan de *l'Aiguille,* a truncated quadrangular pyramid, about 52 ft. in height, resting on a portico with four arches; it is now generally believed to have been part of the *spina* of a large circus, the outlines of which have been traced. The church of St. Peter belonged to an ancient Benedictine abbey and was rebuilt in the 9th century. in the earliest Romanesque style. It has of late years been completely restored, and shelters the magnificent *Musée Lapidaire.* The former cathedral church of St. Maurice (11th to 16th centuries) has three aisles, but no apse or transepts. The most striking portion is the west front (1533), which rises irom a terrace overhanging the Rhône.

There are very important cloth factories and also distilleries, iron foundries, refining furnaces, etc. Vienne is the seat of a subprcfect, of a tribunal of commerce, a chamber of commerce and a board of trade arbitrators.

VIENNE, a river of central France, 217 mi. long, a left-hand tributary of the Loire. Rising on the plateau of Millevaches at a height of 2,789 ft., the Vienne flows westward through the hilly country of the crystalline rocks of the central plateau of France. The first large town on its banks is Limoges. below its confluence with the Taurion (right). The river next reaches St. Junien, turns abruptly northward to Confolens and passes on to the Jurassic rocks to flow through a picturesque and wider valley. Passing Chauvigny. it proceeds to the confluence of the Clain (left). on which stands Poitiers, just above Chhtellerault. Below that town it receives the Creuse (right). which rises on the Millevaches plateau and is 158 mi. long. From near Châtellerault, past Chinon, to its junction with the Loire the Vienne flows across Cretaceous strata. There is little river traffic on the Vienne below its confluence with the Creuse (30 mi.). (See LOIRE.)

VIENNE, COUNCIL OF, an ecclesiastical council, which in the Roman Catholic Church ranks as the 15th ecumenical synod. It met from Oct. 16, 1311, to May 6. 1312, under the presidency of Pope Clement V. The transference of the Curia from Rome to Avignon (1309) had brought the papacy under the influence of the French crown: and this position Philip the Fair of France now endeavoured to utilize by demanding from the pope the dissolution of the powerful and wealthy order of the Temple. together with the introduction of a trial for heresy against the late Pope Boniface VIII. To evade the second claim. Clement gave way on the first (see TEMPLARS). On the 22nd of March the order of the Temple was suppressed by the bull *Vox clamantis,* while further decisions as to the treatment of the order and its possessions followed later. Additional decisions were necessitated by the violent disputes which raged within the Franciscan order as to the observance of the rules of St. Francis of Xssisi.

See Mansi, Collectio Conciliorum, vol. xxv; Hefele, *Conciliengeschichte,* vol. vi, pp. 532–534.

VIERKANDT, ALFRED FERDINAND (1867–1953), German sociologist. who conceived of sociology as the study of human interactions, was born in Potsdam, June 4. 1867. He taught at the University of Berlin throughout most of his career. An early work. Die Stetigkeit im Kulturwandel (1908), anticipated many of the conclusions of F. Boas, A. Kroeber and W. Ogburn on the processes of culture change. Yierkandt was first greatly influenced by the phenomenology (*q.v.*) of E. Husserl and the instinct theory of W. McDougall. He later put greater emphasis on group function and structure in his *Familie,*. Volk, und Staat in *ihren gesellschaftlichen* Lebensvorgangen (1936; new ed., 1949). This work, appearing when National Socialism had virtually smothered sociology. gained little notice. but his *Kleine Gesellschaftslehre* (1949) made an impression after World War II.

Vierkandt edited a massive Handworterbuch der *Soziologie* (1931) to which most of the leading German sociologists contributed. He died in Berlin on April 24, 1953. (HD. BR.)

VIERSEN, a town in North Rhine-Westphalia, Ger., 11 mi. S.W. of Crefeld, at the junction of lines to München-Gladbach, Venlo, etc. Pop. (1950) 36,974. Viersen is one of the chief seats in the lower Rhine country for the manufacture of velvets, silks and plush, cotton, paper, boots and cement.

VIERZON, a town of central France, in the *département* of Cher, zo mi. N.W. of Bourges by rail. Pop. (1954) 26.808. The Cher and the Yèvre unite at the foot of the hill on which lies the greater part of Vierzon into which were incorporated Vierzon-Villages, Vierzon-Bourgneuf and Vierzon-Forges in 1937. The town has a port on the canal of Berry and is an important junction on the Orléans railway; there are several large manufactories for the production of agricultural machines, also foundries, porcelain, brick and tile works and glass works.

VIETA (VIÈTE), **FRANÇOIS,** SEIGNEUR DE LA BIGOTIÈRE (1540–1603), more generally known as FRANCISCUS VIETA, French mathematician, was born at Fontenay-le-Comte, in Poitou. On the completion of his studies in law at Poitiers, Vieta became an advocate in his native town, and later councilor of the *parlement* of Brittany. Rohan, the well-known chief of the Huguenots. took Vieta under his special protection. After the accession of Henry IV, Vieta became in 1589 councilor of the parlement at Tours, and subsequently a royal privy councilor.

While at Tours he discovered the key to a Spanish cipher consisting of more than 500 characters, so that all the dispatches in that language which fell into the hands of the French could easily be read. Philip II was so convinced that his cipher was a safe one that when he found the French were aware of the contents of his letters he complained to the pope that the French were using sorcery against him. Vieta printed numerous papers on various branches of this science, and distributed them to scholars in almost every country of Europe. Vieta has been called the father of modern algebraic notation. All that is nanting in his writings, especially in his *Isagoge* in *artem* analyticam (1591), in order to make them look like a modern school algebra is merely the sign of equality. His *Recensio canonica effectianum geometricarum* was what is now called an algebraic geometry. He conceived methods for the general resolution of equations of the second, third and fourth degrees different from those of L Ferrari, with which, however, it is difficult to believe him to have been unacquainted. He knew the connection existing between the positive roots of an equation (which, in his day. were alone thought of as roots) and the coefficients of the different powers of the unknown quantity. He found out the formula for deriving the sine of a multiple angle. In his *Apollonius Gallus* (1600) Vieta made use of the centre of similitude of two circles.

Vieta's collected works were issued under the title of *Opera Mathematica* by F. van Schooten at Leiden in 1646. (O OE.)

VIETNAM, a country of Indochina. bounded on the north by China, on the east and on the south by the Gulf of Tongking and by the South China sea and on the west by Cambodia and by Laos. It extends from lat 8° 33' to lat 23° 2′ N and from long. 102° 11′ to long. 109° 28' E. While the northern and southern extremities of Vietnam are more than 1,000 mi. apart, the maximum east-west extension is about 330 mi. (in the north) and the minimum less than 40 mi. (in the centre). From July 21, 1954, Vietnam was de facto partitioned in two independent republics: the Democratic (Communist) Republic of Vietnam in the north (area: 60,1j6 sq.mi.; pop. [1957 est.] 14,900,000) and the Republic of Vietnam (area: 65,948 sq.mi.; pop. [1958 est.] 12,366,291) in the south.

Physiography.— The geography of Vietnam is best considered zone by zone.

Northern Vietnam.—Northern Vietnam comprises two distinct regions: the delta. 5,670 sq.mi.; and the mountains. 39,330 sq.mi. The mountains represent the end of the southern Chinese foldings: granitic and calcareous formations alternate. the latter having been so much eroded. north of Red river. that they stand out in intricate and striking relief. South of the river, the folds have a northwest-southeast direction. which the rivers follow. The highest peak is Fan Si Pan (11,191 ft.).

The Red river has its source in Yunnan and a course of 745 mi.. with a discharge of nearly 25,000 cu.ft. per second at low water and of nearly 1,060.000 cu.ft. at flood. Its alluvial deposits have formed the delta. over which it flows at high water. often threatening to burst the dykes and flood the rice fields. The delta of the Song Thai Binh, on which the port of Haiphong stands, is merged with that of the Red river. The coast is muddy. apart from the fine bay of Along and the eastern extremity. which is bordered with islands.

Central *Vietnam.*—The long coast line of central Vietnam is backed by a series of alluvial plains in front of the rocky bastions of the Annamite chain of mountains. The most important of these little plains are those of Thanh Hoa and of Vinh in the north. of Hué in the middle and of Qui Nhon in the south. The coast line itself consists of a succession of dunes and promontories. The Annamite mountains are in some places more than 70 mi. from the coast. though in others they approach within 30 mi. from it.

In the south the Moi plateaus are more extensive, reaching their highest point in the peak of the Mother-and-Child (6.634 ft.) near Cape Varella. Passes across the chain connect central Vietnam with Laos. The streams are torrential, except where they cross the plains.

Southern Vietnam. — In Quaternary times a gulf of the sea was silted up by alluvial deposits of the Mekong (*q.v.*) to form the southern part of what is now Vietnam; some areas were later solidified, others remained marshy. In the east the Rivière de Saïgon and its tributaries drain a group of hills and constitute a system distinct from that of the Mekong. which enters the sea in several branches. The coast is flat and muddy. The little island of Poulo Condore lies about 60 mi. offshore.

Climate, Vegetation and *Animal* Life. — The climate of Vietnam is that of tropical monsoon Asia: equatorial in the south, somewhat milder in the north. At Saigon. in the south, the annual variation of temperature is very slight. averages being 26° C. in January and 29° C. in April. At Hanoi in the north the average temperature is 28° C. for June but only 1 j° C. for January; and the minimum can be as low as 6° C. The summer monsoon, coming from the Pacific. brings rain from May to October (a little later in central Vietnam). Rainfall. which amounts to 58 in. at Saigon and at Hanoi. reaches its maximum in central Vietnam, where Hué gets 116 in. and the mountains even more.

The forests of the north resemble those of southern China, with many species of deciduous trees and an undergrowth of rattans and bamboos. In the south are tropical evergreen forests containing numerous economically valuable species (such as the "sao," the "dan" and the "ban lang") and many palms (*e.g.*, the *Latania* and the coconut palm). In the hills pines (*Pinus* merkusii and P. *khassya*) form almost continuous cover.

Deer. buffaloes. wild oxen. elephants, tigers and panthers are plentiful in the mountainous areas (especially in the south). as fish are on the seaboard. Fish and crustaceans are also abundant in the rivers. in the streams, in the lakes and even in the paddy fields.

History. — Excavations in the caves of Pho-Binh-Gia and of Luang-Com in the north and in those of Minh-Cam in central Vietnam have revealed skulls of a Negrito type in the lower strata and skulls of an Indonesian type. to be assigned to an early Neolithic period, in the upper strata. The Bronze-Age culture. represented by extant specimens of work testifying to a high degree of artistry (notably those of Dong-Son). belongs to the time when Mongoloid peoples from China entered the country and mingled with the Indonesians to form the Vietnamese. Iron seems not to have been worked before the first centuries of the Christian era.

The Vietnamese people had their origin in the delta of the Red river, where. by turning the marshes into paddy fields, a steady gron·th of population was made possible. The adjacent mountains, however. remained occupied by Indonesians until the latter had to retreat before new invasions from China (the Thai from the 13th century onward. the Man and the Meo from the 16th).

Champa.—Throughout the middle ages the greater part of the coast south of the delta of the Red river and north of that of the Mekong was held by the Chams, an Indonesian people to whom a Hindu civilization had been brought from India late in the 2nd century A.D. Seafarers, the Chams traded in spices. in aloes wood and in ivory; their monumental art resembles that of the Khmers. Their kingdom. Champa. which had its capital first at Indrapura (near Touranej. then at Vijaya (near Qui Nhon). lasted for more than 1.200 years but was continually engaged in warfare against Cambodia. with great vicissitudes of fortune. In 1470. however. the Vietnamese (see below). who in the previous century had already advanced their frontier to a line south of Indrapura. won a decisive victory over the Chams. Thereafter Champa disintegrated, till by the end of the 17th century it no longer existed as a political entity.

The Mekong delta itself was part of the Khmer kingdom in the middle ages (see CAMBODIA). The mountains. meanwhile, mere occupied by primitive tribes of Indonesians (called Moi).

Nam-Viet, Annam.—In 207 B.C. a Chinese general who had been appointed governor of the southern province of the empire set up the kingdom of Nam-Viet on the Red river. This kingdom, however, was overthrown by the Chinese under the Han dynasty in the year 111 B.C., whereupon the country became a Chinese province under the name of Giao-Chi, which was later changed to Annam ("Dominion of the South"). Thus Chinese civilization came to mold the lives of the Vietnamese. There were occasional revolts (one. in A.D. 43, was led by two sisters), but these met with no success. The T'ang emperors ruled very oppressively; but their successors in the 10th century weakened their hold on the "land of the south" (Yietnam), which recovered its independence, though theoretically acknon·ledging Chinese overlordship.

After a period of anarchic feudalism, the country was unified by the Li dynasty (11th–13th centuries). The next dynasty. that of the Tran (13th–14th centuries), both repelled the Mongol invasion sent by Kublai Khan and also conducted a successful campaign against Champa (*see* above). Early in the 15th century the country was again under Chinese control for a few years; then a new dynasty. that of the Lê, expelled the Chinese. Le-Thanh-Ton, a great ruler (1466–97), won the victory of 1470 over the Chams; he also established an effective system of administration.

The Vietnamese planted military colonies throughout the former Cham territories. From these, they next began to spread into the hlekong delta, displacing or subduing the few Khmers who were holding it (17th century onward). By the beginning of the 19th century they had overrun the whole delta.

Though the emperors of the Lê dynasty were still theoretically supreme, real power, from the middle of the 16th century. was shared between two families. the Trinh in the north and the Nguyen. with their capital at Hué. to the south. The expansion of the empire over the Cham and Khmer lands was the work of the house of Kguyen; and this family, as its power increased, came more and more into conflict with its northern rivals, the Trinh, particularly in the course of the 18th century.

European contacts began with the visits of Portuguese ships in the 16th century. In the 17th century Dutch and English merchants established counters at Hanoi and Catholic missionaries went to work throughout Annam. It is to one of these missionaries, Alexandre de Rhodes. a Frenchman. that the credit for inventing the *quoc-ngu* (*i.e.*, the adaptation of the Roman alphabet to the Vietnamese language) chiefly belongs.

The insurrection of the Tay-Son (1773) overthrew both the Trinh and the Nguyen; but a IS-year-old member of the latter family, Kguyen Anh (1762–1820) succeeded in organizing a counterrevolution in the south and, with the help of a French bishop, P. J. G. Pigneau de Behaine, and a number of French officers, defeated the Tay-Son, advanced northward, entered Hanoi and, in 1802, under the name of Gia-Long, became emperor of a unified Vietnam (Annam). Gia-Long's policy of friendship with France, however, was abandoned by his successors Minh-Mang (1820–41) and Tu-Duc (1848–83), who began a terrible persecution of the Christians. This led to intervention and eventually to conquest by France in the latter half of the 19th century and thus to a long period of French rule before Vietnam recovered its independence after World War II.

For this French period, for the Indo-Chinese War and for the Geneva convention of 1954, which cut Vietnam in half, see INDO-CHINA.

Partition.— Pierre Mendes-France. who became French premier in june 1954, decided to put an end to the war in Indochina. As there was no hope to maintain French rule there he proposed to negotiate an armistice. This was signed on July 21 at the Geneva conference at which France, the United Kingdom, the United States, the C.S.S.R., Communist China: the two de *facto* states of Vietnam. Laos and Cambodia participated. The armistice ended the seven years' war in Indochina and. among other things. "provisionally" partitioned Vietnam into a Communist state on the north and a national one on the south. divided by the Ben-Hoi river. near the 17th parallel. Elections in both parts of Vietnam were to be held within two years, with the aim of recreating a unified government.

The Democratic Republic of Vietnam. with its capital at Hanoi, was organized on Communist lines. Ho Chi Minh became the president. and Pham Van Dong the chairman of the council of ministers. On Oct. 29. 1956, the central committee of the Lao Dong (Workers' or Communist) party dismissed Truong Chinh, the party first secretary, as responsible for the excesses of the land reform program; Ho Chi Minh succeeded him without ceasing to be head of state. The three-year plan of rehabilitation was said to have been successfully fulfilled in July 1957. About 80 big and medium industrial enterprises had been built and 240 rebuilt with Chinese. Soviet. Polish and Czechoslovak aid.

The National state, with its capital at Saigon, had Bao Dai, the former emperor of Annam, as chief of state, but on Oct. 23, 1955, over 98% out of an electorate of 5,000,000 deposed Bao Dai and declared that Ngo Dinh Diem, the prime minister. was to be head of state. Three days later Ngo proclaimed himself president of the republic under a provisional constitution. The following year Ngo withdrew his country's representatives from the assembly of the French union. On July 21, 1956, the post of French high commissioner was abolished and an ambassador was accredited instead.

A constituent assembly of 123 members (with 66 representing Ngo's National Revolution movement) was elected on March 4, 1956, and a new constitution was adopted on July 7. .The president of the republic, elected by direct popular vote for six years, was to be the head of government. The armed bands of the sects were defeated and strong measures were taken against Communist agitation. An agreement signed on May 8. 1956, between the United Kingdom and the U.S.S.R., the co-chairmen of the 1954 Geneva conference, postponed the general elections that were to reunify the two Vietnams.

Population.— In 1957 the total population of Vietnam was estimated at 27,200,000. Density of population is greatest in the Tongking delta. where it is more than 1,000 per square mile, with the result that famine is chronic and emigration considerable. The little plains of the central zone are also densely populated (more than 200 per square mile).

The Vietnamese. who occupy the plains, number more than 22,000,000. Other peoples include the Cambodians in the south (300,000), the Moi in the Xnnamite chain of mountains (720,000), and the Thai (700,000), the Muong (200,000), the Man (90,000) and the Meo (80,000) in the northern mountains. To these must be added the 400.000 Chinese tradesmen of the towns and 40,000 people of European or partly European descent.

The Vietnamese belong to a southern branch of the Mongoloid races. They are, on an average, a little taller in the north than in the south, where there is a stronger admixture of Indonesian blood. Their language is monosyllabic and can be written either in Chinese characters or in the quoc-ngu alphabet, which is based on the Roman. Chinese civilization has had a great influence on their way of life.

There are many towns with more than 20.000 inhabitants and five large towns: Saigon (1958 est.) 1,219,500. including the port of Cholon; Tourane (1958 est.) 100,978; and Hué (1958 est.) 90.682 in the Republic of Vietnam; Hanoi (1955 est.) 274.000, and the port of Haiphong (1954 est.) 217,000 in the Democratic Republic of Vietnam. Most of the people live in villages, each within its bamboo pale, constituting a largely self-governing commune under the administration of a council of notables.

Religion is mainly ancestor-worship, influenced by Confucianism. by Taoism and by Chinese Buddhism: but more than 2,000,000 Vietnamese are Roman Catholics; and large numbers adhere to modern sects, for instance to Cao-Dai (a syncretism of Christianity and Buddhism) and to Hoa-Hao (a prophetic faith developed from Buddhism).

The Thai. who are racially akin to the Laotians. and the Muong. who are closer to the Vietnamese, have their paddy fields in the valleys but also use the *ray* (terrace) method of growing rice and tubers in the mountains. where the forests on the slopes have to be burned down first; their social structure is quasi-feudal. The Rlan and the Meo occupy the highest ground, where they raise livestock and grow maize and opium.

The Moi (*i.e.*, "savages." so called by the Vietnamese) are the descendants of Indonesians driven into the mountains by invaders. There are several difierent groups of them: some (the Sedang and the Bahnar) speak Mon-Khmer languages, others (the Jarai and the Rhadé) various Indonesian dialects. They live by the *ray* method of agriculture, by fruit picking. by fishing or by hunting. Their clothing consists of a loincloth, their houses are built on piles. Some of them have a matrilineal system of family-reckoning. Social organization goes no farther than the confines of the villages; and ritual is limited to the family circle, within which it is mainly a matter of ancestor worship and of fertility ceremonies.

Economy.— Rice is the principal export oi Vietnam, representing more than one-third of the total value of the country's exports: beiore World War II only two countries in the world exported more rice. Other principal exports are coal (irom Hongay, on the Tongking coal field), rubber and maize. The tea and coffee plantations suffered considerable damage in the course of the war. Forestry, fishing and stock raising (oxen, buffaloes, pigs and chickens) are mainly concerned with supplying the local markets; and the principal industries (cement, textiles and fish curing) also serve local needs. Imports consist for the most part of manufactured goods, machinery, automobiles and textiles.

The major ports are Cholon and Haiphong. The railway along the coast (1,073 mi.) and the road network (15,500 mi.) were largely disorganized by the war. In the late 1950s the Hanoi-Yunnan railway was rebuilt.

The unit of currency is the piastre. That of the Republic of Vietnam has a value of 35 piastres to the U.S. dollar.

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(HU. DE.; X.)

VIETNAMESE LANGUAGE is spoken by over 20,000-000 people in Vietnam and Vietminh, the two sections of what nas called Annam in Indochina. The area occupied by speakers of the language is the Tongkinese delta in the north. the plain of Cochin-China in the south, and the long, narrow coast line betneen. There are a number of dialects. Those of the Tongkinese delta are very similar to one another. Those of Cochin-China, of which that of Saigon is typical, differ somewhat from the northern dialects in pronunciation and vocabulary, but these two groups are mutually intelligible. Many of the dialects of the central coast line differ considerably irom those of north and south.

The language is a typical monosyllabic, nonlnflecting, tonal language The grammar is marked by rigid rules of word order. The major parts of speech, which are distinguished by the positions they occupy in the sentence. include nouns and verbs of several kinds. One class of nouns is the classifiers which are used when nouns are numerated. An interesting feature of the noun system is the use of kinship terms as pronouns. Minor parts of speech include conjunctions and sentence-ending particles: the latter mark sentences as questions, expressions of doubt and the like.

Indochina came under Chinese political influence at least as early as 2,000 years ago. Beginning from that period speakers of Vietnamese have continually borrowed Chinese words. At present the vocabulary of the everyday language contains about 50% Chinese loanwords and that of literature more, sometimes up to 90%. This vocabulary abounds in compounds which were first coined in Chinese.

The first writing known in Indochina was Chinese, and down to the last century all literary and official writing was done in Chinese. A system was evolved of writing Vietnamese with Chinese characters adapted to show Vietnamese pronunciation; it was called *chữ' nôm* "the vulgar writing." The earliest known document is dated A.D. 1343. It was used chiefly for writing popular literature which had no connection with official matters. In the 17th century Catholic missionaries invented a roman transcription for the language, complete with indications of all phonemic distinctions, including the tones. The system is called *quô'c ngữ'* "the national language." The earliest printing using it seems to have been done in 1649. It was adopted by the French for official use as early as 1910. At present it is used for all purposes, and is well adapted to popular education.

In Tongkin are spoken dialects called *Mu'o'ng,* which are closely allied to Vietnamese. The group has variously been held to belong to the Thai family with borrowed Khmer vocabulary, or to the Khmer family with borrowed Thai vocabulary.

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VIGANO, SALVATORE (1769–1821), Italian dancer and choreographer noted for the stirring realism of his dramatic ballets. such as *La Vestale, Otello* and *I Titani.*

Born March 25, 1769, in Naples, he made his debut in Rome. During an engagement in Madrid: he married the dancer Maria Medina. There he also met Jean Dauberval, pupil of Jean Georges Noverre, who strongly influenced his choreography.

With his beautiful. accomplished wife. Viganò toured Italy and Germany. In Vienna he created several ballets, including *Prometheus* (1801), on which he collaborated with Beethoven. In 1811 he became choreographer of La Scala, Milan, where his finest works were produced. He died in Milan Aug. 10, 1821. (LN. ME.)

VIGEE-LEBRUN, MARIE ANNE ELISABETH (1755–1842), French portrait painter, a general favourite at the courts of Europe, was born in Paris on April 16, 1755. the daughter of a painter, from whom she received her first instruction. though she benefited more by the advice of Gabriel François Doyen. Jean Baptiste Greuze, Joseph Vernet and others. When only about 20 years of age she had made her name by her portraits of Count Orloff and the duchess of Orleans. In 1776 she married the painter and art critic Jean Eaptiste Pierre Lebrun, and in 1783 her picture of "Peace Bringing Back Abundance" (Louvre) gained her membership in the French Academy. When the Revolution broke out in 1789 she escaped first to Italy, where she worked in Rome and Naples. In Rome she painted the princesses Adelaide and Victoria. and at Naples "Lady Hamilton as a Bacchante." She then visited Vienna, Berlin and St. Petersburg, returning to Paris in 1802. In April 1802 she went to London, where she painted Byron and the prince of Wales. She was a great traveler, and her portraits are to be found in the collections of many countries. She died in Paris on March 30, 1842, at the age of 87, having been widowed for 29 years.

Among her many sitters was Marie Antoinette, of whom she painted over 20 portraits between 1779 and 1789. A portrait of the artist is in the hall of the painters at the Uffizi gallery, Florence, and another at the National gallery, London. The Louvre owns two portraits of Mme. Lebrun and her daughter. besides five other portraits. A full account of her eventful life is given in her *Souvenirs* (1835–37), which was translated by Lionel Strachey, *Memoirs of Madame Vigée-Lebrun* (1903).

VIGELAND, ADOLF GUSTAV (1869–1943), Norwegian sculptor, was born at Mandal in southern Norway on April 11, 1869. Vigeland studied in Oslo. Copenhagen. Paris, Berlin, Rome and Florence. He created the Frogner park in Oslo, where most of his major works are displayed around a bridge. fountain and monolith. The massive, nude figures of more than 100 men, women and children in granite and bronze were powerfully yet sensitively executed. After Yigeland's death at Oslo on March 12, 1943, his studio was opened as a Vigeland museum. Yigeland also achieved a wide reputation as a portrait sculptor. His imaginative study (1905) of N. H. Abel, considered among his finest works. shows the influence of Auguste Rodin. Later he adopted a more classic style.

VIGEVANO, a town and episcopal see of Lombardia. Italy, in the province of Pavia, on the right hank of the Ticino, 24 mi. S.W. from Milan by rail on the line to Mortara, 381 ft. above sea level. Pop. (1951) 37,101. It is a medieval walled town, with an arcaded market place and a castle of the Sforza family, dating from the 14th century and adorned with a loggia by Bramante and a tower imitating that of Filarete in the Castello Sforzesco at Milan.

VÍGFÚSSON, GÚDBRANDR (1828–1889), the foremost Scandinavian scholar of the 19th century, was born of a good Icelandic family in Breiðafjord. In 1849 he came to Copenhagen university as a *bursarius* in the Regense college. He was, after his student course, appointed *stipendiarius* by the Arna-Magnaean trustees, and worked for 14 years in the Arna-Magnaean library till, as he said, he knew every scrap of old vellum and of Icelandic written paper in that whole collection. During his Danish life he twice revisited Iceland (last in 1858), and made short tours in Norway and south Germany with friends. In 1866, after some months in London, he settled down in Oxford, which he made his home for the rest of his life. He held the office of reader in Scandinavian at the University of Oxford (a post created for him) from 1884 till his death. He was a jubilee doctor of Upsala, 1877, and received the Danish order of the Dannebrog in 1885. Vígfússon died of cancer and was buried in St. Sepulchre's cemetery, Oxford. His memory was remarkable; if the whole of the Eddic poems had been lost he could have written them down from memory.

By his *Túnatál* (written between Oct. 1854 and April 1855) he laid the foundations for the chronology of Icelandic history, in a series of conclusions that have not been displaced (save by his own additions and corrections), and that justly earned the praise of Jacob Grimm. His editions of Icelandic classics (1858–68), *Biskopa Sögur, Bardar Saga, Forn Sögur* (with Mobius), *Eyrbyggia Saga* and *Flatcyar-bdk* (with Unger) opened a new era of Icelandic scholarship, and can only fitly be compared to the Rolls Series editions of chronicles by Dr. Stubbs for the interest and value of their prefaces and texts. Seven years of constant and severe toil (1866–73) were given to the Oxford Icelandic-English dictionary, incomparably the best guide to classic Icelandic, and a monumental example of single-handed work. His later series of editions (1874–85) included *Orkneyinga* and *Háconar Saga,* the great and complex mass of Icelandic historical *sagas,* known as *Sturlunga* and the *Corpus Poeticurn Boreale,* in which he edited the whole body of classic Scandinavian poetry.

VIGIL, in the Christian Church, the eve of a festival. The *vigiliae* (*pernoctationes, παννυχίδες*) were originally the services celebrated during the night preceding the feast. The abuses connected with nocturnal vigils led to their being attacked, especially by Vigilantius of Barcelona (c. 400), against whom Jerome fulminated in this as in other matters. The custom, however, persisted until the middle ages, when the nocturnal *vigiliae* were, except in the monasteries, gradually discontinued, the vigil services, with the term itself, being transferred to the day preceding the feast. The only surviving relic of the older custom, in the Roman Catholic Church, is the midnight mass at Christmas.

The Church of England has a special collect, gospel and epistle for "Easter Even" only. For the other vigils recognized, the rubric directs that the collect appointed for the feast "shall be said at the Evening Service next before."

VIGILANCE COMMITTEE, in the United States, a self-constituted judicial body, occasionally organized in the western frontier districts for the protection of life and property. The first committee of prominence bearing the name was organized in San Francisco in June 1851, when the crimes of desperadoes who had immigrated to the gold fields were rapidly increasing in number and it was said that there were venal judges, packed juries and false witnesses. At first this committee was composed of about zoo members; afterwards it was much larger. The general committee was governed by an executive committee and the city was policed by sub-committees. Within about 30 days four desperadoes were arrested, tried by the executive committee and hanged, and about 30 others were banished. Satisfied with the results, the committee then quietly adjourned. but it was revived five years later. Similar committees were common in other parts of California and in the mining districts of Idaho and Montana. That in Montana exterminated in 1863–64 a band of outlaws organized under Henry Plummer, the sheriff of Montana City; 24 of the outlaws were hanged within a few months. Committees or societies of somewhat the same nature were formed in the Southern States during the Reconstruction period (1865–72) to protect white families from Negroes and "carpetbaggers," and besides these there were the Ku Klux Klan *(q.v.)* and its branches. the Knights of the White Camelia, the Pale Faces and the Invisible Empire of the South. the principal object of which was to control the Negroes by striking them with terror.

See T. J. Dimsdale, *The Vigilantes of Montana* (Virginia City, 1866); H. H. Bancroft, *Popular Tribunals* (San Francisco, 1887); P. Garnett, ed., *Papers of the San Francisco Committee of Vigilance of 1851* (Berkeley, Calif., 1910–19); Mary Floyd Williams, ed., *Papers of the San Francisco Committee of Vigilance of 1851* (Berkeley, 1919); Mary Floyd Williams, *History of the San Francisco Committee of Vigilance of 1851* (Berkeley, 1921); and William John McConnell, *Frontier Law* (Yonkess-on-Hudson, N.Y., 1924).

VIGILANTIUS (*fl.* c. 400), the presbyter, celebrated as the author of a work, no longer extant, against superstitious practices, which called forth one of the most violent and scurrilous of Jerome's polemical treatises, was born about 370 at Calagurris (Cazères or perhaps Saint Bertrand de Comminges, Haute-Garonne), where his father kept a "statio" or inn on the great Roman road from Aquitania to Spain. Sulpicius Severus sent him in 395 with letters to Paulinus of Nola. On his return to Severus in Gaul he was ordained, and set out for Palestine, where he was received by Jerome at Bethlehem. Vigilantius was dragqed into the dispute then raging about Origen, in which he did not see eye to eye with Jerome. About 403, some years after his return from the East, Vigilantius wrote his work against superstitious practices, in which he argued against relic worship, as also against the vigils in the basilicas of the martyrs, the rejection of earthly goods and the attribution of special virtue to the unmarried state, especially in the case of the clergy. All that is knomn of the work is through Jerome's treatise *Contra Vigilantium,* or, as that controversialist would seem to prefer saying, "Contra Dormitantium." 'ihe influence of Vigilantius long remained potent both in France and Spain, as is proved by the polemical tract of Faustus of Rhegium (d. c. 490).

VIGILIUS, pope from 537 to 555, succeeded Silverius *(q.v.)*. having been elected and consecrated pope by order of Belisarius in March 537 while Silverius was still alive. His elevation was due to the empress Theodora. who had induced him to promise to disallow the council of Chalcedon. in connection rvith the "Three 'Chapters" controversy. Failing to fulfil his promise, he was summoned to Constantinople. which he reached in 547. There he issued a document known as his *Judicatum* (548), in which he condemned indeed the "Three Chúpters" but expressly disavowed any intentions thereby to disparage the council of Chalcedon. After some trimming, he prepared another document, the *Constitutum* cd *Imperatorem,* which was laid before the second council of Constantinople (553) and led to his condemnation by the majority of that body. some say even to his banishment. Ultimately, however. he was induced to confirm the decrees of the council and was allowed after an enforced absence of seven years to set out for Rome. He died at Syracuse, before he reached his destination, on June 7, 555.

VIGLIUS, the name taken by WIGLE VAN AYTTA VAN ZUICHEM (1507–1577), Dutch statesman and jurist, a Frisian by birth. who was born on Oct. 19, 1507. Having lectured on law at the universities of Bourges and Padua, he accepted a judicial position under the bishop of Munster which he resigned in 1535 to become assessor of the imperial court of justice (*Reichskammergericht*). In 1542 he became a member of the council of Mechlin, and some years later president of that body. He was soon one of the most trusted of the ministers of Charles V. He was generally regarded as the author of the edict against toleration issued in 1550; a charge which he denied. When the emperor abdicated in 1555 Viglius was anxious to retire also. but at the instance of King Philip II he remained at his post and was rewarded by being made coadjutor abbot of St. Bavon. and in other ways. In 1559, when Margaret, duchess of Parma, became regent of the Netherlands, Viglius was an important member of the small circle who assisted her in the work of government. He was president of the privy council, member, and subsequently president, of the state council, and a member of the committee of the state council called the *consulta.* In 1565 he was allowed to give up the presidency of the state council! but was persuaded to retain his other posts.

However, Viglius had lost favour with Margaret, who accused him to Philip of dishonesty and simony, while his orthodoxy was suspected. When the duke of Alva arrived in the Netherlands Viglius at first assisted him; but he subsequently opposed the duke's scheme of extortion.

Viglius died at Brussels on May 5, 1577.

He wrote a *Tagebuch des Schmalkaldischen Donaukriegs,* edited by A. von Druffel (1877), and some of his lectures were published under the title *Commentarii in decem Institutionum titulos* (1564). His *Vita et opera historica* are given in the *Analecta Belgica* of C. P. Hoynck van Papendrecht (1743).

VIGNOLA, GIACOMO DA (GIACOMO BAROZZI or BAROCCHIO) (1507–1j73j. with Andrea Palladio *(q.v.)* the most important Italian architect- of the later 16th century. He was bom at Vignola. between Modena and Bologna. on Oct. 1,.1507, and, after studying in Bologna, he went to Rome in the 1530s and made drawings of the antiquities for a projected edition of Vitruvius' treatise. In 1541–43 he spent 18 months at the court of Francis I at Fontainebleau and in Paris, and there he must have met his fellow Bolognese Sebastiano Seriio. On his return to Italy he built the Bocchi palace at Bologna and then went to Rome (c. 1550) where he was appointed architect to Pope Julius III, for whom he built the Villa Giulia (now the Etruscan museum) in collaboration with Giorgio Vasari and Bartolommeo Ammanati, between 1551 and 15jj. This was a summer villa, based on ancient villa types as drscribed by Pliriy the Younger, with a small house and an elaborate garden. In 1554 he built the church of S. Andrea in the nearby Via Flaminia, the first church to have an oval dome, although the ground plan is rectangular. In his church of Sta. Anna dei Palafrenieri (begun c. 1572) Vignola extended this idea to include an oval in the ground plan. and this oval theme became a favourite of 17th-century architects. Vignola's most important church was. however, the Gesu in Rome, headquarters of the Society of Jesus, which he began in 1568. It was completed after his death. and not according to his design, but he established the plan, which is of the older cruciform type with side chapels and a broad nave adapted to the new importance attached to preaching. All over Europe there are versions of the Gesu, many by Jesuit architects.

After the death of his patron Julius III in 15jj, Vignola worked mainly for the Farnese family, for whom he completed the huge Villa Farnese at Caprarola, near Viterbo, the plan of which had been established earlier by Antonio da Sangallo and Baldassare Peruzzi. Vignola died at Rome on July 7. 1573.

The academic tendency of Vignola's mind is epitomized in his *Regola delli cinque ordini d'nrchitettura* of 1562, which remained a standard textbook on the architectural orders for three centuries. He also wrote on perspective—Dus *regole della prospettiva pratica,* published posthumously (1583) with a short life.

See J. Coolidge, "The Villa Giulia," *Art Bulletin,* vol. xxv, pp. 177–225 (1943). (P. J. My.)

VIGNY, ALFRED DE (1797–1863), French poet, was born at Loches (Indre-et-Loire) on March 27, 1797. For generations the ancestors of Alfred de Vigny had been soldiers, and he himself joined the army, with a commission in the Household Troops. at the age of sixteen. But the Revolutionary and Napoleonic wars were over. and after twelve years of life in barracks he retired. While still serving he had made his mark, if as yet unrecognized, by the publication in 1822 of a volume of poems, and in 1826 by another, together with the famous prose romance of *Cinq-Mars*, which derived some of its popularity from the enormous vogue of the novels of Scott. Some of his most celebrated pieces — Elon, *Dolorida, Moïse*—appeared (1822–23) before the work of younger members of the Romantic school whose productions strongly resemble these poems. Nor is this originality limited to the point which he himself claimed in the Preface to his collected *Poems* in 183; — that they were "the first of their kind in France, in which philosophic thought is clothed in epic or dramatic form." Indeed this claim is disputable in itself; it is in *poetic*, not *philosophic* quality. that his idiosyncrasy and precursorship are most remarkable. It is quite certain that the other Alfred — Alfred de Musset—felt the influence of his elder namesake. and the verses of Hugo, and even of Lamartine, considerably his elder, owe something to him. His poetry, written for the most part in the earlier part of his life, is small in volume. but it forms probably his chief title to fame.

Alfred de Vigny, though he belonged to no *cénacle,* but shut himself up, as the saying went, in a *tour d'ivoire,* belonged to the Romantic movement of the thirties, and was stimulated by it to drama and to novel writing. In the ·ear before the revolution of July he produced at the Théâtre Français a translation, or rather paraphrase, of *Othello,* and an original piece. *La Maréchale d'Ancre*. In 1832 he published the curious book *Stello,* containing studies of unlucky youthful poets—Gilbert. Chatterton. Chénier—and in 1835 he brought out his drama of *Chatterton,* which, by the hero's suicide, shocked French taste even after five years of Romantic education, but had a considerable success. The same year saw the publication of *Servitude et grandeur militaires,* a collection of sketches rather than a connected work in which Vigny's military experience, his idea of the soltlier's duties, and his rather poetical views of history were all worked in. The subjects of *Chatterton* and *Othello,* were. of course, drawn from English sources, and in fact Alfred de Vigny knew English well, lived in England for some time and married in 1828 an Englishwoman, Lydia Bunbury.

In 1845 Alfred de Vigny was elected to the Academy, but made no compromise in his "discourse of reception," which was unflinchingly Romantic. Still, he produced nothing save a few scraps: antl, beyond the work already enumerated, little has to be added except his *Journal d'un poète* and the poems called *Les Destinies*. Vigny died at Paris on Sept. 17, 1863.

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VIGO, a seaport and naval station of northwestern Spain. in the province of Pontevedra; on Vigo bay (Ria de Vigo) and on a branch of the railway from Tuy to Corunna. The population in 1950 was 51,636. Vigo was attacked by Sir Francis Drake in 1585 and 1589. In 1702 a combined British and Dutch fleet under Sir George Rooke and the duke of Ormonde destroyed a Franco-Spanish feet in the bay. and captured treasure of about £1,000,000. In 1719 Vigo was captured by the British: in 1936 by Spanish Nationalists. Vigo bay, one of the finest of the Galician fjords, extends inland for 19 mi., and is sheltered by low mountains and by the islands (Islas de Cies, ancient *Insulae Sic-cae)* at its mouth. The ton-n is built on the southeastern shore. and occupies a hilly site dominated by two obsolete forts. Vigo owes its importance to its deep and spacious harbour. and to its fisheries. It is a port of call for many lines trading between Western Europe and South America. The town contains flour. paper and sawmills, sugar and petroleum refineries. tanneries. distilleries and soap works.

VIIPURI, or VYBORG. U.S.S.R., formerly a seaport and summer resort of Finland in 60" 43' N., 28° 3j' E., at the mouth of the Saima canal on the Bay of Viipuri in the Gulf of Finland. Pop. (1959) 51,000. The canal links it with a series of lakes. Its exports are timber, timber products, cement and farm produce, and its imports coal. fertilizers, foodstuffs and manufactured goods. It is on glaciated granite hills surrounding the bay, guarded by the naval station of Björkö. Its castle. built in 1293 by Marshal Torkel Knutson. was the first centre for the spread of Christianity in Karelia. It was the chief loss to Russia in the winter war of 1940–41, was regained in 1941 after Finland entered World War II and was lost again to Russia in 1944.

VIJAYANAGAR ("the city of victory"), an ancient Hindu kingdom and ruined city of southern India. The kingdom lasted from about 1336 to 1565, forming during all that period a bulwark against the hlohammedan invasion from the north. The great part of its history is obscure: but its power and wealth are attested by more than one European traveller and also by the character of the existing ruins. At the beginning of the 14th century Mohammedan raiders had effectually destroyed every Hindu principality throughout southern India, but did not attempt to occupy the country permanently. In this state of desolation Hindu nationality rose again under two brothers. named Harihara and Bukka. of whom little more can be said than that they were Kanarese by race. The kingdom reached its greatest extent under Krishna Deva Raya (1509–29). In 1565, on the downfall of the kingdom, the confederate sultans of Bijapur, Ahmednagar and Golconda overwhelmed the Vijayanagar army in the plain of Talikota and sacked the defenceless city. The city has ever since remained a wilderness of immense ruins. which are now conserved by the government.

See R. Sewell, *A Forgotten Empire, Vijayanagar* (London, 1900; new ed., 1924); and B. A. Saletore, *Social and Political Life in the Vijayanagara Empire,* 2 vol. (Madras, 1934).

VIKING. A word *wicing,* "warrior," corresponding to the O. Norse *vikingr* and the modern *viking,* was current in England at least a century before the earliest recorded Scandinavian descents upon the West. Its Scandinavian equivalent early acquired the more specialized sense of "sea-warrior." and the modern term "Viking age" is a convenient designation of the phase of Scandinavian history which produced the incessant raiding expeditions characteristic of the 9th and early 10th centuries. Most of our evidence as to the Vikings of this period is derived from the literature of the lands which they visited. and is therefore essentially hostile. To contemporary chroniclers they were utterly hateful, faithless. cruel and enemies of civilization and the arts of peaceful life. Their own side of the story is untold. for the men who created the great literature of western Scandinavia had no certain memory of events or personalities in the true Viking age. Their character can only be inferred from the scale upon which their raids were planned, the forms of society which arose in the different lands of their settlement, and the archaeological evidence which reveals something of their culture. Judged in this way they cease to appear as a mere blind force of destruction. It becomes clear that they possessed their own culture. though it was not the culture of the Christian West. Long before the end of the 9th century they had learned to penetrate all the greater waterways of Europe. And the raids through which they gained this knowledge were only preliminary to wider voyages through which at last even the New World became known for a moment to men of Scandinavian birth.

The Viking Raids. — The Vikings began by more or less desultory raids. in the course of which they seized upon some island, which they generally used as an arsenal for attacks on the mainland. At first the raids were made in the summer, and the *first wintering* in any new scene of plunder meant settlement in the country, and some sort of division of territory. After that the northerners assimilated themselves more or less to the natives of the country. This course was followed in the history of the Viking attacks on Ireland, the earliest of their continuous series of attacks. Thus they began by seizing the island of Rechru (now Lambay) north of Dublin bay (A.D. 795) and in 20 years were on the northern. western and southern coasts; by A.D. 825 they ventured a considerable distance inland. In A.D. 832 came a large fleet under Turgesius (Thorgestr). The new invader extended his conquests till. in A.D. 832. one-half of Ireland (called Lethcuinn or Con's Half) had submitted; he established his wife: Ota, as a sort of *völva,* or priestess, in what had been one of Ireland's most famous literary monasteries, Clonmacnoise. Turgesius was killed soon after. in 845; and though in A.D. 853 Glaf the White was over-king of Ireland, the Vikings' power diminished. In the end, territory was—if by no formal treaty—ceded to their influence; and the (Irish) kingdoms of Dublin and Waterford were established on the island.

This sketch may be taken as the prototype of Viking invasion of any region of Western Christendom which was continuously attacked. Almost simultaneously with the attacks on Ireland came others, probably also from Norway, on the western coasts and islands of Scotland. Plunderings of Iona are mentioned in A.D. 802. 806, and in the course of a generation almost all the monastic communities in western Scotland had been destroyed. Gn the Continent there were three distinct regions of attack. The Danes early settled on the island of Walcheren, which had, in fact. been given by the emperor Louis the Pious to a fugitive Danish king. Harald by name, who sought the help of Louis and adopted Christianity. From the island the raids extended on either side: sometimes eastward as far as the Rhine. and so into Germany proper; at other times westward to the Somme. and thus into the territory of Charles the Bald, the future kingdom of France. Toward the end of the 9th century all Frisia between Walcheren and the German ocean seems to have been possessed by the invaders. The serious attacks of the pirates in any part of the empire distant from their own lands began about. the middle of the century. when they first wintered in the Seine territory. Their first attack on Paris was in A.D. 845: in A.D. 885–887 a much more important but unsuccessful one took place. the invaders receiving an indemnity for raising the siege and leave to pass beyond Paris into Burgundy. The settlement of Danes under Rollo on the lower Seine, *i.e.,* in Normandy, belongs to the next century.

The third region is the mouth of the Loire, where the island *point d'appui* was Noirmoutier. The Northmen wintered there in A.D. 843. No region was more oiten ravaged than that of the lower Loire, so rich in abbeys—St. Martin of Tours, Marmoutiers, St. Benedict, etc. But the country ceded to the Vikings under Hasting at the Loire mouth was insignificant and not in permanent occupation.

Near the end of the 9th century, however, the plundering expeditions which emanated from these three sources became so incessant and so widespread that we can signalize no part of west France as free from them, and at the same time much mischief was wrought in the Rhine country and in Burgundy. Unfortunately, at this point our best authority ceases; and me cannot well explain the changes which brought about the Christianization of the Normans and their settlement in Normandy as vassals of the West Frankish kings.

For the Viking attacks in the British Isles, the course of events is clearer. In its general features it follows the normal course. The Vikings had begun to visit the English coast about the end oi the 8th century, but their serious attacks do not begin till 838. Their first wintering was on the contiguous island of Thanet in A.D. 851. In 865 England was visited by a "great army," which overthrew the ancient kingdoms of Northumbria, Mercia and East Anglia. Wessex was saved only by Alfred's victory at Edington, after which Guthrum, the Danish leader, accepted baptism and settled with his men in East Anglia. But the forces defeated at Edington represented but half oi the Viking army in England at the time. The other half had already settled in Korthumbria, and the region between Humber and Welland.

The six territories which we have signalized—Ireland, Western Scotland, England, the three in West Francia which merged into each other by the end oi the 9th century—do not comprise the whole field of Viking invasion. To the east they twice sailed up the Elbe (A.D. 851, 880) arid burned Hamburg. Southwards they plundered iar up the Garonne, and in the north of Spain; and one fleet sailed round Spain, plundering, but attempting in vain to establish themselves in this Arab caliphate. They plundered on the opposite African coast, and got as far as the mouth of the Rhone. and thence to Luna in Italy.

In the third quarter of the 9th century two distinct tendencies appeared among the Vikings in the West. One section was ready to settle down and receive territory at the hands of the Christian rulers; the other section adhered to a life of adventure and of plunder. A large portion of the great army, unable to obtain settlement in England, sailed to the Continent and spread devastation far and wide. Under command of two Danish "kings." Godfred and Siegfried, they mere first in the country of the Rhinemouth or the Lower Scheldt; afterwards dividing their iorces, some devastated iar into Germany, others extended their ravages on every side in northern France down to the Loire. 'Ihe whole of these vast countries, Northern Francia and part of Burgundy and the Rhineland, were as much at their mercy as England before the battle of Edington, or Ireland before the death of Turgesius. But in every country alike the wave of Viking conquest now began to recede. The settlement of Normandy was the only permanent outcome of the ?-iking age in France. In England, under Edward the Elder and Aethelflaed, Mercia recovered a great portion of what had been ceded to the Danes. In Ireland a great expulsion of the invaders took place in the beginning of the 10th century. In the following generations the kingdoms of Denmark and Sweden became consolidated, and the energy of the Norwegian peoples found vent in the settlement of Iceland.

Severe as were the raids in Europe, and great as was the suffering —on account of which a special prayer, *A furore Normannorum libera nos* was inserted in some of the litanies of the West—if the Vikings had been nothing more than pirates their place in history would be insignificant. But the Viking outbreak has to some extent the character of a national movement. While some were harrying in the West others were founding Garðaríki (Russia) in the East; others were pressing farther south till they reached the eastern empire in Constantinople, so that when Hasting and Björn had sailed to Luna in the Gulf of Genoa the northern folk had almost put a girdle around the Christian world. There is every evidence that they were not a mere lawless iolk, but under suitable conditions, as in their 10th century colony of Jomborg, could develop an elaborate discipline and a strict code of honour. They mere not entirely unlettered, for the use of runes dates back considerably earlier than the Viking age.

The **Viking** Ships.—In certain material possessions—those belonging to war and naval adventure—the Vikings were ahead of the Christian nations. There is certainly a historical connection betn-een the ships which the tribes on the Baltic possessed in the days of Tacitus and the Viking ships, a fact which would lead us to believe that the art of shipbuilding had been better preserved there than elsewhere in northern Europe. Merchant vessels must, of course, have plied between England and France or Frisia. But it is certain that even Charlemagne possessed no adequate navy. Nor was any English king before Alfred stirred up to undertake the same task. The Viking ships had a character apart. They may have owed their origin to the Roman galleys; they did without doubt owe their sails to them. Their structure was adapted to short voyages in a sea not exposed to the most violent storms or dangerous tides. They were shallow, narrow in the beam, pointed at both ends, and so eminently suitable for manoeuvring (with oars) in creeks and hays. The Viking ship had but one large and heavy square sail, and when a naval battle was in progress it mould depend for its manoeuvring on the rowers. In saga literature we read of craft (of "long ships") with 20 to 30 benches of rowers, which would mean 40 to 60 oars. It is not probable that the largest viking ships had more than ten oars a side. As these ships must often, against a contrary wind, have had to row both day and night, it seems reasonable to imagine the crew divided into three shiits which would give twice as many men available to fight on any occasion as to row. Thus a zo oared vessel mould carry 60 men. Rut some 40 men per ship seems, for this period, nearer the average. In 896, it is incidentally mentioned in one place that five vessels carried 200 Vikings, an average of 40 per ship. Elsewhere about the same time we read of 12,000 men carried in 250 ships, an average of 48.

The round and painted shields of the warriors hung outside along the bulwarks; the vessel was steered by an oar at the right side. Prow and stern rose high; and the former was carved most often as a snake's or dragon's head. The warriors were well armed. The *byrnie,* a mail-shirt, is oiten mentioned in Eddic songs; so are the axe, spear, javelin, bow and arrows and the sword. An immense joy in battle breathes through the earliest Korse literature, which has scarce its like in any other literature; and we know that the language recognized a peculiar battle fury, a madness by which men were seized and which went by the name of "berserk's way" (*berserksgangr*). The courage of the Viking was proof against anything, even as a rule against superstitious terrors. He was unfortunately hardly less marked for cruelty and iaithlessness. It is also true, however, that they showed a capacity for government, and in times oi peace for peaceiul organization. Normandy was the best-governed part of France in the 11th century: and the Danes in East Anglia and the Five Boruughs developed a iorm of society remarkable ior its stability amid changing political conditions. Nevertheless, the significance of the Vikings in the history of western Europe lies less in the communities which they founded than in the stimulus given by their raids to the new military organization oi society out of which feudalism was presently to arise.

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VIKRAMADITYA, a legendary Hindu king of Uzjain, who is supposed to have given his name to the Vikram Samvat. the era which is used all over northern India. except in Bengal, and at whose court the "nine gems" of Sanskrit literature are also supposed to have flourished. The Vikram era is reckoned from the vernal equinox of the year 57 B.C.. but there is no evidence that that date corresponds with any event in the life of an actual king. As a matter of fact, all dates in this era down to the 10th century never use the mord Vikram, but that of Malava instead that being the tribe that gives its name to Malwa.

VILE, WILLIAM (d. 1767), English cabinetmaker and upholsterer, mas partner with John Cobb (q *v.*) from about 1750 to 1765. Vile appears to have been the senior member of the firm whose name appears in the royal accounts only during the period of the partnership. Vile worked for George III both before and after his accession to the throne. Existing accounts show that he supplied furniture also to Strawberry Hill (Middlesex), Longford castle (Wiltshire), and Came house (Dorset). A considerable quantity of superb furniture in the rococo style has been identified as Vile's and has established him as the leading cabinetmaker of the period. Pieces still in the royal collection. such as the jewel cabinet and the *secretaire* made for Queen Charlotte, are characteristic of Vile's best work, both for their imposing design and for the magnificent quality of detail, and rank among the finest pieces of furniture made in England He died in Sept. 1767.

See R. Edwards and M. Jourdain, *Georgian Cabinet-Makeus,* 3rd ed. (1955). (J. E. LE.)

VILL, the Anglicized form of the word *villa,* used in Latin documents to translate the Anglo-Saxon *tun,* "township." Ultimately vill and township became regarded as equivalent terms, and so remained in legal use until the ecclesiastical parish became regarded as the normal unit of local administration. In classical Latin *villa* had meant "country house." "farm," "villa" *(see* VILLA) ; but even by the 3rd century it had acquired the sense of village. Later it even displaced *civitas,* for city. In the Frankish empire *villa* was also used of the royal and imperial palaces or seats with their appurtenances.

VILLA, PANCHO (FRANCISCO) (1878–1923), Mexican revolutionary general, was born in the municipality of San Juan del Río. Durango, on June 5, 1878. At the age of 16 he killed a man for molesting his younger sister and then fled to the mountains. For the next 15 years he lived as a cattle rustler and bandit, meanwhile changing his name from Doroteo Arango to Francisco Villa, and came to be known as "Pancho." Occasionally he worked as a labourer, and on one of these occasions he was persuaded to join the Madero revolution against Pres. Porfirio Diaz in 1910. After Madero's victory, Villa remained in the irregular army. During the campaign against Pascual Orozco in 1912. Gen. Victoriano Huerta condemned Villa to death for insubordination, but Madero ordered a stay of execution and sent Villa to prison. Villa escaped from prison in Nov. 1912 and fled to the United States.

Soon after Madero's assassination in 1913 Villa returned to Mexico and joined Venustiano Carranza against Huerta; his cavalry became the most famous force in the revolutionary armies. After Carranza's victory. he and Villa split as a result of mutual distrust. They renewed the civil war and Villa was defeated in a series of battles. By late 1915, when the United States recognized Carranza, Villa was no longer a serious contender for power; but, in order to demonstrate that Carranza did not control northern Mexico, Villa executed 16 U.S. citizens at Santa Isabel in early 1916 and soon thereafter attacked Columbus. N.M. Pres. Woodrow Wilson then sent an expedition led by Brig. Gen. John J. Pershing to Mexico to capture Villa, but Carranza's unco-operativeness and Villa's popularity among the people of Chihuahua prevented Pershing from fulfilling his mission.

Villa continued his bandit-rebel activities as long as Carranza remained in power, at times capturing some of the larger northern cities, but as soon as Carranza was overthrown in 1920 Villa made peace with the government. In return for agreeing to retire from politics he was given a large ranch in Durango. There he lived until he was assassinated in nearby Parral, Chihuahua, on July 20, 1923. *See* also MEXICO: *Independent Mexico.* (C. C. CU.)

VILLA, the Latin word (diminutive of *vicus,* "a village") for a country house and its appurtenances. In Great Britain the word has come to mean a small detached or semidetached suburban home and has lost much of its original significance. In the United States the mord has been used to mean a real estate development or tract? though generally it refers to a sumptuous suburban or country residence.

References to villas are constantly made by Roman writers, especially Cicero who had seven villas. and Pliny who described his villas in Tuscany and near Laurentum at great length in his letters. The Roman countryside is dotted with ruins of innumerable villas. The most famous of these is the villa of Hadrian at Tivoli which covered an area about two miles in length and in which were reproductions of celebrated buildings he had seen in his travels. Many villas existed throughout the Roman empire.

The villas were frequently asymmetrical in plan (the 4th-century imperial hunting lodge-villa near Piazza Armerina in Sicily is an excellent example), often built with elaborate terracing on hillsides, especially around Tivoli and Frascati, and had long colonnades, towers, fine water gardens with reflecting pools and fountains, and extensive reservoirs for the water supply. According to Pliny there were two kinds of villas. the *villa urbana,* which was a countryseat (with city comforts), and the *villa rustica,* the farmhouse. A villa at Boscoreale near Pompeii, excavated in 1893–94, is an example of a *villa rustica* in which the principal room was the kitchen! with the bakery and stables beyond and room for wine presses, oil presses, hand mill, etc.

During the middle ages the villas were abandoned and in some places castles and monasteries (*e.g.,* the Basilian monastery at Grottaferrata) built in and on top of them. The great Renaissance villas were occasionally built on their ruins and frequently used some of the better preserved remains as models. This influence is especially evident in such early examples as the Villa Madama (1520) just outside Rome, originally designed by Raphael. and Pirro Ligorio's Casino of Pius IV (1558–62) in the Vatican gardens. The Renaissance villas sought, however, for greater symmetry and the houses were less rambling (frequently being remodeled castles, especially in Tuscany), though the gardens were often even more elaborate. In fact, the garden often became the principal element in the 16th and 17th century. as in the Villa d'Este in Tivoli (1549), also designed by Ligorio, and the Villa Lante in Bagnaia and the Villa Orsini at Bomarzo, both near Viterbo. Other important examples are the Villa di Papa Giulio (1550) in Rome and the Villa Farnese at Caprarola, both by

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THE VILLA BARBARO (1560) BY ANDREA PALLADIO. AT MASER IN THE VENETO, ITALY

Vignola, the villas Aldobrandini (1598–1603), Falconieri (1546) and Mondragone (1573–75) at Frascati, the Villa Barberini at Castel Gandolfo (on the site of a villa of the emperor Domitian), the Boboli gardens in Florence, the Villa Barbaro at Maser in the Veneto and La Rotonda near Vicenza by Palladio. and the villas Borghese. Medici (1540) and Doria Pamphili (1650) in Rome By the 18th and 19th century villas in Italy were less extensive. though fine ones were built in Piedmont (Villa Stupinigi near Turin) and Lombardy, especially on the lakes, in the Veneto (Villa dei Pisani at Stra), in Rome (Villa Albani and Villa Torlonia), on the slopes of Vesuvius near Naples (La Favorita at Portici) and at Bagheria near Palermo (Villa Palagonia). The Italian villa had much influence in France and England. See also HOUSE; ROMAN ARCHITECTURE.

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VILLACH, an old Austrian town in the Bundesland of Carinthia (*q.v.*) on the Drava at the western end of the basin of Klagenfurt. It is a timber centre and manufactures lead wares. The 15th-century church of St. Jacob in Gothic style has a tower about 315 ft. high. Pop. (1951) 30,069. Warmbad Villach, with hot sulfur baths, and Mittewald, whence the ascent of the Dobratsch can be made, are near Villach. Some of the prettiest Carinthian lakes are to be found near Villach.

VILLAGE COMMUNITIES. The study of village communities has become one of the fundamental methods of discussing the ancient history of institutions. This article covers countries such as England, Germany and the U.S.S.R. and those of the Balkan peninsula because these nations have gone through all sorts of experiences and the historical data can be tolerably well ascertained. The best way seems to be to select some typical examples, chiefly from the domain of Celtic, Slavonic and Germanic social history, and to try to interpret them in regard to the general conditions in which communal institutions originate, grow and decay. As the principal problem will consist in ascertaining how far land was held in common instead of by individuals, it is advisable to look out for instances in which this element of holding in common is very clearly expressed. We ought to get, as it were, acclimatized to the mental atmosphere of such social arrangements in order to counteract a very natural but most pernicious bent prompting one to apply to the conditions of the past the key of our modern views and habitual notions. A certain acquaintance with the structure of Celtic society, more especially the society of ancient Wales, is likely to make clear from the outset to what extent the husbandry and law of an Aryan race may depend on institutions in which the individual factor is greatly reduced, while the union first of kinsmen and then of neighbours plays a most decisive part.

Seebohm called our attention to the interesting surveys of Welsh tracts of country made in the 14th century, soon after these regions passed into the hands of English lords. The fragments of these surveys published by him and his commentary on them are very illuminating, but further study of the documents themselves discloses many important details and helps to correct some theories propounded on the subject. Let us take up a concrete and simple case, *e.g.,* the description of Astret Canon, a trev or township (villata) of the honour of Denbigh, surveyed in 1334. In the time of the native Welsh princes it was occupied entirely by a kindred (progenies) of free tribesmen descended from a certain Canon, the son of Lawaurgh. The kindred was subdivided into four gavells or bodies of joint-tenants. On the half-gavell of Monryk ap Canon, *e.g.,* there are no less than 16 coparceners, of whom eight possess houses. The peculiarity of this system of land tenure consists in the fact that all the tenants of these gavells derive their position on the land from the occupation of the township by their kindred, and have to trace their rights to shares in the original unit. Although the village of Astret Canon was occupied by something like 54 male tenants, the majority of whom were settled in houses of their own, it continued to form a unit both in regard to the payment of land tax and other services and payments, and also in respect of the possession and usage of the soil. On the other hand, movable property is owned in severalty. Services have to be apportioned among the members of the kindreds according to the number of heads of cattle owned by them. From the description of another township—Pireyon—we hear that gavells ought to be considered as equal shares in respect of the arable, the wood and the waste of the township. If the shares were reduced into acres there would have fallen to each of the eight gavells of Pireyon 91ac., one rood and a half and six perches of arable and woodland, and 53⅓ac. and half a rood of waste land. But as a matter of fact the rights of the tenants of the gavell were realized not through the appropriation of definite acres, but as proportionate opportunities in regard to tillage and as to usages in pasture, wood and waste. Pastoral habits must have greatly contributed to give the system of landholding its peculiar character. It was not necessary, it would have been even harmful, to subdivide sharply the area on which the herds of cows and the flocks of sheep and goats were grazing.

We do not notice any systematic equalization between members of the tribal communities of the trevs. In fact, both differences in the ownership of cattle and differences of tribal standing, established by complex reckonings of pedigree and of social rank, led to marked inequalities. But there was also the notion of birthright, and we find in the laws that every free tribesman considered himself entitled to claim from his kindred grazing facilities and five erws for tillage. Such a claim could be made unconditionally only at a time when there was a superabundance of land to dispose of. In the 14th century, to which our typical descriptions refer, this state of things had ceased to be universal. Although great tracts of Welsh land were undoubtedly still in a state of wilderness, the soil in more conveniently situated regions was beginning to be scarce, and considerable pressure of population was already felt, with a consequent transition from pastoral pursuits to agriculture.

Although there are no rearrangements or redivision within the tribe as a whole, inside every gavell, representing more narrow circles of kinsmen, usually the descendants of one great-grandfather, *i.e.,* second cousins, the shares are shifted and readjusted according to one of two systems. In one case, that of the trevcyvriv or joint-account village, every man receives "as much as another yet not of equal value"—which means, of course, that the members of such communities were provided with equal allotments, but left to make the best of them, each according to chance and ability. This practice of reallotment was, however, restricted in the 14th century to taeog trevs, to villages occupied by half-free settlers. The free tribesmen, the priodarii of Wales, held by daddenhud, were reallotted shares within the trev on the coming of each new generation or, conversely, on the going out, the dying out, of each older generation. In other words: at the demise of the last of the grandfathers in a gavell, all the fathers took equal rank and claimed equal shares, although formerly some of the portions had been distributed equally only between the grandfathers or their offspring (stirps). The right to claim redivision held good only within the circle of second cousins.

Another fact which is brought out with complete evidence by the Welsh Surveys is that the tenure is ascribed to communities of kinsmen and not to chiefs or headmen. The latter certainly existed and had exerted a powerful influence on the disposal of common land as well as on government and justice. But in the view of the 14th-century surveys each township is owned not by this or the other elder, but by numerous bodies of coparceners. In this way there is a clear attribution of rights of communal ownership, and not merely of rights of maintenance.

Let us now compare this description of Celtic tribal tenure with Slavonic institutions. The most striking modern examples of tribal communities settled on a territorial basis are presented by the history of the Southern Slavs in the Balkan Peninsula and in Austria, of Slovenes, Croats, Serbs and Bulgarians, but it is easy to trace customs of the same kind in the memories of Western Slavs conquered by Germans, of the Poles and of the different subdivisions of the Russians. A good clue to the subject is provided by a Serb proverb which says that a man by himself is bound to be a martyr. The Slavs of the mountainous regions of the Balkans and of the Alps in their stubborn struggle with nature and with human enemies have clustered and still cluster to some extent in closely united and widely spreading brotherhoods (bratstva) and tribes (plemena). Some of these brotherhoods derive their names from a real or supposed common ancestor, and are composed of relatives as well as of affiliated strangers. They number sometimes hundreds of members, of guns, as the fighting males are characteristically called. Such are the

Vuktići, Kovacevići,—as one might say in Old English the Vukotings or Kovachevings,—of Montenegro. The dwellings, fields, and pasturages of these brotherhoods or kindreds are scattered over the country. But there was the closest union in war, revenge, funeral rites, marriage arrangements, provision for the poor and for those who stood in need of special help, as in case of fires, inundations and the like. And corresponding to this union there existed a strong feeling of unity in regard to property, especially property in land. Although ownership was divided among the different families, a kind of superior or eminent domain stretched over the whole of the bratstvo, and was expressed in the participation in common in pasture and wood, in the right to control alienations of land and to exercise pre-emption.

As the Welsh kindreds were subdivided into gavells formed of extended family communities, even so the Bosnian, Montenegrin, Serbian and Slovene tribes fell into house communities, *Kućas,* Zadrugas, which were built up on the principle of keeping blood-relatives and their property together as long as possible. They consisted generally of some 15 to 20 grown-up persons, some six or seven first and second cousins with their wives and children, living in a hamlet around the central house of the *domaćin,* the house leader. In some instances the number of coparceners increased to 50 or even to 70. The members of the united house community, which in fact is a small village or hamlet, joined in meals and work. Their rights in the undivided household of the hamlet were apportioned according to the pedigree, *i.e.,* this apportionment took account first of the stirpes or extant descendants of former scions of the family, so that, say, the offspring of each of two grandfathers who had been brothers were considered as equal sharers although the stirps, the stock, of one was represented only by one person, while the stirps of the other had grown to consist of two uncles and of three nephews all alive. There was no resettlement of shares, as in the case of Wales, but the life of the house community while it existed unbroken led to work in common, the contributions to which were regulated by common consent and supervised by the leader. Grounds, houses, implements of agriculture (ploughs, oxen, carts) and of viniculture — casks, cauldrons for the making of brandy, etc.— were considered to be common capital and ought not to be sold unless by common consent. Divisions were not prohibited. Naturally a family had to divide sooner or later, and the shares had to be made real, to be converted into fields and vineyards. But this was an event which marked, as it were, the close of the regular existence of one union and the birth of similar unions derived from it. As a rule, the *kuća* kept together as long as it could, because co-operation was needed and isolation dangerous — for economic considerations as well as for the sake of defence.

Attention, however, should be called more particularly to the parallel phenomena in the social history of the Russians, where the conditions seem to stand out in specially strong contrast with those prevailing among the mountain Slavs of the Balkans and of the Alps In the enormous extent of Russia we have to reckon with widely different geographical and racial areas, among others, with the Steppe settlements of the so-called Little Russians in the Ukraine, and the forest settlements of the Great Russians in the north. In spite of great divergencies the economic history of all these branches of Slavonic stock gravitates towards one main type, viz , towards rural unions of kinsmen, on the basis of enlarged households. In the south the typical village settlement is the dvoris'te, the big court or hamlet consisting of some four to eight related families holding together; in the north it is the *pećišće,* the big oven, a hamlet of somewhat smaller size in which three to five families are closely united for purposes of common husbandry.

Another fact to be noticed is the tendency to form artificial associations on the pattern of the prevailing unions of kinsmen. People who have no blood-relations to appeal to for clearing the waste, for providing the necessary capital in the way of cattle and plough implements, for raising and fitting out buildings, join in order to carry on these economic undertakings, and also to help each other against aggressors. The members of these voluntary associations, which at once call to mind German, Norse and English gilds, are called "siabri," "skladniki," and the gilds themselves "spólkíe," in south Russia. In a district of the Ukraine called the "Ratensky Sharostvo" there were no fewer than 278 such gilds interchanging with natural kindreds. The organization of all these unions could in no way be called patriarchal. Even in cases when there is a definite elder or headman (bolshoy), he was only the first among equals and exercised only a limited authority over his fellows: all the important decisions had to be taken by the council of the community.

In Great Russia, in the districts gathered under the sway of the Moscow tsars, the basis of the household community and of the rural settlements which sprang from it was modified in another direction. The entire agricultural population was subjected to strict supervision and coercive measures for purposes of military organization and taxation. Society was drilled into uniformity and service on the principle that every man has to serve the tsar, the upper class in war and civil administration, the lower class by agricultural labour. **A** consequence of the heavy burden laid on the land and of the growth of a landed aristocracy was a change in the management of land allotments. They became as much a badge of service and a basis for fiscal requirements as a means of livelihood. The result was the practice of reallotments according to the strength and the needs of different families. The shifting of arable (peredel) was not in this case a reapportionment of rights, but a consequence of the correspondence between rights and obligations.

Let us now pass to village communities in Teutonic countries, including England. A convenient starting-point is afforded by the social and economic conditions of the southern part of Jutland. The Saxon or Dithmarschen portion of this region gives us an opportunity of observing the effects of an extended and highly systematized tribal organization on Germanic soil. The independence of this northern peasant republic, which reminds one of the Swiss cantons, lasted until the time of the Reformation. We find the Dithmarschen organized in the 15th, as they had been in the 10th century, in a number of large kindreds, partly composed of relatives by blood and partly of "cousins" who had joined them. The membership of these kindreds is based on agnatic ties — that is, on relationship through males — or on affiliation as a substitute for such agnatic kinship. The families or households are grouped into brotherhoods, and these again to clans or "Schlachten" (Geschlechter), corresponding to Roman gentes. Some of them could put as many as 500 warriors in the field. They took their names from ancestors and chieftains: the Wollersmannen, Hennemannen, Jerremannen, etc.—*i.e.,* the men of Woll, the men of Henne, the men of Jerre. In spite of these personal names the organization of the clans was by no means a monarchical one: it was based on the participation of the full-grown fighting men in the government of each clan and on a council of co-opted elders at the head of the entire federation.

Let us notice the influence of this tribal organization on husbandry and property. The regular economic arrangement was an open-field one based on a three-field and similar systems. The furlongs were divided into intermixed strips with compulsory rotation on the usual pattern. And it is interesting to notice that in these economic surroundings indivisible holdings corresponding to the organic unities required for efficient agriculture arose of themselves. In spite of the equal right of all coheirs to an estate, this estate does not get divided according to their numbers, but either remains undivided or else falls into such fractions, halves or fourths, as will enable the farming to be carried on successfully. The Hufe or Hof goes mostly to the eldest son, but also sometimes to the youngest, while the brothers of the heir either remain in the same household with him, generally unmarried, or leave the house after having settled with their heir, who takes charge of the holding, as to an indemnity for their relinquished claims.

This evidence is of decisive importance in regard to the formation of unified holdings; we are on entirely free soil, with no vestige whatever of manorial organization or of coercion of tenants by the lord. The Hufe, the normal holding, is preserved intact in order to secure agricultural efficiency. This "Anerben" system is widely spread all through Germany. The question whether the eldest or the youngest succeeds is a subordinate one. In any case, manorial authority is not necessary to produce the limitation of the rights of succession to land and the creation of the system of holdings. although this has been often asserted, and one of the arguments for a servile origin of village communities turns on a supposed incompatibility between the unified succession and the equal rights of free coheirs.

We need not speak at any length about other parts of Germany, as space does not permit of a description of the innumerable combinations of communal and individual elements in German law, but we must point out some facts from the range of Scandinavian customs. In the mountainous districts of Norway we notice the same tendency toward the unification of holdings as in the plains and hills of Schleswig and Holstein. The bondrr of Gudbrandsdal and Telemark, the free peasantry tilling the soil and pasturing herds on the slopes of the hills from the days of Harald Haarfager to modern times, sit in *Ødalgaards*, or freehold estates, from which supernumerary heirs are removed on receiving some indemnity. and which are protected from alienation into strange hands by the privilege of pre-emption exercised by relatives of the seller. Equally suggestive are some facts on the Danish side of the straits: viz.. the arrangements of the bols which correspond to the hides and virgates of England and to the *Hufen* of Germany. Here again we have to do with normal holdings independent of the number of coheirs but dependent on the requirements of agriculture—on the plough and oxen, on certain constant relations betn-een the arable of an estate and its outlying commons. meadows and woods. The bol does not stand by itself like the Norwegian *gaard,* but is fitted into a very close union with neighbouring bols of the same kind. Practices of coaration, of open-field intermixture, of compulsory rotation of lot meadows, of stinting the commons, arise of themselves in the villages of Denmark and Sweden.

We catch a glimpse. to begin with, of a method of dividing fields which was considered archaic even in those early times, the so-called *forniskift* and *hamarskift.* The two principal features of this method are the irregularity of the resulting shapes of plots and the temporary character of their occupation. The first observation may be substantiated by a description such as that of Laasby in Jutland: "These lands are to that extent scattered and intermixed by the joint owners that it cannot be said for certain what (or how much) they are." Swedish documents, on the other hand. speak expressly of practices of shifting arable and meadows periodically. sometimes year by year.

Now the uncertainty of these practices based on occupation became in process of time a most inconvenient feature of the situation and evidently led to constant wrangling as to rights and boundaries. The description of Laasby quoted above ends with the significant remark: "They should be compelled to make allotment by the cord." This making of allotments by the cord is the process of *rebning,* from *reb,* the surveyor's cord. and the juridical procedure necessary for it was called solskift—because it was a division following the course of the sun.

The two fundamental positions from which this form of allotment proceeds are: (1) that the whole area of the village is common land (*faellesjord*), which has to be lotted out to the single householders; (2) that the partition should result in the creation of equal holdings of normal size (*bols*). In some cases we can actually recognize the effect of these allotments by ancient solskift in the 18th century. at a time when the Danish enclosure acts produced a second general revolution in land tenure.

The 12 oldest inhabitants, elected as sworn arbitrators for effecting the allotment, begin their work by throwing together into one mass all the grounds on-ned by the members of the community, including dwellings and farm buildings, with the exception of some privileged plots. There is a close correspondence between the sites of houses and the shares in the field. The first operation of the surveyors consists in marking out a village green for the night rest and pasture of the cattle employed in the tillage (*forta*), and assigning sites to the houses of the coparceners with orchards appendant to them (tofts), every householder getting exactly as much as his neighbour. From the tofts they proceed to the fields on the customary notion that the toft is the mother of the field. The fields are disposed into furlongs and shots. as they were called in England. and divided among the members of the village with the strictest possible equality. This is effected by assigning to every householder a strip in every one of the furlongs constituting the arable of the village. Meadows were often treated as lot meadows in the same way as in England. After such a solskift the peasants held their tenements in undisturbed ownership, but the eminent demesne of the village was recognized and a revision of the allotment mas possible.

After having said so much about different types of village communities which occur in Europe it will be easier to analyze the incidents of English land tenure which disclose the working of similar conceptions and arrangements. Features which have been very prominent in the case of the Welsh, Slavs, Germans or Scandinavians recur in the English instances sometimes with equal force and at other times in a mitigated shape.

There are some vestiges of the purely tribal form of community on English soil. Many Saxon and Anglian place names are derived from personal names, followed by the suffix ing, and closely resemble the common patronymics of Saxon and German families and kindreds. It is most probable, as Kemble supposed, that we have to do in most of these instances with tribal and family settlements, although the mere fact of belonging to a great landowner may have been at the root of some cases.

A very noticeable consequence of tribal habits in regard to landownership is presented by the difficulties which stood in the way of alienation of land by the occupiers of it. The Old English legal system did not originally admit of any alienation of folkland, land held by folkright, or, in other words. of the estates owned under the ordinary customary law of the people. Such land could not be bequeathed out of the kindred and could not be sold without the consent of the kinsmen. Such complete disabilities could not be upheld indefinitely, however, in a growing and progressive community. and we find the ancient folkright assailed from different points of view. The church insists on the right of individual possessors to give away land for the sake of their souls; the kings grant exemption from folkright and constitute privileged estates held by charter and following in the main the rules of individualized Roman law; the wish of private persons to make provision for daughters and to deal with land as with other commodities produces constant collisions with the customary tribal views. Already. by the end of the Saxon period, transfer and alienation of land make their way everywhere, and the Norman conquest brings these features to a head by substituting the notion of tenure—*i.e.*, of an estate burdened with service to a superior—for the ancient notion of tribal folkland.

But although the tribal basis of communal arrangements was shaken and removed in England in comparatively early times. it had influenced the practices of rural husbandry and landholding, and in the modified form of the village community it survived right through the feudal period, leaving characteristic and material traces of its existence down to modern times.

To begin with. the open-field system with intermixture of strips and common rights in pasture and wood was the prevailing system in England for more than 1.000 years. Under the name of champion farming it existed everywhere in the country until the Enclosure acts of the 18th and 19th centuries put an end to it; it could be found in operation even in modern times in some of its features in backward districts. It would have been absurd to build up these practices of compulsory rotation of crops. of a temporary relapse of plots into common pasture between harvest and ploughing time, of the interdependence of thrifty and negligent husbandmen, from the point of view of individual appropriation. On the other hand. it was the natural system for the apportionment of claims to the shareholders of an organic and perpetual joint-stock company.

Practices of shifting arable are seldom reported in English evidence. There are some traces of periodical redivisions of arable land in Northumberland: under the name of "runrig" such practices seem to have been not uncommon in the outer fields, the nonmanured portions, of townships in Scotland, both among the

Saxon inhabitants of the lowlands and the Celtic population of the highlands. The joining of small tenants for the purpose of coaration. for the formation of the big, heavy ploughs, drawn by eight oxen, sometimes caused a shifting in the possession of strips between the coparceners of the undertaking. But, as a rule, the arable was held in severalty by the different members of the township.

On the other hand, meadows were constantly owned by entire townships and distributed between the tenements entitled to shares from year to year by lot or according to definite order.

Let us, however, return for a moment to the arable. Although held in severalty by different owners it was subjected to all sorts of interference on the part of the village union as represented in later ages by the manorial court framing by-laws and settling the course of cultivation. It might also happen that in consequence of encroachments. disputes and general uncertainty as to possession and boundaries, the whole distribution of the strips of arable in the various fields had to be gone over and regulated anew. In such cases the strips were apportioned. not to single owners, but to the normal holdings, the hides, and the actual owners had to take them in proportion to their several rights in the hides. This point is very important. It gives the English village community its peculiar stamp. It is a community not between single members or casual households, but between definite holdings constructed on a proportional scale. Each hide or ploughland of a township took as much as every other hide, each virgate or yardland as every other yardland, each bovate or oxgang as every other oxgang. The yardland was almost everywhere one-fourth of the hide or ploughland, and corresponded to the share of two oxen in an eight-oxen plough; the oxgang was reckoned at one-half of the yardland, and corresponded to the share of one ox in the same unit of work.

The natural composition of the holdings has its counterpart, as in Schleswig-Holstein and as in the rest of Germany, in the custom of unified succession. The English peasantry worked out customary rules of primogeniture or of so-called Borough English or claim of the youngest to the land held by his father. The German examples already adduced teach us that the device is not suggested primarily by the interest of the landlord. Unified succession takes the place of the equal rights of sons. because it is the better method for preserving the economic efficiency of the household and of the tenement corresponding to it.

One more feature of the situation remains to be noticed, that is the *commons* which have survived the wholesale process of enclosure. They were an integral part of the ancient village community from the first, because there existed the most intimate connection between the agricultural and pastoral part of husbandry in the time of the open-field system. Pasture was not treated as a commodity by itself but was mostly considered as an adjunct, as appendant to the arable, and so was the use of woods and of turf. The problem of admeasurement of pasture was regulated by a reference to the proportional holdings, the hides. yardlands and oxgangs of the township, and the only question to be decided was how many heads of cattle and how many sheep each hide and yardland had the right to send to the common pasturage grounds.

When in course of time the open-field system and the tenure of arable according to holdings were given up, the right of freeholders and copyholders of the old manors in which the ancient townships were, as it were, encased, still held good, but it became much more difficult to estimate and to apportion such rights.

We may, in conclusion, summarize very briefly the principal results of our inquiry as to the history of European village communities. It seems that they may be stated under the following heads: (1) Primitive stages of civilization disclose in human society a strong tendency towards mutual support in economic matters as well as for the sake of defence. (2) The most natural form assumed by such unions for defence and co-operation is that of kinship. (3) In epochs of pastoral husbandry and of the beginnings of agriculture land is mainly owned by tribes, kindreds and enlarged households, while individuals enjoy only rights of usage and possession. (4) In course of time unions of neighbours are substituted for unions of kinsmen. (5) In Germanic societies the community of the township rests on the foundation of efficient holdings—bóls, hides, hufen—kept together as far as possible by rules of united or single succession. (6) The open-field system, nhich prevailed in the whole of Northern Europe for nearly a thousand years. was closely dependent on the customs of tribal and neighbourly unions. (7) The treatment of commons represents the last manifestations of ancient communal arrangements and it can only be reasonably and justly interpreted by reference to the law and practice of former times. (P. Vi.)

VILLAMEDIANA, COUNT DE (1580–1622), Spanish poet, was born at Lisbon, the son of a diplomatist He acquired a bad reputation as a gambler and was banished from court in 1608. On his return to Spain (1617) he proved himself a fearless, pungent satirist So great was the resentment caused by his envenomed attacks that he was once more ordered to withdraw from court in 1618 Appointed gentleman in waiting (1621) to Philip IV's young wife, Isabel de Bourbon, daughter of Henri IV, his ostentatious attentions to the queen supplied his numerous foes with a weapon which was destined to destroy him. A fire broke out while hii masque. La *Gloria* de *Niquea,* was being acted before the court on May 15, 1622, and Villamediana carried the queen to a place of safety. Suspicion deepened and on Xug. 21 he was murdered as he stepped out of his coach. The responsibility for his death aas divided between Philip IV and Olivares, and naturally the crime remained unpunished.

Villamediana's works contain not only the nervous, blighting verses which made him widely feared and hated, but a number of more serious poems embodying the most exaggerated conceits of gongorism But. even when adopting the perverse conventions of the hour. he remains a poet of high distinction, and his satirical verses. more perfect in form, are instinct with a cold, concentrated scorn which has never been surpassed.

VILLANELLE, in Italy nhere the term originated (Ital. *villanella* from *villano,* "peasant"), a rustic song; the term was used in France to designate a short poem of popular character favoured by poets in the late 16th century. Du Bellay's "Vanneur de Blé" and Philippe Desportes' "Rozette" are excellent examples of this early type of villanelle, unrestricted in form. Jean Passerat (d. 1602) left several villanelles, one of which became so popular that it set the pattern for later poets and, accidentally, imposed a rigorous and somewhat monotonous form: seven-syllable lines on two rhymes (the first feminine). distributed in (normally) five tercets and a final quatrain with line repetitions (indicated by numbered capitals and lines printed in italics below).

J'ai perdu ma tourterelle:	A^1
Est-ce point celle que j'oy?	b
Je veux aller après elle.	A^2
Tu regrètes ta femelle?	a
Helas! aussi fais-je moy:	b
J'ai perdu ma tourterelle.	A^1
Si ton amour est fidelle,	a
Aussi est ferme ma foy:	b
Je veux aller aprds elle.	A^2
Ta plainte se renouvelle?	a
Tousjours plaindre je me doy:	b
J'ai perdu ma tourterelle.	A'
En ne voyant plus la belle,	a
Plus rien de beau je ne voy;	b
Je veux aller après elle.	A^2
Mort que tant de fois j'appelle,	a
Pren ce qui se donne à toy:	b
J'ai perdu ma tourterelle,	A^1
Je veux aller après elle.	A^2

A villanelle double, composed of *sixains* with a final *huitain,* has also been used.

The villanelle was revived in the 19th century by Philoxène Boyer and J. Boulmier; the latter published collections in 1878 and 1879 and, at his death in 1881, left a third collection unfinished.

Théodore de Banville, Leconte de Lisle (two examples only) and, later, Maurice Rollinat also wrote villanelles. In England the revival of interest in French verse forms about *1877* attracted attention to the villanelle and it was cultivated by W. E. Henley, Austin Dobson. Andrew Lang and Edmund Gosse. Among Henley's numerous villanelles is "A dainty thing's the Villanelle," itself descriptive of the form. He and Dobson were also foremost in the writing of humorous villanelles.

See Théodore de Banville, *Petit traité de versification française* (1872) ; J. Boulmier, *Villanelles, . . . précedées d'une notice historique et critique* (1878). (F. J. WE.)

VILLANI, GIOVANNI (*c.* 1275–1348), Florentine chronicler, mas born at Florence of a mercantile family. and spent much of his early manhood in traveling on business in Italy. France and the Netherlands. He returned definitely to Florence before *1312.* and from *1316* onward held many important offices in his native city, and was employed on various diplomatic missions.

In his last years Villani was involved in the bankruptcy of the Bonaccorsi. and fell into poverty. He died in *1348* in the plague epidemic described by Boccaccio.

His *Historie Fiorentine,* or *Cronica universale,* begins with Biblical times and comes down to *1348.* The ground covered by the narrative, especially in the times near Villani's own, bears witness to the author's extensive travels and to the breadth of his mind. It is the cornerstone of the early medieval history of Florence. Villani was Guelph, but without passion; and his book is more taken up with an enquiry into what is useful and true than with party considerations. He is a chronicler, not a historian, and has but little method in his narrative. He provides information on the constitution of Florence, its customs. industries. commerce and arts; and of the chroniclers of his day he is perhaps unequaled for the value of his statistical data. The *Chronicle* has been printed by L. A. Muratori in tome xiii of the *Rerum Italicarum Scriptores* (Milan, 1728) and has been edited by I. Moutier and F. G. Dragomanni (Florence. *1844).*

Other editions appeared at Trieste (1857) and at Turin in *1879.* Selections have been translated into English by R. E. Selfe (2nd ed. *1906).*

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VILLANOVANS, the name applied to the founders of an early Iron Age civilization in Italy, from the village of Villanova near Bologna. where in *1853* a typical cemetery was first discovered. The Villanovans branched from the cremating urn-field cultures of northern Europe and appeared in Italy, perhaps about 1000 B.C. Their characteristic cemeteries have been found in the Po valley from Bologna to Rimini, in Tuscany and. with certain differences. in northern Latium.

(See also ARCHAEOLOGY: *The Iron Age in Europe.)*

The cemeteries contain cremation burials almost exclusively, the ashes of the dead being normally deposited in a large jar of coarse. handmade pottery (*impasto),* which was placed in a round hole in the ground, sometimes enclosed in a rectangular cist of unhewn slabs. In the Po valley and in most of Tuscany the urn is almost universally of the distinctive biconical. or two storied, form, decorated with incised geometric patterns and covered with a shallow. single-handled bowl; in Tuscany the urn is occasionally covered with a bronze helmet with a high triangular crest or a pottery imitation of a helmet; in Villanovan cemeteries in Latium the biconical urn does not occur. but Latium shares with a feu- cemeteries of Tuscany the use of the terracotta hut urn, whose oval shape and pitched roof reproduce a primitive hut of wattle and daub over a frame of poles. The hut urn is characteristic of northern European urn fields, the helmet of western Europe; the two-storied urn may be related to similar types found in Hungary and Rumania.

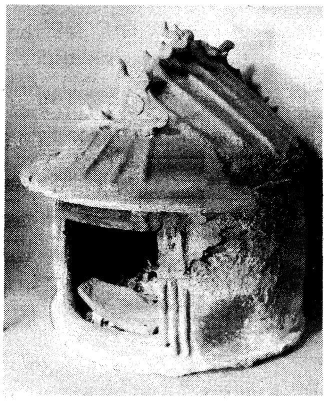

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FIG. 1.—TERRA-COTTA HUT URN USED TO HOLD THE ASHES OF THE DEAD; TARQUINIA

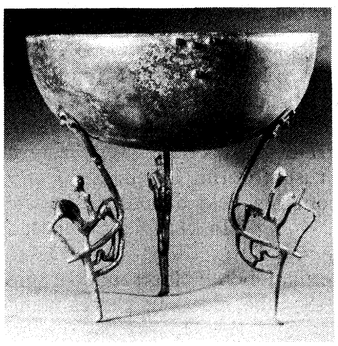

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FIG. 2.—LATE VILLANOVAN TRIPOD, WITH BRONZE HORSEMEN FORMING THE BASE: VETULONIA

The cremation burials of Latium (the Alban hills and the Roman forum) seem to be the earliest; very little metal of any kind was found in the graves. and only an occasional glass or amber bead. In Tuscany metalworking became a fine art; helmets, shields. swords of northern European and Greek types, belts and vessels of many shapes, all decorated with *repoussé* bosses and incision in geometric designs have been found in quantity. In the second half of the 8th century the Villanovans of Tuscany were strongly influenced by Greece: wheel-made painted pottery in imitation of Greek Geometric wares and cast-bronze figures in a style recalling that of Geometric Greece suggest the actual presence of Greek settlers in Tuscany. In this period inhumation became the predominant burial rite. as it did during the same period in Greece.

During the first quarter of the 7th century an orientalizing civilization, presumably introduced by the Etruscans, mas superimposed on the Villanovan in Tuscany and the amalgamation of this and the Villanovan produced, by the end of the 7th century, the Etruscan culture of historic times. The northern Villanovans of the Po valley, however, continued to produce a geometric art closely related to that of pre-Etruscan Tuscany as late as the last quarter of the 6th century, when Etruscan expansion into the Po valley obliterated their civilization.

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FIG 3.—BICONICAL OSSUARY COVERED WITH A CRESTED HELMET; TARQUINIA

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VILLANUEVA Y GELTRÚ, a seaport of northeast Spain. in Barcelona province: on the Barcelona-Tarragona section of the coast railway. Pop. (1950) *19.555* (mun.). It is a modern town, with manufactures of cotton, woolen and linen goods, and of paper. It has also iron foundries and an important agricultural trade. The harbour affords safe and deep anchorage; it is a lifeboat station and the headquarters of a large fishing fleet. The coasting trade is also considerable. Villanueva has a museum. founded by the Catalan poet and historian, Yictor Balaguer (1824–1901), which contains a large library, including not only numerous historical works but also many valuable mss.

VILLARD, HENRY (1835–1900), American journalist and financier, was born in Speyer, Rhenish Bavaria, Apr. 10, 1835 He emigrated to America in 1853 end engaged in journalistic work for German-American newspapers and later for leading American dailies. He reported the Lincoln-Douglas debates for eastern newspapers, the Pikes Peak gold rush for the Cincinnati *Daily Commercial* and the Civil War from the field of action for the New York *Herald* and New Tork *Tribune*. In 1881 he purchased the *Nation* and the New York *Evening Post*.

Through acting as agent for German bondholders he became interested in railway finance. In 1875 he aided in reorganizing the Oregon and California Railroad and the Oregon Steamship company and in 1876 became president of both companies. He was receiver of the Kansas Pacific Railroad in 1876–78. In 1879 he organized the Oregon Railway and Navigation Company which built a line along the Columbia river from Portland to Wallula. In 1881 Villard secured control of the Northern Pacific and became its president. Its transcontinental line was completed under his management but the costs so far exceeded the estimate that both Villard and the road became insolvent in 1883 and Villard was removed from the presidency. He later recouped his losses so that from 1889–1893 he served as chairman of the board of directors of the same company. In 1890 he bought the Edison Lamp Co. at Newark, N.J., and the Edison Machine Works at Schenectady, N Y., and formed them into the Edison General Electric Co. of which he was president until its reorganization in 1893 as the General Electric Co. He died at Dobbs Ferry, N.Y., Nov. 12, 1900.

See *Memoirs of Henry Villard* (2 vols., 1904).

VILLARD DE HONNECOURT, French architect of the first half of the 13th century, whose architectural drawings give a clear insight into the working processes of a medieval workshop, was a native of Honnecourt. in Picardie. Villard's only documentary work is his sketchbook—preserved in the Bibliotheque Nationale, Paris—a fragment of 33 folios with about 325 drawings. It contains a treatise on different subjects, a "livre de portraiture" ("book of portraiture") as Villard himself calls it. Planned partly as a modelbook and partly as lodgebook for construction, it employs geometrical schemes as guiding lines instead of arithmetical measurement. In it Honnecourt demonstrates how to construct ground plans and elevations of Gothic buildings, church furniture, ornaments and ehgines, and depicts human and animal bodies by applying geometrical forms such as the pentagram, quadrangle, triangle and circle "for easy enlargement." As an architect of his time Villard had to combine the skill of a mason and draftsman and a knowledge of engineering with extensive architectural training.

Commissions and journeys led him into Switzerland and Hungary. The places he visited are recorded in the drawings and their explanatory notes: Vaucelle, Cambrai, Meaux, Laon, Reims, Chartres and Lausanne.

See H. R. Hahnloser, *Villard de Honnecourt, kritische Gesamtausgabe des Bauhüttenbuches* (1935) ; P. Frankl, *The Gothic: Literary Sources and Interpretations* (1959). (JA. W.-F.)

VILLARI, PASQUALE (1827–1917), Italian historian and statesman, born at Naples, Oct. 3, 1827, studied with Luigi la Vista under, Francesco de Sanctis. Implicated in the riots of May 15. 1848, at Naples, against the Bourbon government, he took refuge in Florence where he published his *Storia di Girolamo Savonarola e de' suoi tempi* (2 vol., 1859–61). It was followed by a work of even greater critical value, *Niccolò Machiavelli e i suoi tempi* (1877–82). Both these works have been through many editions, the latest in 1927. Meanwhile Villari had been professor of history at Pisa, and then obtained the chair of philosophy of history at the Institute of Studii Superiori in Florence. He was also a member of the council of education (1862), and in 1869 was made undersecretary of state for education. In 1884 he was nominated senator, and in 1891–92 minister of education. His collected essays on Florentine history were published as *I primi due secoli della storia di Firenze* (1893–94), and in 1901 his *Le invasioni barbariche in Italia,* a popular account of the events following the dissolution of the Roman empire. All these works have been translated into English by his wife. Villari died at Florence on Dec. 5, 1917. Villari's historical, political and social writings exercised a deep influence on his generation, and most of the Italian historians of today have been his pupils.

His other works include: *Saggi critici* (1868) ; *Arte, storia, e filosofia* (1884); *Scritti varii* (1894); another volume of *Saggi critici* (1896) ; *Discussioni critiche e discorsi* (190j), containing his speeches as president of the Dante Alighieri society; *Lettere meridionali* containing the first exposure of conditions in south Italy (1885); *Scritti sulla questzone sociale in Italia* (1902); *L'Italia da Carlo Magno alla morte di Arrigo VII* (1910; Eng. trs. 1910) ; and *Storia, politica e istruzione* (1914).

See F. Baldasseroni, *Pasquale Villari* (1907).

VILLARREAL, a town of eastern Spain, in the province of Castellón de la Plana; 4 mi. from the Mediterranean sea, near the right bank of the river Mijares. Pop. (1950) 20,871 (mun.). Under Moorish rule, and up to the expulsion of the Moriscoes in 1609, it was the headquarters of a flourishing trade. There are extensive orange groves, watered by the irrigation canal of Castellón. which is a good example of Moorish engineering skill. There are manufactures of paper, woolen goods and spirits.

VILLARRICA, a city of Paraguay. Population (1950) 14,680 It is the capital of the department of Guairá (pop. 90,308). Villarrica is situated on the Paraguay Central railway 90 mi. east of the capital; it is also connected with Asunción by the highway known as the Mariscal Estigarribia route. The city is in a fertile agricultural region, surrounded by wooded mountains. Principal products of this area are yerba mate, sugar cane, cotton and tobacco (W. Ft.)

VILLARS, CLAUDE LOUIS HECTOR DE, Prince de Martignes, Marquis and Duc de Villars and Vicomte de Melun (1653–1734), marshal of France, one of the greatest generals of French history, was born at Moulins on May 8, 1653, and entered the army through the corps of pages in 1671. He served in the light cavalry in the Dutch wars, and distinguished himself by his daring and resourcefulness. But in spite of a long record of excellent service under Turenne, Condé and Luxembourg, and of his aristocratic birth, his promotion was but slow, for he had incurred the enmity of the powerful Louvois, and although he had been proprietary colonel *(mestre de camp)* of a cavalry regiment since 1674, thirteen years elapsed before he was made a *maréchal de camp*. In the interval between the Dutch wars and the formation of the League of Augsburg, Villars was employed in an unofficial mission to the court of Bavaria, and there became the constant companion of the elector, with whom he took the field against the Turks and fought at Mohacs. He returned to France in 1690 and was given a command in the cavalry of the army in Flanders, but towards the end of the Grand Alliance War he went to Vienna as ambassador. His part in the next war *(see* Spanish Succession, War of the), beginning with Friedlingen (1702) and Hochstett (1703) and ending with Denain (1712), has made him immortal. For Friedlingen he received the marshalate, for the pacification of the insurgent Cévennes the Saint-Esprit order and the title of duke. Friedlingen and Hochstett were barren victories, and the campaigns of which they formed a part, records of lost opportunities. Villars's glory thus begins with the year 1709 when France, apparently helpless, was roused to a great effort of self-defence by the exorbitant demands of the Coalition. In that year he was called to command the main army opposing Eugene and Marlborough on the northern frontier. During the famine of the winter he shared the soldiers' miserable rations. When the campaign. opened the old Marshal Boufflers volunteered to serve under him, and after the terrible battle of Malplaquet (*q.v.*), in which he was gravely wounded, he was able to tell the king: "If it please God to give your majesty's enemies another such victory, they are ruined." Two more campaigns passed without a battle and with scarcely any advance on the part of the invaders, but at last Marlborough manoeuvred Villars out of the famous Ne *plus ultra* lines, and the power of the defence seemed to be broken. But Louis made a last effort, the English contingent and its great leader were withdrawn from the enemy's camp, and Villars, though still suffering from his Malplaquet wounds, outmanoeuvred and decisively defeated Eugene in the battle of Denain. This victory saved France, though the war dragged on for another year on the Rhine, where Villars took Landau, led the stormers at Freiburg and negotiated the peace of Rastatt with Prince Eugene.

He played a conspicuous part in the politics of the Regency period as the principal opponent of Cardinal Dubois, and only the memories of hlontmorency's rebellion prevented his being made constable of France. He took the field for the last time in the War of the Polish Succession (1734), with the title "marshal-general of the king's armies," that Turenne alone had held before him But he was now over eighty years of age, and the war was more diplomatic than earnest, and after opening the campaign with all the fire and restless energy of his youth he died at Turin on June 17, 1734.

Villars' memoirs show us a "fanfaron plein d'honneur," as Voltaire calls him. He was indeed boastful, with the gasconading habit of his native province, and also covetous of honours and wealth. But he was an honourable man of high courage, moral and physical, and a soldier who stands above all his contemporaries and successors in the 18th century, on the same height as Marlborough and Frederick.

The memoirs, part of which was published in 1734 and afterwards several times republished in untrustworthy versions, were for the first time completely edited by the Marquis de Vogue in 1884–92.

VILLARS (VILLARS-SUR-OLLON), a Swiss winter sports centre, frequented in summer also, situated at over 4,100ft. above sea-level, on a narrow gauge railway that branches from the Lausanne-Brig main line at Bex, about 8½m. beyond the point at which the railway leaves the Lake of Geneva. It is some distance above Gryon and commands a fine view of the Dent du Midi and the western Alps, and the Grand Muveran (3,061 metres) nearby. The railway runs on to Chesières, another resort which, in its turn, has road vehicles to Ollon, a station on the light railway from Monthey, which joins the Lausanne-Brig main line at Aigle.

VILLAVICIOSA, a seaport of northern Spain, in the province of Oviedo; on the Rio de Villaviciosa, an estuary formed by the small river Villaviciosa which here enters the Bay of Biscay. Pop. (1940) 2,219 (mun., 22,029). The town is the headquarters of a large fishery, and has some coasting trade. Its exports are chiefly agricultural produce.

VILLEFRANCHE, a manufacturing town of east-central France, capital of an arrondissement in the department of Rhône, on the Morgon river near its junction with the Saône, 21 mi. N. by W. of Lyons by rail. Population (1936) 18,603. Founded in 1212 by Guichard IV, count of Beaujeu, Villefranche became in the 14th century capital of the Beaujolais. Edward II was forced to surrender the Beaujolais to the duke of Bourbon. Among its industries the chief are the manufacture of working clothes, the manufacture, dyeing and finishing of cotton fabrics, including surgical dressings, linings, the spinning of cotton thread, copper founding and the manufacture of machinery and agricultural implements. The wines of Beaujolais, hemp, cotton cloth, linen, cotton thread, drapery goods and cattle are the principal articles of trade. An old Renaissance house is used as the town hall. The 15th century church of Notre-Dame des Marais has a 16th century tower and spire (rebuilt in 1862), standing to the right of the façade. Villefranche is the seat of a sub-prefect and has a tribunal of commerce and a chamber of commerce.

VILLEFRANCHE-DE-ROUERGUE, a town of France, capital of an arrondissement in the department of Aveyron, 36 mi. W. of Rodez by road. Pop. (1936) 6,852. Villefranche, founded about 1252, owes its name to the numerous immunities granted by its founder Alphonse, count of Toulouse (d. 1271), and in 1348 it was so flourishing that sumptuary laws were passed. Soon afterwards the town fell into the hands of Edward, the Black Prince, but was the first place in Guienne to rise against the English. New privileges were granted to the town by King Charles V, but these were taken away by Louis XI. In 1588 the inhabitants repulsed the forces of the League. Villefranche, which has a station on the Orléans railway, lies among the hills on the right bank of the Aveyron at its junction with the Alzou. One of the three bridges that cross the river is of the 13th century, and there are many houses of the 13th and 14th centuries. The church of Notre-Dame is flanked by a massive tower, beneath the porch of which passes one of the chief streets. The fine woodwork in the choir dates from the 15th century. The 15th and 16th century buildings (notably the fine refectory and two cloisters, the smaller a gem of late Gothic work) of a Carthusian monastery stand above the town on the left bank of the Aveyron. Quarries of phosphates and mines of galena and blende are worked near Villefranche. Villefranche is an agricultural centre with minor industries, and is the seat of a sub-prefect.

VILLEHARDOUIN, GEOFFROY DE (*c.* 1160–*c.* 1213), the first vernacular historian of France, and perhaps of modern Europe, who possesses literary merit, is rather supposed than known to have been born at the chhteau from which he took his name, near Troyes, in Champagne, about the year 1160. Not merely his literary and historical importance, but almost all that is known about him, comes from his chronicle of the fourth crusade, or *Conquête de Constantinople.* He was one of a list of knights of Champagne who with their count, Thibault, took the cross at a tournament held at Escry-sur-Aisne in Advent 1199. The next year six deputies, two appointed by each of the three allied counts of Flanders, Champagne and Blois, were despatched to Venice to negotiate for ships. Of these deputies Villehardouin was one and Quesnes de Béthune, the poet, another. They concluded a bargain with the seigniory for transport and provisions at a fixed price. Villehardouin had hardly returned when Thibault fell sick and died. Villehardouin made another embassy into Italy to prevent if possible some of his fellow-pilgrims from breaking the treaty with the Venetians by embarking at their ports and employing other convoy.

Villehardouin does not tell us of any direct part taken by himself in the debates on the question of interfering or not in the disputed succession to the empire of the East—debates in which the chief ecclesiastics present strongly protested against the diversion of the enterprise from its proper goal. It is quite clear, however, that the marshal of Champagne, who was one of the leaders and inner counsellors of the expedition throughout, sympathized with the majority, and it is fair to point out that the temptation of chivalrous adventure was probably as great as that of gain. He narrates spiritedly enough the dissensions and discussions in the winter camp of Zara and at Corfu, but is evidently much more at ease when the voyage was again resumed, and, after a fair passage round Greece, the crusaders at last saw before them the great city of Constantinople which they had in mind to attack.

When the assault was decided upon, Villehardouin himself was in the fifth "battle," the leader of which was Mathieu de Montmorency. But he does not tell us anything of his own prowess. After the flight of the usurper Alexius, and when the blind Isaac, whose claims the crusaders were defending, had been taken by the Greeks from prison and placed on the throne, Villehardouin, with Montmorency and two Venetians, formed the embassy sent to arrange terms. He was again similarly distinguished when it became necessary to remonstrate with Alexius, the blind man's son and virtual successor, on the non-keeping of the terms. Indeed Villehardouin's talents as a diplomatist seem to have been held in very high esteem, for later, when the Latin empire had become a fact, he was charged with the delicate business of mediating between the emperor Baldwin and Boniface, marquis of Montferrat, in which task he had at least partial success. He was also appointed marshal of "Romanie"—a term very vaguely used, but apparently signifying the mainland of the Balkan Peninsula, while his nephew and namesake, afterwards prince of Achaia, took a great part in the Latin conquest of Peloponnesus.

Villehardouin himself before long received an important command against the Bulgarians. He was left to maintain the siege of Adrianople when Baldwin advanced to attack the relieving force, and with Dandolo had much to do in saving the defeated crusaders from utter destruction, and in conducting the retreat, in which he commanded the rearguard, and brought his troops in safety to the sea of Rodosto, and thence to the capital. As he occupied the post of honour in this disaster, so he had that (the command of the vanguard) in the expedition which the regent Henry made shortly afterwards to revenge his brother Baldwin's defeat and capture. And, when Henry had succeeded to the crown on the announcement of Baldwin's death, it was Villehardouin who fetched home his bride Agnes of Montferrat, and shortly afterwards commanded under him in a naval battle with the ships of Theodore Lascaris at the fortress of Cibotus. In the settlement of the Latin empire after the truce with Lascaris, Villehardouin received the fief of Messinople from Boniface of Montferrat, with the record of whose death the chronicle abruptly closes.

Villehardouin reappears for us once, but once only, in the chronicle of his continuator, Henri de Valenciennes. There is a great gap in style, though none in subject, between the really poetical prose of the first historian of the fifth crusade and the Latin empire and the awkward mannerism (so awkward that it has been taken to represent a "disrhymed" verse chronicle) of his follower. But the much greater length at which Villehardouin appears on this one occasion shows us the restraint which he must have exercised in the passages which deal with himself in his own work. He again led the vanguard in the emperor Henry's expedition against Burilas the Bulgarian, and he is represented by the Valenciennes scribe as encouraging his sovereign to the attack in a long speech. Then he disappears altogether, with the exception of some brief and chiefly diplomatic mentions. Du Cange discovered and quoted a deed of donation by him dated 1207, by which certain properties were devised to the churches of Notre Dame de Foissy and Notre Dame de Troyes, with the reservation of life interests to his daughters Alix and Damerones, and his sisters Emmeline and Haye, all of whom appear to have embraced a monastic life. A letter addressed from the East to Blanche of Champagne is cited, and a papal record of 1212 styles him stiil "marshal of Romania." The next year this title passed to his son Erard; and 1213 is accordingly given as the date of his death.

It would be out of place to attempt any further analysis of the *Conquête* here. But it is not impertinent, and is at the same time an excuse for what has been already said, to repeat that Villehardouin's book, brief as it is, is in reality one of the capital books of literature, not merely for its merit, but because it is the most authentic and the most striking embodiment in contemporary literature of the sentiments which determined the action of a great and important period of history. There are but very few books which hold this position, and Villehardouin's is one of them. If every other contemporary record of the crusades perished, we should still be able by aid of this to understand and realize what the mental attitude of crusaders, of Teutonic knights, and the rest was, and without this we should lack the earliest, the most undoubtedly genuine, and the most characteristic of all such records. The very inconsistency with which Villehardouin is chargeable, the absence of compunction with which he relates the changing of a sacred religious pilgrimage into something by no means unlike a mere filibustering raid on the great scale, add a charm.

The book appears to have been known in the ages immediately succeeding his own; and, though there is no contemporary manuscript in existence, there are some half-dozen which appear to date from the end of the 13th or the course of the 14th century, while one at least appears to be a copy made from his own work in that spirit of unintelligent faithfulness which is much more valuable to posterity than more pragmatical editing. The first printed edition of the book, by a certain Blaise de Vigenère, dates from 1585, is dedicated to the seigniory of Venice (Villehardouin, it should be said, has been accused of a rather unfair predilection for the Venetians), and speaks of either a part or the whole of the memoirs as having been printed twelve- years earlier. Of this earlier copy nothing seems to be known, A better edition, founded on a Netherlandish ms., appeared at Lyons in 1601. But both these were completely antiquated by the great edition of Du Cange in 1657, wherein that learned writer employed all his knowledge, never since equalled, of the subject, but added a translation, or rather paraphrase, into modern French which is scarcely worthy either of himself or his author. Dom Brial gave a new edition from different ms. sources in 1823, and the book figures with different degrees of dependence on Du Cange and Brial in the collections of Petitot, Buchon, and Michaud and Poujoulat.

All these, however, have been superseded for the modern student by the editions of Natalis de Wailly (1872 and 1874), in which the text is critically edited from all the available mss. and a new translation added, while there is a still later and rather handier one by E. Bouchet (2 vols., Paris, 1891), which, however, rests mainly on N. de Wailly for text. The charm of Villehardouin can escape no reader; but few readers will fail to derive some additional pleasure from the two essays which Sainte-Beuve devoted to him, reprinted in the ninth volume of the *Causeries du lundi*. *See* also A. Debidour, *Les Chroniqueurs* (1888). There are English translations by T. Smith (1829), and (more literally) Sir F. T. Marzials (Everyman's Library, 1908).

VILLEINAGE (Villainage, Villenage), a mediaeval term (from *villa, villanus*), pointing to serfdom, a condition of men fntermediate between freedom and slavery. It occurs in France as well as in England, and was certainly imported into English speech through the medium of Norman French.

The materials for the formation of the villein class were already in existence in the Anglo-Saxon period. On the one hand, the Saxon ceorls (*twihyndemen*), although considered as including the typical freemen in the earlier laws (Aethelberht, Hlothhere and Edric, Ine), gradually became differentiated through the action of political and economic causes, and many of them had to recognize the patronage of magnates or to seek livelihood as tenants on the estates of the latter. These ceorls, sitting on gafolland, were, though personally free, considered as a lower order of men, and lapsed gradually into more or less oppressive subjection to the lords of whom they held their land. It is characteristic in this connection that the West Saxon laws do not make any distinction between ceorls and laets or half-freemen as the Kentish laws had done: this means that the half-free people were, if not Welshmen, reckoned as members of the ceorl class. Another remarkable indication of the decay of the ceorl's estate is afforded by the fact that in the treaties with the Danes the twihynde ceorls are equated with the Danish leysings or freedmen. It does not mean, of course, that their condition was practically the same, but in any case the fact testifies to the gulf which had come to separate the two principal subdivisions of the free class —the ceorl and the thegn. The Latin version of the *Rectitudines Singularum Personarum*, a document compiled probably in the 11th century, renders *geneat* (a peasant tenant of a superior kind performing lighter services than the gebur, who was burdened with heavy week-work) by *villanus;* but the gebur came to be also considered as a *villanus* according to Anglo-Norman terminology. The group designated as *geburs* in Anglo-Saxon charters, though distinguished from mere slaves, undoubtedly included many freedmen who in point of services and economic subjection were not very much above the slaves. Both ceorls and geburs disappear as separate classes, and it is clear that the greater part of them must have passed into the rank of villeins.

In the terminology of the Domesday Inquest we find the villeins as the most numerous element of the English population. Out of about 240,000 households enumerated in Domesday 100,000 are marked as belonging to villeins. They are rustics performing, as a rule, work services for their lords. But not all the inhabitants of the villages were designated by that name. Villeins are opposed to socmen and freemen on one hand, to *bordarii*, cottagers and slaves on the other. The distinction in regard to the first two of these groups was evidently derived from their greater freedom, although the difference is only one in degree and not in kind. In fact, the villein is assumed to be a person free by birth, but holding land of which he cannot dispose freely. The distinction as against *bordarii* and cottagers is based on the size of the holding: the villeins are holders of regular shares in the village —that is, of the virgates, bovates or half-hides which constitute the principal subdivisions in the fields and contribute to form the plough-teams—whereas the *bordarii* hold smaller plots of some five acres, more or less, and *cottarii* are connected with mere cottages and crofts. Thus the terminology of Domesday takes note of two kinds of differences in the status of rustics: a legal one in connection with the right to dispose of property in land, and an economic one reflecting the opposition between the holders of shares in the fields and the holders of auxiliary tenements. The feature of personal serfdom is also noticeable, but it provides a basis only for the comparatively small group of *servi,* of whom only about 25,000 are enumerated in Domesday Book. The contrast between this exceptionally situated class and the rest of the population shows that personal slavery was rapidly disappearing in England about the time of the Conquest. It is also to be noticed that the Domesday Survey constantly mentions the *terra villanorum* as opposed to the lord's demesne, and that the land of the rustics is taxed separately for the geld, so that the distinction between the property of the lord and that of the peasant dependent on him is clearly marked.

The Domesday Survey puts before us the state of things in England as it was at the very beginning of the Norman and at the close of the Saxon period. The development of feudal society, of centralizing kingship and ultimately of a system of common law, brought about great changes which all hinge on the fundamental fact that the kings, while increasing the power of the State in other respects, surrendered it completely as regards the relations between the peasants and their lords. The protection of the assizes was tendered in civil matters to free tenants and refused to villeins. The royal courts refused to entertain suits of villeins against their lords, although there was a good deal of vacillation before this position was definitely taken up. Bracton speaks in his treatise of the possibility of interference by the courts against intolerable cruelty on the part of the lord involving the destruction of the villein's waynage, that is, of his tillage, and in the *Notebook* of Bracton may be found a couple of cases which prove that 13th century judges occasionally allowed themselves to entertain actions by persons holding in villeinage against their lords. Gradually, however, the exception of villeinage became firmly settled. As the historical and practical position was developing on these lines the lawyers who fashioned English common law in the 12th and 13th centuries did not hesitate to apply to it the teaching of Roman law on slavery. Bracton fits his definition of villeinage into the Romanesque scheme of Azo's *Summa* of the Institutes, and the judges of the royal courts made sweeping inferences from this general position. To begin with, the relation between the villein and his lord was regarded as a personal and not a praedial one. Everyone born of villein stock belonged to his master and was bound to undertake any service which might be imposed on him by the master's or the steward's command. The distinction between villeins in gross and villeins regardant, of which much is made by modern writers, was suggested by modes of pleading and does not make its appearance in the Year-Books before the 15th century. Secondly, all independent proprietary rights were denied to the villein as against his lord, and the legal rule "quicquid servo acquiritur domino acquiritur" was extended to villeins. The fact that a great number of these serfs had been enjoying protection as free ceorls in former ages made itself felt, however, in three directions. (1) In criminal matters the villein was treated by the King's Court irrespectively of any consideration as to his debased condition. More especially the police association, organized for the keeping of the peace and the presentation of criminals—the frankpledge groups—were formed of all "worthy of were and wite," villeins as well as freemen. (2) Politically the villeins were not eliminated from the body of citizens; they had to pay taxes, to serve in great emergencies in the militia, to serve on inquests, etc., and although there was a tendency to place them on a lower footing in all these respects yet the fact of their being lesser members of the commonwealth did not remove the fundamental qualification of citizenship. (3) Even in civil matters villeins were deemed free as regards third persons. They could sue and be sued in their own name, and although they were able to call in their lords as defendants when proceeded against, there was nothing in law to prevent them from appearing in their own right. The state even afforded them protection against extreme cruelty on the part of their masters in respect of life and limb, but in laying down this rule English lawyers were able to follow the precedents set by late Roman jurisprudence, especially by measures of Hadrian, Antonine and Constantine the Great.

There was one exception to this harsh treatment of villeins. The rustic tenantry in manors of *ancient demesne,* that is, in estates which had belonged to the crown before the Conquest. had a standing-ground even against their lords as regards the tenure of their plots and the fixity of their services. Technically this right was limited to the inhabitants of manors entered in the Domesday Survey as *terra regis* of Edward the Confessor. On the other hand the doctrine became effective if the manors in question had been granted by later kings to subjects, because if they remained in the hand of the king the only remedy against ejectment and exaction lay in petitioning for redress without any definite right to the latter. If, however, the two conditions mentioned were forthcoming, villeins, or, as they were technically called, villein socmen of ancient demesne manors, could resist any attempt of their lords to encroach on their rights by depriving them of their holdings or increasing the amount of their customary services. Their remedy was to apply for a little writ of right in the first case and for a writ of *monstraverunt* in the second. These writs entitled them to appear as plaintiffs against the lord in his own manorial court and, eventually, to have the question at issue examined by way of appeal, on a writ of error, or by reservation on some legal points in the upper courts of the king. A number of cases arising from these privileges of the men of ancient demesne are published in the *Notebook* of Bracton and in the *Abbreviatio placitorum.* This exceptional procedure does not simply go back to the rule that persons who had been tenants of the king ought not to have their condition altered for the worse in consequence of a royal grant. If this were the only doctrine applicable in the case there would be no reason why similar protection should be denied to all those who held under grantees of manors escheated after the Conquest. A material point for the application of the privilege consists in the fact that ancient demesne has to be proved from the time before the Conquest, and this shows clearly that the theory was partly derived from the recognition of tenant right in villeins of the Anglo-Saxon period who, as we have said above, were mostly ceorls, that is, freeborn men.

In view of the great difference in the legal position of the free man and of the villein in feudal common law, it became very important to define the exact nature of the conditions on which the status of a villein depended. The legal theory as to these conditions was somewhat complex. Of course, persons born from villein parents in lawful wedlock were villeins, but as to the condition of illegitimate children there was a good deal of hesitation. There was a tendency to apply the rule that a bastard follows the mother, especially in the case of a servile mother. In the case of mixed marriages, the condition of the child was determined by the free or villein condition of the tenement in which it was born. This notion of the influence of the tenement is in accord with feudal ideas and makes itself felt again in the case of the pursuit of a fugitive villein. He can be seized without further formalities if he is caught in his "nest," that is, in his native place. If not, the lord can follow him in fresh pursuit for four days; once these days are past, the fugitive is maintained provisionally in possession of his liberty, and the lord has to bring an action *de nativo habendo* and has to assume the burden of proof.

So much as to the proof of villeinage by birth or previous condition. But there were numbers of cases when the discussion as to servile status turned not on these formal points but on an examination of the services performed by the person claimed as a villein or challenged as holding in villeinage. In both cases the courts had often recourse to proof derived not from direct testimony but from indirect indications as to the kind of services that had been performed by the supposed villein. Certain services, especially the payment of *merchet*—the fine for marrying a daughter—were considered to be the badge of serfdom. Another service, the performance of which established a presumption as to villeinage, was compulsory service as a reeve. The courts also tried to draw a distinction from the amount and regularity of agricultural services to which a tenant was subjected. Bracton speaks of the contrast between the irregular services of a serf, "who could not know in the evening what he would have to do in the morning," and services agreed upon and definite in their amount. The customary arrangements of the work of villeins, however, render this contrast rather fictitious. The obligations of downright villeins became so far settled and regular that one of the ordinary designations of the class was *custumarii.* Therefore in most cases there were no arbitrary exactions to go by, except perhaps one or the other tallage imposed at the will of the lord. The original distinction seems to have been made not between arbitrary and agreed but between occasional services and regular agricultural week-work. While the occasional services, even when agricultural, in no way established a presumption of villeinage, and many socmen, freemen and holders by serjeanty submitted to them, agricultural week-work was primarily considered as a trait of villeinage and must have played an important part in the process of classification of early Norman society.

This point brings us to consider the matter-of-fact conditions of the villeins during the feudal period, especially in the 12th, 13th and 14th centuries. As is shown by the Hundred Rolls and countless other records of the same kind, the customary conditions of villeinage did not tally by any means with the identification of villeinage with slavery suggested by the jurists. It is true that in nomenclature the word *servi* is not infrequently used (*e.g.,* in the Hundred Rolls) where *villani* might have been mentioned, and the feminine *nief (nativa)* appears as the regular parallel to *villanus,* but in the descriptions of usages and services we find that the power of the lord loses its discretionary character and is in every respect moderated by custom. As personal dependents of the lord native villeins were liable to be sold, and we find actual sales recorded: Glastonbury Abbey, *e.g.,* sells a certain Philipp Hardyng for 20 shillings. But such transfers of human chattels occur seldom, and there is nothing during the English feudal period corresponding to the brisk trade in men characteristic of the ancient world. *Merchet* was regarded as a badge of serfdom in so far as it was said to imply a "buying of one's own blood" *(servus de sanguine suo emendo).* The explanation is even more characteristic than the custom itself, because fines on marriage might be levied and were actually levied on people of different condition, on the free as well as on the serf. Still the tendency to treat *nterchet* as a distinctive feature of serfdom has to be noted, and we find that the custom spread for this very reason in consequence of the encroachments of powerful lords; in the Hundred Rolls it is applied indiscriminately to the whole rustic population of certain hundreds in a way which can hardly be explained unless by artificial extension. *Heriot,* the surrender of the best horse or ox, is also regarded as the common incident of villein tenure, although, of course, its very name proves its intimate connection with the outfit of soldiers *(here-geatu).*

Economically the institution of villeinage was bound up with the manorial organization—that is, with the fact that the country was divided into a number of districts in which central home farms were cultivated by work supplied by villein households.

The most important of villein services is the *week-work* performed by the peasantry. Every virgater or holder of a bovate has to send a labourer to do work on the lord's farm for some days in the week. Three days is indeed the most common standard for service of this kind, though four or even five occur sometimes, as well as two. It must be borne in mind in the case of heavy charges, such as four or five days' week-work, that only one labourer from the whole holding is meant, while generally there were several men living on every holding—otherwise the service of five days would be impossible to perform. In the course of these three days, or whatever the number was, many requirements of the demesne had to be met. The principal of these was *ploughing the fields* belonging to the lord, and for such ploughing the peasant had not only to appear personally'as a labourer, but to bring his oxen and plough, or rather to join with his oxen and plough in the work imposed on the village; the heavy, costly plough with a team of eight oxen had to be made up by several peasants contributing their beasts and implements towards its composition. In the same way the villagers had to go through the work of harrowing with their harrows, and of removing the harvest in their vans and carts. *Carriage* duties in carts and on horseback were also apportioned according to the time they took as a part of the week-work. Then came innumerable varieties of manual work for the making and keeping up of hedges, the preservation of dykes, canals and ditches, the threshing and garnering of corn, the tending and shearing of sheep, and so forth. All this hand-work was reckoned according to customary standards as day-work and week-work. But besides all these services into which the regular week-work of the peasantry mas differentiated, there were some additional duties. The ploughing for the lord. for instance, was not only imposed in the shape of a certain number of days in the week, but took sometimes the shape of a certain number of acres which the village had to plough and to sow for the lord irrespectively of the time employed. This was sometimes termed *gafolearth.* Exceedingly burdensome services were required in the seasons when farming processes are at their height—in the seasons of mowing and reaping, when every day is of special value and the working power of the farm hands is strained to the utmost. At those times it was the custom to call up the whole able-bodied population of the manor, with the exception of the housewives, for two, three or more days of mowing and reaping on the lord's fields; to these *boon-works* the peasantry was asked or invited by special summons, and their value was so far appreciated that the villagers were usually treated to meals in cases where they were again and again called off from their own fields to the demesne. The liberality of the lord actually went so far, in exceptionally hard straits, that ale was served to the labourers.

By the 14th century this social arrangement, based primarily on natural economy, had given way; the time of *commercial, contractual, cash intercourse* was fast approaching.

If we now turn to the actual stages by which this momentous passage from the manorial to the commercial arrangement was achieved, we have to notice first of all a rapid *development of contractual relations.* We know that in feudal law there was a standing contrast between *tenure* by custom—villein tenure—and *tenure* by *contract—free* tenure. While the manorial system was in full force this contrast led to a classification of holdings and affected the whole position of people on the land. Still, even at that time it might happen that a freeholder owned some land in villeinage by the side of his free tenement, and that a villein held some land freely by agreement with his lord or with a third person. But these cases, though by no means infrequent, were still exceptional. As a rule people used land as holdings, and those were rigidly classified as villein or free tenements. The interesting point is that, without any formal break, *leasing land for life and for terms of years* is seen to be rapidly spreading during the 13th century, and many small tenancies are created which break up the disposition of the holdings. From the close of the 13th century countless transactions on the basis of leases for terms of years occur between the peasants themselves. Any suitably kept set of 14th century court rolls contains entries in which such and such a villein is said to appear in the *halimote* and to surrender for the use of another person named a piece of land belonging to the holding. The number of years and the conditions of payment are specified. Thus, behind the screen of the normal shares a number of small tenancies arise which run their economic concerns in independence of the cumbersome arrangements of tenure and service, and, needless to add, all these tenancies are burdened with money rents.

Another series of momentous changes took place in the *arrangement of services.* Even the manorial system admitted the buying off for money of particular dues in kind and of specific performance of work. A villein might be allowed to bring a penny instead of a chicken, or to pay a rent instead of appearing with his oxen three times a week on the lord's fields. Such rents were called *mal* or *mail* in contrast with the *gafol,* ancient rents which had been imposed independently, apart from any buying off of customary services. There were even whole bodies of peasants called *Molmen,* because they had bought off work from the lord by settling with him on the basis of money rents. As time went on these practices of *commutation* became more and more frequent. There were, for both sides, many advantages in arranging their mutual relations on this basis. The lord got clear money—a much-coveted means of satisfying needs and wishes of any kind—instead of cumbrous performances which did not come always at the proper moment, were carried out in a half-hearted manner, yielded no immediate results, and did not admit of convenient rearrangement. The peasant got rid of a hateful drudgery which not only took up his time and means in an unprofitnble manner, but placed him under the arbitrary control of stewards or reeves and gave occasion to all sorts of fines and extortions.

With the growth of intercourse and security money circulated more freely and the number of such transsctions increased in proportion. But it must be kept in mind that the conversion of services into rents went on very gradually, as a series of private agreements, and that it would be wrong to suppose, as some scholars have done, that it had led to a general commutation by the middle or even the end of the 14th century. The 14th century was marked by violent fluctuations in the demand and supply of labour, and particularly the tremendous loss in population caused in the middle of this century by the Black Death produced a most serious crisis. No wonder that many lords clung very tenaciously to customary services, and ecclesiastical institutions seem to have been especially backward in going over to the system of money rents. There is evidence to show, for instance, that the manors of the abbey of Ramsey were managed on the system of enforced labour right down to the middle of the 15th century, and, of course, survivals of these customs in the shape of scattered services lived on much longer. A second drawback from the point of view of the landlords was that commutation for fixed rents gradually lessened the value of the exactions to which they were entitled. Money not only became less scarce but it became cheaper, so that the couple of pence for which a day of manual work was bought off in the beginning of the 13th century did not fetch more than half of their former value at its end. As quit rents were customary and not rack rents, the successors of those who had redeemed their services were gaining the whole surplus in the value of goods and labour as against money, while the successors of those who had commuted their right to claim services for certain sums in money lost all the corresponding difference. These inevitable consequences came to be perceived in course of time and occasioned a tendency to revert to services in kind which could not prevail against the general movement from natural economy to money dealings, but was strong enough to produce social friction.

The economic crisis of the 14th century has its complement in the legal crisis of the 15th. At that time the courts of law began to do away with the denial of protection to villeins which, as we have seen, constituted the legal basis of villeinage. This is effected by the recognition of copyhold tenure (see COPYHOLD).

It is a fact of first-rate importance that in the 15th century customary relations on the one hand, and the power of government on the other, reached a stage of development at which the judges of the king began to take cognizance of the relations of the peasants to their lords. The first cases which occur in this sense are still treated not as a matter of common law, but as a manifestation of equity. As doubtful questions of trust, of wardship, of testamentary succession, they were taken up not in the strict course of justice. but as matters in which redress was sorely needed and could only be given by the exceptional power of the court of chancery. But this interference of 15th century chancellors paved the way towards one of the greatest revolutions in the law; without formally enfranchising villeins and villein tenure they created a legal basis for it in the law of the realm. In the formula of copyhold—tenement *held* at the will of the lord and by the custom of the manor—the first part lost its significance and the second prevailed, in downright contrast with former times when, on the contrary, the second part had no legal value and the first expressed the view of the courts. One may almost be tempted to say that these obscure decisions rendered unnecessary in England the work achieved with such a flourish of trumpets in France by the emancipating decree of Aug. 4, 1789.

The personal condition of villeinage did not, however, disappear at once with the rise of copyhold. It lingered through the 16th century and appears exceptionally even in the 17th. Deeds of emancipation and payments for personal enfranchisement are often noticed at that time. But these are only survivals of an arrangement which has been destroyed in its essence by a complete change of economic and oolitical conditions.

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VILLELE, JEAN BAPTISTE GUILLAUME MARIE ANNE SERAPHIN, COMTE DE (1773–1854), French statesman, was born at Toulouse on April 14, 1773 and educated for the navy. He joined the "Bayonnaise" at Brest in July 1788 and served in the West and East Indies. Arrested in the Isle of Bourbon under the Terror, he was set free by the revolution of Thermidor (July 1794). He acquired some property in the island, and married in 1799 the daughter of a great proprietor, M. Desbassyns de Richemont, whose estates he had managed. The arrival of General Decaen, sent out by Bonaparte in 1802, restored security to the island, and five years later Villèle, who had now realized a large fortune, returned to France. He was mayor of his commune, and a member of the council of the Haute-Garonne under the Empire. At the restoration of 1814 he at once declared for royalist principles. He was mayor of Toulouse in 1814–15 and deputy for the Haute-Garonne in the "Chambre Introuvable" of 1815. Villèle, who before the promulgation of the charter had written some Observations *sur le projet* de *constitution* opposing it, as too democratic in character, naturally took his place on the extreme right with the ultra-royalists. In the new Chamber of 1816 Villèle found his party in a minority, but his personal authority nevertheless increased. He was looked on by the ministerialists as the least unreasonable of his party, and by the "ultras" as the safest of their leaders. Under the electoral law of 1817 the Abbé Grégoire, who was popularly supposed to have voted for the death of Louis XVI. in the Convention, was admitted to the Chamber of Deputies. The Conservative party gained strength from the alarm raised by this incident and still more from the shock caused by the assassination of the duc de Berri. The duc de Richelieu was compelled to admit to the cabinet two of the chiefs of the Left, Villèle and Corbière. Villèle resigned within a year, but on the fall of Richelieu at the end of 1821 he became the real chief of the new cabinet, in which he was minister of finance. Although not himself a courtier, he was backed at court by Sosthiines de la Rochefoucauld and Madame du Cayla, and in 1822 Louis XVIII. gave him the title of count and made him formally prime minister.

He immediately proceeded to muzzle opposition by stringent press laws, and the discovery of minor Liberal conspiracies afforded an excuse for further repression. Forced against his will into interference in Spain, he reaped some credit from the campaign of 1823. Meanwhile he had persuaded Louis XVIII. to swamp the Liberal majority in the upper house by the nomination of twenty-seven new peers; he availed himself of the temporary popularity of the monarchy after the Spanish campaign to summon a new Chamber of Deputies. This new and obedient legislature, to which only nineteen Liberals were returned, made itself into a septennial parliament, thus providing time, it was thought, to restore some part of the *ancien régime*. Villèle's plans were assisted by the death of Louis XVIII. and the accession of his bigoted brother. Prudent financial administration since 181j had made possible the conversion of the state bonds from 5 to 4%. It was proposed to utilize the money set free by this operation to indemnify by a milliard francs the *émigrés* for the loss of their lands at the Revolution; it was also proposed to restore their former privileges to the religious congregations. Both these propositions were, with some restrictions, secured. Sacrilege was made a crime punishable by death, and the ministry were preparing a law to alter the law of equal inheritance, and thus create anew the great estates. These measures roused violent opposition in the country, which a new and stringent press law, nicknamed the "law of justice and love," failed to put down. The peers rejected the law of inheritance and the press law; it was found necessary to disband the National Guard; and in Nov. 1827, 76 new peers were created, and recourse was had to a general election. The new Chamber proved hostile to Villèle, who resigned to make way for the short-lived moderate ministry of Martignac.

The new ministry made Villèle's removal to the upper house a condition of taking office, and he took no further part in public affairs. At the time of his death, on March 13, 1854, he had advanced as far as 1816 with his memoirs, which were completed from his correspondence by his family as *Mémoires et correspondance du comte de Villkle,* j vol. (1887–90).

See also C de Mazade, *L'Opposition royaliste* (1894) ; J. G. Hyde de Neuville, *Notice sur le comte de Villèle* (1899) ; and M. Chotard, "L'Oeuvre financière de M de Villèle," in *Annales des sciences politiques,* vol v , (1890).

VILLEMIN, JEAN ANTOINE (1827–1892), French physician noted for his early researches on tuberculosis, was born at Prey, in the Vosges mountains, France, in 1827. Receiving his medical degree in 1853, he served for many years with the French army, retiring in 1885 with the rank of medical inspector-general.

In 1865 Villemin showed that tuberculosis could be transmitted from diseased to healthy animals by inoculation, thus proving that the malady was due to an infecting agent. The actual agent, the tubercle bacillus, was discovered by Robert Koch in 1882. Villemin published *Etudes sur la tuberculose* (1868), in which he announced his findings. Other works by Villemin include *Du tubercule, au point de vue de son siège, de son évolution et de sa nature* (1861) and *Rôle de la lésion organique dans les maladies* (1862).

VILLENA, ENRIQUE DE *(c.* 1384–1434), Spanish writer with a lively interest in a variety of subjects, was born *c.* 1384, of a noble Aragonese family. About 1402 he married Maria de Castilla, who soon became the mistress of Henry III; the complaisant husband was rewarded with the mastership of Calatrava in 1404. He died at Madrid on Dec. 15, 1434.

Villena's works are medieval in theme but look forward to the Renaissance in their latinized language. They include *Los doce trabayos de Hércules* (1417); a culinary handbook, the *Arte cisoria* (1423); and the *Libro de aojamiento* (142j), a treatise on the evil eye, to which Villena's enduring reputation as a sorcerer—the church burned his library after his death—must be attributed. His prose translation of the *Aeneid* (1428) was the first ever made. His treatise on poetry. the *Arte de trobar* (1433), survives only in fragments. (C. C. SH.)

VILLENEUVE, PIERRE CHARLES JEAN BAPTISTE SILVESTRE DE (1763–1806), French admiral, who commanded the French fleet at the battle of Trafalgar, was born at Valensole, Provence, on Dec. 31, 1763. He entered the French royal navy and received rapid promotion, being named post captain in 1793, and rear admiral in 1796. At the close of the year he took part in the unsuccessful expedition to Ireland.

He accompanied the expedition to Egypt, with his flag in the "Guillaume Tell" (86 guns). She was the third ship from the rear of the French line at the battle of the Nile and escaped in company with the "Genereux" (78). Villeneuve reached Malta on Aug. 23. His conduct was severely blamed, and he defended himself by a specious letter to his colleague Blanquet-Duchayla on Nov. 12, 1800, from Paris. In a letter written to him on Aug. 21, 1798, Napoleon said that the only thing with which Villeneuve had to reproach himself was that he had not retreated sooner, since the position taken by the French commander in chief had been forced and surrounded. But, in dictating his account of the expedition to Egypt to General Bertrand at St. Helena, the former emperor attributed the defeat at the Nile largely to the "bad conduct of Admiral Villeneuve." Villeneuve failed in the execution of the scheme for the invasion of England in 1805.

Nevertheless, Napoleon selected him to succeed Latouche Tréville at Toulon on his death in Aug. 1804. The duty of the Toulon squadron was to draw Nelson to the West Indies, return rapidly and, in combination with other French and Spanish ships, to enter the channel with an overwhelming force. It is obvious that Villeneuve had no confidence in the success of the operation. It required a tart order from Napoleon to drive him out of Paris in Oct. 1804. He took the command in November. For the details of the campaign. *see* TRAFALGAR, THE BATTLE OF. Having undertaken to carry out a plan of which he disapproved, it was clearly his duty to execute the orders he received. But Villeneuve could not free himself from the conviction that it was his business to save his fleet even if he ruined the emperor's plan of invasion. Thus after he returned to Europe and fought his confused action with Sir R. Calder off El Ferrol on July 22. 1805, he first hesitated and then, in spite of vehement orders to come on, turned south to Cadiz.

His decision to leave Cadiz and give battle in Oct. 1805, which led directly to the battle of Trafalgar, has been severely criticized. Defeat seemed to be inevitable, and yet he went out after learning from the minister of marine that another officer had been sent to supersede him. At Trafalgar he showed personal courage, but the incapacity of the allies to maneuvre gave him no opportunity to influence the course of the battle. He was taken as a prisoner to England but was soon released. He committed suicide at Rennes, on April 22, 1806.

The correspondence of Napoleon contains many references to Villeneuve. Accounts of the naval operations in which he was concerned will be found in William James's *Naval History.* Troude, in his *Batailles navales de la France,* vol. iii, published several of his letters and orders of the day.

VILLENEUVE-LÈS-AVIGNON, a town of southeastern France, in the *de'partement* of Gard on the right bank of the Rhône opposite Avignon. Pop. (1954) 4,431. In the 6th century the Benedictine abbey of St. André was founded on Mont Andaon, and the village which grew up round it took its name. In the 13th century the monks, acting in concert with the crown, established a *bastide,* or "new town," which came to be called Villeneuve.

The town was the resort of the French cardinals during the sojourn of the popes at Avignon, and was important until the Revolution.

Villeneuve preserves many remains of its medieval importance. The hospice, once a Franciscan convent, and the church and other remains of the Carthusian monastery of Val-de-Bénédiction, founded in 1356 by Innocent VI, are notable. A 17th-century gateway and a rotunda, built as shelter for a fountain, are interesting.

On the Mont Andaon, a hill to the northeast of the town, stands the Fort of St. André (14th century), with a fortified entrance gateway and a Romanesque chapel and remains of the Abbey of St. André.

VILLENEUVE-SUR-LOT, a town of southwestern France, capital of an *arrondissement* in the *de'partement* of Lot-et-Garonne, 22 mi. N. E. of Agen on a branch line of the Orléans railway. Pop. (1954) 13,02j. Villeneuve was founded in 1254 by Alphonse, count of Poitiers, brother of Louis IX, on the site of the town of Gajac, which had been deserted during the Albigensian crusade.

The river Lot divides the town into two parts. The chief quarter stands on the right bank and is united to that on the left bank by a 13th-century bridge. On the left bank portions of the 13th-century ramparts, altered and surmounted by machicolations in the 15th century, remain, and high square towers rise above the gates to the northeast, the Porte de Paris, and southwest, the Porte de Pujols. Arcades of the 13th century surround the Place La Fayette, and there are old houses of the 13th, 14th and 15th centuries in various parts of the town. On the left bank of the Lot, 2 mi. S.S.W. of Villeneuve, are the 13th-century walls of Pujols. The buildings of the ancient Abbey of Eysses, about a mile to the N.E., mainly 17th century, remain. Villeneuve has a subprefecture and a tribunal of commerce. It is an important agricultural centre and has a very large trade in plums *(prunes d'ente)* and in the produce of the surrounding market gardens, as well as in cattle, horses and wine. Many people are engaged in the preparation of preserved plums and the tinning of peas and beans; there are also manufactures of shoes and tin boxes.

VILLEROI, FRANCOIS DE NEUFVILLE, Duc de (1644–1730), French soldier, came of a noble family which had risen into prominence in the reign of Charles IX. His father Nicolas de Neufville, Marquis de Villeroi, marshal of France (1598–1685), created a duke by Louis XIV, was the young king's governor, and the boy was thus brought up in close relations with Louis. An intimate of the king, a finished courtier and leader of society and a man of great personal gallantry, Villeroi was marked out for advancement in the army, which he loved, but which had always a juster appreciation of his incapacity than Louis. In 1693, without having exercised any really important and responsible command, he was made a marshal. In 1655, when Luxembourg died, he obtained the command of the army in Flanders, and William III found him a far more complaisant opponent than the "little hunchback." In 1701 he was sent to Italy to supersede Catinat and was soon beaten by the inferior army of Eugene at Chiari *(see* Spanish Succession War). In the winter of 1701 he was made prisoner at the surprise of Cremona, and the wits of the army made at his expense the famous rhyme:

Par la faveur de Bellone, et par un bonheur sans égal,
Nous avons conserte Crémone—et perdu notre général.

In the following years he was pitted against Marlborough in the Low Countries. Marlborough's own difficulties with the Dutch and other allied commissioners, rather than Villeroi's own skill, put off the inevitable disaster for some years, but in 1706 the duke attacked him and thoroughly defeated him at Ramillies (*q.v.*). Louis consoled his old friend with the remark, "At our age. one is no longer lucky," but superseded him in the command and henceforward Villeroi lived the life of a courtier, much busied with intrigues but retaining to the end the friendship of his master. He died on July 18, 1730, at Paris.

VILLERS LA VILLE, a village of Belgium in the province of Brabant. 2 mi. E. of Quatre Bras, with a station on the direct line from Louvain to Charleroi. Pop. (1939) 1,109. It is chiefly interesting on account of the fine ruins of the Cistercian abbey of Villers founded in 1147 and destroyed by the French in 1795.

VPLLETTE, CHARLES, Marquis de (1736–1793), French writer and politician, was born in Paris on Dec. 4, 1736. He became the *protégé* of Voltaire. who had known his mother. During the Revolution Villette publicly burned his letters of nobility, wrote revolutionary articles in the *Chronique de Paris,* and was elected deputy to the Convention by the department of Seine-et-Oise. He died in Paris on July 7, 1793.

VILLIERS, BARBARA: *see* Cleveland, Duchess of.

VILLIERS DE L'ISLE-ADAM, PHILIPPE AUGUSTE MATHIAS, Comte de (1838–1889), French poet, was born at St. Brieuc in Brittany and baptized on Nov. 28, 1838. He may be said to have inaugurated the Symbolist movement in French literature, and *Axël,* the play on which he was engaged during so much of his life, though it was only published after his death, is the typical Symbolist drama. He began with a volume of *Premières Poésies* (1856–58). This was followed by a wild romance of the supernatural, *Isis* (1862), and by two plays in prose, *Elën* (1866) and *Morgane* (1866). La *Révolte,* a play in nhich Ibsen's *Doll's House* seems to be anticipated, was represented at the Vaudeville in 1870; *Contes cruels,* his finest volume of short stories, in 1883, and a new series in 1889; *Le Nouveau Monde,* a drama in five acts, in 1880; *L'Ève future,* an amazing piece of buffoonery satirizing the pretensions of science, in 1886; *Tribulat Bonhomet* in 1887; *Le Secret de l'échafaud* in 1888; *Axël* in 1890. He died in Paris, under the care of the Frères Saint-Jean-de-Dieu, on Aug. 19, 1889.

Villiers has left behind him a legend probably not more fantastic than the truth. Sharing many of the opinions of Don Quixote, he shared also Don Quixote's life. He was the descendant of the Grand Master of the Knights of Malta, famous in history, and his pride as an aristocrat and as an idealist mere equal. He hated mediocrity, science, progress, the present age, money end "serious" people. He remains a remarkable poet and a remarkable satirist, imperfect as both. He improvised out of an abundant genius, but the greater part of his work was no more than improvisation. He was accustomed to talk his stories before he wrote them. Sometimes he talked them instead of writing them. But he has left, at all events, the *Contes cruels,* in which may be found every classic quality of the French *conte,* together with many of the qualities of Edgar Allan Poe and Ernst Hoffman; and the drama of *Axël,* in which the stage takes a new splendour and a new subtlety of meaning. Villiers's influence on the younger French writers was considerable. It was always an exaltation. No one in his time followed a literary ideal more romantically. **(A. Sy.)**

See also *R.* du Pontavice de Keussey, *Villiers* de *l'Isle-Adam* (1893), a biography, English trans. (1904) by Lady Mary Loyd; S. Mallarmé, *Les Miens. Villiers de l'Isle-Adam* (1892); *R.* Martineau, *Un vivant et deux morts* (1901), bibliography. *A* selection from his stories, *Histoires souvernines,* was made by his friends (Brussels, 1899); there is a translation of the *Contes cruels* by Hamish Miles *(Sardonic Tales,* 1927).

VILLON, FRANCOIS (1431–*c.* 1463), French poet, was born in 1431, and, as it seems. certainly at Paris. He was entered on the books of the university of Paris as François de Montcorbier, but was always known by the name of his patron, Guillaume de Villon. It appears that he was born of poor folk, that his father died in his youth, but that his mother, for whom he wrote one of his most famous *ballades,* was alive when her son was 30 years old. Viilon was received into the house of Guillaume de Villon, chaplain in the collegiate church of Saint-Benoit-le-Bestourné, and a professor of canon law, who was probably a relative. The poet became a student in arts, no doubt early and took the degree of bachelor in 1449 and that of master in 1452.

On June 5, 1453, being in the company of a priest named Giles and a girl named Isabeau, he met, in the rue Saint-Jacques, a certain Breton, Jean le Hardi, a master of arts, who was nith a priest, Philippe Chermoye or Sermoise or Sermaise. A scuffle ensued; daggers mere drawn; and Sermaise, who started the broil, died of his wounds. Villon fled, and was sentenced to banishment—a sentence which was remitted in January 1456, the formal pardon being extant in two different documents, in one of which the culprit is described as "François des Loges, autrement dit Villon," in the other as "François de Montcorbier." By the end of 1456 he was again in trouble. In his first broil "la femme Isabeau" is only generally named, and it is impossible to say whether she had anything to do with the quarrel. In the second, Catherine de Vaucelles, of whom we hear not a little in the poems, is the declared cause of a scuffle in which Villon was so severely beaten that, to escape ridicule, he decided to flee to Angers, where he had an uncle who was a monk. As he was preparing to leave Paris he composed the *Petit Testament.* Hitherto Villon had been rather injured than guilty. But on the eve of leaving Paris he was concerned, just before Christmas 1456, in robbing the chapel of the college of Navarre from which five hundred gold crowns were stolen. The robbery was not discovered till March 1457, and in May the police came on the track of a gang of student-robbers owing to the indiscretion of one of thern, Guy Tabarie. A year more passed, when Tabarie. being arrested, turned king's evidence and accused Villon, who was then absent, of being the ringleader, and of having gone to Angers, partly at least, to arrange for similar burglaries there. Villon, for this or some other crime, was sentenced to banishment: and he did not attempt to return to Paris. For four years he was a wanderer, apparently a pedlar for some part of the time; and he may have been, as each of his friends Regnier de Montigny and Colin des Cayeux certainly was, a member of a wandering thieves' gang. It is certain that at one time (in the winter of 1457), and probable that at more times than one, he was in correspondence with Charles d'Orléans, and visited that prince's court at Blois. He made his way to Bourges where he was again in trouble, and had a taste of prison. From Bourges he went to the Bourbonnais, where he found shelter for a brief period with Jean II de Bourbon. Thence, if his own words are to be taken literally, he wandered to Dauphiné. He was in prison at Orleans, put to the question and under sentence of death, when he was released on the passage of the little princess of Orleans through the town on July 17, 1460. He had spent the summer of 1461 in the bishop's prison of Meung. Villon owed his release to Louis XI, who passed through Meung on a royal progress and freed prisoners on Oct. 2.

It was now that he wrote the *Grand Testament,* the work which has immortalized him. Although he was only 30 nothing appears to be left him but regret; his very spirit has been worn out by excesses or sufferings or both. In the autumn of 1462 we find him once more living in the cloisters of Saint-Benoit, and in November he was in the Châtelet for theft. In default of evidence the old charge of the college of Navarre mas revived, and even a royal pardon did not bar the demand for restitution. Bail was, however, accepted, but Villon was present at a street quarrel from which he hastily got away. Nevertheless he was arrested, tortured and condemned to be hanged, but the sentence was commuted to banishment (for ten years) by the parlement on Jan. 5, 1463. From this time he disappears from history.

Villon's two *Testaments* are made up of eight-line stanzas of eight-syllabled verses, varied in the case of the *Grand Testament* by the insertion of ballades and rondeaux. The sense of the vanity of human life pervades the whole of Villon's poetry. It is the very keynote of his most famous and beautiful piece, the *Ballade des dames du temps jadis,* with its refrain, "Mais où sont les neiges d'antan?", of the ballade of *La Grosse Margot,* with its burden of hopeless entanglement in shameless vice; and of the equally famous *Regrets de la Belle Heaulmière,* in which a woman, once young and beautiful, now old and withered, laments her lost charms. So it is almost throughout his poems, including the grim *Ballade des pendus,* and hardly excluding the very beautiful *Ballade que Villon feist a la requestc de sa mère, pour prier Nostre-Dame,* with its sincere and humble piety. In Villon's verse mediaeval Paris lives. Villon himself was beloved by the Paris of his day. His bright keen intellect, the exquisite polish of his verses and his realism, make him one of the great forces in French poetry. His influence on the moderns has been very great.

His certainly genuine poems consist of the two *Testaments* with their codicil (the latter containing the *Ballade des pendus,* or more properly *Épitaphe en forme de ballade,* and some other pieces of a similarly grim humour), a few miscellaneous poems, chiefly ballades, and an extraordinary collection (called *Le Jargon ou jobelin*) of poems in *argot,* the greater part of which is now totally unintelligible, if, which may perhaps be doubted, it ever was otherwise. Several poems usually printed with Villon's works are certainly, or almost certainly, not his. The chief are *Les Repues Franches,* a curious series of verse stories of cheating tavern-keepers, etc., having some resemblance to those told of George Peele. but of a broader and coarser humour. These, though in many cases "common form" of the broader tale-kind, are not much later than his time, and evidence to reputation if not to fact.

The first dated edition of Villon is of 1489. Before 1542 there were very numerous editions, the most famous being that (1533) of Clément Marot, one of whose most honourable distinctions is the care he took of his poetical predecessors. The Pléiade movement and the classicizing of the *grand siècle* put Villon rather out of favour, and he was not again reprinted till early in the 18th century, nhen he attracted the attention of students of old French like Le Duchat, Bernard de la Monnoye and Prosper Marchand.

The first critical edition in the modern sense—that is to say, an edition founded on mss. (of which there are in Villon's case several, chiefly at Paris and Stockholm)—was that of the Abbé J. H. R. Prompsault in 1832. The next was that of the "Bibliophile Jacob" (P. Lacroix) in the *Bibliotlzkque Elzévirienne* (Paris, 1854). The standard editions are *Oeuvres complètes de François Villon,* hy M. Auguste Longnon (1892), a revision of this text by Lucien Foulet, *François Villon: Oeuvres* (1923); and L. Thuasne, *François Villon; Oeuvres: édition critique* (1923), based on the Stockholm ms. of 1470, the ms. Fr. 20041 of the Bibliothèque Nationale, and Levet's text of 1489. M. Marcel Schwob discovered new documents relating to the poet, but died before he could complete his work, which was posthumously published in 1905. The researches of Schwob were completed by P. Champion in his *François Villon., sa vie et son temps* (1913). *See* also A. Lonpnon, *Étude biographique sur François Villon* (1877); Gaston Paris, *François Villon* (1901); D. B. Wyndham Lewis, *François Villon, A Documented Survey* (1928), with preface by H. Belloc, which contains renderings of the individual poems by Rossetti, Swinburne and Henley, and a full survey of the documents.

VILNIUS (WILNO, VILNA), former administrative district of soviet Lithuania, whose boundaries have shifted considerably with changes of political control. (*See* VILNIUS city.) As restored to Lithuania in 1939 the district was bounded by Latvia on the north, U.S.S.R. on the east, and the Byelorussian S.S.R. on the south, being about one-quarter the area and population of the former Polish province of Wilno (1920–39) and considerably smaller than the tsarist government of Vilna. The area forms an extension of the Baltic uplands and is drained in the north by the Disna and by the Neris (Vilija) in the south. Sand, numerous glacial lakes and marshes, some partially forested, cover large areas. The transportation is primitive except for a few railroads. The climate, slightly tempered by the Baltic sea, has a mean temperature of 43.7° F. and an average precipitation of 23.8 in. Agriculture is backnard, with rye, potatoes and flax the main crops grown on the badly eroded land. Timber and timber products are of considerable importance. The population, actually as well as in allegiance, has been unstable. Estimates of composition vary from 8.2% Poles (1897 Russian census) to 59.9% (1931 Polish census); from 50% Lithuanians (Lebedekin's 1861 estimate) to 10% in various Polish surveys. Statistics on Jewish (6% to 13%) and Russian (20% to 61%) groups are little more consistent, but the White Russians are generally considered the largest group. After the U.S S R. seized eastern Poland in Sept. 1939, it ceded parts of the Vilnius province to Lithuania. Chief city in this district is Vilnius (*q.v.*), but Trakai (Troki), Trumont, Dukszty, Nowoswieciany, and Podbrodzie are of some importance. The soviets absorbed the entire country in 1940, lost it to the German army in 1941, and regained it during the summer of 1944.

VILNIUS (Russian, VILNA; Polish, WILNO), capital of Lithuanian Soviet Socialist Republic, U S.S.R.. located 436 mi. S S.W. of Leningrad at the intersection of railways from Liepaja, Kaliningrad, Warsaw. the Ukraine, Gomel and Leningrad. Pop. (1959) 236.078. The city and its suburbs, Antokol, Lukiski, Pohulanka and Zarzecze, stand on and around an amphitheatre of wooded hills (2,450 ft.) which faces southeast at the confluence of the Neris and Vilejka. The old section of the city, resembling an overgrown village with its narrow winding streets, lies at the foot of Castle Hill on which the ruins of Gediminas' (Gedymin's) castle are still visible.

The newer areas, which spread up the hills and along the Neris, present a more modern aspect.

Situated between eastern and western Europe, Vilnius bears marks of many cultures. There are 28 Roman Catholic churches, 7 Orthodox, 2 Protestant, 1 Moslem mosque, and numerous synagogues. The public buildings show Byzantine, German, Latin, baroque, rococo and gothic influence. Most prominent is the Cathedral of St. Stanislas, built originally in 1387 and subsequently destroyed at least three times. The present neo-classical structure, designed by Gucewicz, was completed in 1801. There is a second cathedral, that of St. Nicholas, built in 1596–1604. Twelve of the city's churches were built in the 17th century by one Pac; one of these, the church of Sts. Peter and Paul, is a fine specimen of baroque style. The church of St. Martin was built on the site of the ancient pagan temple of Perkunas; while the small St. Anne's church, with its intricate gothic facade, so impressed Napoleon in 1812 that he wished he could take it with him to Paris. The Pointed Gate (Ostra Brama), with its venerated 16th century Madonna, is all that remains of the Jagellon wall of 1522.

The old university, in its neo-classical buildings, was originally founded as a Jesuit academy by Stephen Bathory in 1579. It uas re-estabhshed as the Superior school of the Lithuanian grand duchy in 1781, and toward the end of the 18th and early 19th centuries became an agitation centre of Polish culture. Political reasons caused the school to be closed in 1832 and, except for the faculties of astronomy and medicine, it remained inactive until 1919. In 1940, following the reoccupation of Vilnius by Lithuania, the school was reorganized, without most of the Polish staff, as the Lithuanian university. During the subsequent German occupation the school was closed and much of its equipment and archival collection destroyed.

The city possessed a Superior School of Political Science (est.

1930) as well as a college of dramatic art, academy of science, academy of art, academy of music, Roman Catholic and Orthodox seminaries, public library and botanical garden. It is a centre for timber, timber products, and furs, although the relative importance of the city declined between 1920 and 1939 because the city was separated from its natural economic hinterland. The German census of 1942 showed that in the city itself 53.2% of the population were Polish, 18.3% Lithuanian, 6.6% Jews, and 20.3% Russian groups. Heavy Polish refugee immigration and the German Jewish policy are reflected in these figures; the 1897 census reported 30.9% Poles and 40.3% Jews. The population composition of the Vilnius rural district is entirely different with a much stronger White Russian and Lithuanian proportion, fewer Jews, and probably not more than 15% Poles.

History. — Although it was founded in the 10th century, Vilnius was unimportant until Grand Duke Gediminas (Gedymin, *q.v.*) made it the capital of Lithuania (*q.v.*) in 1323. It was destroyed by Teutonic Knights in 1377 and was not completely restored until after the Union of Kreva of 1385. Two years later the first bishopric in Lithuania was established there. The city suffered bitterly in the two centuries following the Lithuanian-Polish Union of Lublin of 1569: the plague of 1588, a fire in 1610, Russian occupation from 1655–60, occupation by Charles XII during the Great Northern War in 1702 and again in 1706 when the city was burned, and a plague in 1710 which killed 35.000. Stanislas Augustus partially restored the city before it fell again to the Russians in 1788. Russian rule did not become permanent until 1795. The city and its Roman Catholic population suffered because of the abortive revolutions in 1831 and 1863.

Vilnius fell easily to the Germans on Sept. 19, 1915. At the end of the war Polish leaders sought to annex all Lithuania including Vilnius, demanding renewal of the ancient union. While the subsequent Polish-soviet frontier war was raging, the supreme allied command three times tried to draw a line of demarcation between Lithuania and Poland, each of which granted Vilnius to Lithuania, but Polish troops violated each one. Vilnius changed hands several times during the war, but the soviets turned over the city to Lithuanian troops on Aug. 24, 1920, according to the conditions of the Litho-soviet Moscow treaty of July 12.

Finally, on Oct. 7, the Polish and Lithuanian governments signed an armistice at Suwalki in the presence of the Allied control commission. Two days later, Gen. Lucien Zeligowski with a freebooting army recruited from the Polish forces and with the secret approval of Joseph Pilsudski, Polish chief of state, captured the city. The Council of the League of Nations immediately made plans for a plebiscite under the supervision of an international police force, but both the Poles and the Lithuanians refused. Paul Hymans, for the League council, then began, in May 1921, to mediate the dispute. His first proposal was to create two autonomous cantons in Lithuania, one centred at Vilnius and one at Kaunas, but with a joint Polish-Lithuanian foreign policy and military co-operation. Lithuania demanded reunion of Vilnius and a guarantee of her independence preliminary to all agreements, but Poland would not yield.

Meanwhile, on Jan. 8, 1922, Zeligowski held a plebiscite in "Central Lithuania." The Lithuanians and Jews boycotted the polls and the results called for union with Poland. In April the Polish Sejm voted to accept the offer and Vilnius was incorporated.

On Feb. 3, 1923, a month after the Lithuanian freebooting occupation of Memel, the League council decided to divide the neutral zone established by the military control commission, replacing it with a demarcation line granting Vilnius to Poland. But Poland and Lithuania remained in a state of war. The Litho-soviet treaty of 1926, stating that the Vilnius occupation was illegal, encouraged Lithuania. On Dec. 10, 1927, the League council forced a termination of the state of war, but the frontier remained closed. A World Court decision in 1931 sustained Lithuania's policy.

Polish suppression of Lithuanian-speaking individuals remained mild until 1937 when the Lithuanian daily papers were banned and Lithuanian leaders arrested. The Polish pretext was the closed frontier. Finally, on March 17, 1938, while the world's attention was distracted by the German occupation of Austria, the Polish government demanded the opening of the frontiers and the renunciation of Vilnius within 24 hours. Lithuania yielded.

The U.S.S.R. seized Vilnius along with eastern Poland in Sept. 1939, and shortly afterwards, on Oct. 10, ceded the city and adjoining areas to Lithuania. Soviet military occupation took place on June 15, 1940, and continued until the Red army was driven out by the German forces on June 22, 1941. The midsummer soviet offensive, 1944, shoved the Germans from the city.

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(F. D. S.)

VIMEIRO, BATTLE OF, 1808. Advancing upon Lisbon (see PENINSULAR WAR), Wellesley halted to cover the landing of reinforcements at the mouth of the Alcabrichella. Two miles from the sea this river cuts its may through a high ridge, which it divides into a western and an eastern section: at the southern entrance of the gorge thus formed lies the village of Vimeiro. Wellesley's force, 20.000 strong. was encamped upon the western ridge, with two brigades upon Vimeiro hill, a knoll just south of the village. On the morning of Aug. 21, 1808. Wellesley learned that Junot, with 13,000 men, was advancing to attack him. Junot, ignoring the western ridge, directed the brigades of Thomières and Charlot to attack Vimeiro hill, while Brennier mounted the eastern ridge and swept along it from the east. Wellesley at once sent five brigades on to the eastern ridge, two to overlook Vimeiro hill and three to stop Brennier's advance along its crest. The attack on Vimeiro hill followed a course that was to be the pattern for many such engagements throughout the war. The French advanced in solid columns on a narrow frontage, having thus little fire power; the British received them in line, wrapping themselves round the head and flanks of the columns, withered them with volleys of musketry, charged with the bayonet and swept them down the hill with heavy loss. A second attack by four battalions of grenadiers met with a similar fate, though two battalions did fight their way into Vimeiro village and were only dislodged after heavy hand-to-hand fighting. Meanwhile Brennier had lost himself among ravines north of the eastern ridge, but Solignac, who had been sent to reinforce him, struck correctly westwards along the ridge and blundered into three British hrigades in line. Within a few minutes Solignac's brigade had practically ceased to exist, but as the bulk of the British chased joyfully along the ridge in pursuit of the survivors Brennier's brigade came up from the valley behind them and roughly handled two battalions that had been left to guard Solignac's abandoned guns. Fortunately their comrades returned in time to scatter Brennier's men.

The moment was ripe for a general advance and pursuit of Junot's beaten army; but Sir Harry Burrard at this point arrived to take over command from Wellesley and timidly ordered hostilities to cease. Junot had lost half his guns and a quarter of his men. the British loss being only 750.

VIÑA DEL MAR, luxurious beach resort on the west coast of South America. just north of Valparaíso, Chile. A municipal gaming casino. attractive beaches and summer climate draw substantial numbers of national and foreign vacationers. Hotels, exclusive clubs, a race course, public gardens and plazas. handsome residential streets and a scenic coastal highway to Concón add to the city's charm. Situated within it are army and navy garrisons. petroleum depots and industries engaged in food. beverage, textile, glass. paint and metals processing or fabricating. Bus and rail communications with Valparaíso and Santiago are good. The population of Viña del Mar in 1952 was 84.471. (J. T.)

VINCENNES, a suburb $4\frac{1}{2}$ mi. E. of Notre Dame de Paris, in the *département* of Seine, on a wooded plateau. Pop. (1954) 50,316. Its celebrated castle. situated to the south of the town and on the northern border of the Bois de Vincennes, was formerly a royal residence, begun by Louis VII in 1164 and more than once rebuilt. It was frequently visited by Louis IS. The chapel, an imitation of the Ste. Chapelle at Paris! was begun by Charles V in 1379. continued by Charles VI and Francis I. consecrated in 13'3'2 and restored in modern times. In the sacristy is the monument erected in 1816 to the memory of the duke of Enghien, who was shot in the castle moat in 1804. Louis XI made the castle a state prison in which Henry of Navarre, the great Condé. hlirabeau and other distinguished persons were afterwards confined. Louis XVIII added an armoury. and under Louis Philippe numerous casemates and a new fort to the east of the dungeon were constructed.

Vincennes has a school of military administration and carries on horticulture and the manufacture of ironware, rubber goods, chemicals. etc.

VINCENNES, a city of southwestern Indiana. U.S., on the east bank of the Wabash river, 57 mi. S. of Terre Haute; the seat of Knox county. It is the centre of an agricultural region which produces apples, peaches. cantaloupes, watermelons. sweet potatoes and wheat. Manufactures include batteries, shoes. paper products. mirrors and window glass.

From the time of its first settlement by French traders on the site of an Indian village (c. 1702), it figured prominently in the colonial. Revolutionary and early national periods of American history. A fort. one of a chain from Quebec to New Orleans built by the French. was erected in 1732 and in 1736 the village was named for the fort's first commander. The French soldiers and *habitants* from Canada who settled there were accompanied by Jesuit missionaries who undertook to convert the Indian tribes of the area.

Ceded to the British at the end of the French and Indian War (1763), the settlement was virtually self-governing until the outbreak of the American Revolution. A British force occupied the fort for a brief period, but in 1779 it was taken by American forces under George Rogers Clark. Clark's dramatic victory at Vincennes, followed by the passage of the Northwest ordinance (1787), brought an influx of settlers from Kentucky. Virginia and Pennsylvania who soon challenged the city's domination by its French element.

Following the organization of the Northwest territory, Vincennes in 1790 became the seat of Knox county, an area then somewhat larger than the present state of Indiana. In 1800 the city was made the capital of the newly-created Indiana territory. which included the present states of Indiana. Illinois. Michigan and Wisconsin. Until the removal of the capital to Corydon in 1813.1-incennes. with a population of about 700. was the political, military and cultural centre of the Northwest frontier. At Vincennes. also; Gov. (later President) William Henry Harrison negotiated numerous land cession treaties with the Indians, bargained with their leader Tecumseh and launched the campaign which culminated in the battle of Tippecanoe (Nov. 1811). The city was incorporated in 1856.

The George Rogers Clark memorial. Grouseland (the Harrison mansion) and Vincennes university. a junior college founded in 1806. are reminders of the city's Iong history. For comparative population figures *see* table in INDIANA: *Population.* (J. *R.* C.)

VINCENT (or VINCENTIUS), **SAINT,** deacon and martyr. whose festival is celebrated on Jan. 22. In several of his discourses St. Augustine pronounces the eulogy of this martyr, and refers to *Acts* which were read in the church. It is doubtful whether the *Acts* that have come down to us (*Acta Sanctorum,* January, ii, 394–397) are those referred to by St. Augustine, since it is not certain that they are a contemporary document. According to this account. Vincent was born of noble parents in Spain, and was educated by Valerius, bishop of Saragossa. who ordained him to the diaconate. Under the persecution of Diocletian. Vincent was arrested and taken to Valencia. He was subjected to excruciating tortures and thrown into prison, where angels visited him. lighting his dungeon with celestial light and relieving his sufferings.

Vincent's warders, having seen these wonders through the chinks of the wall, forthwith became Christians. He died in an interval nhen nen torments were being prepared. His body. exposed to the wild beasts in vain, was thrown into the sea. but was recovered and buried outside Valencia.

See T Ruinart, *Acta martyrum sincera,* pp 364–366 (1713); Le Nain de Tillemont, *Mémoires pour servir* a *l'histoire eccle'siastique,* v, 215–225, 673–675 (1701 *et seq*).

VINCENT, SAINT, OF LÉRINS (d. *c.* 450), important to posterity for his *Commonitorium* (*i.e.,* "memoranda'!), was born perhaps at Toul, France, at an unknown date. After a secular career. he became, at some time before 425, a monk and later an ordained priest. His monastic life was spent at Lérins (in the Mediterranean. a few miles southeast of Cannes), where St. Honoratus had recently founded a community. Vincent wrote various works, most of them lost. The *Commonitorium,* for which he is remembered, attempts to reply to current heresies; it was written about 435 under the name of Peregrinus. It is not clear whether the work once consisted of two books, the second of which was lost but substituted by a résumé (ch. 29–33;) made by Vincent himself, or if the work is complete as it is known today. It is generally admitted now that the work is an indirect attack on Augustine. For the Semipelagians of whom Vincent was a spokesman, Augustine was a dangerous innovator teaching contrary to tradition. In the *Commonitorium* Vincent gives a theory and a norm for valid tradition, and from it is derived the classic formula for traditional doctrine: "What is believed everywhere, at all times, and by all." Vincent's feast day is May 24.

His surviving works are found in J. P. Migne, *Patrologia Latina,* vol. 50. Critical editions of the *Commonitorium* are those by G. Kauschen (1906), R. S. Moxon (1915) and A. Jülicher (1923'). An English translation. *Vincent of Lérins, the Commonitories,* by *R.* Morris is in *The Fathers of the Church,* vol. vii (1949).

See Cooper-Marsdin, *The History of the Islands of the Lérins* (1913). (G. WL.)

VINCENT, SAINT, DE PAUL (1581–1660), founder of the Lazarists and of the Confraternities of Charity, was born at Pouy in the Landes. France. on April 24, 1581. educated by the Franciscans at Dax. ordained priest. Sept. 23, 1600. and took his degree of B.D. at the University of Toulouse in 1604. Captured by Barbary pirates. he spent two years (1605–07) as a slave in Tunisia, whence he escaped to Aigues-Mortes and. after a year in Rome. went to Paris. where he remained for the rest of his life. He placed himself under the spiritual guidance of Pierre de Bérulle (*q.v.*), who directed him to take charge of the parish of Clichy, and, later, to act as tutor to the two sons of Philip Emanuel de Gondi, general of the galleys. of which Vincent became chaplain general in 1617. He subsequently had a hospital built at Marseilles for those wretched convicts.

In 1625 he founded the Congregation of the Mission (Lazarists or Vincentians) to evangelize neglected poor country folk and also to educate and train a pastoral clergy. He likewise established in I'aris and its environs Confraternities of Charity. associations of laywomen who visited, fed and nursed the sick poor in their homes. As these women were mostly members of noble and wealthy families, they enabled him to establish the Foundling and other hospitals and to relieve the distress occasioned by war in Picardy, Champagne and Lorraine. Vincent was the cofounder with Louise de Marillac (*q.v.*) of the Daughters of Charity. He died on Sept. 27, 1660. and was canonized in 1737. His feast day is July 19.

BIBLIOGRAPHY.—P. Coste (ed.), *Saint Vincent de Paul, correspondance, entretiens, documents,* 14 vol. (1920–25); J. Leonard (trans.), *Conferences,* 4 vol. (1938–40) and selections from the letters (1937). *See* also lives *by* P. Coste, Eng. trans. by J. Leonard, 3 vol. (1934–35); J. Calvet, Eng. trans. by L. Sheppard (1952) and V. Giraud (1955). (J. LD.)

VINCENT DE BEAUVAIS (VINCENTIUS BELLOVACENSIS) (*c.* 1190–c. 1264), the encyclopaedist of the middle ages, was probably a native of Beauvais, Normandy. The exact dates of his birth and death are unknown. A tradition preserved by Louis A. Valleoleti (c. 1413), gives the year of his death as 1264; but Tholomaeus de Luca, Vincent's younger contemporary id. 1.321), seems to reckon him as living during the pontificate of Gregory X (1271–76). If we assume that he died in 1264, the immense volume of his works forbids us to think he could have been born much later than 1190.

Very little is known of Vincent's career. He was a Dominican monk and it is certain that he was at one time reader at the monastery of Royaumont (Mons Regalis), not far from Paris: on the Oise.

The *Speculum Majus,* the great compendium of ail the knowledge of the middle ages. as it left the pen of Vincent, seems to have consisted of three parts only, viz.. the *Speculum Naturale, Doctrinale* and *Historiale.* Such, at least, is J. Échard's conclusion! derived from an examination of the earliest extant. manuscripts. All the printed editions. however. consist of four parts, the additional one being entitled *Speculum Morale.* This has been clearly shown to be the production of a later hand, and is ascribed by Échard to the period between 1310 and 1325.

The *Speculum Naturale* is divided into 32 books and 3.718 chapters. It is a vast summary of all the natural history known to western Europe toward the middle of the 13th century, copiously illustrated by passages from Latin, Greek, Arabic and Hebrew authors.

The *Speculum Doctrinale,* in 17 books and 2.374 chapters, is a summary of all the scholastic knowledge of the age. It is intended to be a practical manual for the student and the official alike. and treats of the mechanic arts of life as well as the subtleties of the scholar. the duties of the prince and the tactics of the general. It also treats of mathematics. under which head are included music, geometry. astronomy, astrology, weights and measures and metaphysics. It is noteworthy that in this book Vincent shows a knowledge of the Arabic numerals, though he does not call them by this name. The last book (xvii) treats of theology or mythology, and winds up with an account of the Holy Scriptures and of the church fathers, down to Bernard of Clairvaux and the brethren of St. Victor.

The *Speculum Historiale,* which is 31 books divided into 3,793 chapters, brings history down from the creation to the crusade of St. Louis.

Vincent has hardly any claim to be reckoned as an original writer. But it is difficult to speak too highly of his immense industry in collecting, classifying and arranging these three huge volumes of 80 books and 9,885 chapters. The undertaking to combine all human knowledge into a single whole was in itself a colossal one and could only have been born in a mind of no mean order. Indeed more than six centuries passed before the idea was again resuscitated by the encyclopaedists. and then it required a group of brilliant Frenchmen to do what the old Dominican did unaided.

Vincent's works, both manuscript and printed, are listed by P. C. F. Daunou in the *Histoire littéraire de la France,* vol. xviii (1733 *et seq.*), and by J. Échard in *Scriptores ordinis praedicatorum* (1719–21). The *Speculum Majus* with the *Speculum Morale* was printed by the Benedictines under the title. *Vincentii Burgundi ex ordine praedicatorum, venerabilis episcopi hellovacensis, speculum quadruplex, Naturale, Doctrinale, Morale, Historiale* (Douai, 1624). The *Tractatus consolatorius pro morte amici* and the *Liber de eruditione filiorum regalium* (dedicated to Queen Margaret) were printed at Basel in Dec. 1480. *See* also A. Steiner (ed.), *Vincent de Beauvais, De eruditione filiorum nobilium* (1938). (T. A. A.; F. J. WE.)

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VINCENT (VICENTE) **FERRER, SAINT** (*c.* 1350–1419), Spanish Dominican friar, reputed the greatest preacher of his age, was born *c* 1350, in Valencia, where in 1367 he entered the Dominican order. In 1394. when he was professor of theology in his native city and already a noted preacher. the Avignon pope Benedict XIII summoned him to his court as his confessor and theologian. but five years later he resigned in order to set out on a long missionary enterprise that lasted until his death. Restricting himself to no plan, he wandered through Burgundy, southern France. Switzerland, northern Italy and Spain, recalling thousands to a better life and converting numberless heretics and Jews. Everywhere large crowds gathered to hear him, so that nearly always he was forced to preach in the open air. In 1412 he was one of the nine judges who elected Ferdinand I to the disputed throne of Aragon, and he prevailed on that prince to abandon the cause of Benedict XIII in order to assist in putting an end to the western schism. The last two years of his life he devoted to preaching in northern France, chiefly Britanny and Normandy. In May 1418 he acceded to the request of Henry V of England to preach before him and his court at Caen in Normandy. Vincent died at Vannes, April 5. 1419, and was canonized in 1455. His feast day is April 5. Some of his philosophical writings and several volumes of his sermons have been printed. Of his works, the *Tractatus de vita spirituali sive de interiori homine* is the best known.

See S. M. Hogan, *Saint Vincent Ferrer* (1911); H. Ghéon, *St. Vincent Ferrer,* Eng. trans. (1939). (W. GU.)

VINCI, LEONARDO DA: *see* LEONARDO DA VINCI.

VINDELICIA, in ancient geography. a country bounded on the south by Rhaetia. on the north by the Danube and the Vallum Hadriani, on the east by the Oenus (Inn), on the west by the territory of the Helvetii. It thus corresponded to the northeastern portion of Switzerland. the southeast of Baden, and the south of Württemberg and Bavaria. Together with the neighbouring tribes it was subjugated by Tiberius in 15 B.C., and toward the end of the 1st century A.D. was made part of Rhaetia.

VINDHYA, a range of mountains in central India. They form a well-marked, though not continuous. chain with the river Narbada on the south. and separate the Ganges basin from the Deccan. Starting on the west in Gujarat, they cross the southern edge of the Malwa plateau and, continued by the Bhanrer and Kaimur ranges. abut on the Ganges valley near Varanasi. They have an elevation of 1.500 to 2.500 ft. and nowhere exceed 3.700 ft.

They are built of the "Vindhyan formation" (part of the Pre-Cambrian rocks of India). Traditionally they formed the boundary between the Madyadesha of the Sanskrit invaders and the non-Aryan Deccan.

VINE: *see* GRAPE.

VINEGAR. The term vinegar is applied to one of the most ancient of natural fermentations known to man, and has been closely associated with the human race throughout the ages. Biblical references to its uses can be found in the Book of Ruth and Proverbs; Caesar's armies drank diluted vinegar; and residues in an Egyptian vase dating to 3000 B.C. indicate that it had held vinegar.

Its principal use has been in foods as a flavouring and preservative agent. but throughout history it was believed to have considerable medicinal value as well. Hippocrates prescribed it for his patients and W. R. Fetzer reported that it was used with considerable success in the treatment of scurvy among soldiers during the American Civil War.

The intimate association of vinegar with man's daily life can be seen in a simple survey of newspaper columns devoted to cookery and home management in which such suggestions for its use as a substitute for eggs in baking, a gargle mixed with sugar or honey in relieving sore throat and a cleaning agent in furniture polish have been made. Thus. man has found mechanical. chemical and culinary virtues in vinegar, found in few other products.

Chemistry and Bacteriology.—Vinegar was undoubtedly first made by allowing fermented liquids to acetify naturally but wine was probably the first raw material used in its commercial manufacture. The word vinegar comes from two French words *vin* and *aigre* ("sour wine"), but the term vinegar applies to any product made by the acetous fermentation of a wide variety of materials. Actually, the manufacture of vinegar is a two-stage process (1) the conversion of sugars to alcohol by yeasts; and (2) the conversion of alcohol to acetic acid by bacteria. Thus. vinegar can be produced from any liquid capable of first being converted to alcohol.

There are many types of raw materials suitable for use in manufacturing vinegar, but those most widely used are apples and grapes in making cider and wine vinegars, malted barley and oats in making malt vinegar and industrial alcohol in making white distilled vinegar. Vinegars serve as seasoners for salads, sauces, stews, fish and meat dishes, and as preservatives of meat products, fish, fruit and vegetables, a process commonly termed pickling.

Chemically; vinegar is simply a dilute solution of acetic acid containing soluble substances of the source material. The chemical changes involved in converting sugar to vinegar can be shown by the following simplified formulas:

$$\text{(1)}\quad \underset{\text{Sugar}}{C_6H_{12}O_6} + \text{Yeast} \longrightarrow \underset{\text{Alcohol}}{2C_2H_5OH} + \underset{\text{Carbon Dioxide}}{CO_2}$$

$$\text{(2)}\quad \underset{\text{Alcohol}}{CH_3CH_2OH} + \underset{\text{Oxygen}}{O_2} + \text{Bacteria} \longrightarrow \underset{\text{Acetic Acid}}{CH_3COOH} + \underset{\text{Water}}{H_2O}$$

Theoretically 1.0 part of sugar will produce 0.5 part of alcohol, while 1.0 part of alcohol will theoretically produce 1.3 parts of acetic acid. Under actual conditions yields are somemhat lower because the microorganisms use some of the materials to support life processes and because of losses due to evaporation and to the bacterial conversion of some acetic acid to carbon dioxide and water (over-oxidation).

It was not until 1864 that Louis Pasteur, the French microbiologist, showed that the bacteria present in vinegar were directly responsible for converting alcohol to acetic acid. Since Pasteur's time a number of acid-producing organisms have been isolated from vinegar generators, and these have been given the genus name *Acetobacter*. The usual types of vinegar generators contain a number of strains of acid-producing bacteria and, in addition, the vinegar eel, *Anguilula aceti*, a nematode worm that apparently contributes to the normal bacterial processes within the generator. Vinegar generators, therefore, operate with a group of organisms working together symbiotically and producing sufficient acid to prevent invasion by other organisms.

Analysis.—Vinegars may contain several organic acids and esters derived from the source material and resulting from fermentation and acetification. These substances are responsible for flavour and aroma variations of different vinegars. The Orléans and Boerhaave slow processes of manufacturing are capable of producing vinegar of superior flavour and odour characteristics simply because the limited amounts of air used carry off little of the volatile esters of the mash.

Cider, nine and malt vinegar usually contain 5% to 6% total acid as acetic. Distilled vinegar may range in acid content from 5% to 12%, the snore concentrated types being preferred for commercial operations. The folio\\-ing table, compiled from various sources, shows typical analyses of the several vinegars.

	Cider	*Wine*	*Malt*	*Distilled*
Specific gravity	1.013–1.011	1.013–1.021	1.015–1.025	1.008–1.013
Acetic acid (in %)	4.84	6.55	4.23	6.34
Total solids (%)	2.49	1.93	2.60	0.35
Ash (%)	0.34	0.32	0.34	0.04
Sugar (%)	0.25	0.46	—	—

Processes.—Vinegar bacteria are aerobic types and require an abundant supply of air (oxygen) for proper growth and development. Vinegar can be produced in a small container but the bacteria are active only at the surface of the liquid where air is available. Under these conditions surface area in relation to total liquid volume is low and consequently aeration and the rate of acetification are also low. In spite of its ancient origin technological advances in the production of vinegar came slowly and consisted basically of improved methods of aeration. Starting with the primitive method of placing fruit or other juices in a container and allowing fermentation and acetification to proceed haphazardly the technology advanced through the old Orleans and Boerhaave slow processes to the modern quick vinegar methods of tremendous production capabilities.

The best known of the old acetification methods was the Orléans process in which vinegar was made in barrels of about 50 gal. capacity. In each barrel head one or two small air holes were drilled in such a position that when the barrel was laid on the side bung up and filled to ½ in. below the air holes it would be about three-quarters full, thus allowing exposure of the mash surface to aeration. A wooden spigot was installed close to the bottom in one of the heads to permit drawing off the finished vinegar. In general, the mash was prepared by mixing about 5 gal. of 5% vinegar with 30 gal, of wine or other alcoholic liquid containing 5% to 6% alcohol, the mixture then being poured into the barrel through the bung hole. A small volume of vinegar containing "mother of vinegar," a mass of vinegar bacteria, was then added to the mash in the barrel as a starter. The air holes were covered with screening to keep out insects and the barrel was stored at a temperature of 85° F. to permit acetification to proceed normally. During this period of the process a film, or mat, developed on the surface of the liquid, the film consisting of a mass of bacteria growing at the point of greatest air supply. When the acidity of the vinegar reached about 5% and the alcohol 0.25%, 30 gal. of vinegar were drawn off through the spigot leaving 5 gal. of vinegar in the barrel as an inoculant for the next batch, or charge, of mash. In refilling the barrel with the new charge, extreme care was necessary in order to avoid breaking up the surface film which would cause a setback in operations. Three or four months time was required to complete the acetification process which meant that each barrel acetifier was capable of producing but ¼ gal. of vinegar daily.

In the early part of the 18th century H. Boerhaave, a Dutch technologist, found that the rate of acid production in the vinegar process was directly proportional to the amount of surface exposed to air. He modified the Orlkans process by using large casks and loosely packing the casks with pomace, the residue from grape presses. Wine mash was allowed to trickle down and spread over the considerable area of the pomace thereby increasing the volume of mash exposed to aeration. While the Boerhaave method represented an improvement over the Orlkans method in convenience and in the amount of vinegar produced, it was still a slow method. In 1823, J. S. Schiitzenbach, a German chemist, drilled holes in the Boerhaave generator to permit entrance of abundant asnounts of air, and introduced more satisfactory types of porous materials. This method became known as the German process or quick vinegar process, and modern vinegar generators and methods are based on the principles developed by Schiitzenbach. The quick vinegar process reduced the time of acetification from months to days and brought the control of the acetification process to a great degree within the skill of the operator.

In the quick vinegar process wooden tanks, or generators, anywhere from 3 to 14 ft. in diameter and 6 to 16 ft. in height are used A perforated false bottom or grid is placed in the generator about two feet from the bottom The generator is then filled to about tno feet from the top nith loosely packed beechnood shavings or other suitable porous material. Holes are drilled around the generator to permit entrance of air and some means of mechanically distributing mash over the top of the shavings is installed

The generator is inoculated with fresh unfiltered, unpasteurized vinegar containing active vinegar bacteria, and the mash is then distributed evenly over the top of the shavings and allowed to dribble down through the shaving area, or the oxygen chamber where it comes in contact with the air. The mash is passed through the generator a number of times to complete the acetification and is then drawn off and a new charge added. Once the operation is started the process is continuous.

About 1952 a method of acetification called submerged fermentation was developed that proved capable of far higher production rates and efficiencies than any of the other systems described. Submerged fermentation differs from the usual quick vinegar process in that no wood shavings or other packing material is required. In this process air is supplied to the bacteria by continuously dispersing finely divided air bubbles throughout the mash: this action provides each bacterium with sufficient oxygen for maximum development, thereby increasing the efficiency and speed of acetification.

Considerable heat is produced in all quick vinegar processes and modern generators are equipped with cooling systems for maintaining generator temperatures at about 30" C.. the optimum growth point for vinegar bacteria.

See J. Schierbeck. *The Manufacture of Vinegar,* Technical Information Service report no. 117 (1951). (G. C. En.)

VINEGAR EEL: *see* NEMATODA.

VINET, ALEXANDRE RODOLPHE (1797–1847), French critic and theologian, of Swiss birth. was born near Lausanne on June 17, 1797. He was educated for the Protestant ministry. being ordained in 1819. when already teacher of French language and literature in the gymnasium at Basel; and during the whole of his life he was *littérateur* as well as theologian. His literary criticism brought him into contact with Sainte Beuve. who recognized his quality. Vinet's *Chrestomathie française* (1829), *Études sur la littérature française au XIXme siècle* (1849–51) and *Histoire de la littérature française au XVIIIme siècle,* together with his *Études sur Pascal, Études sur les moralistes aux XVIme et XVIIme siècles, Histoire de la prédication parmis les Réformés de France* and other works. show wide knowledge, moral seriousness and a fine faculty of appreciation.

As theologian he gave a fresh impulse to Protestantism especially in French-speaking lands. but also in England and elsewhere. Lord Acton classed him n·ith Rothe. He built all on conscience, as that wherein man stands in direct personal relation with God. and as the seat of a moral individuality which nothing can rightly infringe. Hence he advocated complete freedom of religious belief. and to this end the formal separation of church and state. in his *Mémoire en faveur de la liberté des cultes* (1826), *Essai sur la conscience* (1829), *Essai sur la manifestation des convictions religieuses* (1842). Accordingly. when in 1845 the civil pon·er in the canton of Vaud interfered with the church's autonomy. he led a secession which took the name of *L'Église libre.* A considerable part of his works was not printed till after his death at Clarens. May 4, 1847. They were re-edited with notes by P. Bridel in 1912.

BIBLIOGRAPHY.—Vinet's life was written in 1875 by Eugène Rambert, n·ho rc-edited the *Chrestomathie* in 1876. *See* also L. M. Lane. *Life and Writings of A. Vinet* (1890): L. Molines, *Études sur Alexandre Vinet* (1890); V. Rivet, *Études sur les origines de la pensée religieuse de Vinet* (1896); A. Schumann, *Alex. Vinet* (1907); E. A. L. Seillière, ?. *Vinet, historien dc la pensée française* (1925). A uniform edition of his works dates from 1903. (J. V. .

VINLAND or **WINELAND.** This was the southernmost of the countries discovered by Leif Ericsson (*q.v.*), the Scandinavian discoverer. on his voyage from Norway to Greenland in the year 1000. and it was later visited also by Thorfinn Karliefni (*q.v.*), probably in the year 1001. It derived its name from the wild grapes which the discoverer found there. It is first mentioned in writing by Adam of Bremen (*q.v.*) in his deicription of the northern countries. about 1075, his informant being King Svein Estridsson of Denmark. The fullest information about this country, as well as about these voyages in general is to be found in the *Sage of Eric the Red* and the *Tule of the Greenlanders.* All these sources agree as to the general characteristics of the country: wild grapes, self-sown wheat and very mild winter. In some Icelandic writings the name Vinland the Good occurs, and this led Dr. Fridtjof Nansen to assume that the story about Yinland was merely a transformation of the old legends about the Isles of the Blest (*q.v.*). His arguments have not been generally accepted, although it is possible that the epithet "the good" may have later been added under the influence of these legends. The historicity of the discovery can hardly be disputed. nor that Vinland was a part of the American continent, but more definite location is difficult. If we are to accept the account of the wild grapes as authentic. the location of Vinland must fall within the northern limits for this plant which, on the Atlantic coast, are generally put at Passamaquoddy bay. Of the principal writers who have dealt with the problem. C. C. Rafn placed Vinland round Mount Hope bay. in the state of Rhode Island. Gustav Storm in Nova Scotia. where the existence of wild grapes is. however. doubtful. W. H. Babcock and W. Hovgaard have practically reverted to Rain's view. while G. M. Gathorne-Hardy looks for it at the mouth of the Hudson river.

For bibliography of the subject see LEIF ERICSSON.

(H. HE.)

VINOGRADOFF, SIR PAUL GAVRILOVICH (1854–1925), Anglo-Russian legal scholar and medievalist noted for his study of the English medieval manor and village community, was born in Kostroma. near Moscow. Nov. 30. 1854. and educated at the University of Moscow. As a young man he traveled widely, and obtained a working knowledge of at least seven modern languages. before being appointed a professor in his own university. He then interested himself in the zemstvo (local self-government) movement and sought to improve the provision for the education of the Russian people. His activities, however. were displeasing to the authorities: consequently he resigned his professorship and in 1902 settled in England. where he had already made friends with many English scholars. In 1903 he was appointed Corpus professor of jurisprudence at Oxford and held this post until his death in Paris on Dec. 19. 1925.

An account of his life by H. A. L. Fisher is contained in his *Collected Papers* (1928). to which a complete bibliography is appended.

Vinogradoff's first book. *The Origin of Feudalism in Italy* (1887), was written in Russian, but his later works were appropriately nritten in English. and he became recognized as probably the first authority on the early laws and customs of England. His standard work is *Villeinage in England* (1892), in which he put forward the theory that the Anglo-Norman manor descended not from a condition of serfdom. but from a free village community. His article "Folkland." published in *The English Historical Review* in 1893, enunciated an entirely new theory on this subject. His other works include: *The Growth of the Manor* (1905); *English Society in the Eleventh Century* (1908): *Roman Law in Mediaeval Europe* (1909); *Self-Government in Russia* (1915); and *Outlines of Historical Jurisprudence* (1920–22). He also contributed to the *Encyclopædia Britannica* and the *Cambridge Medieval History.* (S. E. T.j

VINOGRADSKY (WINOGRADSKI), **SERGEI NIKOLAEVICH** (1856–1946), Russian biochemist. conducted epoch-making research in the fields of bacteriology (especially the bacteriology of soil) and the physiology of microorganisms. Born at Kiev on Sept. 1, 1856, he entered the University of Kiev in 1873 and later studied natural science at the University of St. Petersburg. n·here he continued his graduate studies until 1881, when he obtained the degree of M.S. He went to Strasbourg to work under A. de Bary and studied analytical chemistry. In 1888 he moved to Zürich. n·here he pursued his study of nitrification. He later returned to Russia to become head of the section of general microbiology of the Institute of Experimental Medicine. He was appointed director of the same institute in 1902 and held that position until 1905 when he resigned; although he was on the staff until 1912, he was practically inactive. He resumed his scientific activity only in 1922 when he accepted the position of head of the division of agricultural microbiology, Pasteur institute. Brie-Comte-Robert, near Paris. After the invasion of France in 1910 he again retired. He died Aug. 31, 1946.

Vinogradsky studied sulfur and iron bacteria and discovered that colourless sulfur bacteria in the absence of light can oxidize hydrogen sulfide and sulfur to sulfuric acid. Even more important were his investigations of nitrification (1888–90) and the role of bacteria in that process. In 1893 he discovered an anaerobic organism (*Clostridium pasteurianum*) and showed its ability to fix nitrogen from the atmosphere.

Vinogradsky later studied methods in soil microbiology and investigated the role of bacteria in the decomposition of cellulose and nitrogen fixation.

See Selman A. Waksman, "Sergei Nikolaevitch Winogradsky," *Soil Sci.,* vol. xlii (1946).

VINSON, FREDERICK MOORE (1890–1953), U.S. lawyer who, as 13th chief justice of the United States. was a vigorous supporter of a broad interpretation of federal governmental powers, was born in Louisa. Ky., on Jan. 22, 1890. Following completion of his legal studies at Centre college in 1911. he entered private practice of the law in Louisa and quickly assumed an active role in local political affairs. In 1923 he was appointed to fill a vacancy in the U.S. house of representatives. The following year he was elected to the seat as a Democrat and. except for one two-year period. served as a member of congress until 1938.

As congressman Vinson was recognized as an outstanding expert in tax and fiscal policy. From 1935 to 1943 he served as associate justice of the U.S. court of appeals for the District of Columbia. Between 1943 and 1945 he held a succession of high executive posts in emergency agencies of World War II and in 1945 he became secretary of the treasury in the cabinet of Pres. Harry S. Truman. In this office he helped inaugurate the International Bank for Reconstruction and Development and the International Monetary fund.

Upon appointment by President Truman he became chief justice on June 24, 1946. As a judge his interpretation of the powers of the federal government often led him to reject claims of individual right asserted in opposition to the exercise of governmental authority. Perhaps his best-known opinions, however, are those upholding the rights of members of racial minorities under the equal protection clause of the fourteenth amendment, such as that in *Shelley* v. *Kvaemer,* 334 U.S. 1 (1948). His opinion for the court in 1947 upheld the power of the federal courts to enjoin a strike in coal mines then under control of the federal government. He strongly dissented from the judgment of the court rendered in 1952 which held invalid Pres. Truman's "seizure" of the steel companies.

He died in Washington on Sept. 8, 1953. (F. A. A.)

VIOL, a generic term for the bowed precursors of the violin (*q.v.*), but in England more specially applied to those immediate predecessors of the violin which are distinguished in Italy and Germany as the *Gamba* family. The chief characteristics of the viols were a flat back, sloping shoulders, C-shaped sound holes and a short finger board with frets. All these features assumed different forms in the violin. which was derived rather from the guitar fiddle than from the viol, the back becoming delicately arched. the shoulders reverting to the rounded outline of the guitar, the shape of the sound holes changing from C to F and the finger board being carried considerably nearer the bridge. The viol family consisted of treble. alto, tenor and bass instruments, being further differentiated as *da braccio* or *da gamba* according to the positions in which they were held, against the arm or between the knees.

VIOLA: see VIOLIN FAMILY.

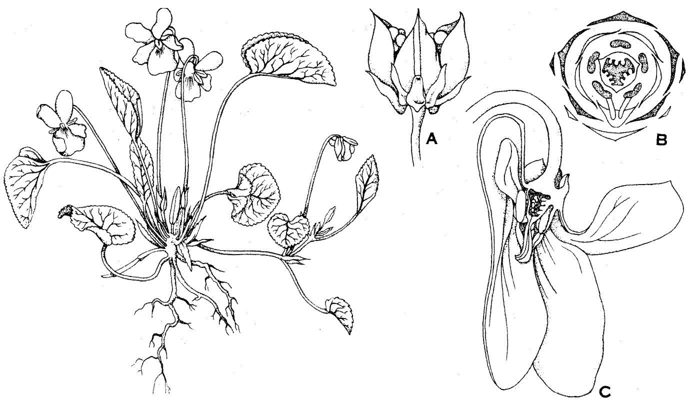
VIOLET (*Viola*) represents one of the larger genera of flowering plants. with approximately 400 species. They are found in both northern and southern hemispheres, most abundantly in temperate climates. The greatest variety is known from the Andes mountains of South America. the ancestral home of the genus. In the northern hemisphere the greatest number of species *(60)* is found in North America. where common species are the bird's foot violet (V. *pedata*), the bog blue violet *(V. cucullata*), the common blue violet *(V. affinis*), the woolly blue violet *(17. sororia*), the canada violet (*V. canadensis*), the mountain yellow violet (*V. rotundifolia*), the smooth yellow violet *(V. pensylvanica*), the dog violet *(V. conspersa*), the striped violet (*V. striata*) and the long-spurred violet (*V. rostvata).* In southeastern United States are also found *V. floridana,* V. *septemloba, V. esculenta* and the beautiful *V. walteri.*

In the great plains and the western mountains are found the prairie yellow violet (*V. nuttallii*), the pine violet (*V. lobata*), the yellow pansy violet (*V. pedunculata*), the western heartsease (*V. ocellata*) and the wood violet *(V. sempervirens*). Several species occur in Alaska and in Mexico. as well as in Australasia. In South America, some of the species attain the size of low shrubs and trees.

Several species of *Viola* grow in Great Britain. *Viola canina* is the European dog violet and is quite variable in appearance. *Viola odorata,* the sweet or fragrant violet, is known both in nature and in a variety of forms in cultivation. Other species grown in gardens are: *V. altaica,* flowers yellow or violet with yellow eye; *V. calcarata,* flowers light blue or white, or yellow in the variety *flava;* and *V. cornuta,* the tufted violet or bedding pansy, flowers blue, or white in one variety.

North temperate violets are all small, herbaceous plants with variously coloured, but characteristically shaped flowers. The species may be divided into those with leafy stems and those with underground rhizomes and no aerial stems. Though the most familiar forms have heart-shaped leaves, other species have leaves with different shapes. In some of them the leaves are cut into many linear segments. Large, leafy stipules subtend the leaves. Some species have stolons that root at the nodes and may form large clones.

Two kinds of flowers are produced by nearly all violets: the familiar open flowers in the spring (and sometimes in the fall), and the less familiar! but more abundant, closed flowers (cleistogenes), produced throughout the summer. The open flowers have five green sepals and five conspicuous petals. There are two upper petals, a pair of somewhat larger lateral petals, and a large, basal, spurred petal; nectiferous glands secrete nectar into this spur.



(LEFT) FROM CHURCH, "TYPES OF FLORAL MECHANISM" (CLARENDON PRESS); (A, B & C) BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM (NATURAL HISTORY)

SWEET VIOLET (VIOLA ODORATA)

(Left) Whole plant and (A) fruit; (B) floral diagram; (C) longitudinal section through flower

Two of the five stamens are also spurred. The pistil has a very short style and a peculiar stigma, the form of which is used in classification. The closed flowers, produced at the base of the plant, occur in abundance during the summer. They are completely enclosed by the sepals, the petals being aborted. Only two stamens are in each flower; from these the pollen tubes grow directly through the ovary wall, thus self-fertilizing the eggs. The seeds of violets are small, oval in shape, and often with a conspicuous caruncle. They are forcibly expelled from the drying capsules. (N. H. R.)

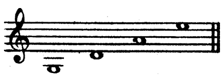
VIOLIN FAMILY, the group of bowed stringed musical instruments that includes the violin, viola, violoncello and double bass and forms the basis of the modern orchestra. The family takes its name from its smallest member, which is perhaps the best-known and most widely distributed musical instrument in the world.

The violin springs from different stock from the viol (*q.v.*). It is a descendant of the horizontally held arm viols of the middle ages by a process of evolution and metamorphosis. Its immediate precursor is the *lyra da braccio,* an elaborate instrument of the Renaissance, whose form foreshadows the physical essentials of the violin body: the arched modeling of the belly and back, and the shallow ribs. This shallow arched form probably encouraged or suggested another important detail: the use of a short vertical stick to prop the front and back apart and prevent the collapse of the belly arch under pressure of the strings. This device. the sound post, is peculiar to the violin; although it was later used on the viols, it is the acoustic effect of the sound post that imparts to the violin its lively response and generous singing tone, for it couples and co-ordinates the vibrations of the body as a whole, under the influence of the strings.

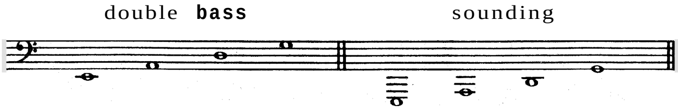
Although the generic name for the family is the Italian *viola* (whence vio*lino*, "small viola"; vio*lone*, "large viola"; violoncello, "small violone"). the treble instrument very soon became its most important member, from which the others took their main characteristics. Unlike the smaller viols. whose tone was reticent and impersonal. the violin was always recognized both for its superior cantabile and for its inherent sprightliness and smart attack. especially in Italy, its birthplace. where the earliest makers. Gasparo da Salò. Andrea Xmati and G. P. Maggini had settled its average proportions before the end of the 16th century. (*See* AMATI.) Thus the violin arrived at exactly the right time to lend impetus and conviction to the innovations of the Florentine school of composers. whose preoccupation with the expressive qualities of the solo voice marked a breakaway from the older polyphony. To this movement. the violin. the first treble instrument to achieve an innate lyricism. formed the perfect instrumental counterpart.

Two other features contributed to the character of the violin. the first heing the tuning of the strings in fifths and their numerical limitation to four. This wide regular tuning. typical of the rebecs (*cf.* the viols. whose six strings were tuned in a mixture of fourths and thirds). was ideal in furnishing a uniform diatonic fingering technique. reducing the amount of string-crossing the bow has to do, generally freeing the bridge from too many strings and permitting better clearance on each string for bowing. The second additional feature is the unfretted finger board, in which the violin followed the *lyra* da *braccio.* No doubt frets, if they were ever used. were removed from the arm viols because they impeded the use of the hand in supporting the instrument and in fingerinn. It is also true that the direct stopping of the strings by the fleshy part of the finger tips produces a tone quality that. although slightly damped. in consequence is more satisfying and easier to listen to than the pure open-string tone obtained from the use of frets. as on the viols. besides being more completely under the control of the player. Moreover. it leaves the player free to temper intonation as much as he pleases. since this is no longer dominated by the fixed tuning of the frets. It is perhaps this capacity for the mutual adjustment of intonation that led to the use of the violin family in a way that was entirely new in instrumental music: *i.e.,* as a massed "choir" in which the several parts were doubled at unison by instruments of like kind. This string ensemble. so different in its effect from the chamber music of the preceding "golden age." owes its first organization. if not its invention. to the French at the court of Louis XIV. whose *vingt-quatre violons du* Roi was the model for Europe of the embryo orchestra-to-be.

The four members of the group are tuned as follows:

violin

viola

violoncello

double **bass** sounding

(Note. the double bass always sounds one octave below the written notes. Observe that it is tuned in fourths not fifths. For a discussion of this matter and of five-stringed instruments, see *Double* Bass, below.)

It will be seen from the above tunings that the viola stands one fifth lower than the violin, its upper three strings being tuned to the same notes as the lower three of the smaller instrument. The tuning of the violoncello is one octave below the viola. while the normal double bass approximately covers the suboctave of the violoncello. There is some evidence for the former existence of a fifth member, the so-called true tenor violin, standing in pitch one octave below the treble instrument.

The violin and viola are the only members of the family that are played in the horizontal position. *i.e.,* "under the chin." The cello (this abbreviation of violoncello will be used in the rest of this article') and double bass both stand vertically on the floor. the first resting on a long steel rod—the end pin—with the player holding the instrument between his knees while seated. For the double bass the player stands. or rests on a high stool. As is done with every other necked stringed instrument, the player's left hand fingers the instrument. the bow being held in the right. The highest string is to the right. viewing the instrument from the front. the lowest to the left. Therefore. on the violin and viola. the bow attacks from the top-string side, and on the bass instruments from the bottom string side. This makes scarcely any difference to the bowing technique except perhaps to give freer control of the upper strings of the smaller instruments and lower strings of the larger. a useful bias in view of their respective functions. at least in earlier times.

Violin.—In structure and appearance, violins of all sizes are quite unmistakable. The body consists of a belly of pine and a back of sycamore, maple or a similar hardn-ood, spaced apart by shallow ribs (sides) of the same material. The arching of the belly and back. already mentioned, is both transverse and longitudinal, so that n-hen viewed from the side the effect is of a central bulge. flattening off in all directions to the edges. the undersides of which are plane where they meet the ribs. In most cases the "modeling" of the bulge changes from convexity to concavity as it approaches the edges. which are given a slight upward curl. The arching is worked from solid wood of suitable thickness, and the plate is dug out on its undersurface to a curve that follows the general contour of the outward modeling but not exactly. for the finished thickness is graduated in all directions. being thinnest in the margins of the outline just inside the ribs. The adjustment of these thicknesses is one of the prime skills in the craft of violinmaking. The wood used in both back and belly is usually, though not always. cut "on the quarter"; that is. in wedge-shaped segmental planks from the centre to the outside of the log. To form a plate. two wedges are glued "back to back" with the thin edges outward. This not only provides the basis for the tnodeling but also ensures that the annular rings of the tree are evenly disposed about the centre line of the plate, the oldest growth being on the outside edges.

The familiar. and deceptively simple. outline of the violin body is aesthetically satisfying. perhaps because its balance and proportion are largely functional. Its master makers have evolved a form based on an artistic unity of opposed curves that allows free play to individual nuance with scarcely any measurable deviation from the norm. The rounded ends of the body.—the upper and lower bouts—are separated by the indented waist. or middle bout, which provides clearance for the bow on the outer strings. The middle bout meets the upper and lower to form outturned corners: where the ribs are brought together and glued firmly to corner blocks within the instrument. Other blocks—the end blocks—are mounted top and bottom centre to provide firm bearings for the neck and end pin. which between them have to resist the tension of the strings. The ribs are slightly inset from the outline of the belly and back, so that the edge overhangs all round. The internal corners between the ribs and the plates are strengthened by a narrow fillet of pine. called the "linings." which runs between the blocks. Despite the very considerable stresses to which it is subject. the violin body is held together by simple flush glued joints. which can in emergency be opened up, without damaging the instrument, for repairs.

The arched belly or soundboard of the violin is supported in a curiously unorthodox and individual way, quite different from the regular barring of instruments with flat soundboards. The sound post has already been mentioned. It is a loose stick of pine. carefully cut to size, that is wedged between the plates of the finished instrument under. but a little behind, the top-string side of the bridge. It is not a fixture because its position is critical and must be adjusted with great care for the best tonal result. This adjustment is made through the sound holes in the belly. The other side of the bridge is supported by a bar glued under the belly and running lengthways along the grain of the wood. This bar, called the bass bar. is deepest under the bridge, but tapers to nothing at either end. since it fits into the internal curvature of the belly. Externally, the plates are finished off with a narrow inlay of laminated woods, the purfling, which follows the outline close to the edges. Even this, the only decoration normally permitted. has the function of preventing incipient splits from running.

The neck and head are cut from a solid block of sycamore wood. The lower end is formed into a shoulder that abuts against the ribs at the top of the body and, in fact, passes through them into a shallow mortise cut in the end block within. The back end of this shoulder is covered by a projection of the wood at the top of the back, known as the button. The head or pegbox carries the four tuning pegs, two on each side. It is slotted lo the front to receive the strings. The pegs are tapered and pass through two holes in the cheeks of the head. At the top of the head is the scroll, again a typical embellishment of the violin, its austere purity of line and curve being both the challenge and the sign manual of the master craftsman. The front face of the neck is flat. and to this is glued the finger board, which projects beyond the shoulder and over the belly toward the bridge. At the top of the neck is the nut, which is grooved to take the strings. keeping them correctly spaced apart and slightly raised over the finger board. The neck is raked back at an angle with the plane of the belly, so that the finger board rises with the strings toward the bridge. The bridge is high and arched because of the bowed technique. It is formed with two feet that are carefully cut to fit the transverse arch of the belly and is given a conventional perforated or fretted design, which is said to aid its free vibration. In section it is wedge-shaped, tapering to the thin, notched edge over which the strings pass. It is not a fixture but is kept in position only by the pressure of the strings. Its correct position is between the sound holes and just above the lower corners of the middle bout. The sound holes are of italic f form. sweeping outward and downward from the waist to the lower corners. A line joining the crosses of the *f*s marks the approximate position of the bridge. The lower ends of the strings are held by the long tailpiece below the bridge, whose function is to reduce the length of unused string behind the bridge and to keep the strings pulling radially inward on its top edge. The lower end of the tailpiece is anchored by a loop of gut to an end peg set in a hole in the lower end block. A small ebony button takes the pull of the tailgut off the edge of the belly.

During its history the violin has been subject to modifications that have progressively adapted it to its evolving musical functions. In general. the more primitive types have been more deeply arched in the plates, and the more modern, follo ing the innovations of **A.** Stradivari (*q.v.*) (1644–1737), have been shallower and more virile, which has affected the over-all tonal characteristics. The stresses to which the instrument is subjected under working conditions have increased not only because of the rise in pitch from the 17th century onward but also because of certain changes in physical design from about the beginning of the 19th century. Before that time the height of the bridge and its arching were lower, the neck thicker and wider and the bass bar shallower and shorter. These, with the type of bow then in use (*see* below) and the lower pitch, produced the small, delicate tone that served composers up to the time of Mozart. With the advent of larger auditoriums and the development of the violin virtuoso. however, greater power was demanded. and this demand was met by raising the height of the bridge., lengthening and slimming the neck slightly and setting it back at a greater angle, and putting in a stronger bass bar. The sum effect of these alterations mas to develop the optimuni sonority of which the instrument was capable. and the long experience of makers and players has shown that the Stradivari type with its shallower arching has stood up best to this metamorphosis. All fine violins now in use have been thus modified to bring them into line with modern technique and modern conditions.

Viola.—This instrument. standing a fifth lower than the violin. is similar to it in every essential, but, owing to its larger size. it has never been completely standardized in its main dimensions. since, whatever these are, they are bound to tax the human frame and fingers when the instrument is played. A compromise has to be effected between ideal size for the best tonal results and what is practicable to the player in handling, Too large an instrument is simply unplayable; too small an instruinent is weakest where it is most wanted—on the lower strings. The problem has never been solved to everyone's satisfaction, but it has produced a viola tone that is darker, more weighty and more sombre than the violin and without which the string ensemble cannot now be imagined. Violas have been made at various times with a body length (the most convenient measure of their maneuverability) of from 15 to 18 in.. and probably the majority of the most manageable and successful instruments are midway between these extremes. However desirable it may appear in theory. too big a body. whether in length or depth, is inclined to develop a "tubby," aggressive. unmanageable tone that lacks the blending qualities of the traditional instrument.

Violoncello.—The true bass of the violin, and the member of the family most nearly approaching it in character, is the violoncello. or cello. In build it differs somewhat, the ribs being proportionately much deeper and the much higher bridge standing on legs rather than feet. The neck is raked back at a sharper angle to allow for the height of the bridge. The instrument is held between the knees while it rests on an end pin, which is telescoped through the tailpin and can be clamped in any position to adjust the height of thc instrument above the floor. This playing position leaves both arms exceptionally free; in particular, the left-hand technique is more fluid and covers a wider range than in any other stringed instrument. This is strikingly shown by the ease with which a good cellist commands the brilliant solo register of the top (A) string! high above the normal *tessitura* of the instrument.

Double Bass.—Because of its great size. the double bass has always shown less regularity of form, stringing, tuning and technique than the other members of the violin family. Double basses have been in use for as long as the parent instrument. but they are not yet completely standardized in number of strings. tuning. shape or body size. The bass is sometimes made with the blunt corners and flat back of the viol and on that account has been called a hybrid instrument. But true double bass violins, with arched back and outturned corners. have existed since the early 17th century and are still in the majority. It is immaterial whether the back is flat or arched, except that the flat back is both more convenient for the player and more economical to make. It is the fitting and adjustment of the bass, which follows that of the cello. that makes it what it is—a double bass violin. The tuning in fourths. which is today almost universal, has been adopted on the bass owing to the great length of the strings ($42\frac{1}{2}$ in.), which makes the whole-tone interval in the fingering so large that it can be covered only by the span of the first and fourth fingers. The closer tuning therefore brings the technique of fingering more into line with what is possible on the smaller instruments, namely a scalewise or diatonic fingering that reduces hand movements to a minimum. The normal tuning, E-A-D-G, means that the bass cannot descend an octave below the cello's bottom string. and it is for this reason that the low fifth string is sometimes added. tuned to 16-ft. C. The note commonly occurs in symphonic works from the classical period onward and is being more specifically demanded by modern composers. Conversely, the high fifth C string, tuned a fourth above the normal top string. is occasionally used in dance bands, where it simplifies the fingering of high pizzicato (plucked) notes.

Another method of obtaining 16-ft. C is to fit an attachment mechanism that lengthens the existing E string (which is carried up to the top of the head on an extension bar) when these low notes are wanted. This has the advantage that it preserves the normal four strings and their normal tuning for all ordinary purposes and imposes no extra load on the bridge, as does the fifth string. On the double bass the pegs are replaced by a "machine head." such as is commonly used on guitars and other plucked instruments, each tuning peg being fitted with a worm-and-wheel screw adjuster. The pegs themselves are made of solid brass. The "tailgut" of the smaller instruments is also replaced by metal. usually a thick copper wire but preferably a stranded steel cable. An extending end pin, similar to the pin used on the cello. is now in universal use. On most basses the ribs are not of equal depth all round but are cut away at the top so that the back slants toward the shoulder of the neck in its upper part. This enables the player to bring the neck and upper portion of the hody closer to him and makes for ease of handling. The normal size of the bass. around six feet high. is about as large as the average person can manage for modern technical requirements. This size has been known since the early 17th century, but larger and smaller basses have been made at all times. without coming into general use.

The Violin Bow.—The bow consists of a strong, light flexible wooden stick. sprung so that a ribbon of horsehairs can be stretched between its ends. Powdered resin is applied to the hair (more properly. the hair is drawn across a solid cake of resin and rubs off a small quantity in powder form) and this supplies the frictional element that is necessary to make the string vibrate. Proper design is as important in a violin bow as in the violin itself. for it must give the player a feeling of complete control over the tone he is producing and must respond to every nuance of pressure and attack imposed upon it. The modern bow, which is really the culmination of a long line of evolution, was perfected late in the 18th century by François Tourte, of Paris. The light tapering stick now is made of Pernambuco wood (brazilwood) with a hatchet-shaped head formed at the thinner end. At the other end is a movable frog. which has a threaded eye projecting into a mortise or groove cut in the stick and runs on a screm that can be turned at the lower end of the stick. The hank of hair is stretched between the head and frog, and its tension is adjusted by the screm. The hair is retained as a flat ribbon by passing through a specially shaped ferrule and a shallow channel in the frog before it is wedged into a socket farther along. The hair is usually concealed in the channel by a small sliding panel of mother-of-pearl, The hair is similarly wedged in the head. the front of which is faced either with ivory or silver to protect it from damage. When the screw is slackened off, the stick curves toward the hair. When the hair is tightened, the stick straightens out. or rather, the curve flattens somewhat. It is the correct setting of this curve. which is put into the stick by bending under dry heat, and the exact shaping of the tapering section of the stick that give a good bow its desired qualities.

The earlier type of violin bow, which was used almost everywhere from the beginning of the 17th century until the end of the 18th century, was shorter and had a lighter head and a narrower ribbon of hair. Its chief characteristic, however. was the shape of the stick. which bent outward from the hair under working tension. This design would not stand up to modern ideas of bowing technique. where. on occasion, optimum sonority must be developed from the instrument. but it was admirably suited to the smaller scale and neat articulations of baroque and early classical violin music.

The larger instruments have followed the violin in bow design. adapting it to their special purposes by adjustments of dimension and weight. For a long time the double bass lagged behind and during the first half of the 19th century this instrument was still being played with a broad. heavy version of the earlier outcurved bow. This was supplanted in France. and in other countries under French influence, by the violin-type bow and in Austria and German-speaking countries generally. a little later. by the "Simandl" bow, named after a contemporary professor of the Vienna academy. The bow is really an adaptation of the older type but with an incurved stick, wide frog and narrow head.

See also STRINGED INSTRUMENTS. (E. HA.)

VIOLLET-LE-DUC, EUGÈNE EMMANUEL (1814–1879). French architect and writer on medieval architecture, was born in Paris on Jan. 27, 1814. and died at Lausanne, Switz., on Sept. 17, 1879. He was a pupil of Achille Leclère. but was inspired rather by Henri Labrouste. In 1836 he traveled to Italy where he spent 16 months studying architecture. Back in France he was drawn irrevocably to Gothic art.. In 1839 his friend, Prosper Mérimée, placed him in charge of the restoration of the abbey church at Vézelay, and in the following year he was appointed inspector, under F. L. J. Duban and J. B. A. Lassus, of the Sainte Chapelle. With Lassus he won a competition in 1843 for the restoration of Notre Dame in Paris. Soon he became a focal figure on the Commission des Monument Historiques, and, after 1848, the Service des Edifices Diocésains', supervising the restoration of numerous medieval buildings. the most important being the abbey of Saint Denis (1846), the cathedral of Amiens (1849), the synodal hall at Sens (1849). the fortifications of Carcassonne and. later. the Saint Sernin at Toulouse. For Louis Napoleon he reconstructed the chhteau of Pierrefonds (1859–70). His numerous written works, all finely illustrated, provide the foundation on which his distinction rests; his two dictionaries serve still as standard works of reference. But his special contribution to present-day thought is the *Entretiens sur l'Architecture,* a theory of modern architecture based on a scientific exposition of Gothic art.

Viollet-le-Duc's principal literary works are: *Dictionnaire raisonné de l'Architecture Française du XI au XV siècle* (1854–68); *Dictionnaire raisonnd du Mobilier Français de l'époque Carlovingienne à la Rénaissance* (1858–75); *Entretiens sur l'Architecture* (1860–72); *L'Art Russe* (1877); *De la Decoration appliquee aux edifices (1879).*

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VIOLONCELLO: *see* VIOLIN FAMILY.

VIPER. In a broad sense vipers include the snakes of the family Viperidae, which is characterized by the presence of poison fangs on a movable upper jaw. The fangs are simply enlarged teeth perforated longitudinally for the passage of the venom and, like those of all other snakes. they are fused to the supporting bones. In this family, however. there are no other teeth on the maxillary bone. which is movable so that the fangs are folded down parallel with the roof of the mouth when not in use. The same mechanism is present in the pit vipers.

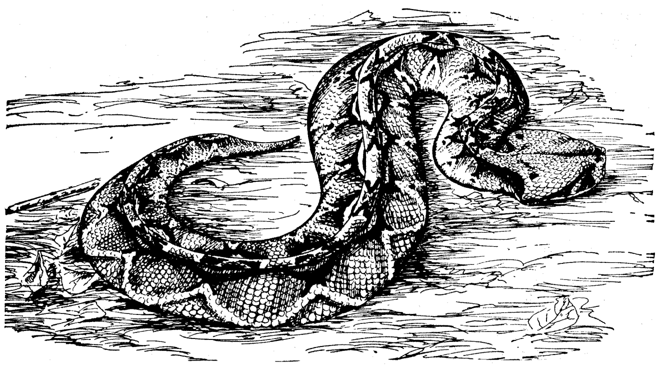
Venom is secreted by a pair of glands, situated behind the angle of the mouth. and is carried to the fangs by a short duct that opens close to their base inside a fold of skin (the *vagina dentis*) which surrounds them; within this fold of skin there is also a series of reserve fangs in different stages of development and, should one of the functional fangs be broken, the largest of these reserve teeth moves into its place and becomes fused to the jaw. Vipers, as a rule, are stout sluggish creatures with a broad. fattened head. and lack the large head shields so characteristic of the majority of other poisonous snakes; most of them are terrestrial, though there are aquatic, arboreal and burrowing species. A few lay eggs but the majority produce fully developed young.

All the Viperidae are very poisonous and the bite of most of them is dangerous to man; the toxicity of the venom varies with each species. and the virulence of any bite depends not only on the species of snake responsible for it but also on the amount of venom injected. the position of the bite and the physical condition of the snake. In composition viper venom resembles that of the back-fanged colubrids, rather than that of the cobras and their allies. and its action consists largely in the destruction of the blood corpuscles and vessels.

The family is closely allied to that of the pit vipers (Crotalidae), which have a similar venom-injecting apparatus. but are well distinguished by the presence of a sensory pit between the eye and the nostril.

The majority of the true vipers are terrestrial, though *Atractaspis* of tropical and South Africa is a genus of small burrowing creatures with enlarged shields on the head; the night adders (*Causus*) of the same region, have the head similarly covered. *Causus* is remarkable for greatly enlarged poison glands that extend into the neck. Arboreal forms are represented by *Atheris,* of the forests of tropical Africa, which is equipped with a prehensile tail and is usually green or olive in colour to harmonize with its

COMMON EUROPEAN VIPER (VIPERA BERUS) ABOVE; GABOON VIPER OF TROPICAL AFRICA (BITIS GABONICA) BELOW



surroundings. The colours of the terrestrial species, on the other hand, are more frequently shades of gray. brown or black to correspond to the rocky or sandy localities they frequent. The puff adder *(Bitis arietans)*, which occurs throughout the drier areas of Africa. is a sluggish. heavily built creature that may grow to a length of four or five feet; it is usually pale brown with a series of regular. dark, chevron-shaped crossbars along the back, a colouring that harmonizes so well with sandy soil that man:; accidents occur when people fail to notice the animal until they actually tread upon it. The Gaboon viper *(Bitis gabonica)*, and the nose-horned viper. *B. nasicornis,* unlike their relative, are inhabitants of the forested regions of Africa and exhibit a geometrical "camouflage" colour pattern of blues, reds and yellows. Many desert species show the ieature characteristic of desert-dwelling animals and plants, the development of spines; *Cerastes cornutus,* the horned viper of Egypt and northern Africa, has a prominent spine above each eye. *Cerastes* and *Echis,* the latter found through northern Africa and southern Asia, including India. exhibit a specialization for desert life not found elsewhere; the scales of the sides are small and have pronounced, serrated ridges which act, through lateral shoveling movements of the body, as scoops to dig up loose sand and throw it onto the creatures' backs: and so enable them to bury themselves completely. In Europe the family is represented by the genus *Vipera* of which the adder (*V. berus*) is the best-known species; it is an inhabitant of the northern countries and is the only venomous serpent in Great Britain.

In southern Europe an allied species *1'. aspis,* is more common, characterized by a "snub-nose." This feature is even more pronounced in *V. latastei* of the Iberian peninsula. while in *V. ammodytes* of southeastern Europe the tip of the snout is prolonged upward into a definite scaly appendage. In India the commonest and most dangerous viper is the handsomely coloured daboia or tic polonga *(V. russelli)*, which reaches a length of five feet.

The extensive parallelism between the genera of the viper family and those of the pit vipers well illustrates the principles of adaptive radiation in an evolutionarily successful group. The arboreal *Atheris,* with their green or mottled colors and prehensile tails are matched by the prehensile-tailed species of the pit viper genus *Trimeresurus* in the East Indies and in tropical America. "Desert coloration" reaches a high development in the vipers of the genera *Vipera* and *Bitis* and in the rattlesnakes of the southnestern deserts of Sorth America. (K. P. S.)

VIPER'S BUGLOSS (*Echium vulgare*); a hairy herb of the borage family (Boraginaceae). indigenous to Europe and western Asia. Also known as blue-weed. it is widely naturalized in the U.S. and Canada, from Nova Scotia to Ontario and Nebraska and southward to North Carolina; in some sections it is a troublesome weed. It prefers dry soil. The flowers are brilliant blue when expanded, but the buds are reddish. The genus *Echium* contains about 30 species, all found in Europe.

VIRCHOW, RUDOLF (1821–1902), German pathologist and politician, was born on Oct. 13, 1821. at Schivelbein, in Pomerania. In 1843 he received an appointment as assistant-surgeon at the Charité hospital, becoming pro-rector three years later. In 1847 he began to act as *Privatdozent* in the university, and founded with Reinhardt the *Archiv* fur *pathologische Anatomie und Physiologie,* which, after his collaborator's death in 1852, he carried on alone. In 1848 he went as a member of a government commission to investigate an outbreak of typhus in upper Silesia. About this time, having shown too open sympathy with the revolutionary or reforming tendencies. he was for political reasons obliged to leave Berlin and retire to the seclusion of Würzburg, the medical school of which profited enormously by his labours as professor of pathological anatomy. In 1856 he was recalled to Berlin as ordinary professor of pathological anatomy. As director of the pathological institute he formed a centre for research.

Pathology.—Wide as were Virchow's studies, yet the foremost place must be given to his achievements in pathology. In his book on *Cellular-pathologie* (1858), he established what Lord Lister described as the "true and fertile doctrine that every morbid structure consists of cells which have been derived from pre-existing cells as a progeny." Virchow made many important contributions to histology and morbid anatomy and to the study of particular diseases. The classification into epithelial organs, connective tissues, and the more specialized muscle and nerve. was largely due to him; and he proved the presence of neuroglia in the brain and spinal cord. discovered crystalline haematoidine. and made out the basic structure of the umbilical cord. Among the books he published on pathological and medical subjects may be mentioned *Vorlesungen über Pathologie,* the first volume of which was the *Cellular-pathologie* (1858), and the remaining three *Die Krankhaften Geschwülste* (1863–67); *Handbuch der speziellen Pathologie und Therapie,* 3 vol. (1854–62). in collaboration with other German surgeons; *Vier Reden über Leben und Kranksein* (1862); *Untersuchungen über die Entwicklung des Schädelgrundes* (18j7); *Lehre von den Trichinen* (1865); *Ueber den Hunger-typhus* (1368); and *Gesammelte Abhandlungen aus dem Gebiete dcr öffentlichen Medizin und der Seuchenlehre* (1879).

Anthropology.—Another science which Virchow cultivated with conspicuous success was anthropology. In ethnology he published a volume of essays on the physical anthropology of the Germans, with special reference to the Frisians; and at his instance a census, which yielded remarkable results, was carried out among school children throughout Germany, to determine the relative distribution of blondes and brunettes. His archaeological work included the investigation of lake dwellings and other prehistoric structures: he went with Schliemann to 'Troy in 1879, fruits of the expedition being two books. *Zur Landeskunde der Troas* (1880) and *Alt-trojanische Gräber und Schädel* (1882); in 1881 he visited the Caucasus, and on his return published *Das Gräberfeld von Koban im Lande der Osseten.*

Politics.— In 1862 Virchow was elected a member of the Prussian lower house. He was a founder and leader of the Fortschrittspartei, and the expression *Kulturkampf* had its origin in one of his electoral maniiestos. For many years he was chairman of the finance committee, and in that capacity was chief founder of the constitutional Prussian Budget system. In 1880 he entered the Reichstag as representative of a Berlin constituency, but was ousted in 1893 by a Social Democrat. In the Reichstag he became the leader of the Opposition, and a vigorous antagonist of Bismarck. In the local and municipal politics of Berlin again he took a leading part. and as a member of the municipal council was largely responsible for the transformation which came over the city in the last thirty years of the 19th century. It was his unceasing efforts that secured for its inhabitants the drainage system, sewage farms and good \\-ater-supply.

Of his writings on social and political questions may be mentioned *Die Erziehung des Weibes* (1865); *Ueber die nationale Entwicklung und Bedeutung der Naturwissenschaften* (1865); *Die Aufgaben der Naturwissenschaften in dem neuen nationalen Leben Deutschlands* (1871); *Die Freiheit der Wissenschaft im modernen Staat* (1877), in which he opposed the idea of Haeckel that the principles of evolution should be taught in elementary schools—on the ground that they were not as yet proved.

VIRELAY, the title applied to more than one fixed form of verse (*virer,* "to turn"). Its history and character are very obscure. It may be connected with the Provençal *ley.* Historians agree that it is a modification of the medieval *lai;* but no example of the *lai* is known except the following (first printed by Pere Mourgues in his *Traité de la Poésie*):

"Sur l'appui du monde Que faut-il qu'on fonde
D'espoir ?
Cette mer profonde Et débris féconde
Fait voir
Calme au matin l'onde Et l'orage gronde
Le Soir."

But this seems to be a mere fragment of a virelay, which proceeds by "veering" the two rhymes *ad libitum.* This is the *virelai ancien,* of which examples are rare in recent literature. There is also the *virelai nouveau,* which was used by Alain Chartier in the 15th century. In French the old and popular *Adieu vous dy triste Lyre* is a perfect example; and in English we have one admirable specimen in Austin Dobson's "Good-bye to the Town. good-bye." A so-called Virelay is found among Chaucer's spurious works (Skeat, vii, 448). The New Virelay is written on two rhymes, and begins with two lines that recur throughout as refrains, and (reversed in order) close the poem in a couplet. The Virelay is a vague and invertebrate form of verse. and one of little importance.

VIREO, the common name of birds of the American passerine family Vireonidae. There are about 50 species of these insectivorous birds. which have characteristic and often very musical songs. Twelve species inhabit the United States. all building deep, pendent, cup-shaped nests. usually hung between the forks of a branch. The red-eyed vireo (*Vireo olivaceus*) breeds from the Gulf states to Labrador and British Columbia, wintering in Central and South America. West of the Cascade mountains, it is replaced by Hutton's vireo (*V. huttoni*), with three subspecies, lacking the slate crown of *V. olivaceus.* The warbling vireo (*V. gilvus*) of eastern U.S. and Canada has a fine song.

VIRGIL (VERGIL; PUBLICS VERGILIUS MARO) (70–19 B.C.), author of the *Eclogues,* the *Georyics* and the *Aeneid,* was the greatest Roman poet. The Latin form of his name was undoubtedly Vergilius; in English Virgil has generally been the traditional form, but both spellings are current. Information about his life is derived partly from his own writings and partly from the ancient lives which have survived under the names of Probus, Aelius Donatus. Servius and others. Virgil was born of peasant stock on Oct. 1j. 70 B.C., at Andes near Mantua; his love of the Italian countryside and of the character of the people who cultivated it is one of the sources of inspiration for his poetry. He was educated at Cremona. Milan and, finally; at Rome. The education which he must have received involved a thorough study of Roman and Greek authors. especially the poets. and a detailed training in rhetoric and philosophy. One of his teachers was the Epicurean Siro. and it is interesting to see how Epicureanism figures largely in his poetry at first, but gradually gives way to an attitude more akin to Stoicism and neo-Pythagoreanism.

Virgil's life was devoted entirely to his poetry and his studies connected with it; his health was never robust, and he played no part in military or political life. It is said that he spoke once in the law courts without distinction, and that his shy and retiring nature caused him to give up any ideas he might have had of taking part in the world of affairs. But it should not be thought that he ever lost touch with current events; his iriends were men directing the movement of affairs. such as Octavian. Pollio. Gallus and Varus. and they must have influenced his thoughts and ideas as doubtless he influenced them. Thus his poetry is often concerned with the large aspect. the underlying significance. of contemporary Roman problems and hopes.

The *Eclogues,* the first of Virgil's certain works (the authenticity of the *Appendix Vergiliana* is discussed below), were composed betn-een 42 and 37 B.C. Two of these poems (the first and the ninth) refer to the confiscations of land in Virgil's own country near Mantua at the time of the resettlement of veteran soldiers after the battle of Philippi; it was widely believed in antiquity that Virgil's farm was among those confiscated (a belief which the poems support), and that it was restored to him on the intervention of friends (the support for this is much more controversial,). The publication of the *Eclogues* brought him recognition as one of the leading poets of Rome. and he became an important member of the literary court circle. under the patronage of Maecenas. to whom he dedicated the *Georgics.* At this time he was living in Rome. but he soon withdrew to Campania, where for the rest of his life he spent most of his time. at either Naples or Nola.

He spent the years 37–30 composing the *Georgics,* and the rest of his life on the *Aeneid.* In 19 B.C., when he planned to spend three more years perfecting the *Aeneid,* he set out on a voyage to Greece. doubtless to obtain the extra local knowledge and colour necessary for the revising and partial rewriting of sections of it, especially of book iii. But at Megara he caught a fever and, returning to Italy, died shortly after landing at Brundisium (Brindisi), on Sept. 21, 19 B.C. He left instructions that the *Aeneid* should be burned, but this was not permitted by Augustus, who ordered Varius and Tucca to publish the work with excisions where necessary. but without additions. A well-known example of such an excised passage which nevertheless survived is the Helen episode in Book ii, 567–588. Evidence of the unfinished state of the poem is to be found in certain relatively minor inconsistencies, in the presence of about 50 half lines and in the stopgap nature of some passages (*tibicines*); but there is no reason to think that Virgil intended any major alteration of scope or plan.

WORKS

Appendix **Vergiliana.**—There is extant a collection of poems said to be the work of Virgil's youth; the question of their authenticity has been much debated. but the evidence does not admit of conclusive proof. The indications suggest that most of them are not by Virgil. The poems generally included in this collection are *Culex, Ciris, Catalepton, Priapea, Copa, Dirae, Lydia. Moretum.* Servius gives all these as \-irgilian except *Lydia* (which is joined on to *Dirae* in the manuscripts) and *Moretum;* Donatus agrees with Servius except that he omits *Copa.* Both also attribute another poem, *Aetna,* to Virgil, but this attribution is extremely unlikely. The external evidence for *Culex* is particularly strong, as it is mentioned as a poem of Virgil's early youth by Lucan, Statius and Martial. It is a mock-heroic poem about the death of a gnat (*culex*), unkindly and too hastily killed by a 'shepherd whom the gnat awoke from sleep because of the approach of a dangerous snake. It contains phrases which occur also in Virgil's major works. but are sometimes not quite appropriate to the context in *Culex;* this suggests that a later author of *Culex* borrowed them not very successfully from Virgil (*see* E. Fraenkel. *Journal of Roman Studies,* 42:1–9, 1952), and the stylistic affinities of *Culex* with the late Augustan age point to the same conclusion. *Ciris* is a mythological poem of Alexandrian type. full of echoes of Catullus; like *Culex* it contains phrases (and indeed whole lines) which are found in Virgil's major poems. It was argued by F. Skutsch in *Aus Vergils Frühzeit* (1901–06) that Gallus wrote it and Virgil imitated it. This view has been widely accepted, but a post-Virgilian date for *Ciris* as well as for *Culex* cannot be ruled out. These two epyllia are the longest poems of the *Appendix*

Vergiliana, and it does not appear likely that Virgil wrote either. On the other hand, a few of the short poems of *Catalepton* (*e.g.,* v and viii) are probably Virgilian, and some of the other poems may be. It is reasonable to 'conclude that there existed a genuine collection of Virgilian *juvenilia* into which a number of non-Virgilian poems early found their way.

Eclogues.—The ten *Eclogues* ("Selections"), sometimes called *Bucolics* ("Pastoral Poems"), are modeled on the *Idylls* of the Greek poet Theocritus of Syracuse (fl. *c.* 310–250 B.C.), founder of pastoral poetry. Virgil several times explicitly acknowledges this debt, and there are many close parallels of diction. Most of the names of the shepherds and shepherdesses are taken from Theocritus, and the setting is a mixture of the Sicilian landscapes of Theocritus with Virgil's Italy. But Virgil does not attempt to imitate the lively realism characteristic of Theocritus' dialogue and situations; with him the pastoral becomes more literary and artificial. Persons of the contemporary literary world, like Gallus, appear in a pastoral setting, and the touches of allegory and topical allusion which are sometimes found in Theocritus (*e.g., Idyll* vii) become more frequent in Virgil. though it is a mistake to look for allegory everywhere.

The second and third eclogues. the earliest, are the closest to Theocritus: the second tells of Corydon lamenting his unhappy love, and the third is a singing match between two shepherds. The seventh and eighth are of this type too; so is the fifth, where Mopsus and Menalcas vie with each other in singing of their sorrow for the cruel death of Daphnis. Daphnis has often been thought to be allegorical, and many have equated him with Julius Caesar, but there are strong arguments against this, and it is wise to bear in mind the view expressed by Servius, that an allegorical interpretation of the shepherds' songs should not be accepted except in the eclogues dealing with the loss of Virgil's farm. These are the first and ninth: in the first Meliboeus laments for the loss of his farm while Tityrus rejoices that Octavian has restored his; in the ninth Menalcas is exiled from his farm—it had been hoped that his poetry would save him, but in vain. Clearly Virgil is here referring to personal experience. but it need not be assumed that he intended all the details to hear a precise allegorical significance.

The sixth eclogue, dedicated to the statesman Varus, is a song of the satyr Silenus about the origin of the world and about many mythological themes; the tenth tells of the unhappy love of Gallus. the fnmous poet and statesman, for Lycoris. This is the most artificial of all the poems. with its highly conventionalized pastoral setting for a subject which is not pastoral. It is a clear ancestor of Milton's *Lycidas.*

The fourth eclogue, perhaps the most discussed poem in Latin literature. prophesies in moving and exalted tones the birth of a child who will introduce a new Golden Age. It is dedicated to Pollio in his consulship, so that its date must be late 41 or 40 B.C. From early times it has often been regarded as prophetic of Christianity, and it is sometimes referred to as the Messianic Eclogue. It blends a mystic and oracular tone, influenced by sibylline prophecies. with the Golden Age motif of classical literature. The identity of the child remains mysterious. as Virgil probably intended; no historical child of this time is suitable, and it seems likely that Virgil was symbolizing the new generation in a way which could have been applied more specifically if a son had been born to Octavian.

The *Eclogues* generally have a gentle and polished charm reminiscent of some of the qualities of Alexandrian poetry and its followers in Rome, the *neoterici;* this is perhaps partly what Horace meant when he used the phrase *molle atyue fucetum* of the *Eclogues.* They foreshadow Virgil's later work in their sincere love of nature and the countryside, of peace and beauty; in their mellifluous control of the hexameter; and in their tender sympathy for suffering, shown especially in the laments for unhappy love and youthful death.

Georgics.—Virgil spent seven years on the composition of the four books of the *Georgics,* a didactic poem on farming which combines practical instruction with descriptive and imaginative passages in praise of Italy and the farmer's life. The first book is about tilling the land. the second about growing trees, especially the olive and the vine, the third about cattle and horses and the fourth about bees, ending with a fable or epyllion about Aristaeus and his bees, which includes the story of Orpheus and Eurydice.

The *Georgics* is clearly related to social and political conditions. The restoration of Italian agriculture, and with it of something of the old traditional way of life, was a matter of vital concern to the government, as well as a theme dear to Virgil's heart. There are enthusiastic references to the achievements of Augustus; the hopes which the Romans placed in their new emperor and their expectation of a stable order after generations of civil war are reflected in the poem. By writing about Italian farming, which he knew well and loved, and by setting it in the large context of a poet's vision. Virgil could contribute to the fulfillment of the Golden Age which he and his friends saw dawning for Rome.

Virgil's Greek model for the *Georgics* mas Hesiod. but the extent of his debt was not considerable. To the didactic poets of Hellenistic Greece he turned for some of his factual information but he owed most to Lucretius, who had shown that a didactic theme could be a subject for inspiring poetry, and had made great advances in the technique of the Latin hexameter.

The theme running through the *Georgics* is the joy of country life. It is a hard struggle which must be waged—Virgil often uses military metaphors—but the rewards are great. The moments of trouble or of triumph are vividly portrayed, and Virgil took advantage of and extended the personification of nature already existing in Roman agricultural terminology. The crops are joyful. the boughs are happy, the fruits of the self-seeded tree gradually forget their old flavour, the grafted tree is surprised when it grows fruit not its own. The animals of the countryside are described with knowledge and affection; they need man's help, and in return they give their service. Finally the bees reflect the organized existence of men, and their intricate arrangements for the well-being of their species serve to symbolize the essential oneness of nature.

Virgil wrote the *Georgics* slowly and with great care. The poem is organized with a harmony of structure which foreshadows the great achievement of the *Aeneid,* and in some ways (on a smaller scale) is more perfect. With the liquid cadences of the hexameter of the *Eclogues* Virgil now blends a more powerful element, able to express majesty as well as beauty, capable of sustained grandeur and unending variety. Here and in the *Aeneid* is the most successful sustained use in Latin literature of what Tennyson called "the stateliest measure ever moulded by the lips of man."

Aeneid.—As the *Georgics* is Virgil's poem of Italy. so the *Aeneid* is his poem of Rome. It tells in 12 books of the legendary foundation of Lavinium (parent town of Alba Longa and of Rome) by Aeneas, a Trojan who had left the burning ruins of Troy to found under divine guidance a new city with a glorious destiny in the west. The choice of subject gave Virgil scope for his poetic purposes; Aeneas, the son of Venus and Anchises, was an important but vaguely drawn character in Homer and in later authors, and the legend itself had many variations and was capable of modification. It thus allowed Virgil some freedom in the selection and treatment of the material, while having immediate and important points of relevance for his own time. By describing the time-honoured origins of contemporary customs and institutions Virgil was able to link the past with the present, and to enlarge the significance of events.

It is possible to distinguish two main sources of inspiration for Virgil's epic. One was the desire to give poetic expression to his conception of the achievements, ideals and destiny of Rome; to carry further the portrayal of Roman character which he had given in the *Georgics;* to show what virtues had made Rome great, and could in this era of new-dawning hopes make it greater still. This theme, which coloured such contemporary writings as Livy's history and some of Horace's odes, clearly captured Virgil's imagination, and throughout the *Aeneid,* particularly in the closing sections of the sixth book; it is given noble expression.

His second source of inspiration was the poetry of Homer. From early youth Virgil had been deeply influenced by the *Iliad* and the *Odyssey.* They had cast their spell upon him as poetic interpretations of the splendour and excitement of human activity, and he wanted to recreate for a later day and in a different idiom something of what these poems had meant to him. The Aeneid continues the story of the Iliad, and Homer's Greco-Trojan theme is completed from a Roman point of view as Aeneas, the new leader of Hector's race and founder of the Roman nation, reverses the defeat of Hector by Achilles when he himself prevails against his opponent, Turnus the Rutulian. The final scenes of Aeneid xii take the reader back again and again to Iliad xxii. Thus the Homeric background to Virgil's legend enriches and gives added significance to his narrative.

In structure and episode, in phraseology and imagery, the Aeneid often has close resemblances to Homer. The first six books, Aeneas' wanderings, are Virgil's Odyssey, and the last six, the battle scenes, his Iliad. Book vi has marked points of similarity with Odyssey xi, though it is entirely different in treatment; book v is based, but again with significant differences, on the funeral games in Iliad xxiii. In the battle scenes reminiscences of Homer are very frequent. Throughout the poem similes. descriptions, speeches, situations: have their Homeric counterparts. It is most important to understand the nature of this literary relationship. It should not be thought that Virgil went to Homer simply because he was his chosen model, and that he did so especially when he had nothing of his own to say. Rather it is that what Homer had said kindled Virgil's poetic imagination. and Homer's world was in a significant and permanent sense a part of Virgil's world.

In a way the Aeneid, is a synthesis of attitudes to human experience which Virgil had assimilated from the great literature of the past. The Greek tragedians had evoked a ready response in Virgil's poetic awareness; it has often been remarked that episodes of the *Aeneid* (*e.g.,* books ii, iv and xii) are closely akin to tragedy. The Alexandrian Greeks, who inherited and developed the intimate study of character which they found in Euripides, exercised a powerfui influence on Virgil: though one which he constantly sought to modify and control. The story of Dido and Aeneas in book iv owes much to the story of Medea and Jason in Apollonius Rhodius' *Argonautica;* but it goes far beyond it. Among the Romans, Ennius, Lucretius and Catullus all contributed largely to the Aeneid, not only verbally and in verse technique, but in attitudes to the different aspects of experience with which the Aeneid is concerned. By relating these interpretations of life to his own experience. Virgil sought to make his epic significant for the whole destiny of man.

The "architectural" structure of the Aeneid is most carefully organized with symmetries and variations of an intricate and aesthetically satisfying kind, both in subject matter and in tension and tone. After the invocation the narrative takes us immediately in medias res with the approach of the Trojans to Sicily; the storm caused by Juno drives them to Carthage, where Aeneas meets Dido. In the second and third books Aeneas describes to her the fall of Troy and his wanderings. and in the fourth Virgil returns to the narrative and to the tragic story of their love. The tension in the third book is at a lower pitch than in the books which precede and follow it, and in the same way the fifth book, mainly concerned with the anniversary games for Anchises, is a calm interlude after the intensity of the fourth and before the majesty of the sixth book, the pivot of the poem. In this book Aeneas descends to the underworld to learn from his father of the tasks and destiny which await him, and when he sees the great pageant of Roman heroes yet to be born he is given new strength to fulfill his mission. It is here, too, that Virgil's religious thought finds its fullest expression in a poetic vision of the world after death, with its atonements for sin and its rewards for virtue. The second half of the poem is concerned with the fighting in Italy before Lavinium can be founded, fighting that is necessary because of the hostility of Juno and of Turnus. her human agent. The numerous scenes of grim battle are diversified with passages of tender pathos; in the eighth book the tension is relieved by Aeneas' visit to the future site of Rome, and the description of the prophetic pictures on the shield which Vulcan made for Venus to give to her son. In the final denouement the action is resolved on the human plane when Xeneas kills Turnus in single combat, and on the divine plane when Juno is reconciled and accepts the common destiny of Italians and Trojans.

The Aeneid ends with the tragedy of Turnus, and one aspect of the inner cohesion of the poem is the tension and balance between the triumphant notes of Rome's heaven-sent destiny, and the feelings of pathos and sorrow which Virgil constantly expresses for the suffering which accompanies man's life on earth. This brooding note of sympathy in Virgil, this sense of the lacrimae *rerum,* is perhaps the feature of his poetry which leaves the deepest impression. The suffering of Dido is portrayed with a sympathy which has made Aeneid iv one of the most famous books of world literature; and our pity is powerfully evoked too for Turnus, for Euryalus, Pallas, Lausus, for the countless young warriors who die in battle. These two themes, Roman destiny and human suffering, are combined in the character of Aeneas himself, a lonely figure struggling against human frailty in order to fulfill a divine mission, and prevailing at last because of his devotion to his duty, his *pietas.* He has not the supreme self-sufficiency of a Homeric hero; he endures to the end to achieve a task which was almost beyond his strength. Tantae *molis* erat *Romanam* condere *gentem* ("So heavy was the task of founding the Roman nation").

Influence. — Virgil's poetry immediately became famous in Rome, and the Aeneid was always regarded by the Romans as their national epic. He was imitated by the writers of the Silver Age and their successors; the study of his works played an important part in Roman education, and many commentaries upon them were produced. Two from the late 4th century have survived, a rhetorical exposition by Tiberius Claudius Donatus. and the indispensable work by Servius. Allegorical interpretations of Virgil's poetry were common in late antiquity, and in the middle ages his popularity did not abate (see Virgil in the Middle Ages, below).

One result of Virgil's popularity is the excellence of his manuscript tradition. For most Latin authors the earliest manuscripts are Carolingian (9th, 10th or 11th century) or later, but for Virgil there are several written in the 4th and 5th centuries, and in addition there are the commentaries mentioned and many citations in early writers.

Virgil's influence on literature and thought has been greater than that of any other classical poet. Many reasons contribute to his continuing fame: his unsurpassed command of diction and rhythm and word music; his expression of the achievements and concepts which Rome has bequeathed to succeeding ages; his power of constructing an intricate work of art on the grand scale; his sense of pathos and sympathy for suffering; perhaps above all his universality, in that he symbolizes within the framework of a legendary story aspects of human experience which are of permanent significance.

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VIRGIL IN THE MIDDLE AGES

Virgil's great popularity in the middle ages was due mainly to the fact that his works never ceased to be the chief textbook in the schools of grammar, which had no Christian writings of anything approaching equal literary reputation with which to replace them. In addition. Virgil's philosophy as revealed in his works, especially the Messianic Eclogue, led to the idea that he was an *anima naturaliter christiana* ("a soul Christian by nature'!), and thus one who, but for the accident of being born too soon, would readily have accepted Christ. It was this idea, together with deep appreciation of his poetic genius, that led Dante to take Virgil as his guide through Hell and Purgatory in the *Divina Commedia,* though as a pagan in fact Virgil could not of course enter Paradise, the subject of the third section of Dante's poem.

Virgil also plays a part in a variant of the story of the seven sages *(see* SEVEN WISE MASTERS, THE) entitled *Dolopathos,* by the late 12th-century monk Jean de Hauteseille. Dolopathos is a king of Sicily whose son Lucinius, educated in Rome by Virgil, is saved from his stepmother's wiles when he returns home by Virgil's advice and intervention.

Apart from his literary reputation, Virgil also became the central figure in a number of absurd but popular legends? the origin of which is obscure: about his magical powers. John of Salisbury, in the 12th century, is the source for the earliest of these, in which Virgil is said to have made a fly which exterminated all other flies in Naples. Later writers add further stories; as for example that Virgil built Naples on a foundation of eggs, and that he took a cruel revenge on a woman who left him hanging halfway up the wall for all to see in a basket in which he was coming by night to visit her in her closely guarded tower. By the early 16th century these scattered legends were collected into a romance entitled *Les Faicts merveilleux de Virgille,* which was soon translated into other languages including English. It relates that Virgil was born in the Ardennes soon after the foundation of Rome, studied at Toledo, exerted his magic art on the Roman emperor, fell in love with the sultan of Babylon's daughter, founded the city of Naples and finally disappeared in a violent storm at sea. Such stories, which are often confused with similar legends told about others. bear little relation to the known facts of Virgil's existence as a historical figure. It is difficult to discover what originally connected Virgil's name with them, but it was probably his early and deserved reputation for great learning, coupled with belief in his supernatural insight shown by his supposed prophesy of Christ.

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VIRGIL, POLYDORE *(c.* 1470–1555), English historian, otherwise known as P. V. CASTELLENSIS, was a kinsman of Cardinal Hadrian Castellensis. Polydore was born at Urbino and was probably in the service of Guido Ubaldo, duke of Urbino, before 1495, as in the dedication of his first work. *Liber Proverbiorum* (April 1498), he styles himself this prince's client. Polydore's second book. *De Inventoribus Rerum,* is dedicated to Guido's tutor, Ludovicus Odaxius, from Urbino, in Aug. 1499. After being chamberlain to Alexander VI he came to England in 1501 as deputy collector of Peter's pence for the cardinal. As Hadrian's proxy, he was enthroned bishop of Bath and Wells in Oct. 1504. It was at Henry VII's instance that he commenced his *Historia Anglica* (1534), on which he had been engaged for nearly 30 years. A rash letter, reflecting severely on Henry VIII and Wolsey, was intercepted early in 1515, after which Polydore was cast into prison for several months. and supplanted in his collectorship (March and April). In 152j he published the first edition of *Gildas,* dedicating the work to Tunstall, bishop of London. Next year appeared his *Liber de Prodigiis,* dedicated from London (July) to Francesco Maria, duke of Urbino. Somewhere about 1538 he left England, and remained in Italy for some time. About the end of 1551 he went home to Urbino. where he appears to have died in 1555. He had been naturalized an Englishman in Oct. 1510, and had held several clerical appointments in England. In 1508 he was appointed archdeacon of Wells, and in 1513 prebendary of Oxgate in St. Paul's cathedral, both of which offices he held after his return to Urbino.

The first edition of the *Historia Anglica* (26 books) was printed at Basle in 1534; the 27th hook. dealing with the reign of Henry VIII down to the birth of Edward VI (Oct. 1536), mas added to the third edition of 1555. It is mainly from the time of Henry VI that Polydore's work is useful.

Polydore's *Adagia* (Venice. April 1498) was the first collection of Latin proverbs ever printed; it preceded Erasmus' by two years, and the slight misunderstanding that arose for the moment out of rival claims gave place to a sincere friendship. A second series of biblical proverbs (553 in numberj was dedicated to Cardinal Wolsey's follower, Richard Pace, and is preceded by an interesting letter (June 1519), which gives the names of many of Polydore's English friends, from Sir Thomas More and Archbishop William Warham to Thomas Linacre and Cuthbert Tunstall. The *Dc Inventoribus* treating of the origin of all things whether ecclesiastical or lay (Paris. 1499), originally consisted of only seven books, but was increased to eight in 1521. It was exceedingly popular. All editions. however, except those following the text sanctioned by Gregory XIII in 1756. are on the Index Expurgatorius. The *De Prodigiis* also achieved great popularity.

VIRGINAL or PAIR OF VIRGINALS, a name applied in England (and also recognized on the continent of Europe) to the spinet as being pre-eminently an instrument for girls. (For further particulars *see* PIANOFORTE.)

VIRGINIA or VERGINIA. in Koman legendary history, daughter of L. Virginius, a plebeian centurion. Her beauty attracted the notice of the decemvir Appius Claudius, who instructed Marcus Claudius, one of his clients, to claim her as his slave. Marcus accordingly brought her before Appius, and asserted that she was the daughter of one of his female slaves, who had been stolen and passed off by the wife of Virginius as her own child.

Appius declared Virginia a slave of Marcus. Virginius thereupon stabbed her to death. A storm of popular indignation arose and the decemvirs were forced to resign. The people for the second time "seceded" to the Sacred Mount. and refused to return to Rome until the old form of government was re-established.

VIRGINIA, officially designated the commonwealth of Virginia (after Elizabeth I, the "virgin queen") and familiarly known as the "Old Dominion," one of the 13 original states of the United States, being the 10th to ratify the constitution (1788). It is the southernmost of the middle Atlantic states, roughly triangular in shape, bounded on the north by West Virginia and Maryland, on the east by the Atlantic ocean and Chesapeake bay, on the south by North Carolina and on the west by Kentucky. Its total area is 40.815 sq.mi., of which 977 sq.mi. inland is water; in size it ranks 36th among the states. The state flag has a blue field in the centre of which the state coat of arms is represented. The flower is the dogwood *(Cornus florida)*; the bird, the cardinal *(Richmondena cardinalis)*; the song, "Carry Me Back to Old Virginia." The capital is Richmond.

PHYSICAL GEOGRAPHY

Physical Features. — Virginia (which lies between the extremes of 36° 32' and 39° 27′ N. latitude and 75° 15′ and 83° 41' W. longitude) before 1851 recognized officially, for statistical purposes, four "grand divisions": tidewater, piedmont, the valley and trans-Allegheny. Since the loss of West Virginia only southmest Virginia remains of the last division. Geographical differences in these divisions have profoundly influenced Virginia's life and history.

Tidewater.—Tidewater is a level plain of alluvial soil lying between the Atlantic ocean and the fall line (*q.v.*), the latter a distinct break in the crystalline rock formation of piedmont, a line where waterfalls furnish power for mills and act as a barrier to advancing tides. Running southwestwardly across tidewater are four great rivers, the lower Potomac, Rappahannock, York and James, the lower reaches of which form estuaries of Chesapeake bay into which they empty. At the fall line, which runs north and south, cities — Alexandria, Fredericksburg, Richmond and Petersburg — arose about trading posts at the head of navigation and on the mill sites at the falls.

Piedmont.—Piedmont, the largest of the geographical provinces, lies between the fall line and the Blue Ridge mountains (*q.v.*), extending in width 40 mi. at the north and 185 mi. along the southern border. It is a relatively low, rolling plateau region cut by many streams.

Valley. — The Valley of Virginia, or the Great valley, between the Blue Ridge mountains on the southeast and the Allegheny mountains (*q.v.*) on the northwest, consists of a number of valleys draining into a series of five rivers or their tributaries: the Shenandoah in the north, the James and Roanoke (*q.v.*) in the centre and the New and the Holston in the south. The waters of the first three flow through tidewater; those of the last two flow into the Ohio-Mississippi basin. The largest of the component valleys, the Shenandoah, is 95 mi. long, divided into two valleys by Massanutten mountain, and varies in width from 20 to 30 mi. (see SHENANDOAH VALLEY).

Mountains.—The Blue Ridge in the northern half of Virginia rises abruptly from piedmont. It is a distinct ridge having subordinate parallel ridges and providing many deep coves on each slope. In the north the Blue Ridge province is narrow, but in the south along the North Carolina and Tennessee borders it is a broad, rugged plateau with rolling upland, deep valleys and high mountains, the highest being Mt. Rogers (5,720 ft., the highest in Virginia) and Whitetop, both in the extreme southwest. The Allegheny mountains, forming the western wall of the Valley of Virginia and part of the great Appalachian plateau, are cut by streams into a maze of narrow valleys and irregular, winding ridges.

Climate. — The climate is mild and generally uniform throughout the state, with adequate rainfall. Snow seldom falls in southeastern tidewater, but occurs occasionally farther inland. The frost-free growing season is one to two months longer in lower tidewater than it is in southwest Virginia.

Soil. —A wide variety of soils is found in Virginia. The coastal plain, built of sedimentary deposits, is chiefly sandy; piedmont soil is the result of weathering of crystalline granite, gneiss and schists. the first two producing good soil. the third a poor soil; the floor of the Great valley, composed mostly of deposits rich in lime, is very fertile; much of the soil of western Virginia is of limestone origin: but a wide variety of soils is found in the region depending on the nature of the basic rock strata.

Vegetation. — The salt flats along the brackish rivers and creeks of tidewater are covered with marsh grass. On the uplands of tidewater and piedmont, crab grass and wire grass are native on arable land, and broom sedge takes over depleted land. Bluegrass is a thriving native of the Great valley and of limestone soils in the southwest. Among the many native Virginia wild flowers are blue lobelia, bluets, blue lupine, May apple, trumpet vine, morning-glory, violets and goldenrod. In the mountains and in the marl-rich woods of tidewater may be found trailing arbutus, laurel and rhododendron. More than half of Virginia is woodland, containing many varieties of trees, among them oak, pine, hickory, cedar, maple. birch, elm. walnut. locust, sweet gum, black gum, ash, persimmon, redbud, the Virginia magnolia and dogwood. Cypress, live oak and wax myrtle grow only in tidewater.

Animal Life. — Animal life is abundant and varied in the state. Some animals commonly found during the colonial period — among them beaver, timber wolf, southern fox, squirrel, panther, elk and bison — no longer occur in the area. Elk recently introduced are of a kind different from that once found in the state. Some animals, including black bear and wildcat, survive only in such primitive surroundings as the Dismal swamp (see DISMAL SWAMP) in southeastern Virginia and the mountains in the west. Mink and otter may be found along some isolated watercourses. Animals common in the state are deer (protected by game laws in Virginia as early as the 1ith century), squirrel, fox (red and gray), opossum, rabbit, raccoon, mole, rat and mouse.

Game birds (protected by law), songbirds and other birds are numerous. Many varieties of game and nongame waterfowl spend part or all of their time in the marshes and tidal waters. Throughout the state bobwhite, quail, wild turkey and, less common, mourriing dove and woodcock are found. The bald eagle and the golden eagle may be seen in a few coastal and mountain regions. Other birds are buzzard: many varieties of hawk and owl, mockingbird, wren, crow, blue jay, hummingbird, wood thrush, whippoorwill, cardinal and many others.

Many kinds of snakes live in the region, some harmless, such as the green snake and the black snake, some poisonous, such as the copperhead moccasin and water moccasin (rather widely distributed), the rattlesnake (found in the mountains and in some isloated eastern places) and the cottonmouth (in Dismal swamp). In addition there are varieties of turtle, terrapin, frog and lizard.

Among the fish of tidewater are the croaker, shad, spot, white perch, rock, menhaden, bluefish, gray trout and spotted trout. Oysters, scallops, clams, blue crabs and shrimp are found in abundance.

Parks, Historic Sites and Recreation. — Virginia is fortunate in the number, variety and interest of its national and state parks and historic shrines. It ranks third in the nation in the number of national park service areas located in the state. Among these are the Colonial parkway joining Jamestown, Williamsburg and Yorktown; the Blue Ridge parkway and the Shenandoah National park (*q.v.*), which includes the beautiful Skyline drive, a mountaintop highway running about 500 mi., from northern Virginia to North Carolina; and the 32-sq.mi. Cumberland Gap park. The national park service and the Association for the Preservation of Virginia Antiquities own and maintain Jamestown Island. The national park service also maintains the chief Civil War battlefields (Fredericksburg and Spotsylvania, Richmond, Petersburg, Manassas, etc.) and such historic places as the Custis-Lee mansion, George Washington's birthplace, Appomattox courthouse and the Moore house at Yorktown. The national and state governments and several private associations and foundations have acquired for preservation historic shrines, including the homesites and homes of Washington, Jefferson, George Mason, John Marshall, Booker T. Washington and other celebrated Virginians. The greatest private contribution to historical preservation is that of colonial Williamsburg, restored by John D. Rockefeller, Jr. (see WILLIAMSBURG).

Across the state are scattered nine state parks and three recreational areas with facilities for camping, fishing, boating. swimming and hiking. Excellent recreational facilities are furnished by three large lakes made by dams across the Roanoke river in Mecklenburg county and by dams on Smith river in Franklin, Patrick and Henry counties, and on the South Holston in Washington county.

HISTORY

Colonization. — After the failure of several attempts by Sir Humphrey Gilbert and Sir Walter Raleigh to plant a settlement in Virginia, Gilbert died. and Raleigh in 1606 transferred his interests to the Virginia Company of London, a group of merchants and others headed by Sir Thomas Smith. The first settlers, 144 in number, left England in Dec. 1606 in the "Susan Constant," the "Godspeed" and the "Discovery" and arrived at Jamestown on May 13, 1607. The aims of the Virginia company were to aid in building a strong merchant fleet (which served as part of the navy) and to train "able mariners" for England's protection; "to spread the gospel among the heathen people of Virginia"; to establish new areas for trade; to find precious metals; and to plant a Protestant English colony in a land threatened by Spain. The colony was kept alive during the first years mainly through the efforts of Capt. John Smith (*q.v.*), who secured food, made peace with the Indians, explored the country, wrote the first published book on Virginia (*A* True Relation, London, 1608) and drew a map of Virginia remarkable for its accuracy. After Smith left in 1609 the colonists experienced a year of great suffering, the "starving time."

In 1609 the company was reorganized, and almost absolute control over the colony was placed in the hands of the governor. The first governor was Sir Thomas West, Lord De la Warr, whose arrival in 1610 saved the colony from abandonment as a hopeless venture. Torn by strife within the company and within the colony, plagued by disease, hunger, lack of adequate shelter and clothing, polluted water, a climate to which they were unaccustomed, hostile Indians, homesickness and lack of experience in primitive surroundings. the colonists lived from one unfortunate experience to another. Among the evils endured were the failure of attempts to set up such industries as glassmaking. shipbuilding and the production of naval stores; the Indian massacre of 1622; and the plague that followed. The mortality rate reached about 75% during those years.

Yet the colony survived. Settlements spread beyond Jamestown. A headright system was established for land. In 1612 John Rolfe started the tobacco industry by introducing the seeds of two foreign varieties, Orinoco and Sweet Scented. of *Nicotiana tabacum,* exporting the first shipment in 1614. In 1618 instructions were given Gov. George Yeardley to call a representative assembly and once more to establish rule under laws to replace the autocratic administration set up in 1609. On July 30. 1619, the general assembly, consisting of the governor, councilors and 22 elected burgesses — the first English overseas representative body— met in the church at Jarnestown. In the same year the first Negro immigrants arrived as indentured servants and the Virginia company sent over 90 young women as wives for the colonists.

Royal Rule. — In 1624 the English government revoked the charter of the Virginia company and organized in Virginia its first royal colony. During the century and a half that followed, the two outstanding factors in the colony's history were the northern and western expansion of the population and a growing political maturity, which produced a strong representative lower house in the assembly, an able group of leaders and a spirit of independence. During Sir John Harvey's administration the first settlement on the York river was made (1630). and three years later a palisade, to provide protection from Indians as well as a large range for cattle, was built across the peninsula, and Middle Plantation (now Williamsburg) was founded. In 1634 a new system of local government began with the creation of the first eight counties, each with its sheriff, constable, justices, clerk and coroner. Church parishes already had been in existence.

First serious attempts to explore the trans-Allegheny region were made during Sir William Berkeley's administrations. The Indian massacre of 1644, in which at least 500 colonists perished, delayed exploration, but trading routes soon led from the sites of Richmond and Petersburg to the Indians in the southwest.

Virginians remained loyal to Charles I during his struggle with parliament, but in 1652 parliamentary commissioners with an overwhelming force assumed control of the colony. During the eight years of rule by parliament life in Virginia changed but little. The governors were only mildly Puritan, and the government in the colony was controlled by the house of burgesses — "representatives of the people." as its members often described themselves. After 1649 hundreds of Cavaliers fled to the colony, and from them were derived some of the leading families of Virginia.

Berkeley's second administration (1660–77) was marked by difficulties: the establishment of proprietorships in Virginia. human and cattle plagues, wars, hurricanes. oppressive trade laws, threats from the Indians who resented English encroachment, and, among the people, widespread discontent and growing distrust of those who governed the colony. The governor tried to prevent oppressive royal measures and to better economic conditions, but by the 1670s he had grown old, crabbed, autocratic, weak in body and inefficient. Yet he had assumed and continued to hold all authority in his own hands. and having secured a house of burgesses that suited him, refused for 14 years — until faced with rebellion — to call for new elections. The climax came when the Indians, made desperate by English encroachment, began war on the colonists. When in 1676 the people found Berkeley unable or, as they believed, unwilling to protect them, they chose young Nathaniel Bacon as their leader, compelled the governor to give him a commission, followed him against the Indians and forced reforms through the assembly. When the governor threatened to use military force against them, Bacon and his men defied him. On the death of Bacon, however, Berkeley soon ended the struggle with a series of hangings that shocked the home government and brought his recall.

From the end of Bacon's rebellion to the revolution of 1688 in England. Englishmen in Virginia, like their kinsmen in England! struggled to lessen the royal prerogative represented in the colony by a succession of autocratic governors.

During the remainder of the colonial period Virginia generally had able and conscientious governors. But conflicts inevitably arose when the mother country failed to realize the growing independence of the colony and refused, in such matters as the use of veto, trade regulations and taxation! to keep the promise of early charters that Virginians would "enjoy all liberties. franchises and immunities . . . to all intents and purposes as if they had been abiding and borne within this our realme of Englande. . . ."

During Francis Nicholson's administrations (1690–92 and 1698–99) the general assembly founded a college and a new capital. Under the leadership of Col. John Page it established the College of William and Mary and sent James Blair, president-elect, to England to secure a charter and endowments. The college received the charter in 1693, and in 1694 the College of Heralds granted it a coat of arms (see *Education,* below). In *1699* Middle Plantation became the capital of Virginia and was renamed Williamsburg; it was incorporated in 1722.

Alexander Spotswood, governor from 1710 to 1722 pursued an enlightened policy toward the Indians and in a famous journey with his "Knights of the Golden Horseshoe" (1716) blazed a trail over the Blue Ridge mountains for settlers in piedmont and the valley. Spotswood's skill as an architect is still seen in Williamsburg in the buildings he designed. In 1721 the first county beyond tidewater was created and named Spotsylvania for the governor.

William Gooch's administration (1727–49j was one of the most eventful periods in Virginia history. In 1730 the assembly passed Gooch's Tobacco act, which continued, with periodic renewals, to regulate the quality of the staple crop and medium of exchange until the Revolution. In 1736 the *Virginia Gazette* was founded. During King George's War Gooch commanded Virginia troops at Cartagena. By mid-18th century Scotch-Irish, Germans and tidewater Virginians had settled the valley and a few had entered trans-Allegheny at Draper's Meadows. The organization of the Ohio company in 1747 and its founding of a fort at the forks of the Ohio precipitated the French and Indian War, in which Virginia took a prominent part.

During the 1730s and 1740s Presbyterians gained a strong foothold in Virginia and organized Hanover presbytery, and in the 1750s the Separate Baptists from New England entered Virginia. Both denominations increased rapidly.

During the quarter-century before the Revolution, as Virginia grew in strength and political maturity, its house of burgesses became increasingly active in opposing the royal prerogative in such matters as the veto of the colony's laws, the Proclamation of 1i63 restricting westward expansion, and taxes imposed by parliament. Before 1776 such leaders as Richard Bland and Thomas Jefferson were formulating the constitutional and ethical bases for revolt, Patrick Henry was becoming an orator and George Washington mas acquiring military and political experience.

Virginia in 1763 had an estimated total population of 121,022 almost evenly divided between whites and Negroes. The population was rapidly increasing. The great planters were building substantial homes: the homes of lesser iarmers were neat and well built. Those who had the means enjoyed good books, music, the theatre and other forms of entertainment. An average of more than 50.000 hogsheads of tobacco, valued at £500,000 moved each year from Virginia to British ports.

Revolutionary Period. — Virginians took the lead in the constitutional crises preceding the Revolutionary War. They passed the Stamp Act resolutions of 1765; started in 1769 the boycott of British goods in order to cause the repeal of the Townshend acts; revived in 1773 the committee of correspondence of 1759 and brought about an intercolonial committee; called the first continental congress in 1774 and furnished its president, Peyton Randolph; set up a revolutionary committee of safety and armed for defense in 1775; called on congress on May 15, 1776, to declare independence; furnished the author, Thomas Jefferson, of the Declaration of Independence; and provided the leader of the Revolutionary army, George Washington. The May 1776 convention, in addition to proposing that congress declare independence, form a union and make foreign alliances; set up a commonwealth and chose Patrick Henry as its first governor. Meanwhile, in 1775, Governor Dunmore, fearful of the volunteer riflemen gathering in Williamsburg, had fled to the safety of the British fleet. On Nov. 7 he declared martial law and waged mar against Virginia until forced to leave the following July.

In 1778 George Rogers Clark led an army of Virginia and Kentucky riflemen in the conquest of the Northwest Territory: his campaign ended the Indian menace and brought that region into the area claimed and secured by the United States in the peace of 1783. Meanwhile, in 1781, Virginia gave up to the Cnited States its claim to the territory, based on its charter of 1609 and the more practical right of conquest, and in 1792 consented to the formation of Kentucky out of the state's westernmost counties.

During the Revolutionary War Virginia moved its capital from Williamsburg to Richmond (*qq.v.*) in 1780, reformed its code of laws in 1779, abolished the African slave trade in 1778 and set up 19 counties in the west (1776–82). The British captured Portsmouth (*q.v.*) in Oct. 1780. In Jan. 1781 Benedict Arnold sailed past Portsmouth, took Richmond and set up headquarters at Portsmouth. Cornwallis brought his army into Virginia from the south that spring, and Jefferson, governor of the state, with inadequate forces, was unable to stop him. Cornwallis, after marching his army through Richmond, Williamsburg (near which, at Green Spring, Lafayette attacked him) and Portsmouth, came to Yorktown and fortified the place. There, trapped by the American and French armies under Washington and Rochambeau and by the French navy under DeGrasse, he was forced to surrender on Oct. 19, 181. This practically ended the war (*see* also YORKTOWN).

Post-Revolutionary Period. — For almost half a century after the Revolution, Virginia, impoverished by two wars and their aftereffects and finding its soil depleted as a result of tobacco growing, suffered economically, and Virginians migrated to populate the west, northwest and southwest. But the foundations for future progress were being laid. The political philosopher John Taylor published a series of essays in 1803, collected in a book. *The Arator,* in which he advocated improved methods of agriculture. In 1818 Edmund Ruffin called attention to the benefit from the use of marl (lime) on acid soil, and his *Essay* on *Calcareous Manures* (1832) and articles in his journal, *Farmer's Register* (beginning June 1833), revolutionized agriculture in Virginia and elsewhere.

Virginia began an efficient system of chartered banks in 1804. The state undertook or aided in the building of roads, canals and railroads, and Virginians began direct trade with Europe and South America. By 1860 Virginia was the leading manufacturing state in the south. A state university and several colleges had been founded before 1850, public schools were being established by local option in 1846 and numerous private schools were flourishing. The constitution of 1851 provided white manhood suffrage, popular election of many officials. including the governor, and ended sectional inequalities in representation.

Slavery remained an unsolved evil. In Jan. 1832, after Nat Turner's slave insurrection in Southampton the previous year, the Virginia assembly tried in vain to find a solution; and abolitionists' indiscriminate abuse almost silenced native reformers.

Civil War and Reconstruction. — In 1861 Virginia seceded from the union. Richmond became the capital of the Confederacy, and Virginia was a battleground throughout the war that followed (*see* AMERICAN CIVIL *WAR*). In 1863 the state lost one-third of its territory to form West Virginia (*q.v.*). In 1867 congress placed the South under military rule. Virginia being Military District No. 1, with Gen. John M. Schofield in command.

Cnder the Reconstruction acts most Virginians with any experience in government were disfranchised. A constitutional convention made up largely of carpetbaggers and scalawags met and drew up a new constitution, which included articles that would have excluded thousands of whites from voting and disqualified almost every native white citizen from holding office. A committee of nine citizens headed by Alexander H. H. Stuart, however, secured permission from the federal authorities to vote separately on these articles, and they were rejected by the voters. The remainder of the constitution, including manhood suffrage, was adopted (1869), and congress readmitted the state to the union on Jan. 26, 1870.

Virginia escaped much of the punishment that Reconstruction inflicted on other states, but it had lost thousands of its young men and had been devastated by invading armies, its banks had been closed, its currency turned into worthless paper, its labour force demoralized and its territory occupied by its former enemy. It n-as also saddled with a prewar debt, made for internal improvements, amounting in April 1871 to over $45,000.000, more than one-third of which was interest accrued during the war and Reconstruction.

Strife over the state debt was the prominent feature of political life during the 1870s and '80s. When the pre-Reconstruction leaders regained control of the government, they provided for payment of the entire debt, designating one-third as West Virginia's share, for the payment of which Virginia assumed responsibility. The bankrupt state could not meet its obligations to its citizens and pay interest to its creditors, however, and the new system of public schools, organized in 1870. suffered accordingly. Then a group, the Readjusters, claiming that the debt and interest needed pruning and with aid of the Republicans: seized control of the government in 1882 and "readjusted" the debt, both principal and interest. Not until 1891–92 was a satisfactory compromise settlement reached with the creditors, and later West Virginia paid its share. The Democratic party was revived in 1883 and has controlled the state since then. In presidential elections the state supported the Republican candidate in 1928, 1952, 1956 and 1960.

Virginia adopted a new constitution in 1902.

20th Century. — In 1926 Harry Flood Byrd became governor of Virginia and within four years he had revolutionized the governmental machinery. During the first 60 days of his administration, the general assembly instituted a remarkable group of reforms through statutes or constitutional amendment. It revised the tax system; reformed the fee system; initiated constitutional amendments which greatly shortened the ballot, concentrating authority in the governor's hands; and encouraged industries to settle in Virginia. The years after World War I found the state's prosperity increasing as agriculture was diversified, manufacturing became more important in the economy and the tourist business became a major enterprise.

The depression of the 1930s was less severe in Virginia than in many other states. In the period before U.S. entry into World War II Virginia was the first state to set up a state defense system. The war brought tens of thousands of soldiers into the military camps of the state. The Hampton Roads area had a great boom with the expansion of the Norfolk naval base and the shipbuilding activities in Newport News.

GOVERNMENT

Alterations in the 1920s and later amendments have made a virtually new constitution from that of 1902. Qualifications for voting. also for office holding are: age. 21 years; residence in the state one year. county. city or town six months, precinct 30 days; payment of poll taxes for the preceding three years; and registration at least 30 days before election or primary election. The voters in state elections choose only the senators and delegates to the general assembly, the governor, lieutenant governor and attorney general.

Executive. — The governor chooses the heads of the 12 administrative departments of the government and is the business manager of the state. To aid the governor and general assembly are such agencies as the division of statutory research and drafting, the legislative advisory council and the state planning board.

Legislative. — The general assembly, which originated in 1619, consists of tn-o houses, the house of delegates, limited to 100 members elected for two years, and the senate, limited to 40 members elected for four years. It regularly meets at Richmond on the second Wednesday in January in even-numbered years.

Judiciary.— The administration of justice is vested in the supreme court of appeals, circuit courts. city courts and such other inferior courts as may be established by law. The seven justices of the supreme court are elected by a joint vote of the two houses of the general assembly for terms of 12 years. Each city of the first class (with at least 10,000 residents) and each county and city is included in a circuit court. These are grouped in 3i districts, each with its judge appointed by the general assembly. who sits in each court of his circuit. Each city of the first class may also have its corporation or hustings court. Each county has a trial justice: usually appointed by the judge of the circuit court. The judge of the juvenile and domestic relations court in each county and city (Norfolk excepted) is chosen by the circuit judge; and in each county the trial justice is appointed to that office.

Local **Government.**—Virginia's 98 counties and the 32 independent cities that have jurisdiction separate from the counties are agents of the state as well as units of local legislative and administrative bodies enjoying a large degree of autonomy. The counties are divided. into magisterial districts, from each of which a representative is elected to a county board of supervisors (Arlington county, however, elects them from the county at large). The board of supervisors is the governing body of the county, controlling taxation, the budget, borrowing and accounting. There are numerous other officers, about one-third elected by the people, others being appointed by the circuit court. This traditional form of government is expensive and inadequate. Yet, though the counties by popular vote may adopt one of three optional forms of county government, each designed to eliminate unnecessary offices and to concentrate county functions under a policy-forming board of supervisors, few counties have elected to do so. Within the old form, however, improvements are being made.

Cities, unlike towns, are independent of the counties in which they are located. The city-manager form of government in the United States originated in Staunton, Va., and 31 of the 32 independent cities in the state have that system.

Finance.—In finance, controlled by the general assembly, Virginia is notably conservative. Since the Readjuster period Virginians have been opposed to a state debt, and since the Budget act of 1918 and later fiscal reform acts the state budget has been balanced. The gross debt, of less than $10,000,000, is offset by sinking-fund assets of more than half that amount; hence the net state debt is negligible. To prevent overlapping taxation, taxable items in Virginia are separate for state and local governments. The state taxes all income, personal and corporate; local governments fix rates and tax real estate, tangible personal property, machinery and tools, and merchants' capital. The budget is prepared by the division of the budget of the governor's office from estimates furnished by the state agencies and after the governor, the director of the budget and members of the governor's advisory board on the budget have visited the state's agencies and institutions and held public hearings in Richmond.

POPULATION

The population of Virginia in 1790 was 747,610; in 1830 it was 1,211,405; in 1870, 1,225,163; in 1910, 2,061,612; in 1940, 2,677,-773; in 1950. 3,318,680; and in 1960. 3,966,949. This last figure represented an increase of 19.5% over the population in 1950. The population per square mile in 1960 was 97.2, as compared with 81.3 in 1950. 65.6 in 1930 and with 49.6 ior the U.S. in 1960.

Of the 1960 population 1,833,283 or 46.2% lived in incorporated places of 2,500 or more. as compared with 40.3% in 1950 and 35.3% in 19-10. The state has five standard metropolitan statistical areas. These areas had a total population of 1,481,008 or 37.3% of the total population of the state in 1960.

The number of households in 1950 was 845,932. as compared with 627,532 in 1940. The average population per household had declined from 4.3 in 19-10 to 3.9 in 1950.

The population of the state was distributed by colour and nativity in 1960 as follows: 78.1% native white; 1.1% foreign-born white; and 20.8% nonwhite, practically all Negro. These were 99.5 males per 100 females in the white population. and 98.1 in the nonwhite population; 7.3% of the population was 65 years old or over: and 55.7% of the population 14 years old and over was in the labour force. Of all employed males. 10.3% was engaged in agriculture. 9.8% in construction. 24.8% in manufacturing and 24.7% in transportation. public utilities and trade.

Very definite trends appear in population statistics: the increasing importance of federal employees to the population and economy. the declining relative importance of agriculture and the increasing importance of manufacturing and other services. the growth of health, medical and educational services, and the decreasing dependence of householders on domestic servants. In composition, in 1960 a larger percentage of Virginia-born whites were living in Virginia; on the other hand, the percentage of non-Virginia-born whites living in Virginia increased from 6% in 1870 to 30.3% in 1960. The proportion of Negroes has decreased steadily since 1830 (then 47.9%); in the 70 years before 1950 it decreased 20%, while the white population increased 19.5%.

*Virginia: Places of 5,000 o~ More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	3,966,949	3,318,680	2,677,773	2,309,187	1,854,184
Alexandria	91,023	61,787	33,523	18,060	14,528
Bedford†	5,921	4,061	3,973	3,243	2,416
Blacksburg	7,070	3,358	2,133	1,095	768
Bristol	17,144	15,954	9,768	6,729	4,579
Buena Vista	6,300	5,214	4,335	3,911	2,388
Charlottesville	29,427	25,969	19,400	10,688	6,449
Clifton Forge	5,268	5,795	6,461	6,164	3,212
Colonial Heights	9,587	6,077	3,194	—	—
Covington	11,062	5,860	6,300	5,623	2,950
Danville	46,577	35,066	32,749	21,539	16,520
Emporia	5,535	5,664	2,735	1,869	1,027
Fairfax	13,585	1,946	979	516	373
Falls Church	10,192	7,535	2,576	1,659	1,007
Franklin	7,264	4,670	3,466	2,363	1,143
Fredericksburg	13,639	12,158	10,066	5,882	5,068
Front Royal	7,949	8,115	3,831	1,404	1,005
Galax	5,254	5,248	3,195	1,250	—
Hampton	89,258	5,966	5,898	6,138	2,764
Harrisonburg	11,916	10,810	8,768	5,875	3,521
Hopewell	17,895	10,219	8,679	1,397	—
Lexington	7,537	5,976	3,914	2,870	3,203
Lynchburg	54,790	47,727	44,541	30,070	18,891
Manassas Park	5,342	—	—	—	—
Marion	8,385	6,982	5,177	3,253	2,045
Martinsville	18,798	17,251	10,080	4,075	2,384
Newport News	113,662	42,358	37,067	35,596	19,635
Norfolk	304,869	213,513	144,332	115,777	46,624
Norton	5,013	4,315	4,006	—	—
Petersburg	36,750	35,054	30,631	31,012	21,810
Portsmouth	114,773	80,039	50,745	54,387	17,427
Pulaski	10,469	9,202	8,792	5,282	2,813
Radford	9,371	9,026	6,990	4,627	3,344
Richmond	219,958	230,310	193,042	171,667	85,050
Roanoke	97,110	91,921	69,287	50,842	21,495
Salem	16,058	6,823	5,737	4,159	3,412
South Boston	5,974	6,057	5,252	4,338	1,851
South Norfolk	22,035	10,434	8,038	7,724	—
Springfield	10,783	—	—	—	—
Staunton	22,232	19,927	13,337	10,623	7,289
Suffolk	12,609	12,339	11,343	9,123	3,827
Vienna	11,440	2,029	1,237	773	317
Virginia Beach	8,091	5,390	2,600	846	—
Waynesboro	15,694	12,357	7,373	1,594	856
Williamsburg	6,832	6,735	3,942	2,462	2,044
Winchester	15,110	13,841	12,095	6,883	5,161
Wytheville	5,634	5,513	4,653	2,947	3,003

*Populations are reported as constituted at date of each census. Excludes Arlington county (pop. [1960] 163,401) which was considered an urban area, †Name changed from Bedford City since 1910.

Note: Dash indicates place did not exist during reported census, or data not available.

EDUCATION

Public **Schools.**—Virginia replaced its local option system of public free schools of 1846 with a state-wide system in 1870. In the late 1950s there were more than 800.000 pupils of school age (7 to 19) and more than 30.000 teachers (including principals and supervisors). The state also supported two schools for the deaf and the blind.

Higher Education.— State *Institutions.*—The Virginia state board of education accredits 13 four-year colleges and universities and 2 junior colleges under state control. The leading Virginia university, indeed one of the leading southern universities, is the University of Virginia at Charlottesville, founded in 1519 and largely the creation of Thomas Jefferson, who left his mark on its beautiful buildings and grounds and on its academic traditions. Women are admitted only to the professional and graduate schools; its liberal arts college for women is the Mary Washington college of the University of Virginia at Fredericksburg, started in 1908. The university's schools and colleges include arts and sciences. architecture. business administration, commerce. education, engineering, law, medicine and nursing. It has several affiliated junior colleges. The university publishes The *Virginia Quarterly Review.*

Oldest of the institutions of higher education is the College of William and Mary at Williamsburg. chartered in 1693 by King William and Queen Mary, the second oldest college in the United States and pioneer in such fields as law, modern history, modern languages, lecture system, honour system and elective system. It is a coeducational college of liberal arts, with its associated Marshall-Wythe school of law. In co-operation with Colonial Williamsburg, Inc., the college conducts the Institute of Early American History and Culture and publishes the *William* and *Mary Quarterly*. Affiliated as the Colleges of William and Mary under one board are, in addition to the College of William and Mary, Norfolk college, the Richmond Professional institute, and two junior colleges—Christopher Newport at Newport News and Richard Bland at Petersburg.

Other state institutions are Longwood college at Farmville, a college for women, at which a few men are admitted as day students (founded 1884), and Madison college (1908) at Harrisonburg, coeducational but enrollment of men limited. The Medical College of Virginia was established in Richmond in 1837 as the Medical College of Hampden-Sydney and became independent of Hampden-Sydney in 1854. Virginia Military institute at Lexington, founded in 1839, is famous for the distinguished military leaders numbered among its graduates. Virginia Polytechnic institute at Blacksburg is a land-grant college established in 1872 under the Morrill act, specializing in agriculture, applied science, business administration, engineering and home economics; it has several branches for the first two years, and Radford college (1910) at Radford is the women's division. Virginia State college at Petersburg was established for Negroes in 1882; it offers a broad program and has a four-year affiliate college in Norfolk.

Private.—The state board of education accredits 18 four-year colleges and universities and 12 junior colleges under private control. Among these are Bridgewater college (Church of the Brethren; 1880) at Bridgewater; Emory and Henry college (Methodist; 1838) at Emory; Eastern Mennonite college (1917) at Harrisonburg; Hampden-Sydney college for men (Presbyterian; 1776) at Hampden-Sydney; Lynchburg college (Disciples of Christ; 1903) at Lynchburg; Mary Baldwin college for women (Presbyterian; 1842) at Staunton; Presbyterian School of Christian Education (1914) in Richmond, devoted chiefly to preparing women for positions in the mission fields and as directors of Christian education but offering also a regular liberal arts program; Randolph-Macon college for men (Methodist; 1830) at Ashland, the oldest Methodist college in the United States; Randolph-Macon Woman's college (Methodist; 1893) in Lynchburg; Roanoke college (Lutheran; 1842) in Salem; Shenandoah College and Conservatory of Music (1875) at Dayton; Sweet Briar college for women (1901) at Sweet Briar; the University of Richmond (Baptist; 1832); Washington and Lee university for men (1749) at Lexington, originating in a classical school and later named for a benefactor, George Washington, receiving its present name in 1870 after the death of Robert E Lee, its president from 1865 to 1870; Hollins college for women (1842) at Hollins.

Hampton institute at Hampton was founded in 1868 by Gen. Samuel Chapman Armstrong to bring education to recently freed Negroes. It is a nondenominational, nonprofit-making institution, incorporated by the state in 1870, that trains students in agriculture, building construction, architectural design and engineering, several trades, business, home economics, education and general studies St. Paul's college at Lawrenceville was founded for Negroes in 1888 primarily as an industrial school, but after 1941 offered a full college course. Virginia Union university at Richmond was organized in 1899 from two schools founded in 1865 for Negroes.

HEALTH AND WELFARE

Virginia established its state board of health in 1872. The commissioner of health formulates public health policies and programs and supervises all personnel and activities of the health department. The department has divisions of alcohol studies and rehabilitation, local health services, engineering and dental health.

The department of welfare and institutions is headed by a director, who is advised by a policy-making board of welfare and institutions. The department has four divisions: (1) division of general welfare, which administers aid to dependent children, old-age assistance, aid to the totally or permanently disabled and general relief; (2) division of corrections, which administers and supervises the six institutions for male and female offenders convicted on felony or misdemeanor charges, and inspects and supervises local jails and lockups in the state; (3) Virginia parole board, which sets the policy for and administers paroles; (4) division of youth services, which supervises the care and treatment of children committed to the board by the juvenile courts, is responsible for supervision and development of local detention and probation services for children, and administers two schools for boys and two for girls committed to the board of welfare and institutions by the courts.

The department of mental hygiene and hospitals controls the seven institutions that care for the mentally ill or deficient and the alcoholic. Virginia's Eastern State hospital at Williamsburg, established in 1773, is the oldest state-supported institution for the insane in the United States.

THE ECONOMY

Ten years of Civil War and Reconstruction and the social and economic troubles that followed during another quarter-century delayed economic development in Virginia for at least a generation, but beginning about 1930 such forces as improved agricultural methods, modern highways, the great increase in military and other federal installations, increased efficiency in government and the coming of industries to small towns and rural communities brought about an acceleration. The flow of native population from Virginia was reversed after 1930, and the increase in average per capita income surpassed that of the country at large. An interesting development of the second quarter of the century was the large number of industries near to and drawing their workers from small neighbouring farms. Automobiles, good country roads, higher incomes and government aid have enabled rural families to enjoy city conveniences: by 1950 four-fifths of farm families had electricity, about one-fourth had running water, one-half had automobiles and one-fourth had telephones. Although the mild climate and lack of population congestion make living conditions generally pleasant in Virginia. the average annual earning per worker is below the average for the nation.

Agriculture.—The average Virginia farm has about 110 ac.; tenancy is around 17%. In the decade 1940 to 1950 for the first time the number of persons employed in agriculture fell below the number employed in wholesale and retail trade and in manufacturing, but agriculture remained a major element in Virginia economy. In spite of a decline of about one-fourth in the number of farmers and the withdranal of 1,000,000 ac. from cultivation for purposes of reforestation. the total value of farm products greatly increased. More than half of Virginia's farm income is derived from livestock and poultry and their products. About one-fifth comes from tobacco, grown chiefly in the lower piedmont. The eastern counties grow truck vegetables, peanuts, potatoes, grains (especially corn) and hogs; peanut-fed hogs from this region, processed at Smithfield, furnish the famous Smithfield hams. Upper piedmont has many stock and dairy farms with crops of grain and hay. In the rich limestone soil of the valley-mountain counties are found large orchards of apple and other fruit trees, bluegrass and grains, as well as cattle, sheep and poultry farms.

Manufacturing.—Manufacturing is growing rapidly in Virginia, the five chief industries (in order of value added) being chemicals and chemical products, textile mill products, tobacco manufactures, food and kindred products, and pulp. paper and paper products. Virginia ranks third among the 11 southeastern states in value added by industry and fourth in numbers employed. Employment in textile manufacturing, though by the late 1950s still occupying the largest number of workers, was on the decline.

Minerals.—The most important of Virginia's mineral commodities in quantity and value is bituminous coal, found in seven counties of the Appalachian plateau region, the annual production over seven years in the 1950s ranging from 17,600,000 to 29,500,000 tons.

Tidewater furnishes sand, gravel, clay and marl. The sand and gravel combination used for building roads, third in importance among Virginia's mineral industries, conies mainly from this region. Clay from all sections of Virginia is used in'brick, tile and ceramic products. Virginia is the only producer of aplite in the United States; other minerals produced in the state for ceramics are kyanite, feldspar and silica sand. Underneath the piedmont and Blue Ridge regions are belts of crystalline rocks that furnish a great reserve of stone. Production of crushed stone and concrete aggregate is state-wide, ranking second in importance among mineral resources. Piedmont also furnishes soapstone and greenstone. Throughout the Appalachian Ridge and valley region are extensive beds of limestone. dolomite and shale. Pulverized limestone and dolomite. T'irginia's fourth-ranking mineral commodity, are valuable for agricultural. chemical, metallurgical and other specialized uses. The manufacture of cement from limestone and shale is an important and growing industry. Virginia's leading metallic mineral, zinc. is mined in the Blue Ridge and valley region.

Other minerals produced in commercial quantities are barite, calcareous marl, gypsum, manganese, mica, pyrites, ilmenite, slate and talc.

Fisheries. — Along Virginia's 1.280 mi. of tidal coast line (780 mi. mainland and 500 mi. island) on the Atlantic ocean, Chesapeake hay and the great tidal rivers, fisheries furnish part or full employment for 6,000 to 10.000 fishermen. Oysters contribute about one-half the value of the total catch. The chief edible fishes are sea bass. porgy. alewife, croaker, shad and spot. About two-thirds of the finfish caught in 1955 were menhaden, valuable for oil, meal and fertilizer. In the coastal counties are located many seafood plants and fertilizer factories.

Trade. — Virginia has four ports on the great Hampton Roads (*q.v.*) harbour — Sewport News, Norfolk. Portsmouth (*qq.v.*) and South Norfolk — and three river ports — Alexandria (*q.v.*) on the Potoniac and Hopewell and Richmond (*q.v.*) on the James. Of the exports from these ports (around 55,000,000 short tons annually) coal comprises 95% (by volume). the Hampton Roads ports being among the world's chief coal-exporting centres. Other products passing through the ports outward are iron. chrome and manganese ores and gypsum (totaling about 30% by volume), grain, soybeans, tobacco. and iron and steel scrap. Petroleum products make up about 60% of imports; also imported are newsprint, logs and lumber. fertilizers and fertilizer materials. and food products, especially sugar and fruits. Sine trunk-line railroads connecting with other railroads throughout the country converge on the Hampton Roads ports. Excellent piers, grain elevators and ore-handling facilities add to the ports' usefulness. More than 450 steamship owners or operators link these ports with about 300 world ports.

Transportation and Communication. — A letter from George Washington to Gov. Benjamin Harrison in 1784 recommended state aid for works of internal improvement connecting the James and the Potomac rivers with the Ohio in order to capture for the Virginia ports the trade of the west. This letter resulted in 1785 in the creation of the James River Co. and the Potomac River Co., starting a new era in constructing works of internal improvement in Virginia. Later the state built turnpikes connecting the Valley of Virginia with the Ohio, and financed other turnpikes. In 1827 Virginia chartered the horse-powered, later steam-polyered, railroad line connecting Winchester with the Baltimore and Ohio at Harper's Ferry. Between 1850 and 1860 Virginia extended its lines from 384 to 1,350 mi. By the second half of the 20th century there were 12 Class I railroads and several lesser roads, with more than 4,000 mi. of main-line track. The focal points of the railroads are Washington. Richmond and the ports of Hampton Roads. Few regions in the state are more than ten miles from a freight depot. but passenger service is limited, buses often furnishing cheaper and more convenient service.

There are about 50.000 mi. of state highways and several thousand more miles of municipal and federal roads. Virtually every part of the state is served by buses.

Interstate and intrastate water transportation, once of vital importance, has given place largely to land transportation systems, but large supplies of raw materials are carried by water to chemical and paper plants having their own piers. There are ferries across Chesapeake bay between the eastern and western shores, and an important amount of local traffic moves by water.

Four main airways enter or cross the state, placing some of the chief cities of I'irginia on air lines serving the chief centres of the north, south and west. The state is well supplied with radio stations and television facilities.

See also Index references under "Virginia!' in the Index volume.

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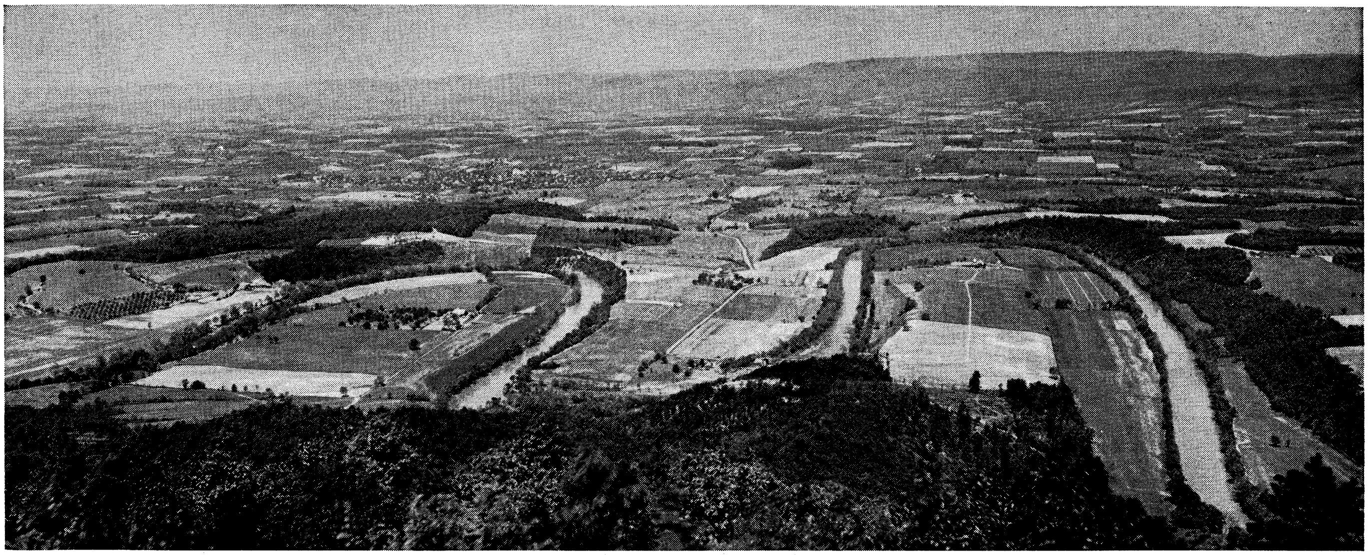
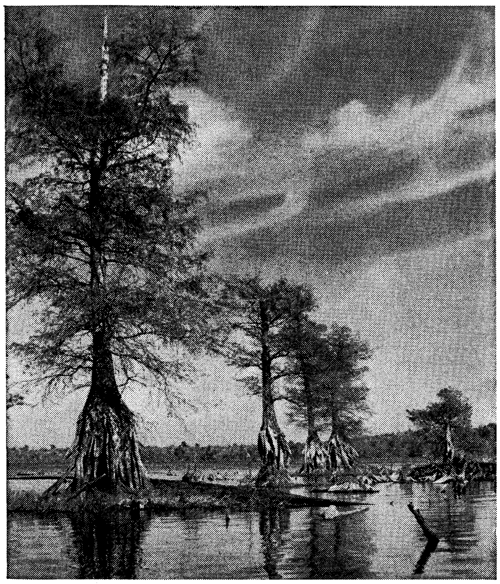


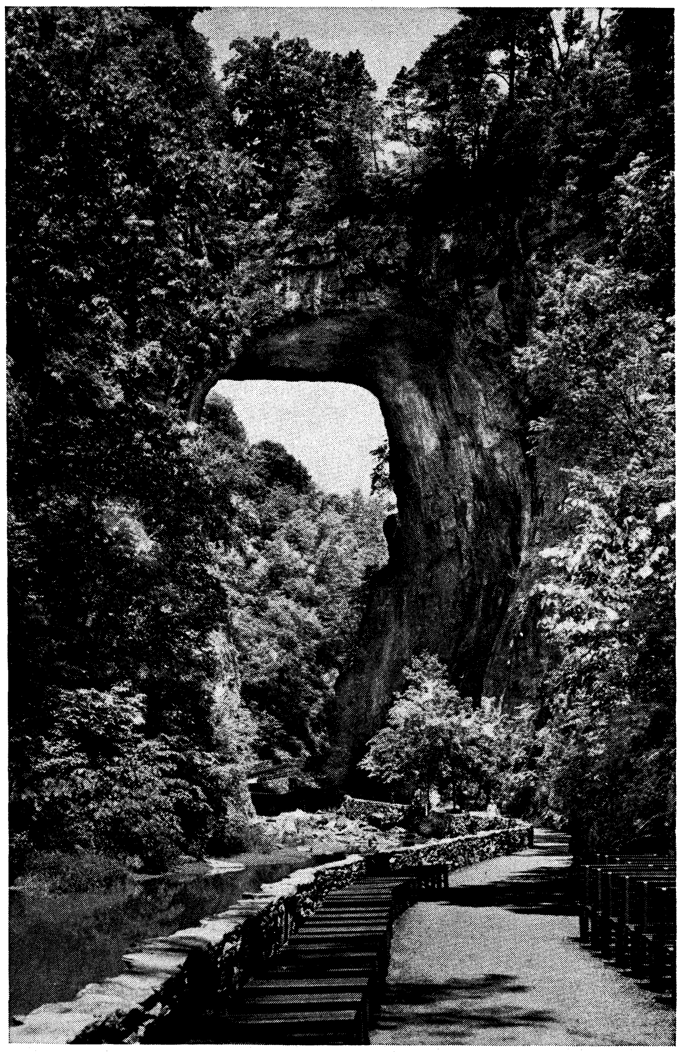
Horseshoe bends of the Shenandoah river, in a section of the Great valley of Virginia between the Blue Ridge and Allegheny mountains. The valley has long been a centre of the state's agricultural production; industry has increased rapidly in recent years



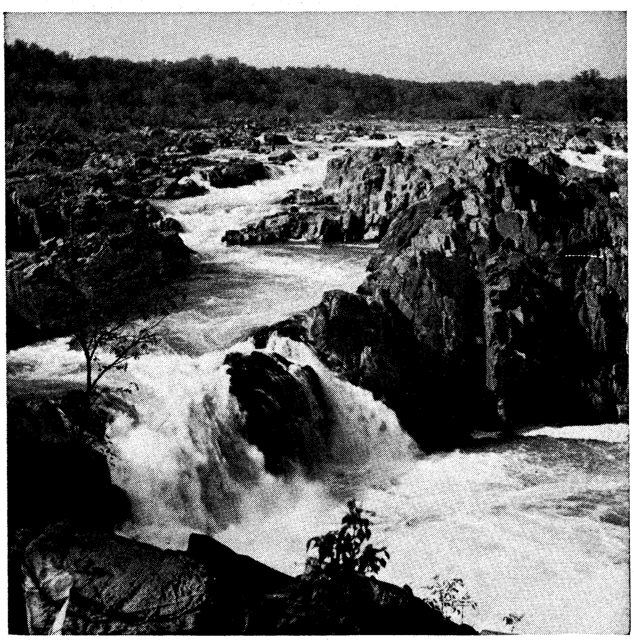
Rotting trees in Drummond lake, the interior pool of Dismal swamp, a fresh-water marsh covering about 750 sq.mi. in Virginia and North Carolina

THE VARIED LANDSCAPE OF VIRGINIA

Natural bridge near Lexington, in the Shenandoah valley. The 90-ft. span crosses a gorge 215 ft. deep cut by Cedar creek

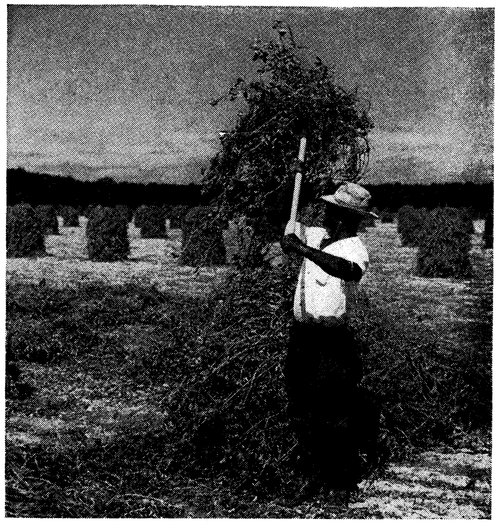


Great falls of the Potomac which mark the descent of the river from the piedmont uplands to the coastal plain near Washington, D.C.



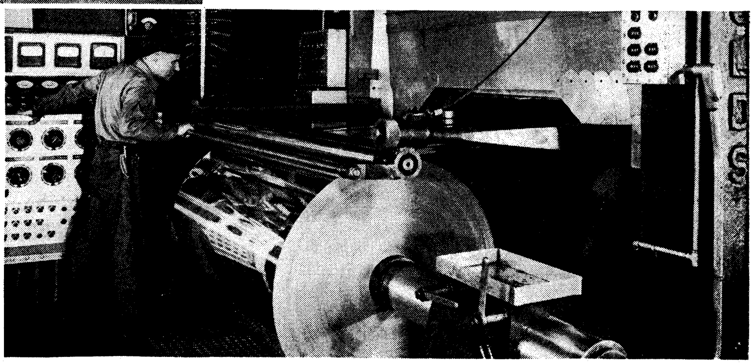
BY COURTESY OF VIRGINIA DEPT. OF CONSERVATION AND ECONOMIC DEVELOPMENT, PHOTOS (EXCEPT TOP) BY FLOURNOY, VIRGINIA CHAMBER OF COMMERCE

Railway classification yard and piers at Norfolk. The port of Hampton Roads, which includes Norfolk, Portsmouth and Newport News, is a centre of foreign trade and an important U.S. naval base

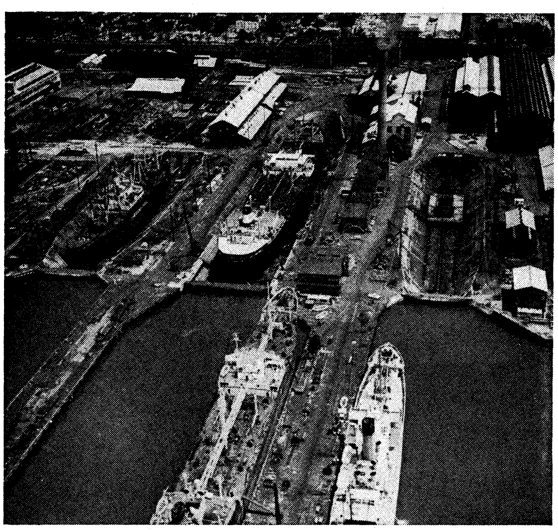


Above: Harvesting peanuts in the tidewater (eastern) region of Virginia. The state is one of the nation's leading growers, producing about 200,000,000 lb. annually

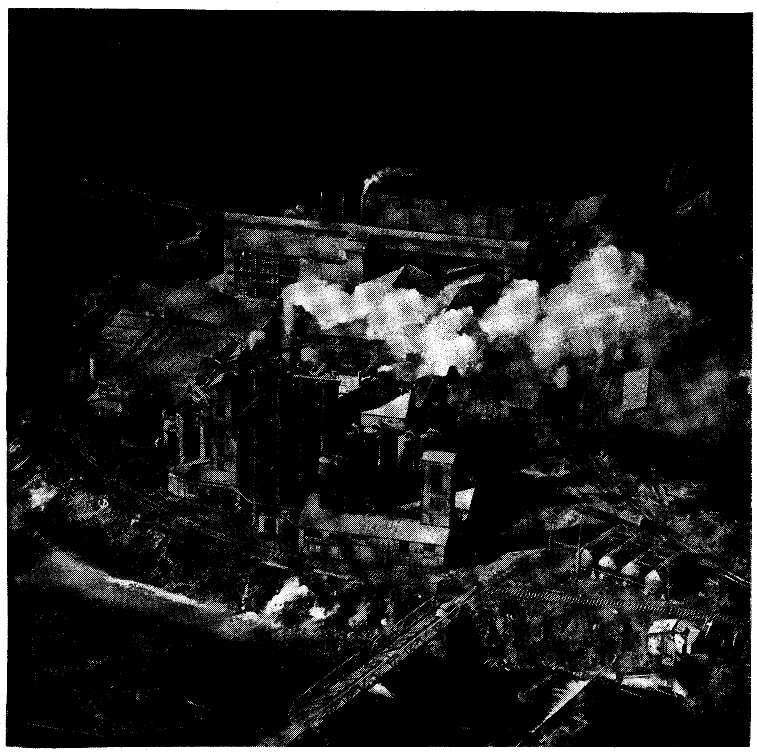
Below: Aluminum foil rolling mill near Richmond, leading manufacturing city of Virginia. Development of foil and aluminum extrusions industry was rapid after World War II



Cutting Burley tobacco in southwestern Virginia. Tobacco is the state's most important agricultural product



Dry docks at Newport News, one of the largest shipyards of the world



Carbon dioxide manufacturing plant at Saltville, western Virginia. Chemicals and allied products are the most valuable industry of the state

AGRICULTURE AND INDUSTRY IN VIRGINIA

BY COURTESY OF (TOP LEFT) NORFOLK AND WESTERN RY., (TOP RIGHT) NORFOLK CHAMBER OF COMMERCE, (CENTRE LEFT) THE AMERICAN TOBACCO CO., (CENTRE RIGHT) REYNOLDS METALS CO., (BOTTOM LEFT) NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO., PHOTO BY NIXON, (BOTTOM RIGHT) OLIN MATHIESON CHEMICAL CORP.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Rook of the Year,* American edition. (R. L. Mo.)

VIRGINIA, UNIVERSITY OF, a state institution of higher learning for men, founded in 1819 near Charlottesville, Pa.. hy Thomas Jefferson. Mary Washington college (I 908) at Fredericksburg, Va., in 1945 became the Women's College of the University of Virginia. See VIRGINIA: *Education.*

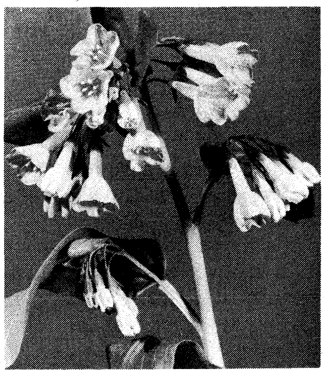
VIRGINIA CITY, county seat of Storey county. Nev., U.S., is situated 23 mi. S.E. of Reno. In June 1859, the fabulous gold and silver strike known as the Comstock lode turned the surrounding area into a booming mining camp overnight. When the Nevada territory was created by congress in 1861, Virginia City had more than three-fourths of the population of the new territory. In the 1870s it had a population of 30.000 persons; there were six churches and 100 saloons. The discovery of the "big bonanza" in 1873 led to a high point of $36,000,000 in mining production in 1878. A great fire in 1875 practically destroyed the town's buildings. with a loss estimated at $12,000,000. The ',bonanza barons" who made their millions in the mines proceeded to build Victorian-style mansions and even the public buildings were elaborately decorated. One of the reporters of the city's newspaper. the *Territorial Enterprise,* during its boom period was Samucl Clemens, who first signed his pen name Mark Twain to one of his newspaper stories.

Virginia City burned itself out in less than a quarter century of frantic mining activity. with the ore beginning to disappear in the 1880s. The population dwindled to less than 1.000 and it soon became a "ghost town," consisting of one main street. two or three parallel streets. and a few short cross-streets. The remaining business houses—mainly saloons and popular museums for the tourist trade––are clustered on the main street and there is only a scattering of buildings and homes in the rest of the city.

See also NEVADA: *History.*

(D. W. Ds.)

VIRGINIA COWSLIP (BLUEHELLS; *Mertensia virginica*), a North American plant of the borage family (Boraginaceae j. called also Roanoke bells or American lungwort. It grows in low meadows and in open woods along streams from New York and Ontario to Minnesota and south to Tennessee and Kansas



ROCHE

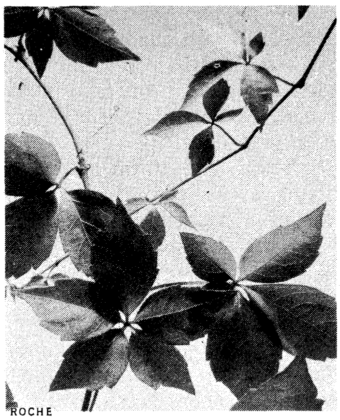
VIRGINIA COWSLIP (MERTENSIA VIRGINICA)

The Virginia cowslip is a smooth perennial, with a usually erect simple or somewhat branching stern, 1 to 2 ft. high, with large, oblong. long-stalked, veiny basal leaves.

In early spring it bears at the top of the stem showy clusters of biue-purple flowers. These are pink in the bud but when expanded are about 1 in, long and trumpet shaped, with a purple tube and a blue bell. This beautiful plant. one of the most popular wild flowers of the eastern states, transplants well and is often cultivated.

See BORAGINACEAE; MERTENSIA.

VIRGINIA CREEPER, a well-known woody vine (*Parthenocissus quinquefolia*) of eastern North America. sometimes cultivated for ornament. but not so well suited for this purpose as the related Boston ivy (P. *tricuspidata*), cultivated in the northeastern U.S. *Parthenocissus* belongs to the family Vitaceae and climbs by means of suckerlike tendrils. The leave? are split into leaflets. of which Virginia creeper has five. The reds and yellows of the leaves in autumn add to the attractiveness of this plant, ahich is sometimes confused with poison ivy (*q.v.*). See also VITACEAE.



ROCHE

VIRGINIA CREEPER (PARTHENOCISSUS QUINQUEFOLIA) LEAVES

VIRGINIA REEL, a lively American country dance. formerly popular in the United States. derived from the Sir Roger de Coverley. Originally intended for six couples only, in longways formation, it later became common practice to form in one long set. the men and women in seuarate lines facing each other. The steps include the usual country-dance, march and galop steps, best danced to the music of the violin, with the fiddler "calling" the figures. the partners advancing and swinging each other and other couples in turn, in a pattern in which the reel is most prominent.

VIRGIN ISLANDS, a group of about 100 small islands and islets: in the West Indies (*q.v.*), only 14 of which are inhabited. They lie about 40 mi. E. of Puerto Rico and extend for about 60 mi.. dominating the Anegada passage between the Atlantic ocean and the Caribbean sea, and covering a total area of 192 sq.mi. The islands are the peaks of submerged mountains that form the eastward extension of the submarine plateau constituting the base of the Greater Antilles. In general, elevations rise only a few score or a few hundred feet above the sea, but isolated peaks reach heights of 2,000 ft. The climate is agreeable and healthful, temperatures seldom going above 90° F. or falling below 65° F. Storms. though not common, are sometimes severe. Rainfall averages about 40 in. annually, a few high exposed slopes getting much more. sheltered spots getting much less; there is much variation from season to season and from year to year. Little ground water can be found in most parts of the islands, and the population depends largely upon cisterns for its water. The surface of the islands is generally rugged. with good soil decidedly lacking. outcrops of bare rock being common, as are also areas with coverings of coral sand or shallow loam derived from volcanic material. Before settlement, the land was largely covered with scant deciduous forest. but most of this has been cut for charcoal and to prepare the land for cultivation. The characteristic vegetation is scrub timber and Guinea grass. The main cultivated crops are sugar cane (used largely for making rum), cotton, tobacco. maize, yams, sweet potatoes and other vegetables for local use. Cattle, goats. sheep and swine are raised both for domestic consumption and for shipment to the larger urban centres such as those on St. Thomas.

Though otherwise closely related. the islands are divided into two political groups, the British Virgin Islands and the Virgin Islands of the United States.

History.—'She Virgin Islands were discovered by Columbus on his second voyage. in 1493, and named Las Virgenes, in honour of St. Ursula and her companions. The inhabitants were Carib and Arawak Indians. In 1666 the British occupied Tortola (previously settled by the Dutch in 1648) and have held it ever since. In the 17th century the islands were favourite resorts of the buccaneers. The islands of St. Thomas, St. John and St. Croix constituted a Danish colony from 1754 till 1917. with brief periods of capture by the British in 1801 and 1807–15.

British'Virgin Islands.—These consist of four larger and 32 smaller islands and tiny islets, with a total area of only 59 sq.mi. The principal islands are Tortola, Xnegada. Virgin Gorda and Jost Van Dyke. The inhabitants numbered 7,338 in 1960. most of them living on the island of Tortola. The chief town and the capital of the British group is Road Town (population in 1960 was 891) in a good harbour on the south side of Tortola Island.

The people are mainly small landowners who replaced the former British plantation owners; they give more attention to stock raising than to farming. A few are fishermen and boatmen, and a number of inhabitants depend upon employment in the U.S. islands. The small trade is mostly with St. Thomas and consists mainly of livestock.

These islands form a separate colony with a government consisting of an administrator who is subject to the governor, an executive council and a legislative council.

Virgin Islands of the United States.—These consist of St. Thomas, St. John and St. Croix or Santa Cruz (*qq.v.*), together with about 50 small islets and cays. The three larger islands of the group were bought from Denmark in 1917 for $25,000,000, mainly for their strategic importance in the Anegada passage and also because they lie about halfway between New York and Panamá. There is a U.S. air-base on St. Croix and a submarine base in St. Thomas harbour. These islands together with Culebra Island and Vieques or Crab Island (both of which are administered by Puerto Rico) constitute one of the most important keys to the defense of the Caribbean sea and the Panama canal. The city of Charlotte Amalie on St. Thomas has an excellent, spacious harbour; formerly an important port of call and coaling station, it more recently built oil reservoirs, shipyards, machine shops and floating docks.

There are commercial airports at St. Thomas and St. Croix and a regular transisland bus service.

The group has an area of 133 sq.mi and a population of 32,099 (1960), of which about 70% is of African descent. St. Thomas, second in area, has the largest population 116.201 in 1960), followed by St. Croix (14,973), the largest of the group, and by St. John (925). The capital. Charlotte Amalie, in 1960 had 12.880 inhabitants: the great majority of whom were engaged in the manufacture and shipping of bay rum and in service to the increasingly large tourist population. The people of St. Croix are occupied largely in raising cattle and sugar cane, making alcohol and in shipping these commodities to St. Thomas. Christiansted and Frederiksted on St. Croix are important ports and trading centres. The inhabitants of St. John raise cattle and collect bay leaves, both for shipment to St. Thomas.

Under the Revised Organic act of 1954, executive power is vested in the governor, who is appointed by the president of the United States for an indefinite term. The unicameral legislature is composed of 11 senators elected for two-year terms. The islands have the status of an organized but unincorporated territory under the jurisdiction of the U.S. department of the interior. Residents of the islands are United States citizens. but have no vote in U.S. presidential elections and are not represented in congress.

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VIRGINIUS RUFUS, LUCIUS (A.D. 15–97), Roman soldier, three times consul (A.D. 63, 69, 97), was born near Comum. When governor of upper Germany under Kero (68), after he had put down the revolt of Iulius Vindex in Gaul, he was urged by his troops to assume the supreme power; but he refused, declaring that he would recognize no one as emperor who had not been chosen by the senate. Galba, on his accession, aware of the feelings of the German troops, induced Virginius to accompany him to Rome. After the death of Otho, the soldiers again offered the throne to S'irginius, but he again refused it. They then attacked him, and he had to escape through the back of his tent. Under Vitellius, one of Virginius' slaves was arrested and charged with the design of murdering the emperor. Virginius was accused of being implicated in the conspiracy, and his death was demanded by the soldiers.

Vitellius refused to sacrifice him to the army's resentment, and Virginius subsequently lived in retirement, chiefly in his villa at Alsium, on the coast of Etruria, till his death in 97, in which year he held the consulship, together with the emperor Nerva. At the public burial with which he was honoured, the historian Tacitus (then consul) delivered the funeral oration.

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VIRGO ("the virgin"), in astronomy, the sixth sign of the zodiac. denoted by the symbol ♍. The Greeks represented this constellation as a virgin, but different fables are current as to the identity of the maid. She is variously considered to be: Iustitia, daughter of Astraeus and Ancora; according to Hesiod, the virgin is the daughter of Jupiter and Themis; others believe she is Erigone, daughter of Icarius, or Parthene, daughter of Apollo. The constellation contains a first magnitude star, Spica, which is a blue star, located at a distance of about 250 light years from the sun.

VIRTANEN, ARTTURI ILMARI (1895–), Finnish biochemist, was awarded the 1945 Nobel prize for chemistry ('for his researches and inventions in agricultural and nutritive chemistry, especially for his method of fodder preservation." He was born at Helsinki, Fin., on Jan. 15, 1895, and studied chemistry at the University of Helsinki. His doctoral thesis (1919) elucidated the composition of abietic acid, the principal constituent of pure rosin. After study in Switzerland, Germany and Sweden, he took up an appointment at the University of Helsinki in 1924. He became professor of biochemistry at the technical high school there in 1931 and at the university in 1939. He investigated the processes which occur during storage of green fodder, a subject of vital importance in countries where the winters are long and severe. Virtanen's researches from about 1920 showed that under ordinary conditions of storage green fodder is spoiled and its nutritive content reduced by fermentation processes. He further proved that addition of definite amounts of acids to the crops arrested the detrimental processes and ensured a constant supply of palatable and nutritious fodder. Extensive experiments carried out during 1928–29 showed that the taste, caloric value and vitamin content of treated fodder were entirely satisfactory and that cows fed on such fodder yielded milk of the highest quality. Virtanen also carried out important work on the bacterial and enzymatic processes concerned in the utilization of nitrogen and other nutritive materials by root crops. (W. J. Bp.)

VIRTUES, NATURAL AND THEOLOGICAL. Virtue is defined as "conformity of life and conduct with the principles of morality" (see ETHICS). The virtues are the practical attitudes adopted in obedience to those principles. They have been conventionally enumerated as seven because that number is supposed. when combined with its opposite number of seven deadly sins, to cover the whole range of human conduct (see SINS: SEVEN DEADLY). In Christian teaching. the seven virtues are divided into two groups, natural and theological, according as they spring from the common endo ment of humanity or as special gifts from God. Another way of explaining the difference would be to describe the natural virtues as those which were inculcated in the old pagan world, and the theological as those which are specifically prescribed in Christianity.

The natural virtues are sometimes known as the four cardinal virtues (Lat. *cardo,* "hinge") because on them all lesser attitudes hinge. They are prudence, temperance, fortitude and justice. Their enumeration is said to go back to Socrates and is certainly to be found in Plato and Aristotle. The Christian moralists, such as St. Ambrose, St. Augustine and St. Thomas Aquinas, took over the list as a convenient summary of the teaching of the ancient philosophers and of the highest excellence at which they aimed.

To these four the Christian teachers added the three theological virtues of faith, hope and charity or love. This classification is taken over directly from St. Paul, who in a famous passage (I Cor. xiii, 13) not only distinguished these three as the specifically Christian virtues but singled out love as the chief of the three. Thus in the Christian ethic, benevolence, which is omitted from the list of the pagan philosophers, becomes the ruling standard by which all else is to be judged and to which in the case of a conflict of duties must be yielded the prior claim. (See also FAITH.)

It is to be noted that according to Christian teaching the theological virtues are not originated by the natural man. They are imparted by God through Christ and are then exercised by the believer. (J. W. C. W.)

VIRTUS, a Roman deified abstraction not of Virtue in general but of prowess in battle. She is often associated with Honos, the deified abstraction of Honour. The earliest temple mentioned is one to Honos and Virtus, originally one of Honos alone. to which Marcellus added a shrine of Virtus (222 B.C.). She eventually attained an independent status. and in the empire the Virtus of a particular emperor is often commemorated. Virtus is at times associated with Bellona (*q.v.*). (R. B. LD.)

VIRUNGA or MFUMBIRO. also called Kirunga and Birunga, is a chain of volcanic mountains north of Lake Kivu in east central Africa. Noted for their scenic beauty, they stretch ior 50 mi. in a direction approximately east-west, perpendicular to the general direction of the rift valley in which lie lakes Kivu. Edward and Albert. The eastern cones (also called the Mfumbiro mountains) span the frontier between the Republic of The Congo and Ruanda, and that between Ruanda and Uganda. Many of the volcanoes and lava fields are within the former Albert national park. and are the habitat of the rare mountain gorilla. The Virunga ("smoking mountains") comprise eight great cones more than 10.000 ft. high. These are, from west to east, the Niarnlagira or Nyamuragira (10.056 ft.), Nyiragongo (11,381 ft.). Mikeno (14,437 ft.). Karisimbi (13,763 ft.). Vishoke (12,175 it.), Sabinyo (11,922 ft.), Gahinga (11,397 ft.) and Muhavura or Mfumbiro (13,537 ft.). Only the two western volcanoes are still active. The Nyamuragira is capped by lava and has a caldera at the summit. $1\frac{1}{2}$ mi. in diameter. The main crater of Nyiragongo is $\frac{3}{4}$ mi. across and contains a liquid lava pool. The other volcanoes are extinct. All are eroded, Sabinyo being the most dissected. The crater of Muhavura contains a lake. The highest cone of the chain is the Karisimbi, so called because of its irequent snow cover.

The volcanoes are of shield or Hawaiian type. In Quaternary times they emitted vast quantities of lava rich in alkalis (leucitite. mikenite. etc.). On their slopes and in the lava fields are many small volcanic cones (150–450 ft. in height) which are of Strombolian type. The lavas and the cones of the western volcanoes have blocked the rift valley in this section, thus forming Lake Kivu. To the east, lakes Bulero and Luhondo in the north of Ruanda have the same origin. Eruptions and lava flows in the western region are frequent (11 at least since 1900). Certain flows (in 1038 for example) descended as far as Lake Kivu. One of these barred the Bay of Sake which is now separated from the rest of the lake.

The peaks of Virunga were first seen by a European in 1861, when J. H. Speke obtained a distant view of the cones. which were also seen by H. M. Stanley in 1576. Their fine position was first ascertained by Franz Stuhlmann in 1891. In 1894 Count von Götzen traveled through the region which was subsequently explored by E. S. Grogan, Maj. St. Hill Gibbons. Capt. Herrmann. R. Kandt. Sir Alfred Sharpe (1912) and others, the chief heights being determined in 1903. In 1907–08 the range was geologically examined by the duke of Mecklenberg's expedition. By the Anglo-German agreement oi July 1. 1890, "Mount Mfumbiro" was included in the British sphere in East Africa.

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VIRUSES, once usually referred to as filterable viruses, may be defined as self-reproducing agents smaller than the microscopically visible bacteria. multiplying only within living susceptible cells and responsible or potentially responsible for a wide range of infectious diseases.

There are virus diseases of man. domestic animals, insects. plants and bacteria. as well as an equally wide range of conditions in which viruses are present as virtually harmless minor parasites.

Historical Background. — In one sense, viruses were being scientifically studied well before the development of bacteriology as a science. In experiments on vaccination with cowpox, Edward Jenner used in crude form essentially the same general type of manipulation used in modern studies of viruses. The development of methods of growing bacteria in "pure culture" by Louis Pasteur. Robert Koch and their followers led for a time to the belief that eventually all agents of disease would be isolated and studied by such methods. The first hint that this was not the case was obtained by the Russian bacteriologist D. Ivanovski in 1892. Using the newly developed porcelain filter candles that were shown by Pasteur and C. Chamberland to stop the passage of bacteria. he found that a filtrate of the sap from tobacco plants infected with mosaic disease could be used to transfer infection to healthy plants. This observation was confirmed a few years later by M. W. Beijerinck. the first to recognize the scientific and philosophical importance of the discovery. The further finding in 1902 of F. Löffler and P. Frosch that the agent of foot-and-mouth disease oi cattle was also capable of passing a filter impermeable to bacteria made it clear that these filterable agents were not solely responsible for disease in plants. Finally, in the period 1915–17, F. W. Twort and F. H. d'Hérelle discovered the phenomenon of "bacteriophagia," now known to be caused by the activity of viruses parasitic on bacteria.

By 1930 it was becoming clear that a wide variety of agents would have to be included in the filter-passing group, some of them by no means easy to pass through the standard filter candles. For this and other reasons, the term "filter-passing" or "filterable" was gradually dropped and among inicrobiologists the term "virus" is now universally used without qualification.

After 1930 there was a steady development of new technical methods for the study of the physiochemical and biological properties \\-hich completely changed the outlook of biologists toward the viruses. Probably the most important single advance toward this new approach was W. J. Elford's development of "graded" filter membranes of known pore size. This allowed for the first time an opportunity of assessing the actual size of the particles responsible and so of replacing the vague idea of a *contagium vivum fluidum* with something much more precise. Thereafter all the apparatus of modern physics was brought to bear on the problem, with a rich harvest of results.

On the biological side an equally important advance was made at about the same time. when E. W. Goodpasture showed that the virus of fowl pox could be grown in the tissues of the developing chick embryo. This led to several important practical advances in the control of virus diseases of man and animals. Then in 1949 tissue culture methods long used in half-hearted fashion for the cultivation of viruses were shown by J. F. Enders and colleagues to be suitable for the growth of poliomyelitis viruses. This not only opened the way to immunization against polio. but supplied a method by which dozens of new types of virus were isolated. There is still controversy as to whether viruses represent a real biological group or a mere heterogeneous assemblage of agents with the single common quality of intracellular parasitism. All are agreed: however. that it is convenient to divide them into four major groups: (1) the animal viruses causing disease in man and other vertebrates; (2) the insect viruses; (3) plant viruses; and (4) bacterial viruses or bacteriophages,

Physical and Chemical Properties of Viruses. — The most obvious physical characteristics are size and shape and, particularly since the electron microscope became a practical laboratory tool, these are known for most of the viruses which are susceptible to experimental investigation. The most convenient unit oi length to express their sizes is the millimicron ($m\mu$) which is $\frac{1}{1,000,000}$ mm. ($\frac{1}{25,000,000}$ in.). On this scale the largest viruses, those of the psittacosis group, are about 300 $m\mu$ in diameter. while the smallest viruses responsible for disease in animals (foot-and-mouth disease virus') have a diameter of about 20 $m\mu$. There is a continuous range of size between these extremes.

Electron microscope pictures of animal viruses show considerable variations in structure, but in shape they are nearly all spherical or ovoid. Influenza viruses. honever. frequently appear in an alternative filamentous form, the threads being about 80 $m\mu$ in diameter and 100–200 times as long. The best-known plant virus. that of tobacco mosaic, is seen as slender rods 1; $m\mu$ by 300 $m\mu$.

Bacterial viruses show a considerable range of size, but all show a rounded or polygonal head and a tail usually several times the diameter of the head in length, but in a few forms very short.

Chemical studies of viruses have made rapid progress since 1946. It is known that the rods of tobacco mosaic virus are built up of a central core of nucleic acid, around which is a sheath of protein molecules, which seem to be related to one another in the form of a flat spiral. The nucleic acid is of the type containing ribose as its sugar component (RNA). There are regularities in such a structure that make it legitimate to speak of the virus rods as macromolecules. The small spherical plant viruses also appear to be built up of a nucleic acid core with an outer shell of protein.

A typical bacterial virus. the bacteriophage T_2 for example, is a highly organized structure composed of nucleic acid, in this case of deoxyribose (DNA) type surrounded by a sheath of protein. The DNA is concentrated in the head, but there is probably a core of nucleic acid running down the length of the tail. At the tip of the tail is a region of different protein adapted to make specific union with the surface of the host bacterium.

Influenza virus is a more complex but less highly organized unit than either the plant virus or the bacteriophage. It contains a relatively small amount of nucleic acid (RNA only) protein. a considerable proportion. 30%, of fatty material and complex carbohydrate. A variety of evidence suggests that much of the substance of the virus particle is almost unmodified material from the host cell. It is probable that the surface is largely composed of virus protein. carrying the specific qualities of the virus as manifested by its power to attach itself to susceptible cells and by its immune reactions.

Other animal viruses differ considerably in composition, vaccinia virus, for instance, containing nucleic acid of DNA type concentrated in a central nucleus. The small viruses. of which polio virus is typical. appear to be composed of protein and nucleic acid (RNA) only.

Biological Properties. — Most biologists would agree that in general all typical viruses behave like micro-organisms and that where the practical problems of control are involved, they must be handled in the same iashion as larger parasitic micro-organisms. There are three inter-related characteristics of living organisms which can be expressed only in the biological terms reproduction. variation and selective survival. Every type of virus that has been studied exemplifies these characteristics modified by the special circumstances of its existence.

There is much more controversy, however. about the evolutionary origin of viruses. Probably a majority would consider that the animal viruses have evolved by parasitic degeneration from larger forms; hut in a more sophisticated form the old speculation is reappearing that some viruses at least represent part of the genetic mechanism of the host species that has become freed from normal control. There are now many instances where an apparently normal plant or bacterium can be shown to carry a virus indefinitely. The multiplication of the virus keeps pace with the multiplication of host cells in so precise a fashion that some form of mutual co-ordination must be postulated. It may well be that viruses have arisen in many different ways and that the qualities that bring them under the definition must not he regarded as signifying that they have a common origin.

In 19jj the main academic interest in viruses was concentrated on the means by which they multiply in the infected cell. Again the iorms that had been most intensively studied as representatives of plant, bacterial and animal viruses were tobacco mosaic virus. the bacterial virus T_2 and influenza virus A. In all three it was evident that the nucleic acid. RNA in tobacco mosaic and influenza viruses. DNA in the bacteriophage. played a key role. There was almost unanimity that the nucleic acid carried the genetic "code" by which subsequent multiplication of the virus was controlled but most workers felt that until more was known of the mechanism of protein synthesis in general. little could be said about the chemical mechanisms by which viruses multiplied.

At a less fundamental level the situation was best known in the bacterial viruses. Here the process in outline is as follows. The virus attaches by the tip of the tail to certain chemical groupings on the bacterial surface. When contact has been completed. a series of reactions is initiated by which the D S A content of the virus particle is as it were injected into the bacterium. The sheath is left temporarily attached to the surface of the bacterium and has no further function. Once the virus D S A enters the cell it appears to take control of the metabolic processes. turning them to the synthesis of components of the virus. After about 12 min. under standnrd conditions, the first of the new brood of virus has made its appearance inside the cell and at 2j min. the bacterium bursts, liberating around 200 new virus particles. The essential features are the disappearance of virus as such as soon as infection is initiated (the eclipse phase) and the production of virus components before any new infectious virus is produced.

In animal viruses a somewhat similar process takes place. An eclipse phase is usually recognizable and in a number of instances, components or incomplete virus particles may be detected before any new complete virus is produced. Animal viruses differ from bacterial viruses in being liberated progressively from the infected cell instead of in a single explosive burst.

In general, the natural history of a virus is determined by the fundamental requirement that multiplication can take place only within the living cells of a susceptible host. For a virus species to survive there must be (1) a means by which virus units can reach susceptible cells; (2) multiplication within these cells; and (3) liberation of virus into the environment. The details of the means by which these requirements are fulfilled naturally vary widely from one virus to another. During an influenza epidemic. spread occurs directly from infected to uninfected persons by transfer of air-borne droplets. Multiplication occurs in the cells lining the air passages and reliberation into the environment is almost automatic. Polio virus is liberated in the intestine and its spread among children probably depends mainly on minor faecal contamination particularly of fingers. Yellow fever (*q.v.*) is spread in totally different fashion by the bite of certain mosquitos, especially *Aedes aegypti*. The virus passes in the blood to the liver and other susceptible tissues and, after multiplication, is reliberated into the blood. where it is available to infect fresh mosquitos. Inside the mosquito, multiplication in the insect's cells is necessary before the virus passes to the salivary glands. making the mosquito infectious for its next victim. Yellow fever persists in tropical America and Africa essentially because of the existence of a reservoir of infection in jungle monkeys. Examples could be multiplied indefinitely, but simple herpes of the lips may be taken as a final one. The virus of this trivial disease normally produces initial infection in children between one year and three years of age. giving rise to a vesicular affection of the mouth and lips of varying severity. The infection is apparently overcome within a week or two. but once it has been experienced the virus persists in the local tissues probably for life. Under various stimuli. particularly fever, it is activated, producing the well-known cold blister or cold sore on the lips: from the contents of these, virus is set frer and is available again for the infection of young children.

In the laboratory, viruses can produce a relatively wide range of mutant strains (with an inheritable variation in one or other property) and mutation is probably important in determining changes in the virulence of certain virus diseases over the years. The influenza viruses have been found to be undergoing continual change in their antigenic pattern in the 22 years since they were first isolated. The extreme virulence of influenza in the years 1918–19 was presumably due to the appearance at that time of a mutant or series of mutants.

Recently it has been shown that recombination of genetic characters can be demonstrated in a number of virus types. With bacterial viruses and influenza viruses double infections with two related but distinct strains can give rise to progeny showing some of the characters of each parent.

When a virus responsible for human disease has to be handled in the laboratory. it is usually necessary to adapt it to some convenient "host?"often to some type of tissue culture or to the chick embryo. By the time the virus has developed a high virulence for the new host it has often lost much of its virulence for its natural host. Such *attenuated* strains will often retain the power to immunize a man or animal against the natural disease and there are many practical applications in which these modified viruses are used as "living virus vaccines."

Human Virus Diseases.—The contribution of virus diseases to human misfortune is a large one. If one includes for practical purposes the diseases caused by rickettsiae the more important diseases may be arranged as follows:

1. Major epidemic diseases: smallpox. yellow fever and typhus.
2. The common specific infectious diseases: measles, German measles (rubella), mumps, chickenpox (with its variant form herpes zoster or shingles). infantile paralysis and, in tropical and subtropical countries. dengue.
3. Common minor infections: colds. influenza A and B and probably other mild or moderately severe respiratory infections such as atypical pneumonia and simple herpes.
4. Rarer infections. mostly derived from animals: rabies. psittacosis, several forms of encephalitis. Q fever and a variety of types of rickettsial diseases transmitted by fleas, ticks or mites, trachoma. the venereal disease lymphogranuloma and a number of less important diseases.

Two important new methods for the isolation of viruses responsible for human disease were developed after World War II, injection into new born mice and the use of tissue cultures of human or monkey cells. Both uncovered an unexpectedly large range of viruses. most of which produce only trivial or unrecognizable illness. The human intestine and the human respiratory tract are now known to harbour on occasion viruses almost as diverse as their bacterial inhabitants.

Although the agent or agents responsible for the common cold had not been effectively isolated by 1955 knowledge of the feverish colds and similar infections had been greatly advanced by the isolation and study of a group of interrelated viruses that produce characteristic effects in tissue cultures of human cells. The viruses of measles. chickenpox and probably rubella had also been cultivated in similar fashion.

Artificial Immunization Against Virus Diseases.—It has been common knowledge for centuries that second attacks of smallpox or measles are virtually unknown. These are typical virus diseases and there are many others which are also followed by a long lasting immunity. Since the days of Edward Jenner. attempts had been made to find a safe means of producing a similar effective immunity against the important infectious diseases. Jenner used cowpox virus (vaccinia) to protect against what is now known to be a closely related disease (smallpox) and his name for the process of artificial infection. vaccination. has come into general use for all processes of this type. A basically similar use of an attenuated living virus is seen in vaccination against yellow fever, developed about 1937 by Max Theiler and H. K. Smith in the Rockefeller Foundation laboratories. An injection of the vaccine provokes what is essentially a symptomless attack of yellow fever with subsequent immunity lasting several years.

A second method of artificial immunization depends on the use of killed vaccines in which the virus is grown in some suitable fashion, usually in chick embryos or in tissue culture. and then killed with formalin, ultraviolet light or some other agent. Such vaccines have been used successfully against typhus fever. and influenza. The most recent example of this type is the Salk vaccine against poliomyelitis (*see* below).

Virus diseases of domestic animals are common and of great economic importance. In recent years there has been great activity in the production of protective vaccines against animal virus diseases, the same principles being applicable as in human preventive medicine. Living virus vaccines were being extensively used in 1955 against the following diseases: rinderpest in cattle. swine fever (hog cholera), rabies and distemper of dogs. fowlpox, infectious laryngotracheitis and Newcastle disease of fowls. Killed vaccines against rabies and distemper were also in use.

Poliomyelitis and the Salk Vaccine.—By 1950 polio was almost the only infectious disease which had resisted preventive and curative measures. The discovery at this time by J. F. Enders and his group at Boston that polio viruses could be cultivated in tissues other than those of the nervous system, was immediately recognized as opening an important approach to prevention by immunization. It was clear from the epidemic behaviour of poliomyelitis that natural immunization by non-paralytic infection in childhood was extremely common and that an adequate method for imitating this process safely would almost certainly prevent polio. There were two possible ways of exploiting Enders' discovery. Virus could be grown in tissue culture, killed with formalin and injected under the skin as a killed vaccine; or an attenuated nonvirulent strain might be developed which could be administered by the natural method and produce a harmless but immunizing infection. To become practical methods in public health, both would of course need years of technical development. The first to reach that stage was the Salk vaccine (see INFANTILE PARALYSIS: The *Salk Vaccine*). first tested on a large scale during 1954 in the United States. The Salk vaccine is essentially a suspension of dead virus particles from the three antigenic types of polio. Briefly, each type of virus is grown on tissue culture till the largest possible amount of virus has been produced. The cells and tissue debris are removed by filtration and the virus killed by carefully controlled treatment with formalin. On the whole the development of the vaccine proceeded smoothly and the test in 1954 indicated that the Salk vaccine was "safe and effective." Comparison of vaccinated children with statistically adequate control groups of unvaccinated children showed that a protection of about 90% effectiveness could be expected against infection by types 2 and 3 virus. The protection against the most important variety of polio (type 1) was less complete, but there was evidence that the most technically satisfactory batches of vaccine were able to protect against type 1 to a much higher level than that given as an average for all the vaccines used. The vaccine was released for general use in April 1955. A serious setback was experienced by the occurence of some 40 cases of paralysis in inoculated children, which could be ascribed with reasonable certainty to the presence of living virus in some batches of vaccine. Requirements for testing vaccine before issue were immediately tightened and no further episodes of this type were reported. A considerable body of opinion regarded it as dangerous to use a highly virulent type 1 strain for the production of a killed vaccine and believed that this should be replaced by a less virulent strain. The vaccine would then have a "built-in" safety factor, which would make a disaster like that of early 1955 impossible, even if an unforeseeable accident occurred. During 1955–56 both the United Kingdom and Denmark developed vaccines of the Salk type in which less potentially dangerous type 1 strains were used.

Despite the considerable success of the Salk vaccine in the United States. it was by no means certain that it would remain the standard approach to the prevention of polio. There were good reasons for believing that use of non-paralytic strains of living virus would provide a more firmly based immunity. Unfortunately no one had yet solved the problem of testing the efficacy and safety of allegedly non-paralytic virus strains without exposing children to danger of paralysis. New technical methods might need to be discovered before it would be possible to exploit the theoretical advantages of a living vaccine against polio.

Plant Viruses.—Virus diseases of plants are widespread, many of them of great economic importance. It is hardly too much to say that the whole organization of the potato industry is conditioned by the necessity for minimizing virus diseases. For more than a century it has been known that if a farmer in England continued to use his own seed potatoes for successive crops, degeneration progressed gradually until the great majority of the plants were malformed and stunted. If. however. new seed was obtained every second or third year from certain Scottish regions, satisfactory crops resulted. Research showed that degeneration results from the accumulation of virus diseases, transmitted by aphides either from other potato plants or from associated plants of other species. In every potato-growing country, it is necessary to find areas for seed production where, because of climatic or other conditions. aphides are absent or ineffective in transmitting disease. Other important economic diseases of the group are spotted wilt of tomato. tobacco mosaic, leaf-crinkle of cotton in the Sudan and swollen shoot disease of cocoa.

Prevention of plant virus disease is based (a) on the development of resistant varieties and (b) on preventing infection. usually by an attack on the insects responsible for carriage of the virus. Different varieties of a given plant species often show sharp differences in their response to virus infection and it may be possible to breed resistant strains which maintain the economically valuable characters of the species. There is nothing in plants to correspond to immunity in animals. Laboratory experiments have shown that in some instances it is possible to protect a plant against severe virus disease by inducting a continuing infection with a mild strain of the same virus, but the principle has no practical application.

The most important approach to prevention depends on the fact that a large proportion of plant viruses are spread from infected to healthy plants by insects. Infection of cultivated plants can be prevented either by eliminating the plants that provide the source of infection, or by destroying the insect vectors. There are many instances where weeds or garden flowers have been shown to be carriers of a virus harmful to crop plants. In Australia, for instance: dahlias are important carriers of tomato spotted-wilt virus. Removal of such carrier plants from the vicinity of the crop may prevent the introduction of disease. Destruction of the insect transporter will of course serve equally effectively and, with the development of modern insecticides, this is becoming a more practical and effective procedure.

Bacterial Viruses (Bacteriophages).—Virus infection is extremely common among bacteria. Careful study will show that a large proportion of laboratory strains of intestinal bacteria and staphylococci carry low-grade viruses (first called by D'Hérelle "bacteriophages") which as a rule cause little visible effect. If a filtrate from sewage is mixed with a pure culture of a suitable dysentery bacillus. it is common to find that the bacterial viruses present will multiply actively at the expense of the dysentery bacilli. The initial turbid culture after a few hours becomes transparent and under the microscope the bacilli have vanished. In plate cultures of bacteria. virus action is shown by the appearance of clear areas (plaques). each of which really represents a localized "epidemic" of fatal disease.

Early hopes that bacterial infections might be cut short by the action of appropriate bacterial viruses have not been fulfilled and little research on such possibilities has been done since 1940. The bacterial viruses, however, are of particular interest to biologists on account of the technical facility with which their activities can be studied. Between 1945 and 1955 extensive investigations using all the newer physical and chemical techniques resulted in the acquisition of more detailed knowledge of the functioning of a bacterial virus than of any other biological unit.

The Relation of Viruses to Cancer. — Few pathologists doubt that eventually it will be found that malignant disease is based on some disorganization of cellular processes that is of the same general quality as that produced by certain viruses. Fewer still would venture to offer any specific estimate as to the part played by viruses in the causation of human cancer (*see* CANCER RESEARCH).

Viruses (or agents which in most essentials resemble independent viruses) can be obtained almost with regularity from many types of malignant tumour in domestic fowls. A virus of rabbits produces skin growths which when irritated by tar rapidly develop into true cancers. Mice of certain strains prone to mammary cancer secrete in their milk a viruslike agent which can confer the tendency to develop mammary cancer on suckling mice which would not otherwise become cancerous. These are the main experimentally verified facts which bear on the problem. None has any direct application to human conditions.

Ever since viruses were recognized as agents of disease, there has been speculation as to whether components of cells might not, under certain circumstances, take on anarchic activity free from the normal intracellular control. Nuclear genes or, later, plasmagenes were suggested as self-multiplying units within the cell which might take on such pathological activity. Once freed from control, such units would have all the characteristics of viruses. It is along such lines that most speculations about virus-cancer interrelationship have traveled.

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VIS: *see* LISSA

VISAKHA, Buddhist laywoman whom Buddha called "chief of almsgivers." a distinction she shared with Anathapindika, a layman. She was disciple, friend and adviser of Buddha and the orders, and a loyal mother of the new creed. Visakha, the daughter and granddaughter of merchants of vast wealth in Bhaddiya, was directly converted by Buddha in her youth. Following her marriage at 16 to a son of the rich Migara .in Savatthi, she devoted her life and wealth to helping the Buddhist orders. Buddha granted her request for permission to bestow eight kinds of permanent alms: to provide robes for the rainy season. food for the incoming monks, for the departing monks, for the sick and their attendants, a supply of medicine, a permanent supply of gruel and bathing dresses for the almswomen, who were not to bathe nude.

Visakha, as well as Mahapajapati, was held to have reliable powers of discretion, and was equally familiar with the Dhamma. A conversation between Buddha and Visakha has survived in the *Anguttara-nikaya* as a talk to laywomen. The monastery that Visakha built in the Pubbarama was used as a retreat by Buddha after he settled permanently at Savatthi.

VISAYAN ISLANDS, the central group of seven large and several hundred small islands of the Philippines. Northernmost. the three small islands Tablas. Romblon and Sibuyan form the province of Romblon. Then, southward. come the islands of Panay with four provinces and Negros with two provinces. Eastward, are the island provinces of Cebu, Kohol. Masbate. Leyte and Samar. Pop. (1958 est.) 8.096.000; area about 22.000 sq.mi. Negros, Panay and the Romblon group sometimes are referred to as the Western Visayas, the others comprising the Eastern Visayas. Visayans all speak related dialects of the Visayan language. *See* also PHILIPPINES. REPUBLIC OF THE. (J. E. SR.)

VISBY, the capital of the Swedish island and administrative district (lan) of Gotland. in the Baltic sea. Pop. (1950) 14.740. The name Visby is derived from the old Norse ***ve*** ("sanctuary") and ***by*** ("town"). It was no doubt a place of religious sacrifice in heathen times. At any rate. it was a notable trading place and emporium as early as the end of the Stone Age, and long continued to enjoy its importance as such, as is proved by the large number of Arabic, Anglo-Saxon and other coins found.

In medieval times Visby was the centre of trade between Asia. Russia and Europe and grew to great wealth and power. It made its own maritime laws and coined its own money. The city was besieged in 1361 by King Valdemar IV of Denmark. who won it in a fierce battle. The defeated people of Gotland buried their warriors in one common grave. on which they placed a cross. This grave was opened by archaeologists shortly before World War II, and it revealed many articles of medieval warfare and art objects.

Visby is the seat of a bishop. the port of the island and a favourite resort. It is picturesquely situated on the west coast, 150 mi. S. by E. of Stockholm by sea. The houses cluster beneath and above a cliff (klint) 100 ft. high, and the town is thoroughly medieval in appearance. The remains from its period of extraordinary prosperity from the 11th to the 14th centuries are of the highest interest. Its walls date from the end of the 13th century, replacing earlier fortifications, arid enclose a space much larger than that now covered by the town.

Massive towers rise at close intervals along them, about 40 are in good preservation. Between them are traces of bartizans. The Cathedral Church of St. Mary dates from 1190–1225, hut was much altered in later times; it has a great square tower at the west end and two graceful octagonal towers at the east, and contains numerous memorials of the 17th century. There are ten other churches, in part ruin d. Among those of chief interest St. Nicholas', of the early part of the 13th century, formerly belonged to a Dominican monastery. It retains two beautiful rose windows in the west front. The Church of the Holy Ghost *(Helgeands-Kyrka)* in a late Komanesque style (*c.* 1250) is a remarkable structure with a nave of two stories. The

Romanesque St. Clement's has an ornate south portal, and the churches of St. Drotten and St. Lars, of the 12th century, are notable for their huge towers. St. Catherine's, of the middle of the 13th century, is Gothic, with a pentagonal apse. Galgberget, the place of execution, has tall stone pillars; and there is a stone labyrinth at Tröjeborg. Modern buildings include the Gotland Museum of Antiquities. The artificial harbour, somewhat exposed, lies south of the ancient Hanseatic harbour, now filled up.

See GOTLAND and MARITIME LAW.

VISCACHA (BISCACHA, VIZCACHA), a large South American burrowing rodent belonging to the family Chinchillidae. The viscacha (*Lagostomus*) is 20 in. long over-all, with an 8-in. tail; it is heavy set, with short ears and a massive head. The fur is short and soft, dark gray in colour, with black and white markings on the face. Viscachas inhabit the South American pampas between the Uruguay river and the Río Negro in Patagonia, where they dwell in warrens (*viscacheras*) covering from 100 to 200 sq.ft. and forming mounds penetrated by numerous burrows.

The ground around the *viscachera* is cleared from vegetation, the refuse of which is heaped upon the mound. Anything the rodents meet on their journeys, such as thistle stalks or bones, is deposited on the *viscachera*. In frequented districts the viscachas seldom emerge till evening. Their chief food is grass and seeds, but they also consume roots. The mountain viscachas, *Lagidium*, are built like the chinchillas, but have rabbitlike ears and yellowish-gray fur; they emerge in the day.

See RODENTIA. (J. E. HL.)

VISCHER, the name of a family of sculptors working in Nürnberg during the last half of the 15th and the first half of the 16th centuries.

1. HERMANN, the elder, was probably of north German origin but acquired citizenship in Nürnberg in 1453. A baptismal font in the Stadtkirche of Wittenberg (1457) is signed by him. He died in Jan. 1488.

2. His son, PETER, the elder, was born about 1460 in Niirnberg, where he died on Jan. 7, 1529. In 1494 he entered the service of Philip, the elector palatine, at Heidelberg but soon returned to Nürnberg, where he worked with the help of four of his sons, Hermann, Peter, Hans and Paul.

His principal works are the tomb of Archbishop Ernest in the cathedral of Magdeburg (1494–95); the tomb of Bishop John IV in the cathedral of Breslau (1496, signed); the shrine of St. Sebald in the Sebalduskirche at Niirnberg (between 1508 and 1519); a large grille ordered by the Fugger brothers in Augsburg. This last was not finished, and most of it was sold for metal in 1806, but four reliefs belonging to it are in the château of Montrottier near Annecy. The tombstone (1521) for Margareta Tucherin in the cathedral at Ratisbon (Regensburg) and that for Cardinal Albrecht of Brandenburg in the collegiate church at Aschaffenburg (1525) have been ascribed to Hans Vischer; that of the Eisen family in the Agidienkirche in Nürnberg to his brother Paul; and that of the electoral prince Frederick the Wise to Peter Vischer, the younger.

The style of Peter, the elder, is essentially Gothic but at the same time not without some Italian influence in detail. His is a case somewhat analogous to that of the painter Jacopo de Barbari, his contemporary.

The shrine of St. Sebald, his most remarkable work, is a tall canopied, bronze structure, lavishly decorated with reliefs and statuettes. Some of the statuettes of saints attached to the slender columns of the canopy are modeled with much grace and even dignity of form. A small portrait figure of Peter himself, introduced at one end of the base, is a marvel of clever realism: he represented himself as a stout, bearded man, wearing a large leathern apron and holding some of the tools of his craft. This shrine is a remarkable example of the uncommercial spirit which animated the artists of that time, and of the evident delight which they took in their work. Dragons, grotesques and little figures of boys, mixed with graceful scroll foliage, crowd every possible part of the canopy and its shafts, designed in the most free and unconventional way and executed with an utter disregard of the time and labour that were lavished on them. (A. K. McC.)

VISCHER, FRIEDRICH THEODOR (1807–1887), German writer and professor, whose Hegelian theories of aesthetics had great influence, was born at Ludwigsburg, June 30, 1807. After studying at Tübingen, he became a lecturer there in 1835 and was made professor in 1844 but was suspended for two years as a result of a characteristically outspoken inaugural address. During this time he began *Ästhetik oder Wissenschaft des Schönen,* finally completed in six volumes (1846–58), his most considerable work as philosopher and critic, which revealed industry and erudition rather than originality but contained much valuable material. In 1855 he became professor at Zürich but returned to Germany in 1866 and was again made professor at Tübingen. This was combined with a post at the Stuttgart polytechnic, which continued after the termination of his professorship in 1869. He died at Gmunden, Aus., Sept. 14, 1887.

As well as writings on aesthetics, and critical essays collected in *Kritische Gänge* (1844) and *Altes und Neues* (1881), Vischer wrote a popular novel, *Auch Einer* (1879; Eng. trans., *The Humour of Germany,* 1892), a satirical tragicomedy which reveals robust humour and interest in philosophy; a critical study of Goethe's *Faust* (1875); a parody of *Faust,* under the pseudonym Mystifizinski; and many poems.

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VISCONTI, the name of a celebrated Italian family which long ruled Milan; members of the family claimed descent from King Desiderius, and in the 11th century possessed estates on Lakes Como and Maggiore.

A certain OTTONE, who distinguished himself in the First Crusade, is mentioned in 1078 as viscount of Milan. The real basis for the family's dominion was laid, however, by another OTTONE (d. 1295), a canon of Desio, appointed archbishop of Milan by Pope Urban IV in 1362 through the influence of Cardinal Ubaldini. The Della Torre family, who then controlled the city, opposed the appointment, and not until his victory at Desio in 1277 was Ottone able to take possession of his see. He imprisoned Napoleone Della Torre and five of his relatives.

His nephew, MATTEO, born at Invorio on Aug. 15, 1255, succeeded him as political leader of Milan, and although an uprising of the Della Torre in 1302 compelled him to take refuge at Verona, the emperor Henry VII, restored him to Milan in 1310 and made him imperial vicar of Lombardy. He brought under his rule Piacenza, Tortona, Pavia, Bergamo, Vercelli, Cremona and Alessandria.

An able general, he yet relied for his conquests more on diplomacy and bribery, and was esteemed as a model of the prudent Italian despot. Persevering in his Ghibelline policy, and quarrelling with Pope John XXII over an appointment to the archbishopric of Milan, he was excommunicated by the papal legate Bertrand du Puy in 1322. He at once abdicated in favour of his son Galeazzo, and died at Crescenzago on June 24.

GALEAZZO I (1277–1328), who ruled at Milan from 1322 to 1328, defeated the Holy Army which the pope had sent against the Visconti at Vaprio on the Adda (1324), with the aid of the emperor Louis the Bavarian. In 1327 he was imprisoned for a short time by the emperor at Monza because he was thought guilty of making peace with the church. By his wife Beatrice d'Este he had the son Azzo who succeeded him. His brother MARCO commanded a band of Germans, conquered Pisa and Lucca and died in 1329.

AZZO (1302–1339), who succeeded his father in 1328, bought the title of imperial vicar for 25,000 florins from the same Louis who had imprisoned Galeazzo I. He conquered ten towns, murdered his uncle Marco (1329), suppressed a revolt led by his cousin Lodrisio, reorganized the administration of his estates, built the octagonal tower of S. Gottardo, and was succeeded in turn by his uncles Lucchino and Giovanni. LUCCHINO made peace with the church in 1341, bought Parma from Obizzo d'Este and made Pisa dependent on Milan. He was poisoned in 1349 by his wife Isabella Fieschi.

GIOVANNI, brother of the preceding, archbishop of Milan and lord of the city from 1349 to 1354, was one of the most notable characters of his time. He befriended Petrarch, extended the Visconti sway over Bologna (1350), defied Pope Clement VI., annexed Genoa (1353), and died on Oct. 5, 1354, after having established the rule of his family over the whole of northern Italy except Piedmont, Verona, Mantua, Ferrara and Venice. The Visconti from the time of Archbishop Giovanni were no longer mere rivals of the Della Torre or dependants on imperial caprice, but real sovereigns with a recognized power over Milan and the surrounding territory. The State was partitioned on the death of Giovanni among his brother Stefano's three sons, Matteo II., Galeazzo II. and Bernabb. MATTEO II., who succeeded to Bologna, Lodi, Piacenza and Parma, abandoned himself to the most revolting immorality, and was assassinated in 13jj by direction of his brothers, who thenceforth governed the State jointly and with considerable ability. GALEAZZO II., who held his court at Pavia, was the patron of Petrarch, the founder of the University of Pavia, and a gifted diplomat. He married his daughter Violante to the duke of Clarence, son of Edward III. of England, giving a dowry of 200.000 gold florins; and his son Gian Galeazzo to Isabella, daughter of King John of France. He died in 1378. BERNABÒ, who held his court at Milan, was involved in constant warfare, to defray the expenses of which he instituted very oppressive taxes. He fought Popes Innocent VI. and Urban V., who proclaimed a crusade against him, and the emperor Charles IV., who declared the forfeiture of his fief. He endeavoured to exercise sole power in the State after the death of his brother, but his young nephew Gian Galeazzo put him to death (1385).

GIAN GALEAZZO, the most powerful of the Visconti, became joint ruler of the Milanese territories on the death of his father in 1378 and sole ruler on the death of his uncle seven years later. He founded the cathedral of Milan, built the Certosa and the bridge across the Ticino at Pavia, improved the University of Pavia and established the library there, and restored the university at Piacenza. He was an able and economical administrator, and was reputed to be one of the wealthiest princes of his time. Ambitious to reduce all Italy under the sway of the Visconti, he conquered Verona in 1387; and in the following year, with the aid of the Venetians, took Padua. He plotted successfully against the rulers of Mantua and Ferrara, and finally turned his attention to Tuscany. In 1399 he bought Pisa and seized Siena. The emperor Wenceslaus had already conferred on him the title of duke of Milan for 100,000 florins, reserving only Pisa, and refused to take arms against him. Gian Galeazzo took Perugia, Lucca and Bologna (1400–01), and was besieging Florence when he died of the plague (Sept. 3, 1402). His sons, Giovanni Maria and Filippo Maria, were mere boys at the time of his death, and were taken under the protection of the celebrated condottiere Facino Cane de Cesale; but most of Gian Galeazzo's conquests were lost.

GIOVANNI MARIA was proclaimed duke of Milan in 1402, displayed an insane cruelty, and was killed in 1412 by Ghibelline partisans. FILIPPO MARIA, who became nominal ruler of Pavia in 1402, succeeded his brother as duke of Milan. Cruel and extremely sensitive about his personal ugliness, he nevertheless was a great politician, and, by employing powerful condottieri, managed to recover the Lombard portion of his father's duchy. From his marriage with the unhappy widow of the above-mentioned Facino Cane he received a dowry of nearly half a million florins. He died in 1447, the last of the Visconti in direct male line, and was succeeded in the duchy, after the shortlived Ambrosian republic, by Francesco Sforza, who had married his daughter Bianca in 1441. (See SFORZA.)

BIBLIOGRAPHY.—A contemporary history of the principal members of the family by Paolo Giovio, bishop of Nocera, was published in several editions. *See* J. Burckhardt, *The Civilization of the Renaissance in Italy,* trans. *by* S. G. C. Middlemore (London, 1898); J. A. Symonds, *Age* of *the Despots* (New York, 1888); C. Magenta, *I Visconti e gli Sfovsa nel Castello di Pavia* (1883); A. Medin, *I Visconti nella poesia contentporanea* (Milan, 1891); F. Mupnier, "Lettres des Visconti de Milan" in *Mémoires et documents de la société savoisienne d'histoire et d'archéologie,* vol. x of the 2nd series (1896).

VISCONTI-VENOSTA, EMILIO, MARQUIS (1829–1914), Italian statesman. was born at Milan on Jan. 22, 1829. At first a disciple of Mazzini, he was later disillusioned by the ineffectual rising at Milan against the Austrians in 1853. Continuing. nevertheless. his anti-Austrian propaganda, he was obliged in 1859 to escape to Turin, and during the war with Austria of that year was appointed by Cavour royal commissioner with the Garibaldian forces. Elected deputy in 1860, he was sent on diplomatic missions to Modena and Naples. He was subsequently appointed undersecretary of state by Count Pasolini. Upon the latter's death he became minister of foreign affairs (March 24. 1863) in the Minghetti cabinet, in which capacity he negotiated the September convention for the evacuation of Rome by the French troops. Resigning office with Minghetti in the autumn of 1864, he was in March 1866 sent by La Marmora as minister to Constantinople. but was almost immediately recalled and reappointed foreign minister in a short-lived Ricasoli cabinet.

Out of office for two more years, he was again foreign minister under Lanza and Minghetti, 1869–76. During this long period he n-as called upon to conduct negotiations connected with the Franco-German War, the occupation of Rome and the consequent destruction of the temporal power of the pope. In 1894, after 18 years' absence from active political life, he was chosen Italian arbitrator in the Bering sea question, and in 1896 once more became foreign minister in the Rudini cabinet after the disastrous military defeat in Abyssinia. His first care was to improve Franco-Italian relations by recognizing the French position in Tunis. Over the Cretan question and the Graeco-Turkish War, he secured for Italy a worthy part in the European concert, and joined Lord Salisbury in saving Greece from the loss of Thessaly. Resigning office in May 1898, on a question of internal policy, he again assumed the management of foreign affairs in the second Pelloux cabinet in May 1899, and continued in the succeeding Saracco cabinet until its fall in Feb. 1901. During this period his attention was devoted chiefly to the Chinese problem and to the maintenance of equilibrium in the Mediterranean and in the Adriatic. For instance, he established an Italo-French agreement, by which France undertook to leave Italy a free hand in Tripoli. and Italy not to interfere with French policy in the interior of Morocco. In Feb. 1906 he was Italian delegate to the Morocco conference at Algeciras. Prudence and sagacity, coupled with unequaled experience of foreign policy, enabled him to assure to Italy its full portion of influence in international affairs.

Ser Giovanni Visconti-Venosta, *Ricordi di Gioventù* (Milan, 1904); F. Cataluccio, *La Politica estera di E. Visconti-Venosta* (Marzocco, 1940).

VISCOSE RAYON: The process of making rayon from a viscose solution of cellulose was introduced commercially in 1905. It is the most widely used method. For particulars of the process see SYNTHETIC FIBRES.

VISCOSITY. When a fluid, which may be a liquid or a gas, is set in motion by any system of forces and then left to itself, it comes to rest by virtue of an internal friction. which tends to resist the sliding of one part of the fluid over another. This internal friction is known as viscosity. If a state of steady motion is maintained by any system of forces the viscosity of the fluid tends to oppose the motion and leads to the dissipation of energy as heat, just as does the friction between solid bodies.

The Coefficient of Viscosity.—The first stage in the study of any process in the physical sciences is to define a quantity which shall give a numerical measure of the property in question, which in this case is the resistance offered by a fluid to one layer sliding over another. Consider the movement of a fluid. for definiteness a liquid, between two parallel plates A and B (see fig. 1), at distance d apart, A being at rest while B is kept moving with a constant velocity v, which is communicated to the liquid in contact with it. With normal fluids the velocity of any given layer will be proportional to the distance from B, as indicated by the length of the arrows. and we speak of a velocity gradient v/d, which is the rate of change of the shear strain. A force, which is propor-

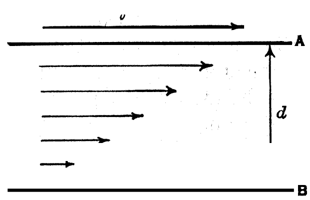


FIG 1 — SIMPLEST REPRESENTATION OF LAMINAR FLOW tional to the area of the plates, will be required to keep A in steady motion and with normal liquids this force is proportional to the velocity gradient. For a class of liquids known as lyophilic suspensions, which includes such substances as gelatin solutions. this proportionality to velocity gradient does not, in general, hold. Further, there are liquids, such as paints, whose flow properties depend upon their recent mechanical history, for instance! upon the time interval since they were stirred.

Normal liquids, such as water, alcohol and benzene, for which the shearing force is proportional to the velocity gradient, are known as Newtonian liquids, because Newton, in considering the behaviour of the imaginary fluid that? on the Cartesian world system, filled all space, assumed that it would have this property. He never considered the viscous properties of real liquids. The viscous behaviour of all gases is Newtonian. The exceptional liquids are called non-Newtonian. The flow of solids. in particular of metals, considered in the second part of this article. is. in general, non-Newtonian.

The constant that characterizes viscosity, known as the coefficient of viscosity. is defined as the shear stress—shearing force per unit area—which exists between parallel planes (as in fig. 1) when the velocity gradient is unity. It is thus a force divided by an area and by a velocity gradient, which gives it dimeniion $ML^{-1}T^{-1}$ (*see* DIMENSIONAL ANALYSIS). The unit of viscosity. when the centimetre-gram-second (c.g.s.) system is used. is called the poise. in honour of J. L. M. Poiseuille (*see* below). For such easily flowing liquids as mater this is rather a large unit, so a hundredth of it, called the centipoise. is often used. To give some notion of the significance of the unit, the viscosity of the very viscous fluid glycerin is about 1j poise (1.500 centipoise). of castor oil about 10 poise. of olive oil a little less than 1 poise, of water about 1 centipoise, of air 0.018 centipoise, all at 20° C. In the accompanying table are given the viscosities of some other well-known liquids.

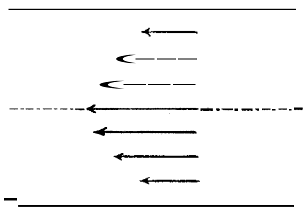


FIG. 2.— DISTRIBUTION OF VELOCITIES IN A TUBE OF CIRCULAR CROSS SECTION

TABLE.—*Viscosities of Pure Liquids in Centipoises at 20° C., Unless Otherwise Stated*

Water at 0°	1.7921	Ethyl alcohol	1.200
Water at 10°	1.3077	Carbon tetrachloride	0.969
Water at 20°	1.0050	Benzene	0.652
Water at so"	0.5494	Methyl alcohol	0.597
Water at roo°	0.2838	Toluene	0.590
Heavy water	1.2514	Carbon disulfide	0.363
Sulfuric acid, 100%	25.4	Ether	0.233
Aniline	4.40	Mercury	1.56

The fluidity, which is defined as the reciprocal of the viscosity, is sometimes used, the unit, a reciprocal poise, being called the rhe (from the Greek *rhein*, "flow"). When accelerated motion is in question on account of inertia the determining factor is the viscosity η divided by density ρ, which is called the kinematic viscosity, $\nu=\eta/\rho$. Thus, although the viscosity of air is less than that of water, stirred air comes to rest much sooner than water similarly stirred; the kinematic viscosities of air and water are, respectively, 0.162 and 0.0101 in c.g.s. units. In the same unit, which is called a stoke after George Gabriel Stokes, a pioneer in the theory of viscous flow, the kinematic viscosity of mercury is 0.00115. The critical velocity at which, with a given disposition, laminar flow breaks down and becomes turbulent is proportional to the kinematic viscosity.

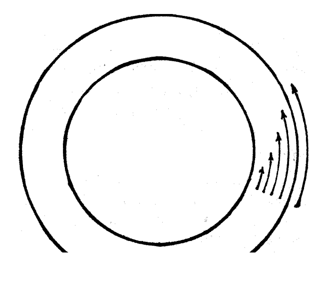


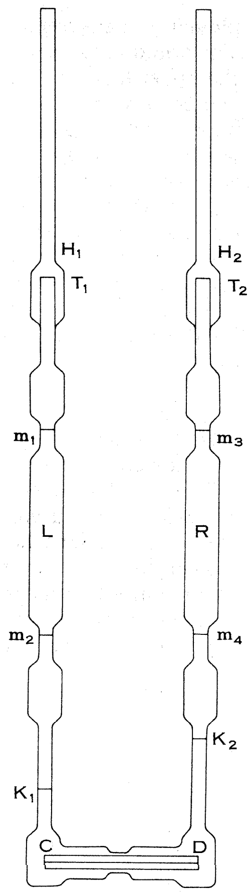
FIG. 3.— DISTRIBUTION OF VELOCITIES BETWEEN TWO CYLINDERS, THE INNER ONE FIXED. THE OUTER ROTATING ABOUT ITS AXIS

Measurement of Viscosity.—The motion contemplated in the definition of viscosity is laminar, that is, one in which the fluid moves in parallel planes gliding one over another. Other types of motion exist—in particular turbulent motion—but to derive simply the coefficient of viscosity laminar conditions are required. Such conditions exist in the not-too-rapid flow of a fluid through a capillary tube, in which the velocity of coaxial cylindrical sheets takes up a parabolic distribution, as shown in fig. 2, being zero at the wall; or in the motion between two coaxial metal cylinders. of which one rotates about the axis, relative to the other. In fig. 3 the inner cylinder is shown as being at rest and the outer rotating, the velocities being indicated by the lengths of the arrows.

The laws governing the flow of a viscous liquid through a fine tube were discovered experimentally by Poiseuille in a classical investigation published in 1842. He was a doctor of medicine and was led to undertake the work by his interest in the flow of blood through capillaries. He found that the volume V passing through the tube in unit time was proportional to (1) the difference of pressure at the two ends of the tube; (2) the fourth power of the radius of the tube: (3) the reciprocal of the length of the tube. E. Hagenbach, several years later, defined the coefficient of viscosity η and worked out the formula

$$V=\frac{\pi}{8\eta}\,\frac{a^4(p_1-p_2)}{l} \qquad (1)$$

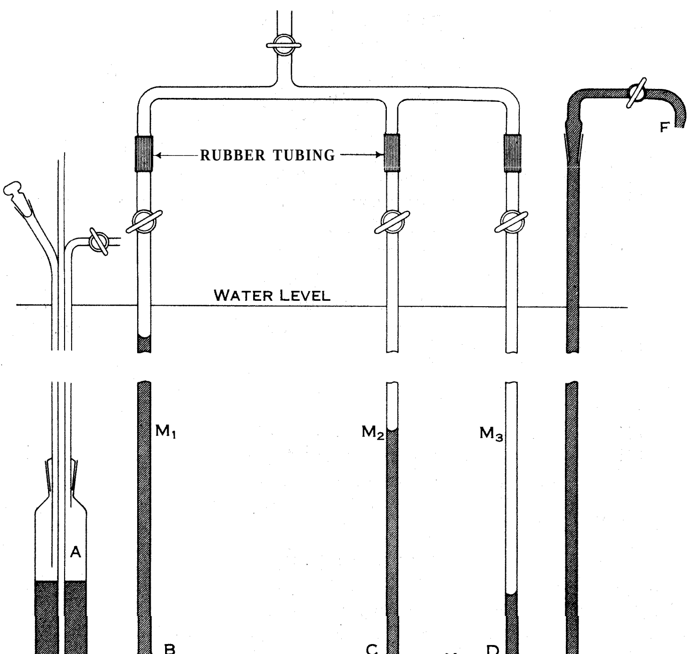
where a is the radius, l the length of the tube and p_1 and p_2 are the pressures at the two ends. This formula nas independently derived by G Wiedemann.



FROM THORPE & RODGER, IN "PHILOSOPHICAL TRANSACTIONS" (COUNCIL OF THE ROYAL SOCIETY)

FIG 4 —VISCOMETER OF THORPE AND RODGER, FOR STANDARD DETERMINATIONS

The capillary viscometer has many forms. The prototype of many used for precise determinations of viscosity was that of Sir Edward Thorpe and J. W. Rodger. em-



FROM GUY BARR, "A MONOGRAPH OF VISCOMETRY," OXFORD UNIVERSITY PRESS, 1931

FIG. 5.— VISCOMETER OF ERK, USED TO ELIMINATE END EFFECTS

ployed in measurements many of which are still standard (fig. 4). The liquid runs under a gravity difference of head, adjusted so that the upper level initially is at the top of the tube in bulb T_1 (or T_2) and the lower level at mark K_2 (or K_1). The time taken for the upper level to pass from m_1 to m_2, (or m_3 to m_4) is measured. Many precautions are taken with this type of viscometer to ensure accuracy. but there are inherent difficulties. The radius enters as r^4, so that any errors in r are multiplied by 4—available capillary tubes are neither exactly circular in cross section nor exactly uniform in bore. There are, further, troublesome end corrections, the formula (1) applying to a tube of infinite length.

To eliminate, as far as possible. the end corrections, S. Erk devised a viscometer (fig. 5) in which the liquid flows through two capillaries of different lengths, K_1 and K_2, cut from the same tube. The pressures at the ends of the tubes are measured by the three manometers M_1, M_2 and M_3. If the tubes were completely uniform in bore the differences in pressure would permit full allowance for end effects.

The capillary tube viscometer is extensively used for ordinary laboratory measurements of viscosity, being calibrated by the use of a standard liquid such as water or sucrose solution. A typical form is shown in fig. 6. A given volume of liquid is charged into the instrument and taken up until the upper meniscus is above A in the left-hand limb. The time for the meniscus to fall from A to B, under gravity. is measured. The viscosity and density of the calibrating liquid being η_0 and ρ_0, the viscosity η_1 of the liquid, density ρ_1, under test is given by

$$\eta_1 = \eta_0 \frac{\rho_1 t_1}{\rho_0 t_0}$$

where t_0, t_1 are the respective times of flow.

Instruments of this general type. in which the quantity to be measured is the time taken by a liquid flowing through a capillary to fall from a mark above a bulb to a mark below are generally known as Ostwald viscometers.

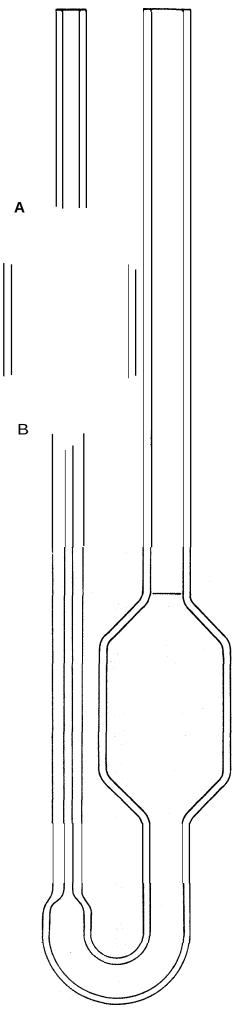
Another general type of instrument for measuring viscosity is the coaxial cylinder apparatus, originated by Maurice Frédéric Couette. In some the inner cylinder is at rest and the outer rotates steadily (schematically shown in fig. 3); in others the inner cylinder rotates while the outer cylinder is at rest. Typical of the former class is E. Hatschek's viscometer for liquids, which has been extensively used in the study of colloidal solutions (fig. 7). The inner cylinder. A, is suspended by a torsion wire; the angle through which it is turned, in consequence of the steady rotation of the outer cylinder, gives the moment M of the viscous forces. E and E' are fixed guard cylinders which eliminate end effects. Then

$$M = K\eta\Omega$$

where Ω is the constant angular velocity of the outer cylinder and K is an apparatus constant involving the radii of the cylinders and the height of the inner cylinder. The apparatus is calibrated by use of a standard liquid.

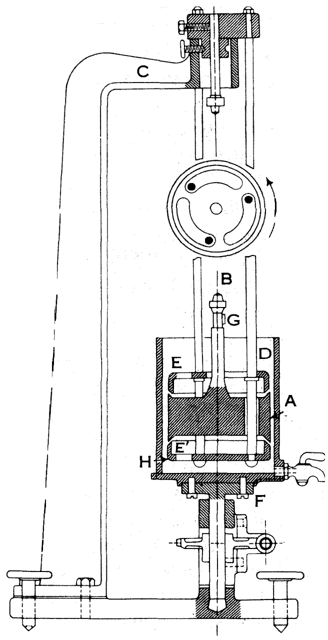
A similar type of apparatus, but with the outer cylinder suspended by a torsion wire and the inner cylinder maintained in steady rotation. was used by J. A. Bearden in his precision determination of the viscosity of air.

In a method which has been worked out practically and employed by E. N. da C. Andrade, the liquid is contained in a closed sphere which hangs by a bifilar suspension in a high vacuum. so that it can execute torsional vibrations about its vertical diameter. If it is set in motion by a twist and then left to itself, the effect of the enclosed liquid is to damp the vibrations and the viscosity can be calculated from the logarithmic decrement. that is, from the rate at which the angular amplitude diminishes. This method has the advantage that the liquid is sealed off and never comes in contact with air or other gas; it has therefore been extensively used for measurements on liquid metals which oxidize easily. The liquid is sometimes contained in a closed cylinder instead of a sphere.



FROM "SECOND REPORT ON VISCOSITY AND PLASTICITY," ACADEMY OF SCIENCES OF AMSTERDAM; BY COURTESY OF NORDEMANN PUBLISHING CO., INC.

FIG. 6.—A REPRESENTATIVE OSTWALD VISCOMETER



FROM E. HATSCHEK, "THE VISCOSITY OF LIQUIDS," G. BELL & SONS LTD., 1928

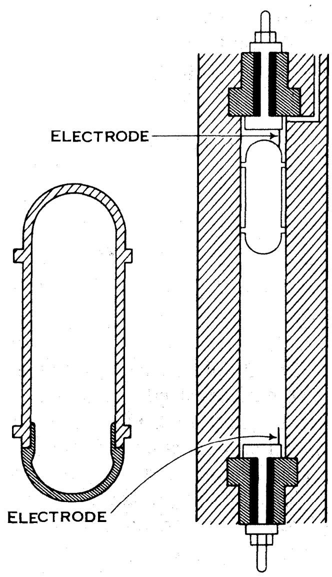
FIG. 7.—THE HATSCHEK FORM OF COUETTE VISCOMETER

Quite a different method measures the viscosity of the fluid from the rate at which a small sphere, of known diameter and mass. falls through it. If the sphere is small enough, the suitable size depending upon the viscosity in question, it soon settles down to a uniform rate, as exemplified by a raindrop falling through the air. Stokes showed that the velocity v of steady fall was given by

$$v = \frac{2r^2(\rho-\rho')g}{9\eta} \qquad (2)$$

where r is the radius of the sphere, ρ and ρ' the densities of the substance of the sphere and of the fluid and g the gravitational acceleration. This formula enables η to be found from v. In the case of oils a small metal sphere can be used. The formula is also involved in the determination of the electronic charge, where the fluid is air and the liquid spheres used are about a thousandth of a millimetre in diameter. (*See* ELECTRON.)

For his measurements on the viscosity of liquids at high pressures. P. W. Bridgman used a tube of about 6 mm. internal diameter, in which slid a short hollow cylinder, with rounded ends, of slightly less diameter, kept central by small projections (fig. 8). The time of fall was measured. This gave relative viscosities under different conditions.



FROM E. HATSCHEK, "THE VISCOSITY OF LIQUIDS," G BELL & SONS LTD., 1928

FIG. 8.—BRIDGMAN'S APPARATUS FOR DETERMINING VISCOSITIES OF LIQUIDS AT HIGH PRESSURES (RIGHT)

An enlargement of the hollow steel weight is shown at left. Projections on weight make electrical contact with the wall of the tube, the circuit being completed when the weight touches the electrode at either end of the tube

The Variation of the Viscosity of Liquids With Temperature.—The viscosity of liquids falls with rise of temperature. It would seem to be a general rule, pointed out by Andrade, that the more complex the liquid, the greater the influence of temperature. Thus, in the temperature range 0° to 30° C., with glycerin the viscosity falls to $\frac{1}{20}$; with water. which at the lower temperatures is heavily associated, it falls to $\frac{1}{2}$; with carbon tetrachloride, a straightforward liquid, to $\frac{2}{3}$;

and with monatomic mercury it falls to $\frac{5}{6}$—all values approximate.

For normal liquids the variation of viscosity with temperature is well represented by Andrade's formula:

$$\eta = Be^{b/T} \tag{3}$$

where B and b are constants; later modified to

$$\eta v^{\frac{1}{3}} = Ce^{c/vT} \tag{4}$$

where T is the absolute temperature. C and c are constants and v is the specific volume. This formula, with only two constants. agrees with observations over a wide range of temperatures. with normal liquids. It was derived by simple considerations which regarded the molecules as vibrating about slowly moving equilibrium positions and communicating momentum at every extreme libration at the temperature of melting. The temperature agitation was supposed to interfere with the communication of momentum, in accordance with L. Boltzmann's principle.

In formulas of type (3) and (4), when the exponential term is written $e^{E/kT}$, k being Boltzmann's constant. E represents an energy involved in the viscous process. Thus bk, or ck/v, represent such an energy and can be shown to be related to, for instance, the internal latent heat. H. Eyring and his colleagues have used consideration of reaction energy in elaborating a general analogy between the viscous process and rate of chemical reaction.

Water is in every way an anomalous liquid. as instanced by the variation of density with temperature, and the variation of its viscosity with temperature is not represented by formulas (3) or (4). There are certain other liquids. anomalous in other respects, such as the tertiary alcohols. whose viscous behaviour is likewise exceptional. For the majority of liquids, however, the formulas are in general use, especially the simpler one in the form

$$\log \eta = A + b/T$$

Andrade's theory, which connects the viscosity of the simplest class of liquids with the frequency of vibration of the molecules, allows an expression which does not contain any arbitrary constant to be worked out for the viscosity of the liquid at the melting point temperature. The frequency is derived from P. Debye's characteristic temperature or from F. A. Lindemann's constant. The absolute values calculated in this way agree well with experiment for liquid metals.

Viscosity and Pressure.—The work of Bridgman has shown that the viscosity of all liquids—water at lower temperatures. with its usual abnormality, excepted—increases steadily with pressure. For typical organic liquids the viscosity at 1.000 atm. is two or three times that at normal pressure, but the increase at the highest pressures is at a much greater rate—to take an extreme example, with isobutyl alcohol the viscosity is nearly 800 times as great at 12,000 atm. as at 1 atm. Bridgman has shown that viscosity is not a function of the volume alone, as certain theories put forward to account for the temperature variation had suggested. Xndrade's theory has given a rough representation of the variation of viscosity with pressure up to 3,000 atm. At higher pressures. where it fails, Bridgman has given clear evidence for supposing that the molecules themselves are deformed, which further complicates matters already complicated.

Viscosity and Chemical Constitution.—In the early attempts to relate viscosity to chemical constitution the viscosity at some particular temperature was selected as typical. Thorpe and Rodger: for instance, took the viscosity at the boiling point. which can have no fundamental significance, since at a pressure other than atmospheric the results would be different. Others have taken a fixed temperature for all liquids, when, again. the results will depend upon the temperature selected. The close fit afforded by formula (4) seems to offer a better opportunity of connecting viscosity and constitution, since the constant c is characteristic of the liquid and represents an energy which should vary systematically within homologous series of organic compounds. It has, in fact, been shown that in series for which figures are available, c varies regularly from member to member, and some connection between the viscosity constant and the intermolecular energy due to van der Waals forces has been indicated.

Viscosity of Suspensions, Sols and Solutions.—In the case of solutions and suspensions, use is often made of the term relative viscosity. defined as $\eta_r = \eta_c/\eta_0$, nhere the viscosities of solvent and solution are respectively η_0 and η_c. The relative or specific increase of viscosity is defined as

$$\eta_{sp} = \eta_r - 1 = \frac{\eta_c - \eta_0}{\eta_0}.$$

The simplest case is that of a suspension of solid spherical particles of microscopic or ultramicroscopic size. For such suspensions A. Einstein, on purely hydrodynamical grounds, derived the formula

$$\eta_c = \eta_0(1 + 2.5\,\phi) \text{ or } \eta_{sp} = 2.5\,\phi$$

where ϕ is the total volume of the solid spheres in unit volume of suspension. Thus only the aggregate volume of the spheres, not their size! comes into question. The formula has been tested with, for example, suspensions of gamboge containing globules of from 0.3 to 4μ in radius, and found to hold well as long as the concentration is not too high. For higher concentrations a term in ϕ^2 has to be added.

Suspensions of this class, which include gold and silver sols with particles whose diameter may be of the order 0.1μ, are known as lyophobic. or solution hating, because the solids are easily precipitated in a form which will not pass back into solution. They have normal Newtonian viscosity. Suspensions of minute rods. such as lengths of fine artificial silk fibre. likewise behave normally. except when the particles are so long as to interact.

With lyophilic or solution-loving sols small additions of the solid substance. *e.g.,* agar. to the solvent *e.g.,* water. cause a great increase of viscosity—even a few per cent may cause a hundredfold increase. Again, the increase of viscosity with concentrations is more rapid than would be indicated by a linear law. Ever?-thing points to the building up of a structure. The viscosity is non-Newtonian, the apparent viscosity at any particular shear stress, as measured by the velocity gradient produced, decreasing rapidly as the shear stress is increased. which would be in accord with the general picture of the breaking down of a structure. The results of the many investigations into the viscous behaviour of such gels are. from the nature of the subject: complicated.

Still more troublesome is the case of the colloidal suspensions whose behaviour depends upon their recent mechanical handling, suspensions which. otherwise expressed. slowly build up a structure which, when broken down. gradually restores itself. Thus paints, which in the simplest case consist of a suspension of a solid such as lithopone in a medium such as oil. flow comparatively freely if recently stirred. but on standing revert to a gellike state. Such behaviour—roughly speaking. a liquefaction on agitation—is known as thixotropy (from Greek *thixis,* "a touch." and *tropos,* "turning"—changing at a touch). The liquid form in some cases behaves in a Newtonian manner, in others not.

In the case of the viscosity of true solutions. such as sugar or salt in water, there is a lack of non-Ken-toninn complications and a simplicity might be expected which is. however. not evident. A distinction is usually made between electrolytes and nonelectrolytes. With electrolytes the relative increase of viscosity may be either positive or negati e: thus a concentration of 0.703 mols per litre of $LiNO_3$ in water at 18° C. gives $\eta_{sp} = 0.0737$, while a concentration of 0.732 mols per litre of $CsNO_3$ gives $\eta_{sp} = -0.0653$. It was at one time believed that only electrolytes could produce a decrease of relative viscosity. hut cases have been found where nonelectrolytes. which generally shon an increase. have such an effect, though small; *e.g.,* 0.25 mols per litre of *p*-nitrobenzene in alcohol give $\eta_{sp} = -0.0011$. The estabiished difference between electrolytes and nonelectrolytes is given by the response of η_r to change of temperature. For electrolytes it increases with temperature. for nonelectrolytes it decreases; in other words, for electrolytes the viscosity of the solution decreases less rapidly, for nonelectrolytes more rapidly. than that of the solvent.

Attempts have been made to connect the viscosity of electrolytes with the conductivity without any pronounced success. In general, while a great body of measurements exists for the viscosity of solutions of both kinds. no widely valid regularities have been revealed. Many empirical formulas have been shown to represent particular cases, but in the absence of either comprehensive empirical rules or approximate theory the subject is not ready for simple exposition. The same is true of the viscosity of liquid mixtures.

Effect of an Electric Field.—Early attempts. from 1885 onward. to detect the effect of an electric field on the viscosity of liquids led to very divergent results. In some cases large effects were found; Xndrade and Cyril Dodd showed that such results were spurious and established that with nonpolar liquids, such as benzene, no change to within 1 part in 100.000 took place even with a field of 42.000 v. per centimetre, but with polar liquids. such as monochlorbenzene, there was a small change of viscosity, $\Delta\eta$, given by

$$\frac{\Delta\eta}{\eta}=fF^2$$

where F is the field and f is the viscoelectric constant, which is around 2×10^{-7} if the field is measured in electrostatic units. This means that with practicable fields. $\Delta\eta/\eta$ does not exceed about 0.0012. so that very precise experimental methods and careful temperature control are necessary to detect it.

A general explanation of the effect can be given in that which polar molecules the field exercises an orienting effect which tends to hinder the rotation of the molecules. which is a consequence of laminar flow. The theory of the viscosity of polyatomic molecular liquids is not yet developed to a stage where a quantitative explanation of the effect can be worked out.

The Viscosity of Gases.—James Clerk Maxwell made his early determinations of the viscosity of air by measuring the damping of the torsional oscillations of a system of three parallel disks. mounted rigidly on an axis suspended by a torsion wire. which moved between four fixed disks (fig. 9). This arrangement made the frictional force produced by the viscosity of the air between the disks comparatively high. Later. the viscosity of gases was measured by methods similar to those used for liquids, in particular by the flow through capillary tubes and by concentric cylinder apparatus of the Couette type. suitably adapted. In particular. very great care was devoted to measuring the viscosity of air. since this enters into R. Millikan's method of measurement of that fundamental quantity, the electronic charge. (See ELECTRON.)

Viscosity measurements furnish strong support for the kinetic theory of gases. According to theory. as first worked out by Maxwell, the viscosity should be independent of the pressure. which at first appears an astonishing result. The reason for this independence can be seen in a general way without mathematics: when the pressure is halved the number of molecules crossing unit area of a given plane is halved, but the mean free path. which determines the momentum transfer from one plane of flow to a parallel plane. is doubled. The region where such considerations hold is limited at one end by densities sufficiently high to make the intermolecular. forces significant. which usually means several atmospheres pressure, and at the other end by pressures sufficiently low to make the mean free path comparable with linear dimensions of the gap used in the measurements. which usually means pressures much lower than a hundredth of an atmosphere.

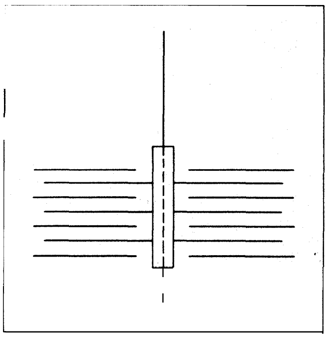


FIG. 9.—SCHEME OF MAXWELL'S VISCOMETER

The independence of the viscosity of gases of their pressure was verified by Maxwell in the experiments to which reference has been made and was later abundantly confirmed within the region indicated.

According to the kinetic theory, the viscosity of gases should increase with increasing temperature, in contrast with the behaviour of liquids. The elementary theory, which treats the molecules as ordinary elastic spheres, indicates that the viscosity should be proportional to the mean molecular velocity. which means to . Experimentally, however. it is found that the viscosity increases more rapidly with T than this law indicates. The reason for this departure is that the molecules do not behave as spheres of constant radius; but that as the temperature rises and the molecular impacts become more severe, the centres of the molecules approach. on the whole, more closely during collision. In consequence the molecules are, effectively. smaller at high temperatures than at low. The exact form of the more precise formula derived for the variation of η with T depends upon the assumption made as to the nay in nhich the repulsive force between close molecules varies with the distance. A successful and widely used formula is that of W. Sutherland:

$$\eta=\eta_0\frac{C+273}{C+T}\left(\frac{T}{273}\right)^{\frac{3}{2}}$$

where C is a constant (Sutherland's constant) pertaining to the gas in question.

At high pressures, in the neighbourhood of the critical point, when the liquid state is approached. matters naturally become very complicated and the viscosity behaviour begins to approach that of a liquid.

The Flow of Solids.—In general. solids. if subjected to stresses large enough, will flow progressively. In particular, there are many solids. of which pitch and sealing wax may be taken as typical, that, although they break with brittle fracture if suddenly stressed. will nevertheless flow under quite small sustained stresses. Pitch left in a funnel, for instance. will slowly creep out under its own weight. Again glass rods. supported horizontally at the two ends, will at ordinary temperature sag progressively under the force of gravity, and sticks of sealing wax flow comparatively quickly under like conditions. Metals. on the other hand. will not, in general, flow even very slowly unless subjected to considerable stress, but they too will creep, to use the term usually applied to their progressive movement, under sufficiently large sustained stresses.

Glass, an amorphous or noncrystalline substance, behaves approximately as a highly viscous liquid. Its flow properties have been measured, usually at temperatures of jooo C. and higher, by the progressive twist of a rod under a constant couple; by the extension of a rod or thread; by concentric cylinder methods; and, at high temperatures, by the slow fall of a sphere of platinum through the substance. Roughly speaking, the rate of flow is proportional to the stress, which enables an ordinary coefficient of viscosity to be calculated. The viscosity of glass at annealing temperature, when it must slowly yield under the internal stresses, is about 10^{13} poise; at the temperatures at which it is blown, about 10^7 poise, as compared with 1,400 poise for golden sirup (Lyle) at 12° C.

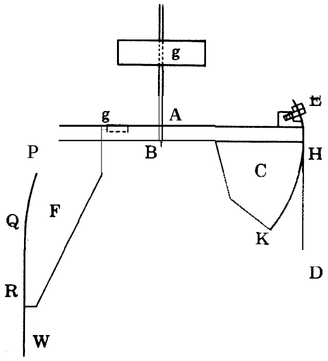
The pitchlike substance known as Chatterton compound is not quite so simple, because under constant stress it flows more rapidly at first: but ultimately reaches a stage at which the rate is constant. This final steady rate is proportional to the stress at higher temperatures, but not at the lower temperatures. Chatterton compound, then, behaves as a viscous liquid at higher temperatures, but at lower temperatures shows a double departure from Newtonian behaviour. Such departure is. in general, characteristic of solids. Clays, doughs. asphalts, and so on, have still more complex flow properties which make them troublesome substances to characterize quantitatively in the matter of flow.

In general, *solid* bodies do not begin to flow at a perceptible rate until a certain stress is exceeded. Bodies with this property are usually called plastic solids. E. C. Bingham imagined a substance which should be stable under stresses below a certain value and flow at a steady rate. connected linearly with the stress, for greater stresses. Such a body is called a Bingham solid or ideal plastic, but. like most ideals, it does not exist and is not closely approached in nature.

Since what is here in question is viscous flow, the discussion that follows will be confined to regions of stress where the flow is easily measurable and the elastic response negligible in comparison. The behaviour of metals, which are crystalline in structure, is in general more regular than that of amorphous bodies and will now be considered.

For many years the only method used for investigating the flow or creep of metals was by extension of a rod or wire under longitudinal stress. If a constant load be used to produce the extension then, as the length increases. the cross section diminishes and the stress increases, causing an additional complication. Andrade was the first to make use of devices which automatically so diminished the stretching force as to keep the stress constant. One such device which has, in various forms, been extensively used is the Andrade-Chalmers bar, or cam balance (fig. 10). The load is hung from the wire or metal tape which is attached at P and lies along the cam surface PQR, and an upward pull is applied to the metal wire under test by the wire or tape D. lying along a circular arc. As the test wire stretches and moves upward the bar tilts and the cam surface is so designed that the couple applied by W, and hence the tension in D, is reduced, in the way required to keep the stress in the test wire constant. The device can easily be modified so as to produce a downward pull. if required.

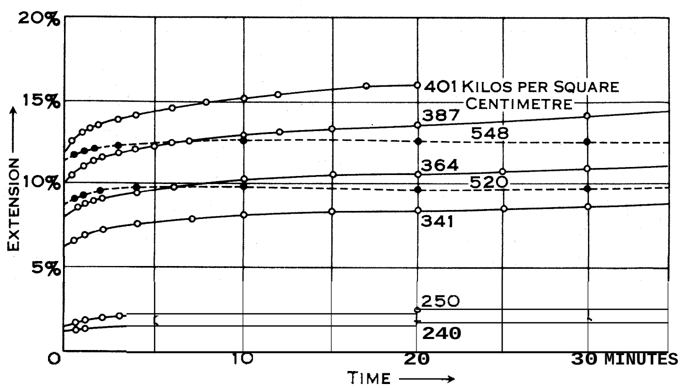
The form of the extension-time curve of a wire flowing under constant stress depends upon the metal and the temperatures. Fig. 11, 12 and 13 show the flow of lead at four different temperatures. The extension is in no case linear with time. At the lowest temperature, −180° C., the rate of flow is small for all stresses, but is much more rapid at the beginning than at a later time, when it is hardly distinguishable from zero. At −78° the rate of flow diminishes as time goes on, but is well marked throughout with the stresses in question. At 17° the rate likewise diminishes with time, but only slowly after some interval. At 160° C. the flow is a little more rapid at the beginning than later for all stresses. but is not far from linear with time.



FROM E. N. DA C. ANDRADE AND B. CHALMERS, "PROC. ROY. SOC. A.," VOL. 138, 1932

FIG. 10.—THE ANDRADE-CHALMERS BAR FOR ENSURING CONSTANT STRESS

These curves are typical of metals in general. the behaviour depending upon the temperature. Roughly speaking, the ratio $\theta = T/T_M$, where T, T_M are the absolute temperatures of the test and of the melting point of the metal respectively. determines the behaviour. Thus the flow behaviour of iron at 530° C. is similar to that of lead at 0° C. ($\theta = .45$ in each case) and that of copper at 15° C. to that of lead at −150° C. ($\theta = .21$).

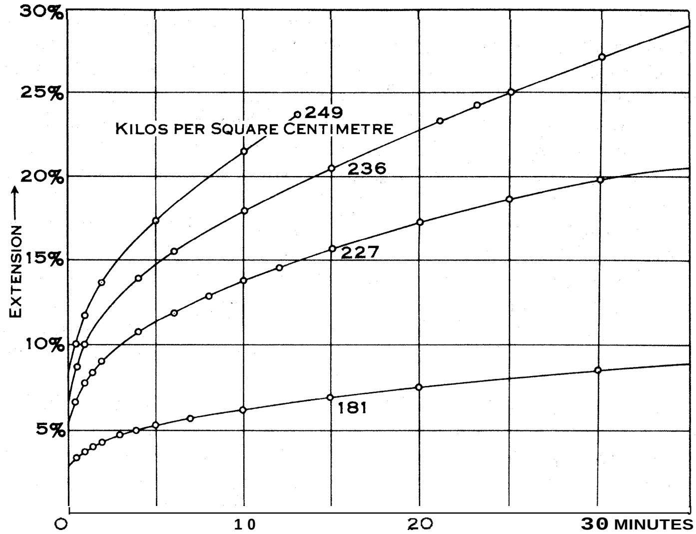


FROM E. N. DA C. ANDRADE, "PROC. ROY. SOC. A.," VOL. 90, 1914

FIG. 11.—FLOW OF LEAD UNDER CONSTANT STRESS AT −180° C. (BROKEN LINES) AND AT −78° C.

The flow of pure metals and certain alloys was expressed by Andrade in the formula

$$l = l_0(1 + \beta t^{\frac{1}{3}})e^{\kappa t}$$



FROM E. N. DA C. ANDRADE. "PROC. ROY. SOC. A.," VOL. 90, 1914

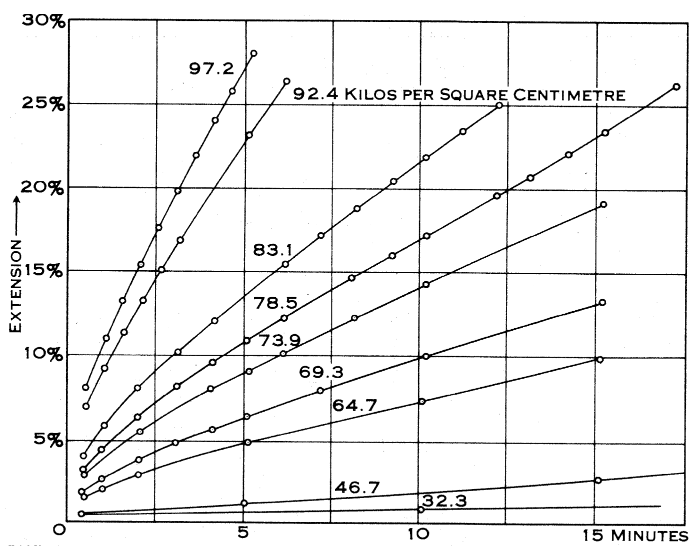
FIG. 12.—FLOW OF LEAD UNDER CONSTANT STRESS AT 17° C.

where l is the length at time t and l_0, β and κ are constants. The exponential term represents a constant rate of flow per unit length, since, if $\beta = 0$,

$$\frac{1}{l}\frac{dl}{dt} = \kappa.$$

Here the term in β represents a flow which progressively becomes slower and slower, which is alternatively called primary creep, transient creep or β flow (beta flow); the term in κ represents a flow which takes place at a constant rate and is called secondary creep, permanent creep, quasi-viscous creep or κ flow (kappa flow). There is much evidence for the physical distinction of the two types of flow, revealed by these analyses, the β flow being dominant at relatively low temperatures and the κ flow at relatively high temperatures. The $t^{\frac{1}{3}}$ law has been confirmed by many workers. Although other variations have been suggested for certain cases, this does not affect the existence of the two types of flow.

There is a large body of evidence for the view that transient creep is connected with processes taking place within the crystal grains which normally make up metals, while permanent creep pertains to processes taking place between the grains. Two experimental results bearing directly on this question may be cited. J. McKeown measured the creep of different specimens of lead varying only in the average size of the crystal grains, extreme values for mean cross-sectional areas being 0.84 and 0.01 mm^2. With the coarse-grained metal both β flow and κ flow were well marked at a given temperature and stress; as the grain size dimin-



FROM E. N. DA C. ANDRADE, "PROC. ROY. SOC. A.," VOL. 90, 1914

FIG. 13.—FLOW OF LEAD UNDER CONSTANT STRESS AT 160° C.

ished the κ flow became relatively more important until. with the finest grain metal, it markedly predominated. the flow being much more rapid than with specimens of coarser grain and nearly linear from the start. Andrade and B. Chalmers. by measuring the electrical resistance at various stages of the flow of different metals. showed that the β flow was connected with a rotation of the axes of the crystal grains, the direction of which was unaffected by the κ flow.

The work of D. Hanson and M. A. Wheeler likewise points to the physical distinctions between β and κ flow. They found a pronounced appearance of slip bands within aluminium crystal grains at low temperatures, n-here β flow was predominant, and absence of such slip bands at high temperatures, where κ flow prevailed, and. further. the crystal-grain boundaries were much emphasized in this latter case.

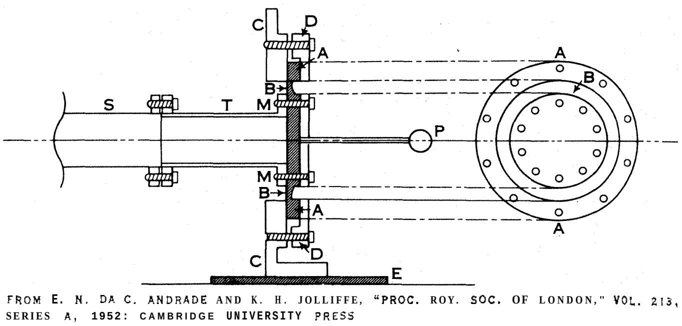
The slip within the crystal grains is a matter to which considerable attention has been devoted by W. Boas, H. Wilsdorf and D. Kühlmann-Wilsdorf. D. McLean and W. A. Wood. Besides the coarse slip. easily visible with a low magnification. which characterizes the β flo process and is accompanied by a rotation of the crystal axes, there is another finer slip process, revealed by such special means as the phase-contrast microscope or the electron microscope. and further a breakup of the grain into units which Wood calls "cells." These features have not been directly connected with flow processes; the fine slip is not, as is the coarse slip, associated with hardening. These processes are mentioned to indicate the complexity of the full problem of large deformations.

Great care should be taken in interpreting surface microphotographs in terms of creep processes. because crystal grains at the surface, whose movements normal to the surface are not constrained, clearly behave differently from grains in the interior, which are subject to stresses from all sides. With ordinary metallic specimens the majority of the grains suffering deformation are internal, and their typical deformations are not revealed by the ordinary methods of investigation.

The mechanism of creep, comprising glide on preferred planes within the crystal grain and relative movement at the boundaries of one grain with respect to others, makes it easy to understand the large effect which the addition of small quantities of foreign metal may have on the phenomena. Large foreign atoms within the crystal, producing local distortion, may tend to check the glide of one plane over another; similarly. foreign atoms in the disordered region between two crystal grains may produce a relatively large effect. In details of behaviour, much depends upon how the particular foreign atoms tend to distribute themselves in the metal.

A different method of studying creep, employed by Andrade and K. H. Jolliffe, is the investigation of behaviour under simple shear. The mechanical conditions are simpler than in the plastic. as against elastic, extension of rods. The experimental disposition is shown in fig. 14. The metal is in the form of a disk, shaded in the diagram, in which is cut an annulus B, B, constituting the metal flowing under stress. The outside part, A. A, of the disk is gripped so as to be held immovably; the inner part, M, M. is held between rigid disks subjected to a constant torque. With this disposition the flow can be observed first under torque in one, say clockwise, sense and then in the other, counter-clockwise, sense.

It was found that under these conditions, the flow under torque



FROM E. N. DA C. ANDRADE AND K. H. JOLLIFFE, "PROC. ROY. SOC. OF LONDON," VOL. 213, SERIES A, 1952: CAMBRIDGE UNIVERSITY PRESS

FIG. 14.— MEASUREMENT OF METALLIC CREEP UNDER SIMPLE SHEAR

in the initial direction followed the $t^{\frac{1}{3}}$ law, there being no permanent flow. This accords well with the geometry of the deformation, which would hinder intercrystalline movement. Under reversed flow a difference was found between the behaviour of lead. of cubic crystal structure, and cadmium. of hexagonal crystal structure. Cadmium behaves in much the same way under reversed flow as under forward flow; lead gives a reversed flow linear with the time, of κ character. This is satisfactorily explained by the fact that single lead crystals harden considerably under large shear strain; cadmium crystals do not. Therefore, lead crystal grains become too hard to be sensibly deformed under shear in the reversed move-, ment; but with the cadmium grains the deformations in forward and reversed movement are much the same.

In general, at no stage does a metal behave as a Newtonian viscous fluid. The transient creep does not have the characteristic of being linear with time. The permanent creep has this characteristic. so that, at a given stress, κ gives a measure of the apparent viscosity. In fact, if S be the longitudinal stress, approximately

$$\frac{S}{\kappa}=3\eta.$$

However, κ is not proportional to S, but increases much more rapidly: experimentally it is found that log κ is proportional to S. Hence. even at high temperatures. relative to the melting point, where the flow is mainly, if not entirely. of permanent type, the metal is behaving as a non-Newtonian liquid.

What is here effectively in question is a diminution of apparent viscosity with stress. Such behaviour is characteristic of most non-Newtonian liquids. such as solutions of cotton yellow or benzopurpurin. Speaking generally, we are confronted with a structure which breaks down, in the sense of allowing easier flow, as the stress is increased.

With transient creep we have what is effectively a hardening as flow under constant stress proceeds. This is a characteristic of a limited class of non-Newtonian liquids. the apparent viscosity of which increases with time, as can be shown with a Couette form of viscometer, in which the liquid lies between the two cylinders. If the outer cylinder is kept rotating at a steady rate, the deflection of the inner cylinder will increase as time goes on. There is a steady hardening or building up of a resistant structure. Speaking generally of non-Newtonian fluids. it is modifications of structure, affected either by time or by shear stress or both, that are the causes of the complications. These general wide resemblances between the flow of metals and of certain classes of non-Newtonian liquids do not imply that the mechanism is similar in detail in both cases for the internal structures are very different.

The constant β varies with stress in a sigmoid manner, increasing at first slowly, then rapidly and finally approaching a constant value.

There is no fully satisfactory theory of metal creep. The difficulties in the way of constructing such a theory are clear: the behaviour of a single metal crystal under a carefully specified stress system is a complicated matter; the behaviour of a crystal grain in a polycrystalline metal. where it is surrounded by other grains, each under the complicated stress system created by their preferential yields in certain directions. is clearly much more complicated. Crystal grains are known to contain inherent structural faults. It is the glide on preferred planes of a parallel system under inhomogeneous stresses that apparently gives rise to the β flow. As regards the κ flow, while the intergranular layer may be taken as homogeneous material of an unchanging thickness for very small stresses. as shown by C. Zener and T. Kê, it is improbable that this assumption can justifiably be made for the large stresses which produce progressive creep.

Besides the primary and secondary creep, a region of tertiary creep, in which the rate increases rapidly with time, is often recorded. Tertiary creep of n-hat would superficially appear to be much the same character, as judged by the form of the extension-time curves, may be due to various causes. In the old tests carried out on rods in tension under constant load, with final extensions of several per cent, it was usually a trivial phenomenon due to increase of stress, and not an intrinsic property of the material.

There are, however, many well-established cases of tertiary creep when the stress is approximately constant throughout the flow, due either to the final extension being very small or to the use of a constant stress device. In such cases it may be due to recrystallizations of various types, such as the migration of the crystal boundaries or the growth of new crystals under stress, any such internal movements leading to relative ease of local deformation. In the case of complicated alloys a phase change may take place, with a like result. Or transverse intercrystalline cracks, which effectively increase the local stress, may lead to increased rate of flow.

The creep of metals, a subject that before World War I attracted little attention, assumed great importance afterward because of its significance in such engines as the jet propulsion gas turbine, and gas turbines in general, in which the blades revolve at high speed, and so under considerable tension, in gas at temperatures of 800° C. or higher. There is the possibility of a slow progressive increase in length. which in view of the small clearances could seriously reduce engine life. Permanent, as distinct from transient, creep is particularly dangerous. There has been, therefore, intensive and successful research to evolve alloys free from pernicious creep.

Since the creep of simple metals is so difficult to explain in detail, it is easy to understand that there is no basic theory of the creep properties of the complicated alloys in question, usually containing two or more of the metals nickel, chromium. iron and cobalt, as well as small quantities of some or all of the elements carbon, silicon, titanium, aluminum, molybdenum, tungsten and niobium (often called columbium). There are, however, certain well recognized and approved lines of development; it is usual to start with a binary, ternary or even more complicated solid solution of the basic metals, to which elements judged likely to produce hardening by precipitation are added.

Viscosity and Elasticity.— A conception which was introduced by Clerk Maxwell is important as showing how the viscous behaviour of an ordinary liquid can be regarded as due to an evanescent elasticity, permanent elasticity being a characteristic of solid bodies. There is a certain mathematical similarity between viscosity and elasticity. In a Newtonian liquid the rate at which shear strain increases is proportional to the shear stress: in a perfect elastic solid it is the shear strain that is proportional to the stress. A viscous liquid may be regarded as an elastic substance which is unable to sustain a shearing stress; under the strain the elastic stress rapidly breaks down. Maxwell assumed that the stress decayed according to the exponential law that governs many such processes, for instance the decay of a radioactive body. If the stress be τ, then

$$\frac{d\tau}{dt} = -\frac{\tau}{\lambda}$$

where λ is a constant called the time of relaxation. If the elastic modulus in question be n, then it can be shown that $\eta = n\lambda$.

The time of relaxation for an ordinary liquid is probably of the order of a ten thousandth millionth (10^{-10}) of a second. which gives an elastic modulus of reasonable magnitude. This way of regarding viscosity may afford an approach to a general theory comprehending the behaviour of real solids and liquids in simple cases.

See also DIMENSIONAL ANALYSIS; ELECTROS; HEAT; KINETIC THEORY OF MATTER; LUBRICATION: *Lubricants;* MATERIALS, STRENGTH OF; METALLURGY.

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VISCOUNT, a title of nobility.

In the Carolingian period of European history the *vicecomites* or *missi comitis* were deputies, vicars or lieutenants of the counts (*see* COUNT; CHÂTELAIN), whose official powers they exercised by delegation. As the countships eventually became hereditary, the lieutenancies did so too: for instance, the viscounts in Narbonne, in Nîmes and in Albi appear to have made their office hereditary by the beginning of the 10th century. Even so, viscounts remained for some time with no other status than that of the count's officers, either styling themselves simply *vicecomites* or qualifying their title with the name of the countship whence they derived their powers. By the end of the 11th century, however, the universal tendency of feudalism to associate status with the possession of land caused the viscounts to qualiiy their title with the name of their own most important fief: thus the lords of Thouars, hereditary lieutenants of the counts of Poitiers. called themselves viscounts oi Thouars; and those of Bruniquel, lieutenants of the counts of Toulouse, viscounts of Bruniquel. In Aquitaine, of which the counts of Poitiers were dukes, and in the county of Toulouse the viscounts were great barons often able to assert themselves against their suzerain (*e.g.,* those of Limoges, of Turenne, of Béziers and of Carcassonne). In the Île de France, in Champagne and in parts of Burgundy, on the other hand, the viscounts by the end of the 12th century were surviving only as minor feudatories, having lost their special administrative functions to the *prévôts.*

In Normandy, however, the judicial functions of the viscounts as deputies of the duke remained important; by the middle of the 11th century most oi the country was administratively divided into *vicomtés* (this explains the Norman use of the name *viscounte* or *vicecomes* for the sheriff in England); and under Henry I the hereditary holders of the *vicomtés* were to a large extent replaced by ducal officials.

In England the viscountcy was not introduced into the peerage until nearly 400 years after the Norman conquest: John, Lord Beaumont, who had been created count of Boulogne in 1336, was on Feb. 12, 1440, created Viscount Beaumont in the peerage of England. with precedence over all barons. The oldest English viscountcy surviving in the second half of the 20th century was that of Hereford, created in 1550; the oldest Irish one, however, that of Gormanston, was considerably senior, having been created in 1478.

Viscounts had been set up in Catalonia by Charlemagne in the 8th century, whence the title had spread. with diminishing functions and increasing nobility, to Aragon and to Castile. Philip IV of Spain introduced the system of *vizcondados pvcvios* (regulations of 1631 and of 1664): under this, no one could proceed to the rank of *conde* or of *marqués* unless he had previously been *vizconde;* a fee of 750 ducats had to be paid for this habilitating title (except in the case of counts' sons); and a further iee of 750 ducats was required for the obligatory cancelation of the *vizcondado* when the time came for conferring the higher rank. The removal of the obligation to cancel, in 1846, led only to confusion, as numerous families began petitioning to have their already canceled titles revived; and in 1858 it mas declared that the *vizcondado previo* was no longer necessary for accession to the higher titles.

VISHNU [Sanskr. the "active one"], in the Indian Rig-Veda a minor deity. who takes three strides. *vi-kram*. the last and highest beyond mortal ken: these probably denote the three divisions of the universe. Closely allied with Indra in his fight with Vritra, the drought-dragon, and against the Dāsas. the dark aborigines, Vishnu in the Epic mythology developed into the Preserver god. one of the Hindu triad with Brahma, the creator; and Siva. the destroyer; and as such he has saved mankind in ten incarnations. His special devotees, the Vaishnavas, have evolved numerous sects.

VISIBILITY. In meteorology the word "visibility" has a technical significance entirely unlike its meaning in ordinary speech. Visibility on a given occasion in the daytime is the greatest distance at which an observer with normal eyesight can see a dark-coloured object which stands up against the horizon sky. It is the range of vision under the atmospheric conditions prevailing at the time. At night it is the greatest distance at which lights of certain standard candle powers can be seen. Its observation is of obvious importance to the aviator.

When the term is used without qualification the horizontal direction of view is always understood; the terms "vertical visibility" and "oblique visibility" are used to denote the range of vision (usually from an aircraft but sometimes from the ground) in the directions indicated. These latter concepts are not as clearly defined as is the horizontal visibility, nor are the techniques of observation as well standardized.

An atmosphere containing only permanent gases and uncondensed vapours is exceedingly transparent to visible light. In such an atmosphere it would be possible for an aviator to see a mountain at least 250 mi. away. The fact that such great values of the visibility seldom occur indicates that the air nearly always contains large numbers of particles of various sizes, but all considerably larger than the molecules of the atmospheric gases. The smallest among these particles are visible as haze. They consist of finely divided salt from sea spray, exceedingly fine dust. or (especially near cities) products of combustion. They are small enough to act differently on light of different colours, scattering the shorter waves of blue light more than the longer waves of red, and for this reason a haze seen against a dark background looks bluish. whereas a distant lamp or the setting sun seen through a haze looks redder than its normal hue.

Most haze particles are hygroscopic; *i.e.*, they attract water vapour. If there is enough water vapour present, some of it will condense on the particles and they will increase in size. When they reach a diameter of about half a micron (one micron = $\frac{1}{1,000}$ mm. = $\frac{1}{25,400}$ in.) they begin to act differently toward light, and by the time they are five microns in diameter they have become practically nonselective to light of different colours, appearing white to the eye; then we call them fog. At this stage they are almost entirely water, condensed on a very small nucleus of some other substance.

Under some circumstances the visibility can also be reduced by nonhygroscopic dusts (as in sandstorms). microorganisms. or even insects. It can of course be brought down to almost zero by snow or heavy rain. But generally it is the haze particles or fog droplets that determine how far one can see.

The theory of the phenomenon differs. depending on whether we have to look at lights at night, or ordinary objects in the daytime. The former case is the simpler. A distant lamp will emit a certain amount of light in the direction of the observer, some of which will travel within the narrow cone having the pupil of the eye as its base. Not all the light, emitted into this cone will reach the eye, some being absorbed by the particles in the intervening atmosphere: and some being scattered by them out of the cone, so that it proceeds in some other direction. If there is only a little light remaining to enter the pupil of the eye, the lamp will be only just perceptible; and the distance at which this occurs will be the visual range of the lamp. Should the lamp be of the standard candle power, this distance will be the visibility. The amount of light from the lamp that the eye needs in order to see it depends on many factors, of which the most important are: (1) the presence of other lights in the vicinity; (2) the brightness of the background against which the lamp is seen; and (3) the length of time the observer has been in comparative darkness. Unfortunately all these factors are variable under the conditions of observation usual at an airport.

The way in which the air obscures terrestrial objects in the daytime is quite different. An object which does not of itself emit light is distinguishable because of the contrast between the object and its background; for example, a wooded hill is seen against the horizon sky because the sky is much brighter than the hill. By scattering light into the eye of the observer, the atmosphere adds to the apparent brightness of all objects, making it approach more and more closely to that of the horizon sky as the observer gets farther away—an effect easily appreciated in mountainous country. and known to painters as "atmosphere." When the apparent brightness of two adjacent surfaces differs by less than about 2%, the eye cannot distinguish them and nothing is recognizable. Because the contrast at a given distance depends upon the colours of the objects, a standard pair of objects is used for the estimation of the visibility. A black object against the horizon sky affords the maximum contrast, and its visual range has been found to depend least upon the direction of the sun and the state of the sky, but any dark-coloured object is satisfactory as long as it is seen against the sky near the horizon.

Instruments are seldom used in observing the visibility, which is determined rather by simple estimation, the observer noting how many of a previously chosen series of objects or lamps can be seen from the observing station. The visibility is the distance of the farthest one distinguishable. It is reported directly in miles for airway purposes on the North American continent. For other meteorological purposes and elsewhere a two-digit code is employed. representing values from less than 20 m. (22 yd.) to the greatest possible. Ships and some other stations use an abbreviated code having only ten steps representing values from less than 50 m. (55 yd.) to 50 km. (31 mi.) and over.

See W. E. K. Middleton, *Vision Through the Atmosphere* (1952).

(W. E. K. M.)

VISION or **SIGHT**, the function in which the organ known as the eye, and its more immediate nervous connections in the brain. are crucially involved in a series of reactions to the form of radiant energy called light. Although the existence of an organ (the eye) which mill somehorv copy or report upon certain aspects of the organism's physical surroundings is indispensable in seeing, the behaviour of the eye is by no means sufficient to account for vision. The nervous system to which it is connected is also necessary, and it at the same time is receiving inputs from other sense organs which must be handled in the light of each other and the visual input. The central nervous system is a constantly active system. a going concern governed by principles of its own. and its activity is thus more than merely an end result of the combined peripheral sense-organ inputs. In seeing. the organism as a whole brings something to the occasion. Into this the ocular activity set up by physical stimulation must appropriately mix. The internal events of one moment determine in part those that occur later. The present is dependent upon the past.

The initial process in seeing is induced by the action of light on the retina, the photosensitive part of the eye. If light were to act uniformly over the entire retina there would be at any one time only a general awareness of light without reference to an external object. One of the essential conditions for vision as a guide to action is the formation of an image on the retina. Images are a kind of copy of external objects in terms of the distribution of light intensity resulting from nature's having placed refractive structures in the eye in front of the retina which properly bend the luminous rays so as to focus them on the retina.

PHYSICAL CONDITIONS FOR VISUAL STIMULATION

Radiant energy is dealt with not only in terms of magnitude of flux per unit area of object, but also in terms of the component wave lengths. The eye is selective, in the sense that only a restricted band of the full radiant spectrum is effective in eliciting experience. This band for daylight conditions lies roughly between 400 mμ and 700 mμ. The exact limits, however, are determined by intensity conditions. The eye is selective further in not responding equally to equal amounts of energy in all parts of the visible spectrum.

The Visibility Curve or Luminosity Curve of the Eye.— The relative sensitivity to various parts of the visible spectrum when measured and plotted in the usual way yields what is known as a visibility curve, or luminosity curve. For what is known as an equal-energy spectrum, the subjective brightness elicited by the constituent wave lengths of the spectrum is measured. the value being then converted to a common scale wherein the most effective wave length is given a value of 1.0. Luminosity curves for the human eye for two different conditions are shown in fig. 1. Curve *A* is for full daylight vision, the other for vision under definitely reduced illumination. It will be seen that a shift in the wave length which is maximally effective occurs from one set of conditions to the other. Not only does the maximum of the curve shift, but also the value of the other and less-effective wave lengths.

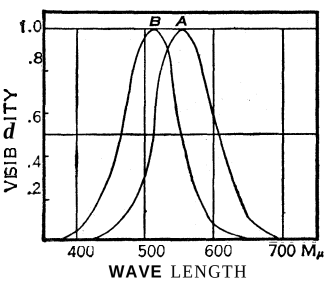

FIG. 1.—VISIBILITY CURVES OF THE HUMAN RETINA: *A*, PHOTOPIC; *B*, SCOTOPIC

At intensities corresponding to daylight, the maximum of the curve lies at about 554 mμ, but under twilight illumination, it shifts to the neighbourhood of 511 mμ. When a stimulus of fixed wave-length composition is varied in intensity, brightness is found to be a logarithmic function of the latter in the range of ordinary daylight intensities.

Minimal Energy Need for Vision.—There have been a number of studies on the question of the least amount of radiant energy required to elicit a reaction leading to the perception of light. The possibility of doing this developed when Samuel P. Langley, in the latter part of the 19th century, invented the bolometer, an instrument for measuring the energy distribution of the solar spectrum. Langley himself soon attempted to make the determination of the smallest amount of energy required to elicit visual sensation. He found it to be of the order of 3×10^{-9} ergs for light of 550 mμ. Between then and 1942, when Selig Hecht reported the investigation he and his colleagues. Simon Shlaer and M. H. Pirenne. had made, about a dozen other attempts to solve this problem had been made. Hecht reported that between 2.2 and 5.7×10^{-10} ergs at the cornea is required, this being from 58 to 148 quanta of blue-green light. A number of corrections had, of course, to be applied to arrive at a figure which would represent the number of quanta actually reaching the retina. The first of these corrections pertains to reflection from the cornea, a proportion which amounts to about 4%. The second correction has to do with loss in the ocular media between the outer corneal surface and the retina. Measurements made by others had found this loss to be 50% in young individuals and more in older persons. The third correction pertains to the amount of energy absorbed by the receptors themselves. Correction for this factor is considerably more difficult, but Hecht concluded that the upper limit of absorption is 20%. Taking into account the three corrections, it can be said that between 5 and 14 quanta are actually necessary at the retina. Since the probability that one single rod will absorb two quanta is only about 4%, it can be concluded that only one quantum of light need be absorbed by each of 5 to 14 rods in order for vision to be elicited. By a set of corollary experiments, Hecht obtained the value of between five and seven for the number of critical events to happen in order that a visual effect result. Hence it was concluded that between five and seven quanta is the actual number of quanta absorbed by the retina in threshold vision. Hecht, furthermore, believed he had shown that biological variation is of no great consequence in the threshold act. He believed he showed that in the threshold act, it is the stimulus rather than the observer which is critically variable.

LIGHT DISTRIBUTION AND IMAGE FORMATION ON THE RETINA

Kinds of Light-Sensitive Organs.—Light sensitive organs include three general kinds: (1) the sensitive light patch, activated more or less in accordance with average illumination; (2) the compound eye, which is made up of a number of cylindrical structures positioned side-by-side and directed more or less directly toward the light and (3) the complex eye, such as is illustrated by the human-eye form. In the first form, no redirection of the rays of light occurs. There are no structures for the purpose interposed between the light source and the sensitive area itself. In the second form, the light reaching each segment (ommatidium) falls on sensitive tissue at the opposite end, when its angle is such as nearly to parallel the long axis of the segment. Light falling on the cornea (the transparent structure in front of the ommatidia) is effective only so long as this is true. Oblique light is lost and so as an object passes this eye, light reflected from it reaches first one ommatidium and then another as the object becomes normal to the various ommatidia in succession. Motion differentiation is effected by the animal on this basis. The human eye represents another principle, that of refraction through a nodal point.

The Human Eye and Image Formation.—Before a ray of light can reach the human retina, it must pass through a number of transparent media and refractive surfaces. The eye is a nearly spherical organ, formed of transparent parts situated behind each other, and surrounded by various membranous structures, the anterior part of which is also transparent. The transparent parts are: (1) the cornea; (2) the aqueous humour, found in the anterior chamber of the eye; (3) the crystalline lens, formed by a transparent convex body, the anterior surface of which is less convex than the posterior and (4) the vitreous humour, filling the posterior chamber of the eye. The ray must therefore traverse the cornea, aqueous humour, lens and vitreous humour. Since the two surfaces of the cornea are parallel, the rays suffer practically no deviation in passing through that structure, but they are refracted during their transmission through the other media.

The action of a lens in forming an inverted image is illustrated by fig. 2, where the pencil of rays proceeding from a is brought to a focus at a′, and those from b at b′; consequently the image of ab is inverted at b′ a′. The three characteristic features of the retinal image are: (1) it is reversed; (2) it is sharp and well defined if it be accurately focused on the retina and (3) its size depends on the visual angle.

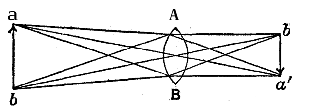

FIG. 2.—INVERSION BY ACTION OF A LENS

If we look at a distant object, a star for example, the rays reaching the eye are parallel, and in passing through the refractive media they are focused at the posterior focal point; that is, on the retina. A line from the luminous point on the retina passing through the nodal point is called the visual line. If the luminous object is not nearer than. say. 60 yd. the image is still brought to a focus on the retina without any effort on the part of the eye. Within this distance, supposing the condition of the eye to be the same as in looking at a star, the image would be formed somewhat behind the posterior focal point, and the effect would be an indistinct impression on the retina. To obviate this, for near distances, accommodation, so as to adjust the eye, is effected by a mechanism to be described later.

When rays, reflected from an object or coming from a luminous point. are not brought to an accurate focus on the retina, the image is not distinct in consequence of the formation of circles of diffusion, the production of which is illustrated in fig. 3. From the point A luminous rays enter the eye in the form of a cone, the kind of which will depend on the pupil. Thus it may be circular, or oval. or even triangular. If the pencil is focused in front of the retina, as at d, or behind it as at f, or, in other words, if the retina, in place of being at F, be in the positions G or H, there mill be a luminous circle or a luminous triangular space. and many elements of the retina will be affected.

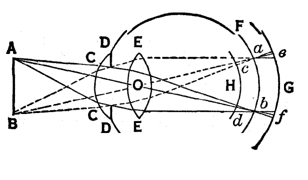

FIG. 3.—FORMATION OF CIRCLES OF DIFFUSION

The size of these diffusion circles depends on the distance from the retina of the point where the rays are focused: the greater the distance, the more extended mill be the diffusion circle. Its size will also be affected by the diameter of the pupil.

Light passing through all portions of the pupil are by no means equally effective in stimulating the retina. This inequality is known as the Stiles-Crawford effect, after the individuals who first gave the phenomenon considerable study.

Optical Defects of the Eye.—As an optical instrument the eye is defective. Because of optical conditions and defects of the eye, a mathematically punctuate image is never formed upon the retina even in a normal eye. The optical defects of the eye are primarily of two sorts: (1) those accruing from the curvature of the refractive surfaces and (2) those caused by the dispersion of the light by refractive media.

Spherical Aberration.—Suppose. as in fig. 4 *MAK* to be a refractive surface on which parallel rays from L to *S* impinge, it will be seen that those rays passing near the circumference are brought to a focus at F^1, and those passing near the centre at F^2, intermediate rays being focused between these tno positions. Consequently on the position of the axis betneen F^1 and F^2 there will be, in effect, a series of focal points and a surface interposed normal to F^2 will receive a blurred and distorted image. In the eye this defect is to a large degree corrected by the following arrangements: (1) the iris cuts off the outer and more strongly refracted rays; (2) the curvature of the cornea is flatter at the periphery and therefore those rays farthest from the axis are relatively least deviated; (3) the anterior and posterior curvatures of the lens are such that the one corrects to some extent the action of the other and (4) the structure of the lens is such that its power of refraction diminishes from the centre to the circumference. and therefore the rays farthest from the axis are relatively less refracted.

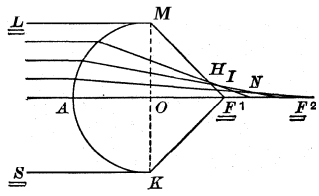

FIG. 4.— SPHERICAL ABERRATION

Astigmatism.—Another very common defect of the eye arises from different meridians of some of the media having different curvatures. This is known as astigmatism. The vertical meridian of the cornea generally has a shorter radius of curvature and is therefore more refractive than the horizontal. The meridians of the lens may also differ, but ordinarily the asymmetry of the cornea is the greater. The optical explanation of astigmatism can be gained from fig. 5. Suppose the vertical meridian CAD to be

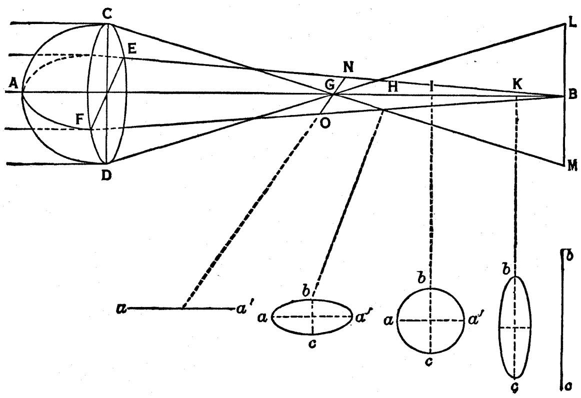

FIG. 5.— DIAGRAM ILLUSTRATING ASTIGMATISM

more strongly curved than the horizontal *FAE*, the rays which fall on CAD will come to a focus at *G*, and those that fall on *FAE* at B. If we divide the pencil of rays at successive points G, H, I, K, B by a section perpendicular to *dB*, the various forms it would present at these points are seen in the figures underneath, so that if the retina were placed at G, a horizontal line *aa'* would be seen, and if at *H* an ellipse with a long axis parallel to AB would he seen, etc. The degree of astigmatism is ascertained by measuring the difference of refraction in the two chief meridians. and the defect is corrected by the use of cylindrical glasses, the curvature of which added to that of the minimum meridian makes its focal length equal to that of the maximum meridian.

Chromatic *Aberration*—When a ray of white light passes through a lens the component rays, since they are unequally refrangible, are dispersed. The violet rays, the most refrangible, are brought to focus nearest the lens. and the red rays. the least refrangible, are brought to a focus somewhat farther away. If a lens uncorrected for chromatic aberration is used, a series of concentric circles will be formed wherever borders exist in the image which is formed. If the image is that of a so-called point or a disk, the near circle will be violet, and the outer a red colour, if the screen on nhich the image is formed is placed at the distance from the lens at nhich violet rays come to a focus. The reverse effect is produced if the screen is placed where the red rays come to a focus.

Diffraction.—Light at the edge of the pupil is broken into a series of concentric spectra contributing to the imperfection of the image. Diffraction is greatest with a small pupil, but is virtually negligible with a pupil three or more millimetres in diameter. Chromatic aberration and diffraction tend to counteract each other.

Defects Caused by Opacities, etc., in the Transparent Media.—Such opacities are termed entoptic and may be of two kinds: (1) extraretinal. those caused by opaque or translucent bodies in any of the refractive structures in front of the retina and presenting the appearance of drops, lines and bodies of unusual and grotesque shape and (2) intraretinal, those opacities in the layers of the retina in front of the rods and cones.

Entoptic Stray Light.—The light activating the retina is of two sorts: (1) the light entering the eye through the pupil and focused to form the retinal image; and (2) the light that reaches the retina otherwise. The latter is called entoptic stray light. Some of this stray light reaches the retina through the walls of the eyeball. and some is reflected from the media within the eye in the course of and after its transmission to the image. Most of the stray light in this category is reflected from the image itself, reaching the other parts of the retina by multiple reflection within the eye. the inner walls of the eye participating. Even when the eye is confronting a visual field, dark except for a single restricted target (stimulus) area, the retina must not be considered as containing an active and an inactive region, but as a system, all parts of which are stimulated to some extent or other. For most purposes, the veil of stray light thrown over the whole retina has been neglected, but in certain kinds of experimentation aimed at understanding retinal function, it has been taken into account.

The amount of entoptic stray light accruing from internal reflection from the retinal image is a function of both the intensity of light in the image and the size of the image. As the size of the image of a bright disk in a dark field is increased and covers a progressively greater fraction of the total retina, the smaller the ratio between the image intensity and the intensity of the light on the rest of the retina becomes. This ratio may be reduced to a much smaller fraction than is ordinarily supposed. It has been found, for example, that a test object (target) subtending a visual angle of 46° resulted in an intensity ratio between retinal image and the area outside of it, of 12 to 1. With a 7° stimulus, the ratio was 700 to 1. These figures were obtained by using excised albino rabbit eyes and microphotometry. The effective value of stray light within the eye may be ascertained by measuring the rise in the differential threshold at the fovea caused by the existence of a light in the periphery of the visual field. By this method it was found that the effect tapers as the peripheral light is placed at a progressively greater angle from the fovea. One of the indications in such an experiment, that it is the veiling effect of stray light and not merely some nervous interaction whose effects are being measured, is the folloning. When the peripheral object is made to cast its image on the optic disc (the insensitive part of the retina), the differential threshold at the fovea is somewhat greater than when the image of the peripheral object falls on retinal areas surrounding it. Since we should expect the less-pigmented optic disc to reflect more light than adjacent areas, the elevation of the differential threshold at the fovea would seem to be, in large part at least, a consequence of a greater amount (veil) of light reflected onto the fovea.

Beyond image formation, the problem of vision involves a number of aspects: (1) the photochemical processes which occur in the receptor cells directly affected by radiant energy; (2) nervous structures in the eye and optic pathway and **(3)** the introspective result called perception, and also the oculo- and other motor phenomena which form an integral part of the act of seeing. While sensation and perception are retained as somewhat separate concepts, modern studies of the manner of dependence of experience upon cerebral conditions have made rather free use of the concept of sensation. Whereas perception is the name for experience as it occurs, the term sensation varies from being a synonym of perception to a hypothetical ingredient of the perception complex, too elusive to extract satisfactorily from it.

THE STRUCTURE AND FUNCTIONS OF THE RETINA

The Structure of the Retina.—As already indicated. the light-sensitive layer of the retina is made up of a carpet of microscopic photosensitive elements, the photoreceptors. These form a mosaic, the fineness of grain of which is one factor in the smallness of object and the fineness of line which can be seen. In general, the retina consists of three main conducting elements lying end-to-end. The first is the receptor cell, the next is the bipolar cell and the third is the ganglion cell. Arborizations (branches) of these cells function for cross-connection and integration of the activities of individual parallel elements. Several other elements, among which are the transverse cells and the amacrine cells, also interconnect parallel elements. To simplify the description, lve may confine ourselves to the first three. The human retina contains two kinds of receptor cells which differ somewhat in their structures, anatomical interconnections, in their distributions in the retina, and in the kinds of sensations they mediate. First of all, the rods are sensitive to much weaker levels of stimulation than the cones and are spoken of as mediating scotopic vision. The cones mediate photopic vision. At very low levels of illumination. sensitivity to colour does not exist. The rods have been shown to be responsible for only the achromatic aspects of sensation. The complete set of differences in function between the two kinds of receptors has long been set forth in what is known as the duplicity theory, a combination of facts and deductions which came to form the basis for understanding human retinal function and human vision. The rods and cones are dissimilarly distributed across the retina. The very centre is rod-free. Beyond this both rods and cones are found, the latter diminishing disproportionately as the periphery of the retina is reached. In the rod-free area (1.5°) the connections of the cones to the bipolar cells and the connections of the bipolar cells to the ganglion cells differ from the connections between these elements toward the periphery. In the rod-free area there is a one-to-one relation between the cells in the three layers. Beyond this region, groups of several cones converge upon each bipolar cell. Convergence of rods occurs in all retinal regions and tends to overlap with that of the cones so that from the bipolars onward a mixed rod-and-cone system eventuates.

Aside from the cones being less sensitive than the rods and mediating vision only at higher levels of illumination, the cones mediate colour vision. This is evidenced by the fact that at very low levels of illumination all radiation, regardless of wave length dives rise to colourless sensations. The ordinary spectrum n-hen reduced in intensity becomes a neutral brand differing in brightness from one part to the other, the brightest part of which is at about 530 $m\mu$, a region which at ordinary levels of intensity would appear green. If the illumination level is raised, the brightest part of the spectrum becomes a region centring at j80 mp. or what is now yellow. That the cones mediate colour vision is also evidenced by the existence of concentric retinal colour zones.

The field of vision for colours is more restricted than for light itself. This is true for illumination of ordinary intensities: but the colour-sensitive held can be greatly expanded by increasing the intensity of illumination. In fact it may be made almost as extensive as that for white light. With ordinary intensities and with patches of coloured paper two centimetres square, the blue field is about 10° smaller than for white. yellow somewhat smaller than for blue and red about 20° smaller than for white. The zone sensitive to green is smaller still. Most colours change their hue as the stimulus object is moved from the fixation point outward toward the periphery. Some spectral colours, however, become merely paler or less and less saturated.

If instead of a spectral mixture monochromatic light is used, low intensities give rise to colourless or gray sensations. The interval measured by the absolute threshold for intensity and the colour threshold is called the photochromatic interval. This varies according to the wave length used. In case of those giving red, the interval is so small that its very existence is difficult to prove.

The shift in point of maximum brightness in the spectrum as intensity is lowered is shared to some degree by all parts of the spectrum, and is known as the Purkinje shift or Purkinje phenomenon. The shift is so marked that. for instance. a red of 670 $m\mu$ viewed under light adaptation at ordinary intensities may be ten times as bright as a blue of 480 $m\mu$, but only one-sixteenth as bright at decreased illumination and under dark adaptation.

The yellow spot or macula lutea in the centre of the retina is the area that is peculiarly sensitive to light. This area mediates the finest distinctions which are possible to perceive. Vision using this area is called direct vision.

The macula is oval. the vertical axis being about 1 mm. and the horizontal 3 mm. representing visual angle of about 3° and 12°. Within the macula is a 1" region.—a pit called the fovea, which is the part of the retina specialized for the most distinct vision.

The field of vision around the fixation point extends for more than go° horizontally outward, 70° downward, 60° inward. or nasally. and 50° upward.

There is one portion of the retina nhich is not excitable at all. This is the small region at which the fibres of the ganglion cells assemble and leave the eye to form the optic nerve. The area is called the optic papilla or optic disc. Distinguished from this, the area of the visual field within which stimuli cast light on the optic disc is called the blind spot. The diameter of the optic disc is about one and four-fifths millimetres, equivalent to a visual angle of about 6". The shape of the blind spot is generally somewhat ovoid with the centre lying somewhat below the visual fixation point and from 12° to 18° temporal to it.

If the visual field is unilluminated save for the test object whose image is made to fall on the optic disc. the sensory end result will vary in accordance with the intensity of the test object and its size in relation to the disc. Because of the fact that the light incident on the disc must reach sensitive elements on the retina around it to be effective, the threshold for obtaining any perceptual effect from optic-disc illumination is higher than for direct stimulation of other parts of the retina. The sensitive elements that surround the optic disc may be considered adjacent to each other as are two elements which lie close to each other in other regions of the retina. Light cast on the disc may be considered as cast between adjacent elements On other parts of the retina, were light to be precisely confined to the microscopically tiny space between adjacent cones or rods, it would not be expected to stimulate them, and no sensory end result mould occur. If, however, adjacent elements are stimulated the end effect is the impression of a single or continuous surface. This is why, when the sensitive border lying around the optic disc is illuminated, the subjective result is not that of a ring but of a patch or disk of light. If the image of the stimulus object is small and lies well within the optic disk, the stimulus must be rather intense to provide enough light to reach the borders of the optic disk. The phenomena arising from experimentation with optic-disk illumination are many because of the fact that many spatial and other arrangements of the stimuli have been studied.

Photoreception. — The initial visual activity is the photochemical processes in the eye. These possess characteristics which are reflected all the way from the retina through the neural elaborations which take place in the various parts of the nervous system, ultimately to consciousness itself. It has been pointed out that whatever the detailed processes may be, the photochemistry of the eye must possess three essentials: (1) there must be a sensitive substance which absorbs light and is transformed by it into one or more active products; (a) a supply of this substance must be maintained. or the activity would tenninate and vision would no longer be possible; these processes. (1) and (a), have customarily been called the primary light and primary dark reactions; (3) the active products of the primary light reaction must act in such a way that the end result is an impulse in the outgoing fibre of the receptor cell; this activity has been called the secondary dark reaction. The simplest photochemical postulates assume a photosensitive substance *S*. which, as a result of light shining on it, is broken into two other substances P and *A*. It is generally supposed that some of the photoproducts can reunite with or without the aid of additional substances or energy, to re-form the original sensitive material *S*. When such a chemical system of two opposing reactions (separation and recombination) is exposed to light, the two reactions proceed concomitantly until their rates become equal and the system reaches a pseudostationary state. The production of substances P and *A* of a given concentration at a given moment *t* reaches a velocity which is proportional to the light intensity I falling upon S, and to the difference between the original concentration a of S and its concentration at the moment x. Thus the equation may be written

$$dx/dt=k_1I(a-x)^m,$$

in which m is the order of the reaction and k_1, a velocity constant including the absorption coefficient. On the other hand, the velocity of the opposite reaction (dark reaction) is proportional to the concentrations x of the photoproducts. The equation for this is therefore

$$dx/dt=k_2x^n,$$

n being the order of the reaction and k_2 the velocity constant. Although this formulation of the processes may be too simple to account for all the facts, it has been found that the equations are so close to the data that the numerical values which represent the specific shapes and slopes of the curves representing certain visual functions can be determined.

The quantitative properties of several of these visual functions have been described faithfully in terms of the above-mentioned theoretical assumptions, apparently the siniplest which can be conceived to take place in the retinal elements. After the general acceptance of these assumptions and equations, there were occasional attempts to modify the equations so as to handle the visual phenomena which experimentation had brought to light but not yet explained at mid-20th century.

Since the photoreceptors of the eye are of two kinds (the rods and the cones). and functions somewhat differently, it might be expected that separate photosensitive pigments for the two would be detectable. Such has not been the case. No photosensitive substance characteristic of the cones had been discovered by mid-20th century although repeated efforts had been made. The visual purple found in the rods has manifested many properties which fit in well with visual information. It possesses an absorption spectrum with a maximum coinciding with the rod visibility curve. Likewise visual purple even in solution can undergo colour regeneration following bleaching. It has also long been known that visual purple may regenerate in two ways; (1) directly from its products and (2) from the proper materials supplied to the system.

The Retinoneural Events. — The retina, consisting, as already described, of a layer of photosensitive cells, is able to transmit to the brain a kind of complex set of signals regarding the outside world. Light acts on each of the individual cells making up the retinal mosaic in accordance with its intensity. Since all images consist of weak and intensely lighted parts, some cells transmit more activity than others. This activity is modified even before it leaves the retina, by the already described neural layers. The activity of the cells or units in each of the three layers of the retina consists in trains of very brief and tiny electrical impulses. Intense activity is represented by the occurrence of a very rapid series of impulses; weak activity is indicated by a slow series. There is not a one-to-one relation between the rate and number of impulses in the first, second and third layers of the retina; hence a modified version of the activity of the first or photoreceptor cell layer is transmitted along the optic nerve to the brain. Here, likewise, the pattern of activity reaching it is modified again and again as the input travels from the lower to the higher centres. Throughout the nervous system it is characteristic for the individual nerve cells, when set into action, to express something of their own properties in their discharge. This is manifest in impulse rate and the over-all duration of the impulse series. Modifications in impulse-discharge patterns are caused by (1) collateral impulses from other parts of the brain arriving in the same area along with the visual input, (2) the activity already in existence in the tissue in question as the visual input arrives, and (3) the basic principle already stated in regard to the retina; *i.e.*, that there is no one-to-one relation between reception of impulses in a complex nervous tissue (mass of cells) and the over-all distribution of impulses that is sent on to other regions.

The **Electroretinogram—The** Gross **Record of** Eye Activity. — Electrical effects can be detected if electrodes be placed, one upon the cornea, and the other either somewhere on the back of the eyeball or else on the tissue over the eye. The effects recorded are called electroretinograms and have most usually been investigated in animal forms rather than in man. In the former, the rear electrode can be placed near the optic nerve, and many other conditions can be obtained which are more conducive to good recording than in the human.

The electroretinogram is an over-all effect of the activity of the many receptors in the eye. For this reason it is not extremely definitive, but by the use of depressants, etc., the electroretinogram has been analyzed into three major components, *PI*, *PII* and *PIII*, which individually or in various combinations are responsible for the four waves, a, *b*, *c*, and *d*, which appear in the electroretinogram. The a wave is an initial slight negative deflection; the *b* wave, the large positive deflection which follows and declines often, but not always, to the base line before the *c* wave appears as a second positive wave, much longer and slower in its rise to maximum. If the flash producing the electroretinogram is quite long, a dip in the decline of the *c* wave to base line is known as the d wave. If the flash is very short the *c* wave is absent. It has been found that the many receptors aeakly stimulated by entoptic stray light contribute vastly more to the production of the recordable electroretinogram than do the intensely stimulated receptors which the image covers.

EVENTS IN THE OPTIC PATHWAY

Response of the Optic Nerve. — The long processes (axons) of the ganglion cells of the vertebrate retina form the fibres of the optic nerve. These number into the myriads, the actual number depending upon the animal form. The final pattern of events in the retina is transmitted to the brain in the form of groupings of impulses conducted along the optic-nerve fibres. These have been recorded by electrical methods in a few animal forms, such as the rabbit, cat and guinea pig. When a flash of light is presented to the eye, a burst of impulses is discharged into the optic nerve. The burst in some cases is not single but dual. Regardless of the duality, the result is taken together as the "on" response. If the flash is very short and quite weak, the response wave, if slightly above threshold, is quite simple and brief. Either lengthening the flash or strengthening it soon causes the response to contain a series of small sharp wavelets to follow the "on" response. Further increasing the stimulus in either respect results in the emergence of a single secondary wave which replaces the wavelet train. Still further stimulus increases results in the diminution of the secondary wave almost to a mere trace. If stimulation increase is brought about by lengthening the flash, a wave appears in the record to represent the flash's termination. However, by the time that this "off" response has reached a fair size, it is obvious that the remnant of the secondary wave has moved out later in the record and follows the "off" response. The use of the same stimulus setup for obtaining human sensory impressions has demonstrated that a flash of a given range of latency elicits a second visual impression. That is to say, a single flash (photic impulse) may appear to be a pair of flashes. If the stimulus is made still more potent, the second subjective impression disappears. A correlation between the sensory phenomena just described and the appearance and disappearance of the secondary wave in the optic-nerve discharge has been made. The second of the pair of sensory impressions is so timed as to appear to be one of the classical train of afterimages.

Response of the Optic Cortex. — The recordable response of the cortex is a complex wave whose major components have been analyzed by several methods including the local application of drugs to restricted areas of the cortical surface and by recording from the cortex at various depths below the surface. The usual response recorded at the surface consists of several parts. some tiny spikes which are not always detectable and two larger components, the earlier of which is augmented and made repetitive by strychnine locally applied, the later component being obliterated under the same conditions. The later component is assignable to certain cortical elements having to do with the continued spontaneous activity of the cortex, at least those underlying the alpha-rhythm, the main waves in the standard electroencephalogram.

At times the alpha-rhythm is masked by the presence of the many lesser waves comprising the spontaneous activity of the cortex. The cortical response to flashes of light manifests both an "on" and an "off" component when the flash is long enough and this need only be a fraction of a second. As already indicated the second major component of the cortical response and the alpha-rhythm are related. In fact it seems that a part of it represents the first wave in a train of alpha-waves. A brief but intense flash of light will institute a whole train of alpha-waves in a cortex which at the time is not manifesting prominent alpha-waves spontaneously. This is taken as a demonstration of the fact that sensory stimulation can drive the cortex. This driving effect can also be demonstrated by use of a continued series of light flashes, depending upon the rate at which the flashes are presented. Driving has certain fairly circumscribed upper limits in regard to the flash frequencies involved. If the alpha waves in the cortex are quite pronounced at the time of stimulation, the first few flashes at least will not find themselves equally well able to elicit recordable responses. The sizes of the responses will vary in accordance with where they fall in the activity-rest cycle of the groups of cells responsible for the alpha-waves. Soon however, the result may be one of driving in which fairly regular responses will follow in a train, or else the flash frequency may prove to be so remote from the range in which driving can occur that little detectable result will accrue from the flash series. This does not mean that a rapid series of flashes is ineffective in eliciting what might be called a visual response from the cortex. It only means that whatever activity there is, is more nearly uniformly distributed in space and time so that no groupings of activity are represented by waves in the record.

Response at Other Stations in the Optic Pathway.— Between the eye and the optic cortex there are several way stations such as the lateral geniculate body and the superior colliculus from which recordings can and have been made. Correlations of the events in these stations with the known microanatomical structures involved affords a way of constructing a picture of how the optic pathway operates. Furthermore, such studies have contributed valuable information regarding nervous function in general.

THE NATURE OF VISUAL PERCEPTION

Perception as the Creation of Objects.—The world as the physicist knows it is not composed of the objects we experience, but is made up of molecular and atomic activities which cannot be appreciated in a sensory way at all. They are conceived of only through the effects produced on recording instruments. Were it not for the fact that man cannot think in terms which are devoid of objects, the physicist would probably prefer to rid himself of some of the thinglike characters of his constructs in his own field. One form of this imputed activity is a kind of radiation called light which affects our eyes. The end result is the experience of objects which, although human constructs, are the only "reals" we have. At least, when in doubt, the conflict is resolved by believing something we sense rather than our ideational constructs. It can be said that vision is one of our object-constructing activities. It is by virtue of vision and the other object-constructing processes that me live in a world of obje'cts. All external influences which lead to consciousness at all result in thinglike characteristics.

The minimum of thinglikeness exists in vision when the radiation in the visual field is such as uniformly to stimulate the entire retina. We then say that the visual field is homogeneous. It may be gray, or coloured, but let the least differentiation in radiation reach the eye, as when a black line is drawn on a white card, and immediately one sees a localized thing. The visual field is now differentiated into figure field, and ground field. The visual properties that each possesses are different from the other. One of the simplest illustrations of a figure-ground situation is the perceptual result when two parallel lines are drawn on a blank sheet of paper. (*See* fig. 6.) These may be seen simply as lines in which case each one is a figure on a ground (the blank area), or they may be seen as the edges of a strip of material, the boundaries of a plank or walkway or a vertical pillar. If so, the visual quality of the area they bound is distinctly different from the quality of the area outside the lines. It is said that the area possesses a thinglike quality, whereas the area outside simply gives the impression of extent in space. The area within the figure has a surfacelike property and is localized. The ground is unlocalized and recedes into the remote distance. All visual fields are by no means so simple and what is figure and what is ground becomes more difficult to define. Nevertheless the figure-ground concept has served to emphasize certain basic features of visual perception and has instigated considerable visual research.

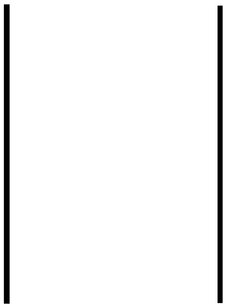

FIG. 6.—A FIGURE-GROUND PATTERN

Segregation and Synthesis.— There remains the problem of why and how certain parts of the visual field are seen as belonging together and others as not. In the case of a single dark line on a white field, the problem is nonexistent, but in the case of complex visual fields, why certain portions are seen as adhering (belonging) together and others not, is a subtle problem. In solving this. there are certain factors that can be imputed to the nature of the visual field itself, and others must be sought in the organization of man himself.

Identity and Localization.— In addition to solving the problem from instant to instant as to what belongs together and thus is one object, and what is to be seen as other objects, the organism must identify and localize the objects it sees.

Temporal Continuity in Vision.—The individual not only supplies the anatomical structures for action but an ongoing functional organism which is often overlooked in analysis. The organism must be looked upon as a continuity so that the investigator's problem is more than a problem of the present. He must see the present in the light of the past and in terms of the future. This is merely to say that organismic activity is directional. Vision partakes of these characteristics and becomes fully understandable only when this is actually recognized in the methods used to analyze it.

Sensation as Prognosis.—Visual perception is prognostic in the sense that what one sees is of one's own construction using the stimulation of the instant in ways which. although perfectly lawful, do not always produce the answer which will tally with some other sense. Vision, taken as a single sense, is generally aided by other senses which help account for its character, but it is possible for these other senses to collide with vision. It is scarcely possible for all of them always to substantiate each other. There are those students of human behaviour who teach that the feeling of certainty is a measure of the many cues which exist at a given moment, and how well they harmonize. Action is not only directional but also purposeful. By purposeful is meant simply that certain conditions are required to bring activity to rest.

SOME FACTORS INVOLVED IN OBJECT PERCEPTION

General.— It was pointed out in the last section that vision is an object-forming activity. The general principles of visual perception were briefly sketched. It is the purpose of the present section to indicate some of the features of the visual processes which provide the basis for separating the various parts of the visual field from each other and thus for the perception of objects. It is only nith an organism which can adapt to levels of illumination, discriminate between the existing levels in the momentarily given field, and appreciate differences involving small spatial dimensions that man can begin to construct a world of sensory objects. His appreciation of temporal features of the stimulus situation is also involved in object perception. For example, the spokes in a wheel may turn so fast that visually the wheel becomes a disk. Out of a series of flashes of light the organism may construct a uniformly illuminated field with surface properties not previously existent.

For the study of the basic functions involved in object-formation, an understanding of what is known as the threshold or limen is necessary.

The Threshold.— The threshold is a concept arising from the fact that sensory changes are not always commensurate with and concomitant with changes in physical conditions. For example, the intensity of illumination upon a surface may change and be accompanied by no shift in the perceived brightness of the surface. A difference is perceived only after the physical change has reached a sufficient magnitude. This amount is spoken of as the threshold. Whereas the shift in illumination may be gradual, the experienced changes may be stepwise if the physical change is slow. Thresholds are defined statistically. If an observer is asked to judge whether two adjacent surfaces are equal in brightness, he will vary from trial to trial in what he sees. If one surface is slightly more luminous than the other, he may see it as brighter than the other in some of the trials. Just what proportion of the trials yields judgments of brighter will depend, among other things, upon the absolute physical intensity differences between the two surfaces. The percentage expressing threshold is arbitrary. In defining threshold, the number of kinds of choices the observer can make is taken into account, for this determines the percentage of times the observer could be correct by guessing. Thresholds have been classified in two groups: (1) absolute and (2) differential. The former are obtained by measuring the required differences in intensity between the target and a homogeneous dark field. The latter are measured by ascertaining differences between two parts of a target in a field, either dark or illuminated, or between an object and its illuminated surrounding field. The determination of thresholds of one sort or another enters into all kinds of experimental investigations of vision.

Adaptation. — If one suddenly enters a dimly lighted room from bright surroundings, he finds himself almost unable to see objects in the room. Shortly, however, the darkness becomes less extreme and the larger or more luminous objects become distinguishable. The brightness level continues to rise from a period of 30 min. to 40 min., or more. This process is known as dark adaptation and is measured by subjection of the individual to complete darkness and determining at a series of successive intervals the threshold for seeing a standard test object. The results show that after dark adaptation an object need be many thousand times less intense in order just to be seen. Thus it may be said that in the fully dark-adapted condition the eye is many thousand times as sensitive as in ordinary daylight. Daylight illuminations, of course, vary over a considerable range and for precise purposes a standard intensity must be chosen for reference and for the preadaptive period. When an individual enters a lighted area from a dark room, the reverse adjustment, namely light adaptation, takes place. This occurs much more rapidly than does dark adaptation. For the most part adaptation is a basic shift in the level of functioning of the photoreceptor cells in the retina. Both the rods and cones adapt. Cone adaptation, of course, occupies the first portion of the dark-adaptation period, and the rods primarily the latter. When thresholds are plotted against time in the dark, the adaptation curve is composed of two segments, the first representing cone adaptation which is complete in the first few minutes and the second representing rod adaptation. Each segment begins with a steep portion and ends by tapering off toward horizontal. Certain other phenomena sometimes included in the category of adaptation take place in the neuroretina and elsewhere in the optic pathway. These phenomena have received much less study than have the receptor processes and are less well known.

Brightness Discrimination. — Brightness discrimination is the broad term which includes all those features of distinguishing one part of the visual field from the other on the basis of relative amounts of radiant flux reaching the different portions of the retina. Discriminations based on differences in wave length are colour discriminations, although amounts of flux cannot be eliminated as factors even here. Colours as well as grays vary in brightness. Brightness discrimination has received much formal investigation. Standard test situations have included: (1) single disks on dark backgrounds, (2) single disks on lighted backgrounds in which cases the intensity levels of the disks were sometimes below that of the backgrounds, (3) bipartite test objects on light or dark backgrounds, in which cases the test objects were either bisected rectangles, or disks, or disk-annulus figures. The detection of the difference between the component surfaces of a bipartite test object is manipulated by the level of the background. The lowest thresholds are obtained when the background is at the mean level of the components. Both the absolute threshold and the differential are dependent upon the area of the test surface.

Visual Resolution and Visual Acuity. — In order that one part of the visual field be distinguished from others, spatial as well as intensity relations must be taken into account. When two portions of the visual field are moderately widely separated, the matter of space is not critical in this distinguishing process. But when two areas are separated by only a narrow area between them, the width of the latter area becomes critical. Two objects not actually touching can become so close that no space between them is discernible. If they are alike in surface brightness they visually become one continuous form. That the separation of two areas can be a finite amount without being discernible makes visual resolution of both practical and theoretical importance. Separations in the visual field are measured by what is known as the visual angle. It is the solid angle subtended at the eye by an object or interspace. The smaller the visual angle at which the separation between any two areas can be perceived, the greater the visual acuity. Visual acuity is generally measured as the reciprocal of the visual angle measured in minutes of arc. Visual acuity is dependent, among other things, upon the resolving power of the retina. This in turn is dependent upon the size and spacing of the retinal elements which make up the grain of the retina. Since the distribution of the light on the retina does not involve gradients as steep as exist at the boundary between the reflecting surfaces in the visual field, a second factor in relation to the mosaic is brought into play; namely, the intensity differential between the total amount of light falling on adjacent retinal elements. If this is of the order of 1%, apparently the end result is the perception of a border. Though retinal cells do not lie in perfectly straight lines, the border that is perceived is nevertheless regular. Visual acuity is measured in a number of standard ways. It is derived either by the use of pairs of bars, gratings, figure C's (Landolt broken circles), or less accurately by lines of letters of predetermined sizes (Snellen charts), etc. The several methods do not yield results of the same order of value. In fact a single dark line on a homogeneous light field has yielded the highest visual acuity of all. A line subtending only 0.5″ of arc in width has been perceived. Visual acuity differs in accordance with the intensity relations between test objects and background. If the bars are dark and on a light ground, the resolvability increases as the intensity level of the ground increases. If bright bars on a dark background are used, the resolvability does not reach so high a maximum as with converse intensity relations between the bars and ground. As the intensity of the bars is increased beyond a certain point, resolvability decreases. Also the width of the bars plays a role in their resolvability. With wide bars visual acuity at first increases rapidly with increase in intensity, and then more slowly. With the same intensity increases in narrow bars, visual acuity reverses in value beyond a certain maximum.

Response to Variable and Intermittent **Illumination.**— Any rapidly varying or rapidly intermittent visual stimulation gives rise to what is known as flicker, an experience occurring in many everyday situations. Intermittent stimulation is important as a means of studying visual response, for by means of a series of flashes not only the lag in response to a single flash, but also the physiological effects remaining from the preceding flash can be studied. An everyday example of the action of an intermittent component of visual stimulation occurs when an individual passes along a high paling fence. In such a situation, a given portion of the retina is subjected to a temporarily alternate series of lights and shadows.

Intermittent stimulation may be so applied to the retina that the members of the series are applied to a succession of different retinal areas. This is the case when a neon lamp is rapidly passed before the eyes. The lamp has an extremely short lag and thus follows the phases of the alternating current with a slight dark interval between glow periods. Each glow period finds the lamp at a different position before the eyes and thus produces an image on a fresh portion of the retina. As a result a row of lamps is seen as the lamp is passed before the eyes. This is one example of stroboscopic effect. Continuously moving objects as a result of a series of stationary picture presentations, as in motion pictures, is another example. A third example' is the stationary appearance derived from a moving object, intermittently illuminated. For example, if a disk with a series of black and white radial bands on it is moved so that one or more of the white bands pass a given point during the dark interval between two flashes of light, the disk will appear to be stationary. If the rate of flashes in the series is known, and the number of bands on the disk is also known, the rate of the revolution of the disk can be calculated. A special application of this exists in the movies when a carriage is seen to pass by the spectators. Very often the spokes of the wheels will be seen to move backward or stand still. This means that the timing of successive frames and the position of the spokes in the frames is inappropriate, except to give the stationary effect or backward motion.

The rate of intermittency of illumination can be made great enough to result in the perception of steady brightness without even a trace of a flicker. The classical formulation with regard to this is Talbot's law. It states that the brightness of subjectively steady light obtained with intermittent illumination is equivalent to the brightness obtained when the same amount of radiation is uniformly distributed in time. For example, if alternate periods of illumination and darkness are of equal length, the brightness level will be one-half of the value resulting from continuous illumination. The point at which all flicker disappears is called the fusion point. The flash rate necessary just to produce fusion is called the critical flicker frequency (c.f.f.). Critical flicker frequency is higher the greater the intensity of the light and the greater the area of the stimulus field. Over a considerable range of intensities this relation describes a straight line when the logarithm of flash intensity is plotted against flash frequency required just to reach the fusion point.

Whereas most of the studies dealing with intermittent stimulation have pertained to critical flicker frequency, some attention has been paid to what happens below that point. The best way to understand some of these phenomena is to know that single isolated flashes produce greater brightness than does continued illumination of the same physical intensity.

However, a finite amount of time is required for a flash to elicit a response, and the brightness of the subjective impression rises to a peak and then declines if the flash is protracted for a considerable period. A very rapid series of flashes, however, simulate uniform stimulation in respect to subjective continuity produced, but not in intensity. Each flash in a series does not elicit the same vigour of response as do isolated flashes. If rates much lower

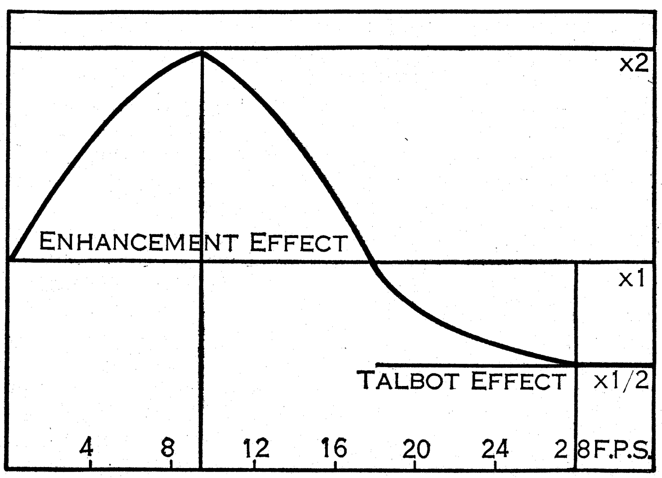

FIG. 7.— THE TALBOT AND ENHANCEMENT EFFECTS

than c.f.f. are used, the net result is greater, however, than that obtained from steady illumination. This is called the enhancement or Bartley effect and reaches a maximum at a flash rate of 8 or 10 per second. Incidentally this rate happens to be of the same order as that of the alpha-rhythm in the cerebral cortex. Certain good reasons are given for attributing the enhancement effect to the same origins as that of the alpha-rhythm. Fig. 7 illustrates both the Talbot effect and the enhancement effect. The horizontal parallel to the abscissa indicates the brightness level of continuous illumination of the same physical intensity as the flashes used. The left end of the curve transcends this and illustrates the enhancement effect. The right end of the curve drops below the horizontal line (brightness of continuous illumination) and illustrates the Talbot effect. The abscissa of the graph indicates the number of flashes per second (f.p.s.). The first perpendicular line is at between 9 f.p.s. and 10 f.p.s. The second one is at c.f.f., in this instance, 28 f.p.s. The light-dark ratio of the cycle used is one-to-one.

Whereas it might be expected that at all flash rates below c.f.f. the subjective pulses would follow the flashes in a one-to-one relation, this is not the case. At times the retinal effects follow at half rate (one retinal discharge burst for every second flash). The subjective rate of the flicker existing just below its final obliteration need not follow the flash rate. If a series of very weak flashes are used, c.f.f. may be found to be as low as 3 or 4 per second. The last vestige of flicker possesses a much higher rate than this. If a series of very intense flashes is used, c.f.f. may be 50 per second. The last vestige of flicker is much below this rate. The actual rate has not been precisely measured, but it is safe to say it is in the region of 20 per second. This discrepancy between flash rate and the last remnant of flicker is taken to be one indication that the intrinsic properties of the ganglion cells themselves play a definitive role in the rate of impulses sent into the optic nerve. Flicker rates tally with this rate rather than flash rate. Under many conditions flash rates and discharge rates coincide; under some they do not.

Contour Formation.— All the factors which pertain to the structurization of objects are not included in dealing with adaptation, visual acuity and brightness discrimination. Another aspect of the matter falls into the category of contour formation. The phenomena pertaining to contour formation include those of brightness contrast and visual field structure. Contour can thus be thought of in two sets of terms, those of gradient and those of shape. Contour is involved in the production of the differential threshold, for one essential feature of distinguishing the intensity level of one area as compared to another is the perception of a boundary between them. Putting the matter the other way around, the matching of two adjacent homogeneous areas is accomplished when conditions are such that the boundary betneen them disappears This is taken advantage of in photometers, instruments designed for measuring light intensities.

It has been found that the presence of other contours in the field of vision influence the level of the differential threshold. In many cases in which it was once thought that only the area of the surrounding field influenced threshold, it has been demonstrated that the existence of other borders in the field played a role. The distance of such borders from the area in question is a factor in their effect.

An example of this is the fact that the threshold of a disk on a slightly darker ground drops as the area of the disk is increased. Some authors attributed this to the inclusion of more and more receptor elements within the retinal area stimulated by the image of the disk. Evidence indicates that the effect is rather to be assigned to the action of border processes. When a disk area is used for measuring threshold. the borders on the opposite sides of the disk tend to interfere with each other, the amount depending on the size of the disk. When the disk is small, the borders of the disk are closer and the threshold is high. In fact some go so far as to state that Fechner's paradox (*q.v.*) is not dependent on the presence or absence of summation, but rather is an example of one of the functions of contour processes. It can be said that whatever reduces or obliterates border formation destroys the appreciation of the brightness a surface would otherwise have. This is illustrated by an experiment in which a dark disk is presented to an observer, and as it is removed a ring whose centre is concentric with the disk is presented. The inner edge of the ring is in the same place as the outer edge of the disk. If the rate of the successive presentations is critically timed, the blackness of the disk disappears. In other words, the area where the dark disk was being shown now becomes white. The disk loses its original value and disappears. If, however. the disk is followed by the presentation of only a half ring, the part of the disk on the ring side is all that will disappear. The processes which are involved in this phenomena may be something as follows: when the disk is presented first, to be soon followed by the ring, the border of the disk may not have had sufficient time to form. Since the border is not completely formed during the only period it could, the ring simply develops as a ring without the disk's ever having been perceivable. At a crucial instant in the existence of the partly formed disk border, the presentation of the ring may be able to utilize it to form or accentuate its own inner border.

Sensations of **Colour.**—Colour is a special sensation excited by the action on the retina of rays of light of a definite wave length. The most likely hypothesis as to the physical nature of light is that colour depends on the rate of vibration of the luminiferous ether, and white light is a compound of all the colours in definite proportion. When a surface reflects solar light into the eye without affecting this proportion, it is white, but if it absorbs all the light and reflects nothing, it appears to be black. If a body held between the eye and the sun transmits light unchanged and is transparent, it is colourless, but if translucent, it is white. If the medium transmits or reflects some rays and absorbs others, it is coloured. Thus, if a body absorbs all the rays of the spectrum but those which cause the sensation of green. we say the body is green in colour; but this green can be perceived only if the rays of light falling on the body contain rays having the special rate of vibration required for this special colour. The part played by the light illuminating the surface and the way in which the colours of mixed pigments are produced are discussed under COLOUR.

Modes of Mixing Colour Sensations.—Various methods have been adopted for studying the effect of mixing colours. They are mixed by:

1. Superimposing parts of two spectra.

2. Method of reflection. Place a red disk near the farther end of a sheet of paper lying on a table and a blue disk on the nearer end. By holding a glass plate vertically, the eye can be so placed as to receive light from the red disk by transmission through the glass, and from the blue disk by reflection. Under such conditions the disk will appear to be purple, and by using disks of different colours, many experiments may be performed.

3. By rotating disks which quickly superpose on the same area of retina the impressions of different wave lengths. Such disks have two or more sectors, each of a different colour. For example, the angles of the sectors originally given by Sir Isaac Newton were:

Red	60° 45.5′	Green	60° 45.5′
Orange	34° 10.5′	Blue	54° 41′
Yellow	54° 41′	Indigo	34° 10.5′
Violet	60° 45.5′		

With sectors of such a size, gray will be produced on rotating the disk rapidly. This method was carried out with great efficiency by the colour top of J. Clerk-Maxwell. This is a flat top, on the surface of which disks of various colours may be placed. Wayne Dancer has added to it a method by which, even while the top is rotating rapidly and the sensation of a mixed colour is strongly perceived, the eye may be able to see the simple colours of which it is composed. This is done by placing on the handle of the top, a short distance above the coloured surface, a thin black disk, perforated by holes of various size and pattern and weighted a little on one side. The disk vibrates to and fro rapidly and breaks the continuity of the colour impression; and thus the constituent colours are readily seen.

Colour Blindness.—The character of colour blindness is studied by ascertaining abilities of individuals to compare narrow bands or single wave lengths of the visible spectrum. The major fact of normal colour vision is that any part of the spectrum may be matched by combining three properly chosen parts of the spectrum. Individuals possessing such vision are trichromats.

Individuals whose colour vision is defective have most frequently been put into three general classes: (1) anomalous trichromats, those who confuse parts of the spectrum, but require three primaries to make a spectral match; (2) the dichromats, the colour-weak persons; (3) the monochromats, the fully colour blind. The dichromats are persons who confuse large sections of the spectrum, matching any part of it with a mixture of two primaries, and matching yellows and blue-greens with white. There are three types of dichromats: (1) protanopes, who confuse green, yellow and red, and match blue-green with white; since their brightness sensitivity is depressed in the red end of the spectrum, they are often called red blind; (2) deuteranopes, who also confuse green, yellow and red, and match a point in the blue-greens with white. but possess brightness perception approaching normal; (3) tritanopes, who are unlike the first two groups since they match a yellow with white. Monochromats confuse various parts of the spectrum with each other, which they match by proper manipulations of intensity. This class includes two types of individuals: (1) those with brightness perception following the visibility curve of the rods; they are the scotopic monochromats; (2) those whose brightness perception simulates cone vision; they are called photopic monochromats. Notwithstanding the impression this classification may give, colour-defective people do not actually fall into distinct classes.

When everyday colour combinations are not discriminated, the individual erroneously sees surfaces juxtaposed, or he mistakes them for a chromatically homogeneous surface. The result is camouflage. In war, camouflage is intended. In everyday affairs, camouflage is incidental and may occur from defective colour vision. For an area to be hidden from the deuteranope or protanope, it is required only that it be neither lighter nor darker and neither yellower nor bluer than the surroundings. Whether it is redder or greener is immaterial.

Two surfaces, although appearing to match in hue, may be different in their reflectances of certain parts of the spectrum. Such surfaces may therefore involve spectral differences undetectable even to the normal eye. Such pairs of colours are termed pseudo matches, or metameric pairs. A metameric pair of coloured surfaces satisfactory to the normal observer will often be a little off-match for an anomalous trichromat.

RELATIONS BETWEEN OBJECT, IMAGE AND VISUAL EXPERIENCE

It is customary to attempt to discover as many fixed relations between object, retinal image and sensation as possible. As far as geometry is concerned, a few generalizations can be made. For example, the relation between the visual angle and the size of the retinal image is fixed. Furthermore there are known relations between the positions of the eyes and certain over-all features of images of two-dimensional objects. There is not a fixed relation between the shapes and sizes and orientations of plane surfaces and the shapes and sizes of the retinal images. Just as long as the outline of an object subtends the same visual angle, it fulfils the same visual function as that of an infinity of other objects which would do likewise. In fig. 8, geometrical patterns 1, 2. 3. 4 and 5 differ in shape, size and in the plane or planes in which they lie. They are not even all plane objects, and their orientation, with reference to the section of the retina on which their image falls, differs in each case. Thus, while there are fixed relations between an object's shape, size, distance and orientation, and the image formed on the retina, these do not differentiate it from some other object of different size, shape, distance and orientation which subtends the same visual angles. The fact that objects subtending the same visual angles are seen as identical can

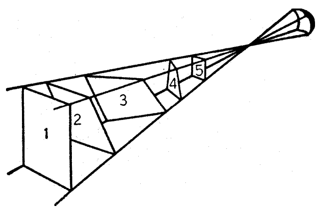

FIG. 8.— GROUP OF FIGURES EACH SUBTENDING THE SAME VISUAL ANGLE

well be illustrated by the following method used by Fritz Heider. Support a small cube by a wire or rod about six inches from a table. At the edge of the table erect a screen bearing a peephole about ten inches from the level of the table. Position the cube so that it presents three vertical edges to view and so that a large white sheet of paper is seen when looking past the cube. While sighting past the visible corners of the cube, place pencil marks to indicate the positions on the paper. Connect the appropriate points by straight lines, and a drawing which is a representation of a distorted three-dimensional figure (when viewed by looking obliquely at it from any ordinary viewing position) will result. However, after removing the cube, view the drawing through the peephole and it will be seen as a cube. This means that both the drawing and the cube itself look like a cube. If the extraneous cubes are eliminated, and the brightness values are equivalent in the fields view, the cube and the drawing will be indistinguishable. The setup is illustrated in fig. 9. A. Ames further exemplified this principle by making three situations equivalent. The original cube is a white wire model, the wire constituting the edges of the cube. This is suspended in space and viewed through a peephole and against a dark background. The second is a white wire plane figure of the proper shape to be equivalent in appearance to the cube when viewed through a properly placed peephole. This also is suspended in space by five invisible wires and viewed against a dark background. The third object which is visually equivalent to the other two is a set of white strings tied to a set of invisible wires which radiate from the peephole viewing position and subtend the proper visual angles. These angles are, of course, those subtended by the corners of the real cube. It does not matter how far away from the eye these strings are attached, or what angles they make with the line of regard; they form the edges of what appears to be a genuine cube. This then is a demonstration of how three very different objects all appear to be the same objects, or perfectly equivalent objects.

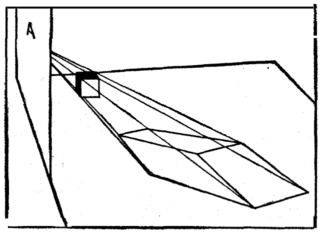

FIG. 9.—VISUAL EQUALITY OF THREE-DIMENSIONAL CUBE AND ITS TWO-DIMENSIONAL REPRESENTATION

Objects of fixed size, shape, distance and orientation, of course, cast a fixed image on the retina so long as the eye does not move. But when the eyes move, the images change location on the two retinas and the relative shapes and sizes of the images change without a resulting change in the perceived object. It remains fixed and retains its original geometrical properties. Objects, on the other hand, appear to change even when practically no change in retinal image occurs. Figures of reversible perspective, such as a cross, etc. (see fig. 10), change from one thing to another under good fixation. Size of retinal image is no sure indicator of the location of the object or of its size. Another factor, called by some known size, must be injected into the situation. The organism does this spontaneously and almost unwittingly in sensation. The fact that there is not a complete set of fixed relations calls for a further consideration of sensation than would be indicated were the fixities to exist. The organism never fails to see something as it is confronted with patterns of light radiation. Since there is no single end result possible, there must be some basis exclusive of the radiation reaching the eye upon which the organism can put some functional reliance. We have already mentioned what, for want of a better name, some have called known size. This may be exemplified in its operation by the use of some familiar object which is presented to the observer alone in a dark field. To do this best, a dark room whose walls have been painted black is used. The object is suspended in mid-air, or supported upon a fine wire post. Light from a small projector is cast upon the object without lighting up the room. Let the familiar object be for example, a playing card, a maple leaf, etc. It subtends an angle dependent upon its distance from the eye; it forms a retinal image whose size is likewise dependent upon the size of the object and its distance from the eye. The observer is able to detect the distance of the object quite well. But let the size of the object be not normal, but considerably greater or smaller than normal. There is no way by which the observer may detect this in the situation we have described. If the specimen is of a giant size, the object will look nearer, the amount depending on the increased visual angle it subtends. If the specimen is miniature, it will seem farther away than if normal, or of giant size.

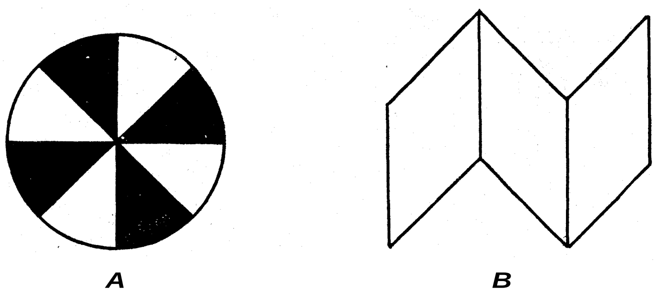

FIG. 10.—REVERSIBLE PERSPECTIVE FIGURES

SPACE PERCEPTION

The perception of objects involves not only their identity, size, shape, brightness and colour, but also their positions relative to each other and to the observer. Space perception is not the perception of space as such, but of objects in their spatial (geometrical) relations to each other and the observer. It is as if sensation were answering the questions "where?" and "what?" in an immediately forthcoming single answer. What an object is seen to be and where it is seen depend upon each other.

A number of factors are involved in producing this outcome. Some of them pertain to organismic function, some to the character of the stimulus (even though dealt with in sensory terms rather than physical) and some to the characteristics of the retinal images.

Monocular Vision.—Most of these factors apply to the use of the single eye as well as in the use of two eyes as in integrated system. Hence monocular vision is all that is necessary for the operation of the factors that are described below. **A** factor of the first type mentioned in the previous paragraph is the organism's use of a reference. An example of this is the operation of known size in the case of familiar objects. This factor in connection with the size of the retinal image largely determines how far away familiar objects are seen to be. Factors of the second type include overlay (super position), brightness, parallax, elevation, colour and distinctness of contours. Overlay is the partial obstruction of the view of some object by another, leading to the impression that the partially obstructed object is farther away than the other one. Brightness is the subjective effect somewhat related to intensity of radiation reaching the eye. It happens that the manipulation of brightness plays a factor in positioning objects and surfaces. The brighter it appears the nearer the object or surface seems. Parallax is the relative change of position of objects with regard to each other. During the individual's motion from place to place, or during the movement of the head only, objects near by tend to move in a direction opposite to that of the observer. This is an aid in discerning the separation of areas in the visual field. That which remains stationary cannot be a part of that which moves, so that areas difficult to segregate are segregated in this way. Elevation is here the name for the fact that an object higher than another is seen to lie farther away. Elevation functions both in actual three-dimensional situations and in two-dimensional representations of three-dimensional situations. Were it not for the fact that elevation functions in this manner, there could be no satisfactory two-dimensional representation of three-dimensional objects.

Colour functions both to separate and combine areas in the visual field. Like colours tend to represent continuous surfaces. Unlike colours, of course, involve bounding contours and thus tend to segregate areas from each other. While colour in some cases does not directly position areas, it helps determine what areas do or do not belong together. This indirectly has to do with spatial localization. Colour, especially as it pertains to familiar objects, does, however, tend to have properties of localization. Relative distinctness of contours within and bounding objects helps position them. Blurred contours indicate remoteness of objects.

Perception possesses a kind of self-consistency, as has been illustrated in the relations between size, brightness and position, etc. When these are investigated, one factor in the complex seems to be the reference toward which all other factors assume their rightful value. One of the references is the previously illustrated known size, a property possessed by all familiar objects. For example, if a playing card is the sole object illuminated in a dark room, the observer's familiarity with the normal size of a playing card determines the distance at which the card seems to be. Curiously enough, subsequent knowledge of the substitution of undersized and oversized specimens does not materially change the error in perception, at least without the intervention of a learning period.

Although known size is a very common reference toward which all other perceived qualities bear a consistency, it is not always the reference. Under certain conditions the factors of parallax or overlay operate as the primary considerations.

Overlay may be illustrated in the example given in fig. 11.

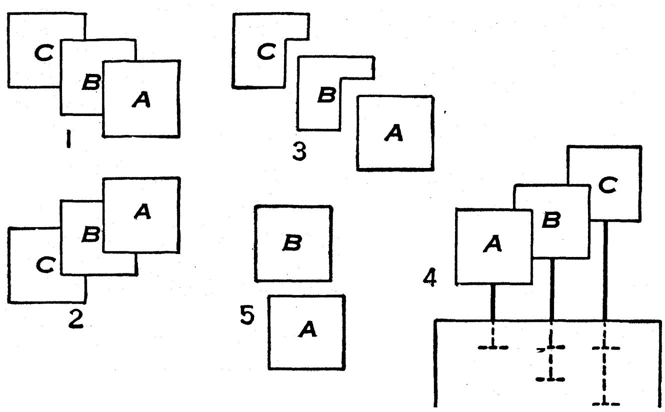

FIG. 11.—OVERLAY AND ELEVATION DETERMINING SPATIAL LOCATION

Square *A* overlays square *B* which in turn overlays C. This may be literal overlay in which B is actually behind *A*, and C is actually behind B in space. In the illustration all three squares lie in one plane for they are part of a two-dimensional drawing. If appropriate portions of squares B and C are removed as in the illustration, the three squares may be set up as cards on rod stands on a table, in which case *A*, instead of being nearest the observer, can be placed farthest away. Card C can be placed in front of B. All that matters is that the three cards be properly lined up with direction of the observer's regard and cues which help to indicate distance are obliterated. One of the main cues of this sort is the position of the rod stands on the table. These can be shielded from view as in 4 of fig. 11. When cards *A*, B and C are not placed so as to overlay one another, the upper of the three generally appears to be farther away. The apparent relative positions of the upper and lower of the three cards is, however, reversible so that the lower card may sometimes appear to be farther away. When the cards are mere pictures of squares in a two-dimensional drawing, relative elevation is a very common factor in producing perspective. However, in three-dimensional situations, sidewise motion of the head will involve parallax, providing sufficient indication for seeing the cards in their true relative distances from the eye regardless of relative elevation. The role of colour is best illustrated in the case of mountains and distant hills. They appear a different colour than near by elevations in land and appear at different distances from day to day depending among other things upon the change in colour. With changes in colour from day to day goes relative indistinctness from haze.

Experimental shifts in brightness will plainly indicate the role of this factor in positioning objects subjectively. All that is needed is to change the brightness on the playing cards under the conditions of presentation described above. If two cards, for instance, are used, the illumination on the one may be dimmed while that on the other may be raised. The two cards will change relative positions. The one whose illumination was lowered will recede, whereas the other one will come nearer to the eye.

The size of the retinal image of an object can be manipulated by three methods—changing the size of the object itself, changing its distance from the eye, and using optical devices involving magnification or diminution. Three-dimensional objects as well as those of two are represented upon the retina in only two dimensions, for it is, in effect, a plane. While the relation between a three-dimensional object and its representation in two dimensions is subject to law, the relations are far from simple, this being in part due to the fact that perceptual processes are involved in the outcome. As previously pointed out, objects of rather fixed conceptual size retain this, regardless of certain changes in the size of the retinal images involved. Manipulations of retinal-image size are interpreted by the individual as manipulations in distance from the individual. This factor comes into play in the use of magnification (in the use of binoculars), the result being that instead of its causing the object to appear larger, it tends to make it appear closer to the observer.

Augmenting the size of the retinal image of an object by bringing the object close to the eye differs from augmentation by instrumental magnification in the effect produced upon the angular relations of the components of the retinal image. Bringing an object closer to the eye (the object retaining its own fixed actual third dimension) enhances the angular relations subtended by the third-dimensional components in the eye. Increasing the image by instrumental magnification of an object at a fixed distance from the eye results in an over-all magnification without an increase in the angles subtended by the third-dimensional components of the object. This diminishes the amount of third dimension relative to the other two. The object, if originally a cube, now looks flatter than a cube.

While many three-dimensional objects tend to appear flattened when magnified by optical means, some of them, which when viewed without magnification are rectilinear, assume what is known as Chinese perspective (see fig. 12). The magnification is two-fold, as is indicated schematically by the dotted lines in fig. 12. The broken lines in the drawing converge at the eye position. The nearer dark-walled cube indicates where the cube is seen when instrumental magnification is employed. The basis for distortion known as Chinese perspective is indicated by the broken lines projected from the magnified cube. Note that the cube after magnification covers more area on the retina, a two-dimensional surface, but does not change shape so as properly to represent an object magnified in the third dimension. The result is that what was rectilinear becomes distorted so that the vertical a representing the more distant edge of the figure is greater than the nearer one b. The cube is now distorted, and becomes an example of Chinese perspective.

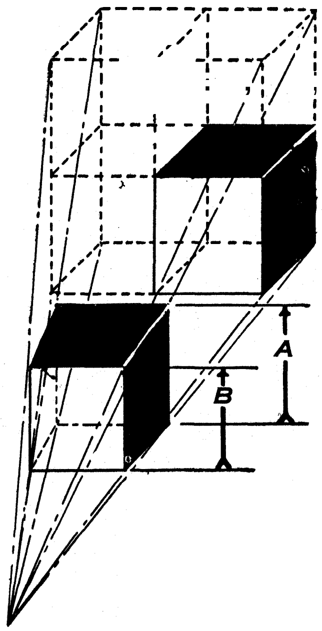

FIG. 12.—CHINESE PERSPECTIVE INSTRUMENTAL MAGNIFICATION OR RETINAL IMAGE

Binocular Vision.—The factors of overlay, etc., operate when only one eye is used and even though they operate in the use of both eyes, they are spoken of as uniocular or monocular factors. The factors peculiar to binocular vision arise from the relations in size, shape and position of the images on the two retinas. The points on the two retinas are classified into those which correspond and those which do not. Corresponding points are the points on the two retinas from which images are projected to the same place in the common visual field. Since the two uniocular visual fields do not fully overlap, the nasal periphery of each retina possesses no corresponding point in the other eye. In all other areas of the retina, each point is physiologically related to a corresponding point in the other eye. The centres of the two foveae are corresponding points, and thus, if an object is looked at directly, the images of the point fixated will fall on them. In cases of squint (cross-eyedness), this is not the case and only seldom is binocular vision possible. Either the image lying off the fovea in one eye is functionally suppressed, or double vision results. When, in some cases of squint, binocular (single) vision is possible. the off-fovea point must function as a corresponding point to the foveal one in the other eye. Noncorresponding points are also called disparate points. Although single vision is possible with disparate points, double vision with corresponding points has not been proved to occur.

To illustrate the operation of the two images in providing cues for space localization, the following will serve Let the individual fixate a square The images of the square are presumably equal in size and fall correspondingly on the two retinas The square is seen directly in front of the individual and in a plane at right angles to the line of regard. If the square is now rotated about its vertical axis so as to be obliquely oriented with regard to the observer, the two retinal images of it will now differ one from the other. If the square is turned so that the left side is farther anay from the eyes than the right side, the shift in the dimensions of the images in the horizontal axis will be as indicated in fig. 13.

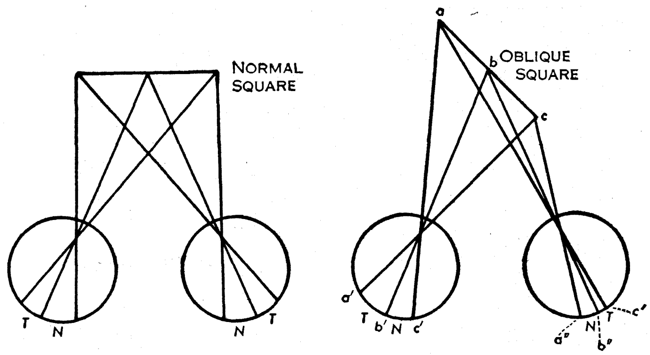

FIG. 13.—SIZE RELATIONS OF THE COMPONENTS OF THE RETINAL IMAGES

Since the surface of the square is more nearly at right angles to the left eye, the image in that eye will be larger than the one in the right eye. Likewise there will be less difference between the nasal and temporal portions of the image in the left eye than in the right. There will be less difference between the temporal portion $a'b'$ (see fig 13) and the nasal portion $b'c'$ in the left eye than between $a''b''$ and $b''c''$ in the right eye. Likewise the over-all image size $a'c'$ in the left eye will be different from $a''c''$ in the right eye Such differences as these in the two retinal images are used by the organism to indicate the spatial orientation of objects. Whereas we have just described some of the image differences which were produced by a specific object of a given size and a given orientation in space, and at a given distance from the eyes. this object is not the only one nhich will produce retinal images of the same specification. The retinal images in the two eyes in the original situation were squares; in the second situation, they were two unequal trapezoids. Any figure which, when properly oriented. will approximate the obliquely oriented square in producing retinal images will tend to function as square. This result is dependent in large part upon the absence of cues in the visual field which would aid in distinguishing the new figure from the square. In a drawing on a sheet of paper normal to the line of regard. a trapezoid can be seen as a square turned obliquely toward the observer. If certain lens systems are interposed between the visual field and the eyes. manipulations in space perception are the result. Lenses not only have what are called power effects, but result in size or magnification effects. Magnification can be produced in all meridians or in one meridian. In the first case, it is called over-all magnification; in the latter, meridional. A refracting medium such as glass or transparent plastic, whose surfaces are parallel (plano) will, when shaped into a curve, produce the necessary refraction to result in the magnification of the image in one meridian; viz, the meridian of the curvature. If this sort of a lens is placed in front of one eye and no lens or a plano lens in front of the other, an experienced distortion of visual space results. The experience is, of course, that of a distortion only by virtue of the fact that known objects no longer possess their original shape, or by virtue of the fact that unknown spatial fields cannot be properly responded to by bodily movements. Objects do not look to be where they can be reached by the hands and feet, etc. While the precise description of the geometry and physiological optics involved in the use of size lenses is too complex to be given here, it can be said in general that experiences produced are those which would result from manipulating the relative sizes and shapes of the two retinal images by moving actual objects (walls, tables, etc ,) toward or away from, or to one side or another, tilting them, or distorting their shapes. There is one gross exception—that the more distant objects appear to be larger and the nearer objects smaller when size lenses are used. This is just the reverse of the resulting appearances of objects in normal naked-eye situations. Since the lenses unequalize the sizes of the two retinal images, the effects have been given the name of aniseikonia, a nord derived from Greek words meaning unequal images. Aniseikonia is of two forms. the laboratory variety, which is produced by size·lenses, and a form occurring clinically with sometimes attendant disturbing symptoms all the way from headaches and gastrointestinal disturbances to feelings that the environment is somewhat unreal.

The **Horopter.**—This is the sum of the points in space that are projected on corresponding points of the two retinas, for any given fixation of the two eyes. Since, by definition. all the points which fall on the corresponding portions of the two eyes are seen as single. all the respective points on the horopter are seen as single. The horopter is an imaginary line, its form depending upon the distance of the fixation point from the eyes. At about two metres. it is theoretically a straight line passing through the fixation point. At a distance considerably less than two metres, the line is concave in the direction of the observer. At distances greater than two metres, the line is convex.

Curiously enough. other than geometrical considerations have to do nith the shape of the horopter. Its shape changes with the level of illumination. with the degree of contrast between objects observed and their backgrounds. Colours also help to determine the end-results. For example, the horopter for red is flatter than for blue. Actually the duration of stimulus exposure used in the determination of the horopter also affects its position.

Visual Perception of Movement.—Response to movement is the most primitive of all visual reactions. An observer may respond to visually presented movement. with only the vaguest apprehension of the direction and extent of the movement and with no appreciation of the size, contours or colour of the moving object.

Most of the other functions of vision, the object reference, localization of objects. attribution of size, contour and distance, may be regarded as bound up in some way with the response to movement. In the course of development, however, they come to have independent status.

The experience of motion is dependent first upon what happens in the retina. Shifts in images on the retina involving certain rates of temporal sequence give rise to the sensation of motion. Such sequences are set up by the images of physical objects which actually move relative to the eye, but it is not only the actual motion of such objects that forms the basis for retinal events leading to the experience of motion. Stationary objects appearing and disappearing at the proper places in the visual field. and at certain critical time relations relative to each other will serve to provide sequences of retinal stimulation adequate to elicit motion perception. The experience of movement induced in this way is called apparent movement, whereas the experience dependent upon physical movement of objects is called real movement.

The experience of movement (real) possesses both lower and upper limits for its elicitation. If the angular movement of an object is 30° per second, its contours are distinct, but if angular movement is considerably below this, no movement is seen. Two successive observations separated by a time interval will serve to indicate that the object has moved, but no direct perception of that movement is possible. The upper range of motion perception involves stages in which the object loses its sharp contours and a limited streaklike effect emerges (14°–21° per second). Finally. the result is a streak across the entire field of vision (116° per second). Under some conditions an object travelling at high rates of angular speed across the field of vision will not be seen even as a streak. It will not be seen at all. The experienced (phenomenal) rate of movement does not bear a fixed relation to actual speed of movement. The size of field through which an object moves is one determinant of this. Other determinants include: (1) geometrical complexity of the field through which an object moves; (2 j the orientation of the object (whether moving in a line with its long axis or its short axis) ; (3) the size of the object and (4) possibly the direction of movement.

Apparent movement can be elicited in many ways. One of the simplest of these is to open and close the eyes alternately while looking in the distance. A near-by object such as a pencil held vertically will move horizontally back and forth. The amount of this motion depends upon which of the two eyes is opened and closed. The dominant eye tends to induce the greater shift in position of the object. Another good example of apparent movement is the experience produced when a lamp is turned on and off while fixating it. As it is turned off. the light it produced does not seem to disappear from all parts of the visual field simultaneously. It disappears last at the lamp itself, having progressively contracted centripetally from the periphery of the field. When the lamp is again turned on, the reverse progression occurs. The light quickly expands centrifugally. Most examples of apparent movement are classified into the following categories:

1. Gamma-movement, the kind just described. It is the expansion and contraction in the visual field elicited by a single stationary object as illumination is raised or lowered at a sufficient rate.

2. Beta-movement. the experience of a single object moving from one place to another when two stationary objects separated in space and time appear and disappear.

3. Delta-movement, a second effect gained from the same objects which produce beta-movement, when they are considerably brighter than the surrounding visual field: and the second object is brighter than the first. Upon the usual presentation of the two objects. beta-movement first occurs. It proceeds from the first to the second objects. Then. since the second object is more intense than the first, a movement in the reverse direction immediately follows. This latter movement is the phenomenon which is called delta-movement.

4. Alpha-movement, the elongation and contraction or other change of an illusory pattern as the appropriate parts of it are exposed in succession. For example, we have in fig. 14 what is known as the Müller-Lyer illusion. Whereas, the two sections of the horizontal line are of equal length as measured physically, they appear unequal. If this figure is presented in two parts, alpha-movement will be seen. Let the lower section including the wings on both ends of the section be presented first. As this is made to disappear, let the upper section be presented. The observer will see the wings change direction and the horizontal line shrink. If the presentation of the two sections is in the reverse order, the line will elongate.

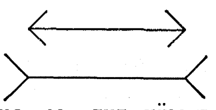

FIG. 14.—THE MÜLLER-LYER ILLUSION.

It was pointed out elsewhere (see *Response to Variable and Intermittent Illumination* above) that motion pictures provide a good example of stroboscopic effect. They also represent a very good example of beta-movement, inasmuch as each successive frame presents certain components in different positions than its predecessor and elicits the experiential effect of motion. When a jumpy effect is created in the movies, it is because of improper timing between the frames for the amount of displacement of the particular objects involved, at least for the amount of absolute illumination or perhaps intensity differential between them and their surroundings. Timing. spatial separation and intensity (and perhaps intensity differential) are crucial in the obtaining of apparent motion that is indistinguishable from the experiential effect elicited by physically moving bodies. As time between successive exposures is lengthened, the spatial separation between objects must be increased. As intensity of bright objects on a dark field is increased their temporal separation must be decreased or their spatial separation increased.

In the case of beta-movement, the experience elicited by the two stationary objects will not always simulate the smooth movement of a single object moving from one position to another. When it does, the motion is called optimal movement. The rules for retaining it, once it exists, were just given. The experienced movement may be confined to one or both of the two objects. This is called part movement and is single part movement if confined to one and dual part movement if it involves both objects. In part movement as the object appears it manifests a sidewise jump. R'hen conditions are not quite right for optimal movement, dual part movement is often quite pronounced.

To understand apparent movement the character of retinal stimulation underlying it must be known. As a beginning, a consideration of what happens on the retina to produce gamma-movement is quite appropriate. A single intense area of illumination, such as an electric lamp, produces not only an image on a restricted part of the retina, but also a veil of stray light over the whole retina. Thus all of the retina participates in the activity of the movement. The region which receives the image of the lamp is most intensely illuminated; and regions surrounding it, least. In other words, a gradient of stimulation is set up. Not only does this gradient exist, but there is also a sensitivity gradient inherent in the retina. The net result is translated into a centre-periphery gradient in latency of retinal response. In terms of the time of sending impulses up the optic nerve. this acts as though the centre of the retina had been stimulated first and then progressively more and more peripheral portions. Granting this, it is perfectly natural to expect to see motion in the instance we have chosen.

Conflicts.—As might be supposed. the cues that the individual gets from the environment do not always harmonize. When it is remembered that all experience is constructed by the organism and that this pertains not only to intellectual deductions but to immediate sensory experience, it is not strange that conflict tends to result. We have already indicated that from the very same physical situation any one of many alternatives is often possible in sensation. This being the case, the task of the organism is to select those alternatives that will fit together to give, at any instant, a self-consistent whole, and to act from instant to instant in such a nay as not to violate a kind of temporal consistency. Notwithstanding, conflict does result. Its most obvious sign is the rapid oscillation between two ways of perceiving something which sometimes occurs. Uncertainty, hesitation and doubt are sometimes experienced by the individual in the act of seeing.

OCULOMOTOR ADJUSTMENTS

General.—The act of seeing is a complex motor process in which each eye must be so adjusted internally as to produce the sharpest retinal image possible. The two eyes must also constantly maintain appropriate positions with reference to each other and to viewed objects. Many movements of the two eyes are spontaneous motions not continually following some specific target (external object in the field of vision) but are instead rotational excursions in obedience to the innervations supplied by the intrinsic features of the nervous organization at the moment. Under such conditions it might be said the movements are spontaneous or free, although during this time the two eyes tend to keep their proper convergent relation. At any instant! any appropriate stimulus factors are able to elicit the individual's attention during which time the eyes are momentarily and intermittently fixed on the objects eliciting this attention. If these objects move relative to the observer, the two eyes follow in such a way as constantly to converge on the area attended to. Eye movements are of the following kinds: idle, spontaneous, exploratory and pursuit. Spontaneous movements of the eyes occur when the individual is not looking at anything in particular. The relative strengths of the innervations of the various eye muscles are determined by differences in balance between several nervous centres. each of which is subject to a different set of influences. Thus eye positions and movements are controlled not only by visual stimuli but also by impulses received from other sources, for instance, from the vestibular nervous centres activated by the organs of equilibrium in the ear. Exploratory movements are those in which the individual is looking to discover or detect something. This may be an unknown something in an unknown position, or it may simply be the unknown material in the task of reading lines of print. In exploratory movements of the latter type, a series of jumps and pauses rather than long sweeps occur. Such movements are called saccadic and bear some relation to speed and comprehension in reading. Pursuit movements are those eye movements which occur in following a moving object in the visual field. The eyes move in such directions as to keep pointed directly at the object of attention.

To effect the proper refraction so that the retinal image of the external object viewed is at its best. the shape of the lens must be properly adjusted. This is called accommodation.

Accommodation, or the Mechanism of Adjustment for Different **Distances.**—When a camera is placed in front of an object. it is necessary to focus it accurately in order to obtain a clear and distinct image on the sensitive plate. This may be done by moving either the lens or the sensitive plate backward or forward so as to place the posterior focal point of the lens on the sensitive plate. For similar reasons, a mechanism of adjustment, or accommodation for different distances. is necessary in the human eye. In the normal eye parallel rays coming from a great distance are focused on the retina. Such an eye is termed emmetropic. Another form of eye is such that parallel rays are brought to a focus in front of the retina. This form is myopic or shortsighted, inasmuch as, for distinct vision, the object must be brought near to the eye. In a third form the focal point, for ordinary distances. is behind the retina, and consequently the rays must be made more convergent by accommodation. This kind of eye is called hypermetropic or farsighted. For ordinary distances, at which objects must be seen distinctly in everyday life, the fault of the myopic eye may be corrected by the use of concave and of the hypermetropic by convex glasses. The concave glass will move the posterior focal point a little farther back, and the convex glass will bring it farther forward; in both cases, however, the glasses may be so adjusted, both as regards refractive index and radius of curvature, as to bring the rays to a focus on the retina, and consequently secure distinct vision.

The imputation that some eyeballs are appropriate, some too short and some too long, for the refractive system of the particular eye is generally made. This is only one way of looking at the matter. Since the lens will accommodate in accordance with the innervation supplied the ciliary body, it can be considered that in myopia, etc., for example, it is the innervation that is inappropriate for the eye as it is. The use of cycloplegics (a kind of eye drops) is a conventional clinical method which attempts to determine the intrinsic relation of lens systems to length of eyeball when the accommodation is relaxed. Some believe that the information gained in this way does not vitiate the idea that the relation between accommodative innervation, focal power of the lens and length of eyeball is a dynamic rather than anatomically referable affair.

From any point 65 m. distant, rays may be regarded as practically parallel, and the point will be seen by the emmetropic eye without any effort of accommodation. This point, either at this distance or at infinity, is called the punctum remotum. In the myopic eye it is much nearer, and for the hypermetropic there is really no such point, and accommodation is always necessary. If an object were brought too close to the eye for the refractive media to focus it on the retina, circles of diffusion causing indistinctness of vision would result, unless the eye possessed some power of adapting itself to different distances. That the eye has the power of accommodation is proved by the fact that, if we attempt to look through the meshes of a net at a distant object, we cannot see both the meshes and the object with equal distinctness at the same time. Again, if we look continuously at very near objects, the eye speedily becomes fatigued. Beyond a distance of 65 m., no accommodation is necessary; but within it, the condition of the eye must be adapted to the diminished distance until we reach a point near the eye which may be regarded as the limit of clear vision for near objects. This point, called the punctum proximum, varies according to the age of the individual. The range of accommodation is thus the distance between the punctum remotum and the punctum proximum.

The mechanism of accommodation has been much disputed. but there can be no doubt it is chiefly effected by a change in the curvature of the anterior surface of the crystalline lens. If we hold a lighted candle in front and a little to the side of an eye to be examined, three reflections may be seen in the eye. The first, a, is erect, large and bright, from the anterior surface of the cornea; the second, b, also erect, but dim, from the anterior surface of the crystalline lens; and the third, *c*, inverted, and very dim, from the posterior surface of the lens, or perhaps the concave surface of the vitreous humour. Suppose the three images to be in the position for distant vision, it will be found that the middle image *b* moves toward a, on looking at a near object. The change

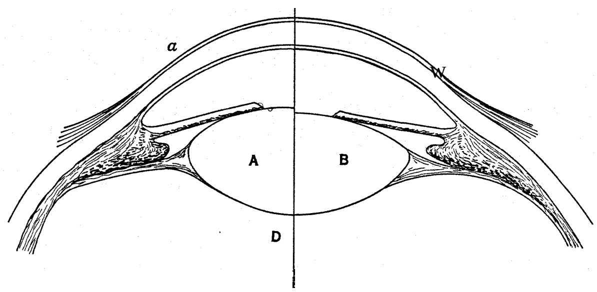

FIG. 1.5.— MECHANISM OF ACCOMMODATION

is caused by an alteration of the curvature of the lens. (See fig. 15.) The changes occurring during accommodation are: (1) the curvature of the anterior surface of the crystalline lens increases, the radius of curvature changing from ten millimetres to a minimum of six millimetres; and (2) the pupil contracts. An explanation of the increased curvature of the anterior surface of the lens during accommodation was thus given by H. von Helmholtz. In the normal condition (that is, for the emmetropic eye) the crystalline lens is flattened anteriorly by the pressure of the anterior layer of the capsule; during accommodation. the radiating fibres of the ciliary muscles pull the ciliary processes for ard, thus relieving the tension of the anterior layer of the capsule, and the lens at once bulges forward by its elasticity.

By this mechanism the radius of curvature of the anterior surface of the lens. as the eye accommodates from the far to the near point, may shorten from ten millimetres to six millimetres. The ciliary muscle, however, contains two sets of fibres, the outer, longitudinal or meridional, which run from before backward, and the inner, circular or equatorial (Müller's muscle). Direct observation of the eye of an animal immediately after death shows that stimulation of the ciliary nerves actually causes a forward movement of the ciliary processes, and there can be little doubt that the explanation above given applies to man.

There is still some difficultyin explaining the action of the equatorial (circular) fibres. Some have found that the increased convexity of the anterior surface of the lens takes place only in the central portions of the lens, and that the circumferential part of the lens is actually flattened, presumably by the contraction of the equatorial fibres. Seeing, however, that the central part of the lens is the portion used in vision, as the pupil contracts during accommodation, a flattening of the margins of the lens can have no optical effect. During accommodation the pupil contracts. and the pupillary edge of the iris, thinned out, spreads over the anterior surface of the capsule of the lens, which it actually touches. This part of the iris, along with the more convex central part of the lens, bulges into the anterior chamber and must thus displace some of the aqueous humour. To make room for this, however, the circumferential part of the iris, related to the ligamentum pectinatum, moves backward very slightly, while the flattening of the circumferential part of the lens facilitates this movement.

Helmholtz succeeded in measuring with accuracy the sizes of the reflected images by means of an instrument termed an ophthalmometer, which he invented. His description of what occurs in accommodation has been attacked a number of times. All opponents of the Helmholtz theory accept the flattened rather than the thickened form of the lens as its resting form. For some theorists, accommodation is not caused by relaxation of the zonula but rather by the direct action of the ciliary muscle on the lens, pressing it together. Some, while subscribing to the Helmholtz zonula-relaxation idea, emphasize the conoidal form of the anterior surface of the lens resulting from the differences in the thickness of the capsule in different parts. Some assign the thickening of the lens in accommodation to the contraction of the ciliary muscle which produces a pressure of vitreous humour against the periphery of the lens tightening the zonula. Another theory postulates contractile fibres within the lens itself, these possessing a similarity to nonstriate muscle fibres, and also sensitive to influences other than by way of ordinary innervation. Still another claims that accommodation is produced by lengthening and shortening of the eyeball itself. Holders of the latter theory point to cases in which accommodation has allegedly occurred in aphakia (absence of the lens). Helmholtz's description continued to be held by most authorities.

Convergence and the Extrinsic Muscles.—The relative positional relations of the two eyes to each other is called convergence. Each eye possesses a centre of rotation. This is slightly behind the centre of the optic axis. Around the centre of rotation there are three principal axes—the anterior-posterior, the vertical and the transverse. In normal oculomotor behaviour the two eyes retain postures so that their axes converge on a point called the fixation point, or point of regard. The lines extending from the centre of rotation to the fixation point are called the lines of regard. The plane defined by these two lines is known as the plane of regard. The referential positions of the eyeballs are as follows:

1. First position. This is defined by erect head posture, the lines of regard directed toward the distant horizon.

2. The second order of positions includes all those involved in moving the eyes around the transverse and horizontal axes. When the eyes rotate around the first, the line of regard is displaced above or below, making with the line representing its former position an angle called the angle of vertical displacement, or the ascensional angle. When the eyeball rotates around the vertical axis, the line of regard is displaced laterally, forming with the median plane of the eye an angle called the angle of lateral displacement.

3. The third order of positions includes all those assumed by the eyeball in performing a rotary movement along with the lateral or vertical displacements. Such movements of rotation are measured by the angle which the plane of regard assumes with the transverse plane, which is called the angle of torsion or angle of rotation.

Normally the movements of the two eyes represent a system so co-ordinated as to direct the two lines of regard toward the common point in space. This is accomplished by six pairs of muscles. When we look at a distant object and the optic axes of the two eyes are virtually parallel, the image of the object falls upon the yellow spots of each retina, and is seen as a single object. An object is always seen as one object if it is imaged on the corresponding points of the two eyes. The four straight or recti muscles of the eye originate in the back of the orbit and are inserted in the front part of the eyeball or its equator. The two oblique muscles pass forward around the eyeball from the nasal side, one to the upper part of the eyeball and the other to the lower, both being inserted on the temporal side. The internal and external recti move the eyes around their vertical axis directing the line of regard to the right or to the left. The superior and inferior recti rotate the eyes around the horizontal axis, raising or lowering the gaze. The oblique muscles rotate the eyes around axes passing through the centre of the eye to the back of the head. These muscles are also responsible for a slight rotation of the eyeballs around the visual axes themselves. Such movements are spoken of as cyclotorsional movements. These muscles operate in pairs under the influence of what is known in physiology as reciprocal innervation.

Convergence and accommodation bear certain relatively fixed relations to each other. For example, when an object approaches the eyes, two things must happen in order that the eyes remain properly adjusted. Convergence must increase and so must accommodation. Any condition which calls for the increase of one without the concomitant change in the other process leads to unsatisfactory results. Failure to maintain the proper relations between accommodation and convergence arises either from the unusualness of the stimulus situation or from the specific characteristics of the visual system of the observer, or both. If the proper convergence does not take place while objects are accommodated for, single objects will be seen as double—as two. This double vision is called diplopia and is not well tolerated by the organism. Sooner or later, what is known as suppression occurs. This is a state in which, although the two eyes do not properly converge on the object of attention, the input from one eye only functions to provide object perception. If the proper accommodation does not occur, the viewed object will be indistinct; it will appear blurred. In addition to the convergence and accommodative mechanisms there is also presumed to be a fusion mechanism. Without the operation of this, many individuals would definitely lose their proper convergence with regard to viewed objects. This is called a state of muscle imbalance, and is detected in a number of ways; one of the simpler ways is to cover one eye while the individual looks at a given object. While the individual continues to regard this object steadily, the second eye is quickly uncovered. It sometimes will be seen that the covered eye quickly changes position as it is uncovered. This is taken to mean that the convergence mechanism was not functioning to hold the covered eye so as to converge on the position to which the uncovered one was directed. Uncovering the second eye supposedly allows the fusion mechanism to begin to operate. This discrepancy between the positions of the eye under the two conditions is one measure of what is called a phoria. Orthophoria is the condition of the binocular system in which no phoria in any direction is demonstrable. Heterophoria is the condition in which one or more phorias exist. If the eye or eyes tend to turn outward, the condition is an exophoria. If inward, it is an esophoria. The eyes may tend to rotate, in which case the condition is one of cyclophoria. They may tend to turn upward or downward in which case the condition is one of hyperphoria or hypophoria, respectively.

The condition of heterophoria is also spoken of as that of latent muscle imbalance. Manifest muscle imbalance is called squint or strabismus.

Pupillary Reflexes and the Iris.—In addition to convergence and accommodation, changes in the size of the pupillary aperture are constantly occurring. The size of the aperture is controlled by the tissue surrounding it and this tissue is called the iris. Strictly speaking, the reflexes involved in controlling pupillary size are iris reflexes rather than pupillary reflexes, for the iris is the tissue constituting the muscles which carry out the necessary mechanical performances.

The iris constitutes a diaphragm which regulates the amount of light entering the eyeball. The aperture in the centre, the pupil, may be dilated by contraction of a system of radiating fibres of involuntary muscle, or constricted by the action of a circular system of fibres, forming a sphincter, at the margin of the pupil. The radiating fibres are controlled by the sympathetic, while those of the circular set are excited by the third cranial nerve. The variations in diameter of the pupil are determined by the greater or lesser intensity of the light action on the retina. A strong light causes contraction of the pupil; with light of less intensity, the pupil will dilate. In the human being, a strong light acting on one eye will cause contraction of the pupil, not only in the eye affected, but also in the other eye. These facts indicate that the phenomenon is of the nature of a reflex action, in which the fibres of the optic nerve act as sensory conductors to a centre in the brain, whence influences emanate which affect the pupil. The centre is in the neighbourhood of the nucleus of the third nerve, beneath the anterior pair of the corpora quadrigemina. On the other hand, the dilating fibres are derived from the sympathetic and it has been shown that they come from the cervical region of the spinal cord. The iris in some animals is directly susceptible to the action of light.

The pupil contracts under the influence of: (1) an increased intensity of light; (2) convergence of the two eyes, as in accommodating for a near object; and (3) such active substances as nicotine, morphia and physostigmine. It dilates under the influence of: (1) a diminished intensity of light; (2) vision of distant objects; (3) a strong excitation of any sensory nerve; (4) dyspnoea; and (5) such substances as atropine and hyoscyamine. The chief function of the iris is to moderate the amount of light entering the eye so as to secure sharpness of definition of the retinal image. This it accomplishes by: (1) cutting off the more divergent rays from near objects; and (2) preventing the error of spherical aberration by cutting off divergent rays which would otherwise impinge near the margins of the lens and would thus be brought to a focus in front of the retina.

As well as manifesting light reflexes and several other specific reflexes not named, the pupil manifests what is called a dark reflex. The dark reflex is a response to very brief intervals of darkness interspersed in otherwise continuous, bright illumination. This would have only academic interest were it not for the fact that some individuals in whom the light reflex has become inoperative still possess a dark reflex, indicating that the nervous paths mediating the two reflexes are not wholly identical.

Whereas constriction in response to light is fairly rapid, dilatation during periods of subsequent darkness is considerably slower.

Pupillary Response to Intermittent Stimulation.—A series of flashes will be followed by the pupil with alternate constriction and dilatation when the flash series does not exceed a rate of almost three per second. As flashes at a rate of one in four or five seconds to three per second are presented, the alternations in the size of the pupil become more and more slight till the pupil no longer follows, but becomes either stationary or irregularly variable. (See fig. 16.) That the stationary state under flash rates of two or three per second is not equivalent to the immobility with steady illumination or with very much faster flash rates has been discovered. Whereas ordinary immobility is a matter of reciprocal innervation, the stationary state here is one in which both the constrictor and the dilator fibres are in contraction more or less simultaneously. Simultaneous tensory activity in both sets of pupillary fibres gives rise to considerable discomfort and is at least part of the basis for discomfort in viewing flickering illumination.

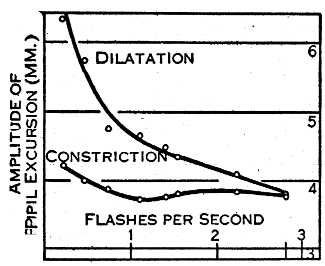

FIG. 16.—CHANGE OF PUPILLARY SIZE AS DEPENDENT UPON FLASH RATE

Differential Nature of Pupillary Response.—A pupillary light reflex is not merely a response to the total quantity of light falling on the whole or any given portion of the retina but is a highly differential response. This is demonstrable in the following way. Let it be arranged so that the two eyes can independently be stimulated. On the one retina let an image of a disk of light in a dark field be formed.

As the intensity of this light is raised from a low level to a fairly high one, the pupils of both eyes (the unstimulated one as well as the one receiving the image) constrict.

Upon reaching the desired maximum of intensity, let the brightness of the disk remain constant, while now applying the same progressive stepwise intensification of a similar image in the corresponding area of the second retina. Whereas it might be expected that the addition to the total amount of light would effectively add to the amount of constriction manifested by the two pupils, such a result is not the case. The initial amount of stimulation applied to the second eye induces, on the contrary, dilatation in both eyes. This result is shown in fig. 17, in which the ordinate represents the diameter of pupillary aperture, and the abscissa the logarithm of the light intensity applied first to one eye and then to the other. The second eye begins to be illuminated at the perpendicular C. It is only after the light in the second eye reaches a considerable fraction of the constant illumination in the first eye that constriction sets in. When both eyes are equally illuminated the combined effect in terms of constriction definitely exceeds the effect elicited by using one eye alone. To obtain this effect the areas on the two retinas need not correspond, nor need the images of the two disks be placed on separate retinas. It is thus evident that the pupils respond differentially rather than to the gross amount of light falling on the two retinas or to the light falling on two separate portions of either one of them. This kind of behaviour parallels very closely perceptual behaviour (brightness discrimination) under the same conditions.

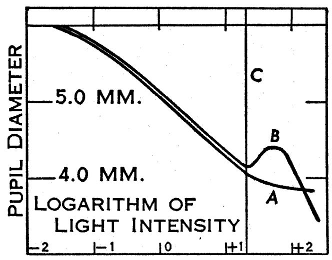

FIG. 17.—THE PUPILLARY REFLEX AS A COMPLEX RESPONSE

A, RESPONSE WHEN TOTAL AMOUNT OF LIGHT IS PRESENTED EXCLUSIVELY TO ONE EYE; *B*, RESPONSE WHEN LIGHT IS VARIOUSLY DISTRIBUTED, THE FIRST PART TO ONE EYE AND THE SECOND PART TO THE OTHER EYE WITH STIMULATION OF THE FIRST EYE CONTINUED

It is known that unequally intense images on the corresponding areas of the two retinas do not sum to give rise to a subjectively brighter surface than does either image alone, but rather give rise to a brightness somewhat between the two. This has long been known as Fechner's paradox. G. T. Fechner found, however, that if the intensities of the images were made equal, the combined effect of the two was a surface of greater brightness than was elicited by stimulating one eye alone.

We also know that a bright object on a dark field is less bright when a similar-sized dim object is in the visual field at the same time than when it exists alone.

Comparing these sensory effects with what was just described regarding pupil behaviour, it is obvious that the sensory and the motor phenomena coincide. See also Index references under "Vision" in the Index volume.

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VISIT AND SEARCH, a term for the procedure adopted by a belligerent warship to ascertain whether a merchant vessel is enemy or neutral and, if neutral, whether she is carrying contraband. The vessel's papers are first examined, and if these are in order and no suspicions are aroused she is allowed to proceed on her voyage, a note of examination being entered in her logbook. If inspection of the papers shows the vessel to be hostile or to be carrying contraband or performing services incompatible with neutrality, she is immediately seized; more often there is merely suspicion, in which case she may be searched. The search is carried out by a small party from the belligerent warship in the presence of the master. If the searching officers are satisfied with the results of their investigation the vessel is allowed to proceed; if suspicion still remains she may be brought into port for more thorough search. If she is finally declared innocent and a prize court considers that the suspicion was not reasonable, it may order damages to be paid.

As the size of modern ships makes it impossible to search them thoroughly on the high seas the practice of taking them automatically into port for search became widely recognized. This however caused difficulty between Great Britain and the United States of America in World War I and led to the adoption in 1916 of the navicert system. The navicert, issued by the belligerent's representative in a neutral country. was tantamount to a ship's passport, possession of which ensured in the absence of suspicious circumstances that the vessel would be alloned to proceed on her way. In World War II Great Britain again introduced the navicert system and, as a reprisal for Axis submarine and mine warfare, made it compulsory by an order in council of July 31. 1940. The effect of this order was that any ship not covered by a navicert and proceeding to or from a port whence goods might go to or be exported from enemy territory was deemed to be carrying contraband and was liable to seizure. (X.)

The instructions for the U.S. navy issued in May 1941 and in effect during World War II stated:

48. The belligerent right of visit and search subject to exemptions mentioned in section VII may be exercised outside of neutral jurisdiction upon merchant or private vessels after the beginning of war in order to determine their nationality, the character of their cargo, the nature of their employment, or other facts which bear on their relation to the war.

Such instructions also provided that:

233. Outside neutral jurisdiction, belligerent military aircraft have the right to visit and search. If circumstances make visit and search impracticable, a belligerent militarv aircraft may order a neutral civil craft, subsurface. surface or air, to proceed under escort as directed.

The instructions of the U.S. navy, as well as those of most other maritime states, recognize the exemption from visit and search of neutral merchantmen under convoy.

During World War I the British government developed the practice. continued during World War II. of taking ships or cargoes into British ports and there detaining them for the purpose of general search for evidence of contraband. The practice. said to be justified by the size and seaworthiness of modern vessels, was the subject of objections by the U.S. government during both wars. See also NEUTRALITY. (J. W. Mw.)

VISITATION, an act of visiting, or going to see. a formal visit; also: from biblical phraseology, an act of divine retributive justice.

There are three classes of official visitations: ecclesiastical, charitable and heraldic. Ecclesiastical visitations, originally the periodical journeys of personal inspections to ascertain the temporal and spiritual condition of each parish, form part of the functions of an archbishop, bishop or archdeacon.

In Great Britain all charitable corporations were at law made subject to visitation. If no visitor had been appointed by the founder, the sovereign or his representative was the visitor of all lay, and the church of all ecclesiastical charitable corporations. Under the Charitable Trust acts and the Endowed Schools acts, the board of charity commissioners and the board of education were given certain visitorial powers.

Heraldic visitations (which ceased about 1686) were perambulations made by a king at arms, or other heraldic official with a commission under the great seal, to examine into pedigrees and claims to bear arms. The results of these visitations were entered in visitation books; their admissibility as judicial evidence, however, was questioned on the ground that they merely contained statements obtained from the families to whom they referred (*cf.* D'Arcy de Knayth case, 1901).

VISITING CARD, a card also known as a calling card, bearing the name and sometimes the address. of an individual or a married couple. Visiting cards are used when visiting, to enclose with gifts and flowers, or as an invitation by people in socially active circles, members of the military and diplomatic services and professional people. Cards which include a business address are known as business or trade cards.

The custom of carrying a personal card became popular in Europe in the 18th century. Cards were engraved with classical and allegorical scenes with space left within the design for the caller's signature. Ambassadors, bankers. doctors and prominent citizens who had more frequent use for cards had their names engraved within the design. This was rare and expensive. Cards for business visits ranged from simple printed papers to engraved cards with baroque! rococo or classical style borders. Wares for sale were often listed and illustrated.

Embossed cards with simple classical borders appeared after 1796. During the 19th century visiting cards were decorated nith more elaborate embossing, lace paper borders and hand painting. Messages written on cards were often holiday greetings, leading to the name, "cards of compliment." The first Christmas cards of the 1840s were the same size as the ladies' visiting cards of the decade. Gentlemen's cards were always smaller than ladies'. It nas customary to fold down a corner of a card to express a sentiment. The right-hand bottom corner meant a personal call: the right-hand top corner meant condolence; the left-hand bottom corner meant congratulation.

People in mourning often had solid black cards with the name in white. but this was modified into the use of the black-bordered white card. While professional people usually preferred a simple card, tradesmen utilized every means of graphic reproduction. Thousands of trade cards with elaborate printing and illustration were printed as advertisements rather than as business visiting cards

Cntil World War I the use of cards socially was a highly stylized ritual The telephone and the greeting card (*q.v.*) are partially responsible for its decline. Twentieth century cards are plain nhite cardboard or parchmentlike paper with the name engraved in black ink. Business cards may be printed. Women's cards are approximately $3\frac{1}{4} \times 2\frac{1}{4}$ in.; men's cards are seldom more than $1\frac{1}{2}$ in. deep; children's cards are slightly smaller than those of adults. When the street address is included, it is in the lower right-hand corner. Cards may be left for a friend or client whether or not the caller found him in. They are given to a servant to deliver, put on a card tray, or left in a conspicuous place. Etiquette books define the exact style specifications and uses of cards.

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VISITING NURSE. In the United States, public health nurses act as teachers, helpers and friends in homes! clinics, industrial establishments and schools. Public health nursing began in 1877. In many places public health nursing is privately supported; in other places it is a function of the local or state government. Privately supported public health agencies are usually called visiting nurse or public health nurse associations. There are also, however, community nursing services. The workers under the National Red Cross do a considerable amount of public health nursing in rural areas. The public agencies which employ health nurses include boards or departments of health and boards or departments of education. The United States public health service and the United States children's bureau also employ considerable numbers of public health nurses. In many states the state department of health has a supervising nurse who is adviser on public health nursing problems throughout the state. There is also an occasional organization for public health nursing. Much of this work relates particularly to the care of the crippled, maternal and child health and the control of venereal diseases.

The National Organization of Public Health Nursing, in cooperation with the American Public Health association, set up (and periodically revised) standards of appointment for public health nursing positions. There are also minimum requirements for school nurses. In addition to being a graduate registered nurse, a public health nurse must have had special supervised experience or a postgraduate course of at least one year dealing with her specialty. (M. FI.; X.)

In England and Wales a health visitor was defined as a state registered nurse who trained at least six months in midwifery and passed the first examination of the Central Midwives' board, and obtained the health visitor's certificate of the Royal Sanitary institute aiter a course of training lasting six to nine months; or, if she was not a fully trained nurse, underwent a recognized two years' course of training, had at least six months' training in a hospital and passed the first examination of the Central Midwives' board. Training centres were approved by the minister of health for the training of health visitors under memorandum 101 MCW issued in 1925. The syllabus was revised in Jan. 1950. Section 24 of the National Health Service act, 1946, required local health authorities (that is, county councils and county borough councils) to provide a complete health visitor service either by themselves employing health visitors or by making arrangements with voluntary organizations to do so. Duties include visiting persons in their own homes "for the purpose of giving advice as to the care of young children, persons suffering from illness, which includes mental illness, and any injury or disability requiring medical or dental treatment or nursing, and as to the measures necessary to prevent the spread of infection." (E. JN.; X.)

VISSCHER, WILLIAM LIGHTFOOT (1842–1924), U.S. author, was born in Owingsville, Ky., on Nov. 25, 1842. He attended Bath seminary in Owingsville and also Stevenson's academy in Danville, Ky. On the outbreak of the Civil War, Visscher joined the Union army. He enlisted in the Kentucky volunteers and served for more than three years.

In 1868 Visscher was graduated from the University of Louisville (Ky.) law school. He mas admitted to the bar the same year, but never practised law although he served as apprentice to a judge for a few months. The remainder of his life was spent mainly in newspaper work in St. Joseph and Kansas City, Mo.; San Francisco, Calif.; Cheyenne, Wyo.; Denver, Colo.; Portland, Ore.; and Tacoma, Wash. The western U.S. fascinated Visscher and from it he drew heavily for his novels.

He was a public lecturer and dramatic actor for a few years and wrote more than 1,000 poems, the majority of which were published. Visscher's collaboration with William F. ("Buffalo Bill") Cody resulted in *Buffalo* Bill's Own Story (1917). Visscher died in Chicago, Ill., on Feb. 10, 1924.

Among his writings are *Carlisle* of Colorado; Way Out Yonder; Thou Art Peter; Fetch Over the Canoe (1908); Ten Wise Men and Some More (1909) ; Amos Hudson's Motto (1905) ; *A* Thrilling and Truthful History of the Pony Express (1908); Black Mammy (1886); Harp of the South; *Blue* Grass Ballads (1900) ; Chicago, an Epic (1897); Poems of the South (1911); My Lady of the Island; How They Came to Be Statues; Stars of Our Country; and Portraits and Pen-Pictures.

VISTULA, a river of north and central Poland, 677 mi. in length, rises on the northern slopes of the western Beskids, southeast of Cieszyn, flows along the former frontier of East Prussia and flows out to the Baltic sea at the Gulf of Danzig. Main tributaries on the right include the Bug, Dunajec, San and Wisloka rivers; on the left, the Nida, Pilica and Wierzyca. It is connected with the Oder river via the Brda river, the Bydgoszcz canal and the Notec and Warta rivers.

Coal and lumber from Silesia are transported on the Vistula. It was made navigable for small craft as far as Cracow, the river being able to accommodate larger ships up to the mouth of the San river.

During World War I important battles took place on the river. After ihe war the lower part of the river was the dividing line between East Prussia and the Polish corridor.

Before World War I conservancy works had only been carried out on the German part of the river, 138 mi. in length; spur and longitudinal dikes had been built to maintain the water level, thereby facilitating the flow of water at floodtime and also improving navigability.

After the war Poland was too occupied with other matters to carry out improvement works, or even contribute much to the upkeep of the river.

Traffic on the river, consequently, greatly decreased. Later, however. large reservoirs were constructed on the Carpathian tributaries of the river at Roznow and Porembka; thus important steps were taken not only toward efficient regulation of the river itself but also toward the establishment of valuable sources of electrical power. The river is called the Wisła in Polish, Visla in Russian and Weichsel in German.

VITACEAE, a family of cosmopolitan. woody plants, most of them tendril-bearing vines, with 12 genera and about 650 species. The largest genus, which is pantropic, is *Cissus,* containing about 250 species. *Vitis,* with about 60 species, is its one genus of great economic importance, including as it does the European wine grape (V. vinifera), and the North American fox grape (V. labrusca), the parent species of most of the cultivated slip skin American grapes. The Boston ivy (Parthenocissus tricuspidata), cultivated from Massachusetts to Ohio, is native to China and Japan, while the Virginia creeper (*q.v.*) (P. *quinquefolia*) is native to the eastern United States. Leea is a genus of about 100 species, some erect shrubs, others vines, all without tendrils, native to Malaysia and the subcontinent of India.

VITALI, GIOVANNI BATTISTA (c. 1644–1692), Italian violinist and composer, noted for his sonatas for strings. Born in Cremona about 1644, he studied counterpoint under Maurizio Cazzati. From 1666 he served in church positions in Bologna and from 1674 at the court of the duke of Modena.

A prolific composer, he wrote, in addition to sonatas in early forms, dance and vocal music. He is considered to have possibly influenced later development of sonata forms.

He died in Modena on Oct. 12, 1692.

Giovanni Vitali's son, Tommaso Antonio, born at Bologna about 1665, was also an accomplished violinist and composer. He became known principally for his chaconne, which continued to be a standard piece in the violin repertoire of performers in modern times. Tommaso was music director at the court of Modena and from 1706 he was a member of the Bologna Philharmonic academy. He edited a collection of Giovanni's sonatas (1692).

VITALIAN (VITALIANUS), **SAINT** (d. 672), pope from 657 to 672, was consecrated as successor to Eugenius I on July 30, 657. In the Monothelite controversy then raging he refrained from express condemnation of the *Typus* of Constans II (*q.v.*). When Constans visited Rome in 663, the pope received him "almost with religious honours," a deference he requited by stripping all the bronze ornaments of the city—even the tiles of the Pantheon—and carrying them off. Vitalian died about Jan. 27, 672.

His feast day is Jan. 27.

See H. K. Mann, ***The Lives of the Popes in the Early Middle Ages,*** vol i, pt. 2, pp. 1–16 *(1902).*

VITALISM, a school of scientific thought—the germ of which dates from Aristotle—which attempts (in opposition to mechanism and organicism; *qq.v.*) to explain the nature of life as being due to a vital force peculiar to living organisms and different from all other forces found outside living things. This mysterious force (entelechy; *q.v.*) controls form and development and directs the activities of the organism. Vitalism has lost prestige as more and more vital phenomena have been shown to be of chemical and physical nature, and few rigid vitalists are to be found in modern science.

See DRIESCH. HANS ADOLF EDUARD; BIOLOGY: History: *Aristotle* as a Biologist.

VITAL STATISTICS are data on births, deaths, fetal deaths, marriages, divorces, annulments, adoptions, legitimations and notifiable diseases. A vital statistics system includes the collection and preservation of records and reports of these events, and the compilation and analysis of data contained on the records. Individually, the vital record represents evidence of the occurrence of the vital event and of certain facts related thereto. These records are important for many legal and administrative purposes, such as the establishment of citizenship, the right of inheritance, entitlement to benefits and allowances, eligibility for school attendance and military service.

Central vital statistics offices issue certified copies of birth and death certificates to qualified persons on request. Many states of the United States also use the birth registration card or other type of short-form certification of birth facts which does not disclose such information as the occurrence of birth out of wedlock or adoption

Many county and municipal officers also issue copies of vital records which were filed with them prior to the establishment of central registration or passed through their hands before reaching state offices. Collectively, the vital records provide statistics which serve a host of uses, including demographic. genetic and medical research, social welfare and education programs, market analysis and the planning of community facilities.

The subject of vital statistics is treated in a number of separate articles. This article traces the history of vital statistics from church-kept records through the development of the general register office in England and the routine registration of births, deaths and other vital records in Europe and the United States and discusses registration and reporting activities in the United States.

For the theory and application in connection with population, and data on world population, *see* POPULATION; POPULATION ECOLOGY. For the history and modern practices and methods of national censuses *see* CENSUS. (For detailed census figures *see* the POPULATION sections in separate articles on various countries and other political subdivisions.) Movements of peoples are dealt with in MIGRATION. *See* also DEMOGRAPHY; PUBLIC HEALTH and such titles as BIRTH RATE; DEATH RATE; DIVORCE; ILLEGITIMACY; LIFE EXPECTANCY; LONGEVITY; MARRIAGE RATE; SEX RATIO.

History. — Some countries have long-established and highly developed vital statistics systems, while in others, only partial development has occurred. For the origin of vital statistics pertaining to health *see* MEDICINE. HISTORY OF. The earliest known records of vital events were maintained by the church. In England, for example, these records date back to 1538, when the clergy in all parishes were first required to keep a weekly record of christenings, marriages and burials. A beginning was made by the English colonies in America in 1632 when the grand assembly of Virginia passed a law requiring a minister or warden from every parish to appear annually at court on the first day of June and present a register of such events. In 1639 the general court of the Massachusetts Bay colony passed a registration law based on the English precedent but differing in two important respects: the responsibility was placed on government officers rather than on the clergy; and it called for the recording of vital events — births, deaths and marriages — rather than church-related ceremonies, such as baptisms.

The first analytical study based on vital events was made by John Graunt of London in 1662. In 1693 the astronomer. Edmund Halley. applying mathematical techniques, constructed the first scientific life table. About 1800 the Industrial Revolution with the resultant health and social problems stimulated interest in vital and health statistics. As a result, by 1833 births and deaths were routinely registered in France, Belgium. Austria, Prussia. Bavaria, Saxony, the Scandinavian countries, Finland and five cities in the United States.

In 1836 Great Britain enacted a registration law creating a central register office with responsibility for the records and statistics of births, marriages and deaths — by cause — for all of England and Wales.

Birth and death statistics first published by the United States government concerned events in 1850 and were collected by the census method for the entire United States. Beginning in 1900 annual death statistics for a group of states were based on registered events, and beginning in 1915 annual birth data were reported similarly. Beginning with 1933, birth and death statistics included data for the entire country. By 1925 all states were making regular summary reports of notifiable diseases to the federal government.

Registration and Reporting Activities in the United States. — In the United States, vital registration is governed by state laws. Vital records originate with private citizens, members of the families affected by the events, their physicians, funeral directors, clergymen and others. Requirements for filing and penalties are defined by statute. While registration has been the responsibility of the attendant at birth, generally a physician or midwife. newer laws may place the responsibility on hospitals. Each birth must be reported promptly: the reporting requirements vary from state to state, ranging from 24 hours after the birth to as much as 10 days. Certificates must be filed with the local registrar of the birth district. Births to United States citizens in foreign countries are reported to the U.S. department of state.

With regard to the registration of deaths in the United States, the funeral director or person acting as such is responsible for reporting the event. He obtains the data required, other than the cause of death. The latter information is furnished by the physician in attendance, or the coroner. The registration of fetal deaths (infants born dead) is the responsibility of whoever makes final disposition of the fetus, usually the hospital administrator or funeral director.

In most states, marriage licences are issued by town or county clerks who obtain the personal particulars from the applicants. After the marriage is performed, the officiant certifies to the facts of the marriage and sends the record to the official who issued the licence. In most of the states, there is some provision for the local licensing official to send the original marriage record or a copy to the state registrar of vital statistics.

Original divorce and annulment records are, in most states, first filed with the clerk or other official of the court where the decree is granted. Personal particulars are obtained by the clerks from attorneys or petitioners. In many states these records are regularly transmitted to the state vital statistics offices as are records of birth, death and marriage.

Each state is divided into local registration districts for the purpose of collecting vital records. The local and county registrars are responsible for the complete, accurate and timely collection of vital records. These records are permanently filed in vital statistics offices of the state governments.

Through a co-operative arrangement with the individual states, copies of birth, death and fetal death records are sent to the national office of vital statistics, U.S. public health service, for tabulation and publication of national data. This office also promotes more complete and uniform registration throughout the nation, and is the official technical representative of the United States in the advancement of international vital statistics. *See* also references under "Vital Statistics" in the Index volume.

BIBLIOGRAPHY.—United Nations, *Demographic Yearbook* (annual); National Office of Vital Statistics, *Vital Statistics of the United States* (annual), (see *History and Organization of the Vital Statistics System,* vol. *1,* pp. 2–19, 1950), *Vital Statistics Rates of the Cnited States, 1900–1940* (1947); Warren S. Thompson and P. K. Whelpton, *Population Trends in the Cnited States* (1933); Mortimer Spiegelman, *Introduction to Demography,* Society of Actuaries (1955). (H. L. D.)

VITAMINS are specific organic compounds that are required in the diet in very small amounts (0.005% to 0.00002%). In the absence of sufficient amounts of any one of these substances, growth failure of young animals usually occurs, and specific pathogenic changes recognizable as disease develop in both immature and adult individuals. Naturally occurring diseases in man that result from an insufficient intake of one or more vitamins are termed vitamin deficiency diseases. Beriberi, scurvy, rickets, pellagra, xerophthalmia and pernicious anemia are examples of such diseases.

The vitamins are differentiated from other essential organic dietary ingredients chiefly on the basis of the very small amounts required in the diet. A typical vitamin such as thiamine may comprise 0.001% of an adequate diet, whereas other organic dietary essentials, such as an essential amino acid, are required in amounts at least 1,000 times as great (about 1%).

Deficiency Diseases. — Not until experiments with animals were undertaken near the beginning of the 20th century did the concept become established that the lack of certain dietary constituents could cause disease. This was radical departure from the prevalent idea that all diseases were caused by positive agents. such as bacteria. In 1897 Christiaan Eijkman, working in the Dutch East Indies where a disease known as beriberi was widespread, was able to produce a similar malady in chickens simply by restricting their diet to polished rice, the staple food of the human population. Extracts of the usually discarded rice polishings were found to cure the deficiency disease, and later work showed that the vitamin involved was thiamine (B_1).

Following the demonstration that beriberi is caused by a dietary deficiency, other diseases that resembled certain naturally occurring disorders of mankind and of animals were produced experimentally by feeding various deficient diets.

Thus, A. Holst and T. Frohlich (1912) were able to produce scurvy in guinea pigs by withholding from them fresh plant materials and by feeding them only dried hay and oats. By the use of such a ration it was possible to determine which foods contained the antiscorbutic vitamin (vitamin C or ascorbic acid). If it was present, scurvy was prevented when the food under examination was fed as a supplement to this ration. If the vitamin was absent or present in insufficient amounts, scurvy resulted. In this way the presence of the vitamin in fractions prepared from lemon juice was traced, and the isolation of the antiscorbutic compound, ascorbic acid, was eventually accomplished (C. G. King and W. A. Waugh, 1932).

A similar pattern of events led to the recognition of many of the other vitamins. In more recent years it has been recognized that all classes of living beings—man, microorganisms, plants and animals—require vitamins for growth and well-being. However, the particular ones required in the diet differ from species to species. Thus whole green plants manufacture all the vitamins they require for themselves. In all other classes of living organisms there are many species that require one or more vitamins in the diet, and some that do not. In the latter case, the particular species may, like plants, be capable of making sufficient quantities of it to fulfill its needs, or, in exceptional instances, may have no absolute need for the vitamin in its life processes.

The recognition that bacteria and yeasts may require the same vitamins that man requires greatly facilitated recognition of various vitamins. Approximately half the vitamins now known to be required by animals were discovered originally as substances required for growth of one or another of these microorganisms.

Once the existence of a vitamin is recognized through its effects in permitting growth or curing deficiency disease in a living organism, these effects provide a test or assay method by means of which the vitamin can be isolated as a pure chemical compound from suitable rich source materials. This in turn permits a study of its chemical constitution and eventually its chemical synthesis. Most of the vitamins are now available commercially as synthetic compounds identical in composition and physiological effects with the naturally occurring substances.

Although most of the vitamins are widely distributed in nature, some foodstuffs may be rich sources of one or more vitamins and poor sources of others. Subsequent manufacturing processes may diminish the actual content of one or more of the vitamins. However, some foods are routinely enriched with several of the vitamins to offset these losses, as for example enriched white flour.

Animals that have grown to maturity on diets containing adequate amounts of the vitamins usually require months (with some animals and certain vitamins, even years) to develop signs of deficiency disease when placed on a vitamin-deficient ration. On the other hand, young animals (or adult animals that have grown to maturity with marginal vitamin intakes) have poor vitamin reserves and show deficiency symptoms rather soon when fed vitamin-deficient rations. Both young and old, however. require relatively shorter periods to become deficient in some vitamins than in others. In general the symptoms of a given vitamin deficiency are fairly similar among species, although occasionally one species may show symptoms not manifested by others.

The requirements for vitamins are fairly well established for experimental animals but are only approximate in the case of man. Quantities recommended for human consumption are generally likely to be too high rather than too low. It has been found that in several cases the requirement for a given vitamin can be altered by the amount of some other essential nutrient present. For example, W. A. Krehl, L. J. Teply and C. A. Elvehjem (1945) found that an amino acid, tryptophan, could be substituted for nicotinic acid, a vitamin. This is because part of the former is converted to the latter in the animal body. An example of the opposite effect is the increased requirement for vitamin B_6 that results when a diet high in protein or in methionine is fed to animals.

Vitamins have been classified arbitrarily into fat-soluble and water-soluble groups. The fat-soluble ones are represented by vitamins A, D, E and K, while the water-soluble group consists of the remainder. The water-soluble vitamins other than ascorbic acid are sometimes known collectively as the B-complex.

Determination of the Vitamins in Foods.—Because of the fact that individual foods differ widely in their content of the several vitamins, it is a matter of practical importance to be able to estimate accurately how much of each is present in a foodstuff. This may be done in different ways.

The oldest method for the quantitative determination of a given vitamin is an animal assay. In the making of such an assay, a ration is devised that lacks that vitamin but is otherwise quite adequate. This basal ration plus graded amounts of the material to be tested are fed to some animals (white rats are usually used) while others receive the basal diet plus graded amounts of the pure vitamin. By comparison of the performance of the former with that of the latter, a value for the quantity of vitamin in the unknown can be calculated. Such methods are cumbersome, time consuming and costly. For these reasons they are supplanted by the following procedures whenever the latter are proved to have sufficient specificity; *i.e.*, when it becomes evident that there are no other materials in foods whose effects could be confused with those of the vitamin.

A general method for the determination of vitamin content of foods is based on the fact that various microorganisms need the same vitamins as do the higher animals. The procedure is then the same as in the method of assay. The only difference is that some suitable microorganism is used in place of the rats or other animals. These microbiological methods are useful because they allow the determination of exceedingly minute amounts of the various vitamins, because they are rapid and inexpensive to conduct and because they are generally more precise than animal assays. They were first introduced by E. E. Snell and F. M. Strong in 1939.

Another general method of quantitative determination of a vitamin becomes possible when the chemical structure is elucidated. Then a procedure may be devised that takes advantage of some distinctive chemical property of the vitamin, which sets it apart from other constituents of foodstuffs. Chemical analyses recommend themselves because of their precision, speed and ease of operation.

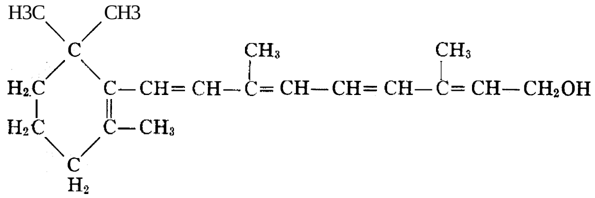
Vitamin A.—Vitamin A is a fat-soluble alcohol of the formula shown in the diagram. Because of its chemical nature it is readily destroyed by exposure to air and light. It occurs most abundantly in fish and especially in fish-liver oils, and to a considerable extent in butter and in the liver fat of various animals. Vitamin A does not occur in plants, but many vegetables and fruits possess potency because they contain carotenoid pigments that are converted to the vitamin in the body. Most of these yellow and red pigments do not possess this property, but one called p-carotene can serve as a good source of the vitamin. The yellow colour of carrots is caused largely by p-carotene.

Lack of vitamin A in the diet leads to poor growth in young animals, to inability of the eyes to adapt normally to dim light (night blindness) and, as the deficiency progresses. to xerophthalmia and eventual complete blindness. The vitamin is known to function directly in vision as a component of the pigment, visual purple, in the retina. Changes in the skin and in the mucous membranes of the body, best described in general terms as keratinization, are characteristic. Alterations in the growth of bones occur, and these may lead to manifestations such as blindness in calves or deafness in dogs. The reproductive process is specifically interfered with, and this is possibly associated with the alteration that occurs in mucous membranes.

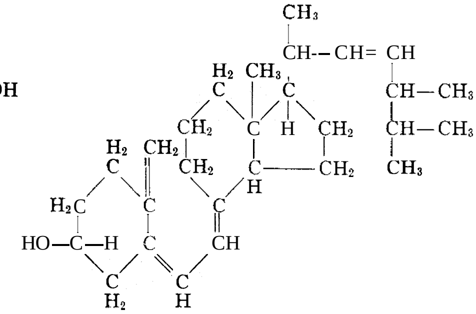
Several closely related compounds that have vitamin A potency are found in animal fats. For example. fresh-water fish oils contain, in addition to vitamin A, a vitamin A_2, which differs from the former by having two fewer hydrogen atoms in the cyclic portion of its structure. It also can form a visual purple.

Vitamin A is reauired in verv small amounts. For example, 4,000 international units of the vitamin or 2.4 mg. of β-carotene per day are said to be sufficient for man.

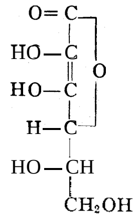
The existence of vitamin A was first clearly recognized by E. V.



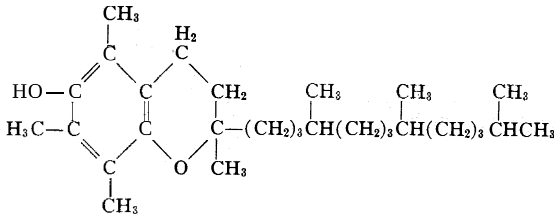
VITAMIN A



VITAMIN D_2

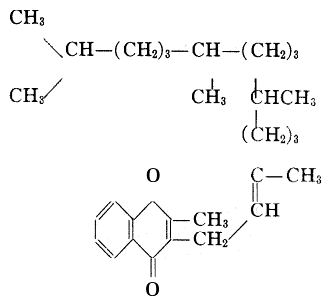


ASCORBIC ACID

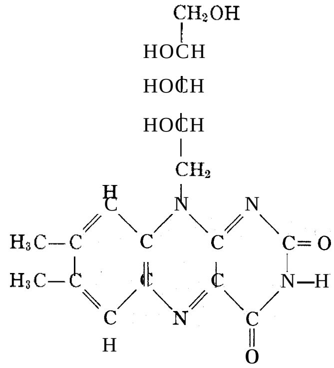


VITAMIN E (ALPHA-TOCOPHEROL)

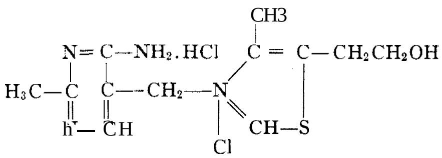
Beta- and gommo-tocopherols differ in having one less methyl group in the benzene ring



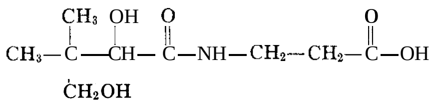
VITAMIN K



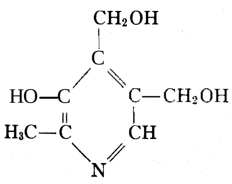
RIBOFLAVIN



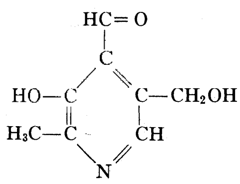
THIAMINE



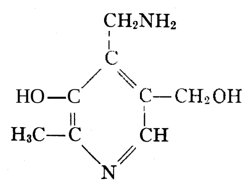
PANTOTHENIC ACID



PYRIDOXINE

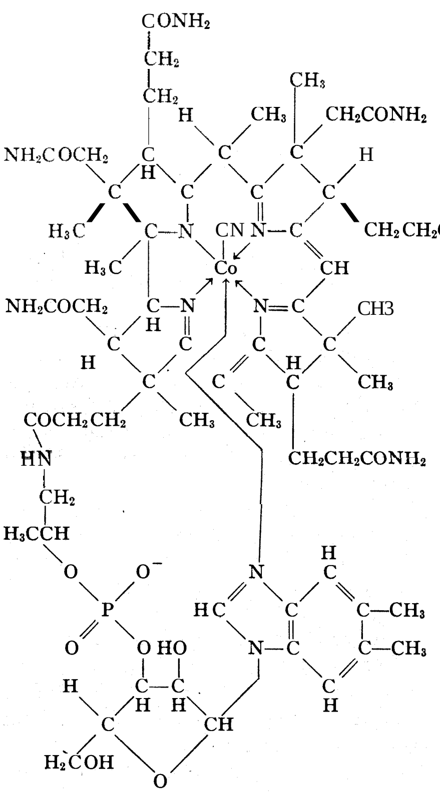


PYRIDOXAL

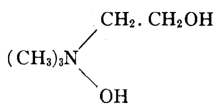


PYRIDOXAMINE

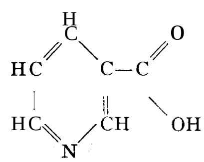
VITAMIN B_6



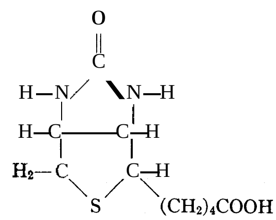
VITAMIN B_{12} (CYANOCOBALAMIN)



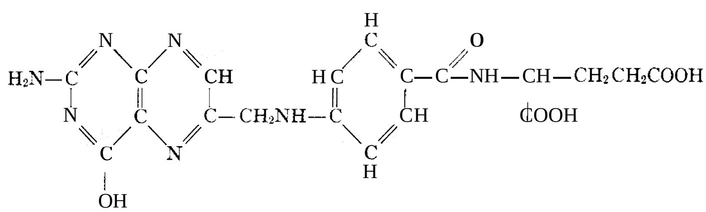
CHOLINE



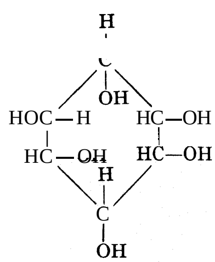
NICOTINIC ACID



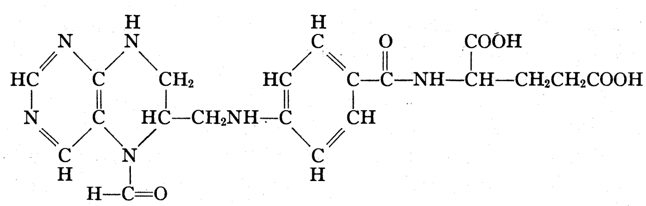
BIOTIN



FOLIC ACID



MESO-INOSTOL



FOLINIC ACID

CHEMICAL FORMULAS OF THE VITAMINS

McCollum and M. Davis in 1913 and by T. B. Osborne and L. B. Mendel in 1913; its chemical nature was established by P. Karrer and his associates in 1933.

Vitamin D.—Vitamin D is a fat-soluble alcohol that occurs only in animals but that may arise in dead plant materials when they are exposed to ultraviolet light. The action of such light on ergosterol, on 7-dehydrocholesterol or on certain other sterols leads to the formation of vitamin D. With vitamin D as with vitamin A there are several closely related compounds that possess potency, and any one of these may predominate, or be present exclusively, in a given source. Since the active substance arises by irradiation of various sterols with ultraviolet light, it is not essential that the vitamin be taken in the food because the irradiation of the animal will allow the activation of its sterols. Without such irradiation, the animal must receive food that contains the vitamin. The food may in turn have acquired its vitamin as a result of exposure to light of suitable wave length. Now, although tropical sunlight contains light of the proper wave length to produce activation of sterols, winter sunshine in northern regions of the world, or sunlight that has passed through certain glasses or through clouds, may lack sufficient ultraviolet rays to bring about adequate production of the vitamin in the animal.

Lack of vitamin D leads to the appearance of rickets. In this disease, calcification of bone is retarded and, as a result, such abnormalities as grotesquely bowed legs and malformed skull and chest are produced.

Vitamin D is one of the most active of vitamins from the point of view of the amount required per day. About 10 pg. (400 international units) are considered adequate for a growing child.

Recognition of the therapeutic effects of cod-liver oil and of sunlight in preventing or curing rickets in man was made in the 18th century or earlier. The existence of a vitamin responsible for the effects of cod-liver oil was indicated in experimental animals by E. Mellanby in 1918 and by McCollum in 1922. H. Steenbock, A. F. Hess and M. Weinstock in 1924 demonstrated that the curative effects of ultraviolet light resulted from formation of vitamin D by such irradiation. A pure vitamin D was first isolated from irradiated ergosterol in 1930–31 by large groups of workers in England and in Germany.

Vitamin E or the Tocopherols.—Vitamin E is a fat-soluble phenol found principally in certain plant oils. Wheat-germ oil is a particularly rich source. This vitamin was recognized first by H. M. Evans and K. S. Bishop in 1922, obtained in pure form by Evans and O. H. and G. A. Emerson in 1936, and identified chemically by Karrer, H. Salomon and H. Fritzsche in 1938. Three similar compounds, a-, β- and y-tocopherol, each with vitamin E activity, have been found in nature. Of these, the a-isomer is the most active.

In several species of rodents and in dogs, lack of vitamin E leads to muscular dystrophy. Furthermore, in rats a deficiency results in sterility in the male and leads to failure to bear young in the female. This failure is caused by the death and resorption of the embryos in the later part of the gestational period. In addition to these functions in animals, tocopherols also play a role as antioxidants which retard the rancidification of fats. If these compounds were not present, many vegetable oils would become rancid very rapidly.

Vitamin K.—In 1934 H. Dam showed that when chickens were fed a modified ration they developed spontaneous hemorrhages. This condition subsequently was found to be caused by the lack of a naphthoquinone now known as vitamin K_1. The vitamin present in green leaves mas isolated and shown to have the structure represented in the diagram (R. W. McKee, S. B. Binkley, D. W. MacCorquodale, S. A. Thayer and E. A. Doisy, 1940). Related compounds, both naturally occurring and synthetic, may have activity.

Lack of vitamin K leads to increased clotting time of the blood because of a reduction in the amount of prothrombin. H. A. Campbell and K. Link found a substance, dicumarol, in spoiled sweet clover which causes a drastic increase in clotting time. This effect can be rapidly counteracted by the administration of vitamin K_1.

Ascorbic Acid or Vitamin C.—Vitamin C is a water-soluble, easily oxidizable, carbohydratelike lactone which is necessary in the diet of some animals in order to prevent scurvy. Its structure is shown in the diagram. Only a relatively few species (man, monkeys and guinea pigs) need this vitamin, since most animals can synthesize it themselves. Those which require it in the food depend primarily on fresh fruits, vegetables or other plant materials for their supply of this factor.

Although scurvy was recognized for many centuries, little progress was made in its treatment until the production of the disease in guinea pigs (Holst and Frohlich, 1912), the isolation of the curative agent, ascorbic acid (King and Waugh, 1932), and the elucidation of its nature. A. Szent-Gyorgyi in 1927 isolated ascorbic acid inadvertently without recognizing its vitamin character. Relatively large amounts of this vitamin are required; *i.e.*, an adult man is said to need about 30 mg. per day. The ease of destruction of ascorbic acid by oxidation, especially in neutral or alkaline solution or at elevated temperatures, makes its preservation in foods difficult. Citrus fruits and fresh vegetables and fruits are the best dietary sources of the vitamin.

Thiamine (Vitamin B_1).—Thiamine is a water-soluble nitrogenous basic alcohol which is necessary in the food in order to prevent beriberi. Although this disease results from severe deficiency, less drastic restriction of the vitamin may lead to failure of appetite and to certain types of neuritis. Thiamine is the substance for which the word vitamin was first coined (C. Funk, 1912). The isolation of thiamine absorbed the attention of biochemists for many years until it was finally achieved by B. C. P. Jansen and W. F. Donath in 1926. However, several years elapsed before an improved method of isolation was developed (R. R. Williams and associates) that allowed adequate study of the substance. The problems involved were common to the isolation of many of the vitamins but were magnified by the fact that experience in such matters was lacking since thiamine was the first vitamin to be obtained in pure form. These problems revolve about the exceedingly small amounts present in even the richest sources and the ease of destruction of some of the vitamins.

Thiamine occurs most abundantly in cereal grains and in certain other seeds. Pork is one of the richest animal sources. About 1 mg. per day meets all the needs of an adult human being.

Thiamine functions in some of the enzyme systems by means of which the body converts carbohydrates into energy. In these functions it acts in the form of its ester with pyrophosphoric acid.

Riboflavin (Vitamin B_2).—Riboflavin is a yellow nitrogenous polyhydroxy alcohol, which occurs abundantly in whey and in egg white. Indeed, the greenish-yellow fluorescence of these materials is caused by the presence of this pigment. It was recognized as a vitamin in 1933 (R. Kuhn, P. Gyorgy and T. Wagner-Jauregg).

In addition to failure of growth, the lack of riboflavin leads to changes in the skin and tongue. The eyes frequently are involved. The vitamin is known to function as part of enzyme systems that are concerned with oxidation of carbohydrates and of amino acids. Like thiamine and most other vitamins, it fills its metabolic function not in the free form but as a more complex derivative formed from the vitamin by the organism and containing esterified phosphoric acid derivatives.

Slightly more riboflavin than thiamine is required for the well-being of several species of animals, and it is said that 2 mg. per day will meet the needs of an adult human being adequately. It is widely distributed in both plants and animals, but the richness of diverse materials varies considerably.

Nicotinic Acid (Niacin).—This nitrogenous acid (or its amide) is the water-soluble pellagra-preventative vitamin. J. Goldberger's demonstration that pellagra was a deficiency disease (1925) was followed in 1937 by the identification of nicotinic acid (or its amide) as the vitamin involved (Elvehjem, R. J. Madden, Strong and D. W. Woolley). Pellagra is a disease primarily seen among people who eat large quantities of maize. The dogs and cats owned by pellagrous families may show a similar deficiency disease, which may be cured with the vitamin. Nicotinic acid is one of the most stable of the vitamins, and resists well most cooking or preserving processes. It is widely distributed among plants and animals but, just as with riboflavin, some materials are rich in it while others are poor. On most diets, the requirement of man for nicotinic acid is estimated to be from 5 to 15 mg. per day. However, the amino acid tryptophan can be converted to nicotinic acid by animals, and hence the requirement for the vitamin varies with the amount of this amino acid supplied by the diet. On diets high in good-quality protein, the amount of tryptophan present may be such as to reduce the dietary requirement for nicotinic acid to zero. This explains the early observations of Goldberger that good-quality protein such as that of eggs and milk, both of which are poor sources of nicotinic acid, could prevent or cure pellagra in man.

Like thiamine and riboflavin, nicotinic acid is also a part of enzyme systems concerned with the metabolism of carbohydrates. In these systems, it acts (when combined as cozymase) in catalyzing the oxidation of sugar derivatives.

Pyridoxal, Pyridoxamine and Pyridoxine (Vitamin B_6).—The existence of a vitamin distinct from thiamine and riboflavin that appeared to be an organic base was established in 1936 by T. W. Birch and Gyorgy in experiments with rats. This substance was termed vitamin B,; deficiencies of it led to a disease characterized by severe reddening and erosion of the skin on the ears, nose and paws. A substance that prevented or cured these changes was isolated almost simultaneously in five independent laboratories in 1938. Kuhn and co-workers in Germany and S. A. Harris and K. Folkers in the United States synthesized the compound in 1939; it was named pyridoxine (see diagram).

Snell and co-workers demonstrated in 1942–44 the existence of two additional forms of this vitamin and named these pyridoxal and pyridoxamine. The latter two compounds are more widely distributed than pyridoxine and are responsible for most of the vitamin B_6 activity of natural materials. The vitamin functions as a phosphorylated derivative of pyridoxal and pyridoxamine in the formation and breakdown of amino acids, and hence indirectly of protein, in living tissues.

Up to mid-loth century no human disease had been found to be caused specifically by a deficiency of vitamin B_6 in the food although certain human ailments of obscure origin had been shown to respond to administration of this substance. When such responses had been observed, the lack of sufficient vitamin in the food had not been shown. Although the production of pyridoxine deficiency in animals such as rats: mice, dogs and chickens is readily accomplished, the signs of deficiency depend to some extent on the other constituents of the diet; *e.g.,* the skin lesions in rats may not appear if certain fats are present in the ration. The intensity of the deficiency symptoms and the amount of vitamin B_6 required to prevent them are increased by feeding diets unusually high in protein or in certain amino acids such as methionine. This situation is not unique for pyridoxine deficiency, because a similar dependence of pathology on other constituents of the food is found with several vitamins.

About 1950, vitamin B, deficiency was produced experimentally in man and infants. In infants, the deficiency first manifests itself in a specific type of convulsion that is readily controlled by administration of the vitamin. A large number of cases of such convulsions have been reported in infants fed a processed substitute for human milk. Milk may be marginal in its vitamin B, content, and a portion of this vitamin is destroyed by improper heat treatment. The deficiency is corrected by improved processing procedures.

Pyridoxal, pyridoxamine and pyridoxine are interchangeable in nutrition of animals. although not always in that of microorganisms. Their potency is of the same order as that of thiamine and riboflavin. They are widely distributed in various foodstuffs.

Pantothenic Acid.—This vitamin was first discovered as a growth-promoting substance for yeast by R. J. Williams and collaborators in 1933; it was subsequently discovered independently by others as a growth factor for lactic acid bacteria and as a vitamin for animals. Collaborative studies by R. J. Williams and K. Folkers and their co-workers led to its synthesis in 1940. The compound is a nitrogenous hydroxyacid highly soluble in water but very insoluble in oils.

Pantnthenic acid does nnt occur free in tissues. The nature of the bound forms was clarified through discovery and synthesis by Snell and co-workers during 1947–50 of the compound pantetheine, which contains pantothenic acid combined with thioethanolamine. Pantetheine is required in place of pantothenic acid for growth of some bacteria and is, in turn, a fragment of a larger compound termed coenzyme A. Existence of coenzyme A was first noted by F. Lipmann in 1947 and its structure finally determined during the period 1950–55. In the form of this coenzyme, pantothenic acid promotes a large number of synthetic and degradative reactions in the body that are essential for growth and well-being.

In the absence of pantothenic acid (or its dietary equivalents, pantetheine or coenzyme A), experimental animals fail to grow, show skin lesions and frequently show a graying of the hair. All animals so far studied require the vitamin, but a dietary deficiency sufficiently severe to lead to a clear-cut deficiency disease has not been described in man. Prisoners of war in Japan during World War II, however, were reported to develop subjective symptoms described as "burning feet" that were relieved by administration of pantothenic acid.

The vitamin is widespread in nature and it is not so active, weight for weight, as most other vitamins. For example, a rat needs about ten times as much pantothenic acid as it does of thiamine or of pyridoxine.

Biotin.—This water-soluble nitrogenous acid was first discovered as a nutritive requirement of yeast. Indeed, it was one of the first vitamins to be isolated solely because it was a microbial growth factor, and subsequently to be found necessary for animals. However, after the years 1937–40, the use of bacteria and yeasts in the discovery of new vitamins, and as an aid in their isolation, became common. Biotin was isolated in pure form in 1935 by F. Kogl and B. Tonnies, and its structure was established by V du Vigneaud and his collaborators in 1942, after they had shown that it is required by animals.

The demonstration that biotin is required by certain animals was dependent on the fact (M. A. Boas, 1927) that the addition of uncooked egg white to a diet which is otherwise adequate leads to the production of a disease. This malady is caused by the presence in egg white of a specific protein, termed avidin, which combines with biotin and thus effectively prevents its utilization.

A human need for biotin was not known by the 1950s, possibly for reasons similar to those discussed under previous vitamins. It is a relatively stable substance which is found rather widely distributed in nature. Judged on a weight basis, biotin is one of the most active of the water-soluble vitamins (about 20 times as potent as thiamine for rats or chickens).

Folacin (Folic Acid or Pteroylglutamic Acid).—The existence of a new vitamin that was necessary for growth and for the prevention of anemia in monkeys and chicks and for the growth of various bacteria was demonstrated independently in 1938 by P. L. Day and in 1940 by A. G. Hogan and E. M. Parrott, and by Snell and W. H. Peterson.

Folic acid is a nitrogenous acid the nature of which was established, by Lederle laboratories in 1946, to be xanthopterylmethyl-para-aminobenzoyl glutamic acid. Several related substances that differ from folic acid only in their glutamic acid content have been isolated; their relative potencies in correcting folic acid deficiency in animals and microorganisms differ slightly. They are referred to as polyglutamates of folic acid.

In nature there exists a related group of substances that are derived from folic acid and its polyglutamates by reduction and that may or may not contain a combined formyl group. The first of these to be isolated and synthesized was *folinic* acid (*see* diagram); corresponding modifications of each of the polyglutamates of folic acid presumably occur naturally.

The various compounds of this type are interchangeable in animal nutrition but not always in bacterial metabolism. This vitamin is required for synthesis and breakdown in tissues of a number of important compounds, especially the nucleic acids.

Folic acid or one of its related derivatives is required in the diet of all higher animals studied. However, this requirement is difficult to demonstrate directly with some animals because the vitamin is synthesized by bacteria contained in the intestinal tract and absorbed from there into the body of the host. In such instances, it frequently happens that a deficiency is readily observed in animals fed certain drugs, such as sulfonamides, that interfere with synthesis of this vitamin by intestinal microorganisms. A deficiency of the vitamin in animals leads to anemia and a marked reduction in the number of one type of white blood cells. Some anemias found in human populations, such as the megaloblastic anemia of infancy and nutritional macrocytic anemia, are controlled by administration of the vitamin. An intimate but still poorly understood relationship between folic acid and vitamin B_{12} deficiency also occurs in pernicious anemia. A deficiency of folic acid is also characteristic of the disease sprue. Despite the natural occurrence of deficiency diseases that respond to it, the quantitative requirement for the vitamin is not well established. In chickens and guinea pigs, the amounts required are of the same order of magnitude as those of thiamine.

Vitamin B_{12} **(Cobalamine)**.—Although vitamin B_{12} is one of the most recently isolated and characterized vitamins, its discovery antedates that of many other B vitamins. G. R. Minot and W. P. Murphy found in 1927 that pernicious anemia could be treated successfully with large amounts of whole liver. Much smaller amounts of appropriately purified liver concentrates administered by injection were similarly effective. Over a period of many years pernicious anemia patients were used experimentally to determine the efficacy of purification procedures, and liver concentrates of higher and higher effectiveness were prepared. Finally, in 1948, a crystalline substance that controlled pernicious anemia when extremely small amounts mere administered by injection was isolated by workers in the Glaxo laboratories in England, and at Merck and Company, Inc., in the United States. The substance was called vitamin B_{12} and was shown to be the same as a substance, previously called animal protein factor, required for growth of animals on diets of all-vegetable origin.

Vitamin B_{12} is the most complicated vitamin in structure yet known and is unique in containing a metallic ion, cobalt. It occurs naturally in several closely related forms, all of which are now termed cobalamines because of the presence of cobalt in the molecule. The principal one used for medical purposes is called cyanocobalamin. Its structure was determined in 1956 by a collaborating group headed by A. R. Todd in England and by Folkers in the United States.

So far as known, vitamin B_{12} is not present in higher plants. It is required in the diet of all higher animals studied. It is synthesized by several molds and bacteria, and the ultimate source of the vitamin in liver and animal materials generally appears to be microorganisms of various kinds. Several bacteria that have lost the ability to make the substance for themselves are known; these require minute amounts of it for growth One of these was used as an assay organism during isolation of the vitamin, and all currently used methods of estimation depend upon its ability to promote growth of bacteria that require it. Its exact function in living organisms is unknown, but it clearly functions in some way to permit synthesis of methyl groups of choline and methionine, and in the synthesis of nucleic acid.

Vitamin B_{12} when administered by injection cures pernicious anemia in amounts as small as two millionths of a gram per day. Amounts that are fully curative by injection are without effect if given orally unless they are administered together with preparations from normal human or hog gastric juice. The substance in gastric juice is termed intrinsic factor and was discovered by W. P. Castle in 1934; purified preparations appear to be glycoprotein in nature. Intrinsic factor functions by promoting absorption of vitamin B_{12} through the intestinal wall. It is lacking in the gastric juice of pernicious anemia patients; they develop pernicious anemia even while ingesting a ration that contains adequate vitamin B_{12} for normal persons because, unlike normal persons, they are unable to absorb the vitamin. Thus pernicious anemia can be controlled either by injection of vitamin B_{12} in minute amounts or by oral administration of intrinsic factor with or without added vitamin B_{12}, but not by oral administration of small amounts of the vitamin alone. The condition therefore is not a nutritional deficiency disease produced by lack of the vitamin in the diet. Vitamin B_{12} deficiency from this latter cause is not common, but appears to occur occasionally in strict vegetarians who have persisted in their dietary habits for several years.

Choline.—Before the discovery of vitamin B_{12}, the nitrogenous alcohol choline appeared essential for growth of rats and chicks. Although required in amounts larger than most of the vitamins, it was nonetheless considered as a vitamin by many. The requirement for it largely disappears in animals provided with adequate amounts of the essential amino acid methionine and sufficient vitamin B_{12} to permit synthesis of its methyl groups. For this reason, its status as a vitamin is questionable, although it may promote growth in diets of marginal adequacy. Under conditions where it is required for animal growth, its absence results in hemorrhagic kidneys and an excessive deposition of fat in the liver. The substance is an important component of the metabolically important fatlike substance lecithin.

Choline also functions in the transfer of methyl groups in metabolism.

Inositol.—The vitamin status of inositol, like that of choline, is somewhat in doubt. Its role in nutrition was demonstrated in 1928 by E. V. Eastcott, who showed that it was required for growth of some yeasts. Woolley in 1940 demonstrated an apparent requirement for it by rats and mice. This requirement was not always observed, however, and many purified rations suitable for rat growth do not contain added inositol. Experiments with isotopic glucose have demonstrated its conversion to inositol in animals, hence its synthesis in vivo is possible. On the other hand, most isolated human tissues require the substance for growth in tissue culture (H. Eagle, 1956). It is evident that its nutritional role requires further study. Like choline, inositol occurs in certain lipids.

Miscellaneous.—A number of substances that function similarly to vitamins and are required for growth of various microorganisms are known. They appear not to be required in the diet of animals, so far as now known, and therefore should not be considered as true vitamins. Examples of such substances are lipoic acid, spermine or spermidine, protoporphyrin, cholesterol and several derived forms of the true vitamins such as pyridoxamine phosphate, pantetheine. etc. Such compounds are also required by higher animals, but these have retained the capacity to synthesize them and hence they are not dietary requirements for animals.

See also DIET and DIETETICS; NUTRITION; and articles on the vitamin deficiency diseases.

See J. S. McLester and W. J. Darby (eds.), *Nutrition and Diet in Health and Disease,* 6th ed. (1952); W. H. Sebrell, Jr., and R. S. Harris (eds), The Vitamins, vol. i–iii (1954). (E. E. SN.)

VITEBSK, a town of the Byelorussian Soviet Socialist Republic, U.S.S.R. (White Russia). on both banks of the western Dvina (Daugava), and on the railway. in 55° 10′ N., 30° 11′ E. Pop. (1956 est.) 128,000. Industries include the manufacture of glass, agricultural machinery, boots and shoes. sewn goods, sewing needles, spectacles and bristles. There is a large Jewish element in the town.

Vitebsk (Dbesk, Vitbesk and Vitepesk) is mentioned for the first time in 1021, when it belonged to the Polotsk principality. Eighty years later it became the chief town of a separate principality, and so continued until 1320, when it came under the dominion of the Lithuanians. In the 16th century it fell to Poland. Under the privileges granted to the city by the Polish sovereigns it flourished. but soon began to suffer from the wars between Russia and Poland, during which it was thrice taken by the Russians and burned. Russia annexed it finally in 1772. During World War II Vitebsk was captured by the Germans in 1941 and recaptured by soviet troops in the summer of 1944.

VITELLI, VITELLOZZO (?–1502), Italian *condottiere*. Together nith his father, Niccolò, tyrant of Città di Castello. and his brothers, who were all soldiers of fortune, he instituted a new type of infantry armed with sword and pike to resist the German men-at-arms, and also a corps of mounted infantry armed with arquebuses.

Vitellozzo took service with the republic of Florence against Pisa, and later with the French in Apulia (1496) and with the

Orsini faction against Pope Alexander VI. In 1500 Vitellozzo and the Orsini made peace with the pope, and the latter's spn, Cesare Borgia, being determined to crush the petty tyrants of Romagna and consolidate papal power in that province, took the *condottieri* into his service.

Vitellozzo distinguished himself in many engagements, and in 1501 he advanced against Florence, moved as much by a desire to avenge his brother Paolo, who while in the service of the republic had been suspected of treachery and put to death (1499), as by Cesare's orders. In fact, while the latter was actually negotiating with the republic, Vitelli seized Arezzo.

Forced by Borgia and the French, much against his will, to give up the city, he began from that moment to nurture hostile feelings toward his master and to aspire to independent rule. He took part with the Orsini. Oliverotto da Fermo and other captains in the conspiracy of La Magione against the Borgia; but mutual distrust and the incapacity of the leaders before Cesare's energy and the promise of French help brought the plot to naught, and Vitelli and other *condottieri,* hoping to ingratiate themselves with Cesare once more, seized Senigallia (Sinigaglia) in his name. There they were decoyed by him and arrested while their troops were out of reach, and Vitelli and Oliverotto were strangled that same night (Dec. 31, 1502).

VITELLIUS, AULUS (15–69), Roman emperor Jan. 2–Dec. 22, A.D. 69, was born on Sept. 24, A.D. 1j. He was the son of Lucius Vitellius, who had been three times consul and colleague of Claudius as censor. Aulus was consul in 48, and later (perhaps in 60–61) proconsul of Africa. Under Galba, to the general astonishment, at the end of 68 he was chosen to command the army of Lower Germany. His good nature, which was fatal to discipline, made him popular, but he was not ambitious, and was raised to the throne by Valens and Caecina, two commanders of legions on the Rhine. They contrived a military revolt, and early in 69 Vitellius was proclaimed emperor of the armies of Germany at Cologne. He was accepted by the senate after his victory over Otho (*q.v.*), but never by the whole empire. The armies of the east and of the Danube declared for Vespasian, and Vitellius' general Caecina turned traitor. His legions were then defeated before Cremona by the invading general Antonius Primus, and as the victors neared Rome Vitellius meditated abdication. His praetorian guard forbade this and events moved to a tragic climax, during which the capitol of Rome was burned. On the entry of Vespasian's troops Vitellius was dragged from a miserable hiding place and butchered at the fatal Gemonian stairs, crying "Yet I was once your emperor." During his brief administration Vitellius showed indications of a desire to govern wisely. He has a reputation as one of the greatest eaters and drinkers known to history.

VITERBO, a provincial capital and episcopal see of the district of Lazio (Latium), Italy, 54 mi. N.N.W. of Rome, 1,073 ft. above sea level. Pop. (1951) 25,909. It is surrounded by gardens, and enclosed by walls and towers which date partly from the Lombard period. The streets are paved with large lava blocks, of which the town is also built.

The Piazza St. Pellegrino is said to be the best example in the country of a 13th-century piazza. The citadel (Rocca) itself, erected by Cardinal Albornoz in 1345, is now a barrack.

The cathedral, a fine basilica, of the 12th (?) century, with columns and fantastic capitals of the period, originally flat-roofed and later vaulted, with 16th-century restorations, contains the tomb of Pope John XXI, and has a Gothic campanile in black and white stone. Here Pope Adrian IV (Nicholas Breakspear) compelled the emperor Frederick I to hold his stirrup as his vassal.

The church of Sta. Rosa exhibits the embalmed body of that saint, a native of Viterbo, who died in her 18th year after working various miracles and having distinguished herself by her invectives against Frederick II (12j1). Some ruins of Frederick's palace, destroyed after his death, exist. S. Francesco, a Gothic church (1236), contains the fine Gothic tombs of Popes Clement IV and Adrian V, and has an external pulpit of the 15th century. Sta. Maria della Cella is noteworthy for one of the earliest campanili in Italy (9th century). The town hall, with a medieval toner and a 15th-century portico. contains some Etruscan sarcophagi and a few paintings. Close by is the elegant Gothic façade of Sta. Maria della Salute, in white and red marble with many fine scplptures.

The Gothic cloisters of Sta. Maria in Gradi and of Sta. Maria della Verita just outside the town are strikingly beautiful. The latter church contains frescoes by Lorenzo da Viterbo (1469) and an interesting museum.

Viterbo is by some identified with Surrina nova, which is only mentioned in inscriptions, while some place this to the west of Viterbo on the line of the Via Cassia. The Via Cassia was joined there by the Via Ciminia, passing east of the Lacus Ciminius, while a road branched off to Ferentum. It is not an unlikely assumption that there, as elsewhere, the medieval town occupies an Etruscan site. It was fortified by the Lombard king Desiderius. It is the centre of the territory of the "patrimony of Peter." which Countess Matilda of Tuscany gave to the papal see in the 12th century; in the 13th century it became a favourite papal residence.

(T. A.)

VITORIA, FRANCISCO DE (Lat. FRANCISCUS DE VICTORIA) (1483?–1546), one of the greatest of the Spanish theologians, was noted principally for his defense of the rights of the Indians of the new world against the claims of the Spanish throne. He studied at Burgos and after three years teaching at the University of Valladolid (1523–26), became professor of theology at Salamanca in 1526, where he remained until his death. In 1532 he delivered lectures subsequently published under the title, *De Indis et de iure belli relectiones* ("Readings on the Indians and on the Law of War") which, in the course of a defense of the rights of the Indians, set forth certain fundamental principles of the law of nations. One by one he rejected various alleged justifications for the subjection of the Indians, maintaining their rights to the lands they had occupied and their freedom from any compulsion in the acceptance of the Christian religion, and limiting the interposition of the Spaniards to the organization of a government on behalf of the welfare of the Indians. He applied the natural law, derived from right reason to nations as well as to individual men and drew the conclusion that nations in their separate capacities constituted a single commonwealth which possessed an authority to establish laws for the common good. In respect to the form of government of the individual state Vitoria, while preferring monarchy, recognized that the ultimate power of government rested in the people.

His *De Indis et de iure belli relectiones,* with introduction by Ernest Nys, trans. by J. P. Bate, was published in "Classics of International Law Series" (1917).

See James Brown Scott, *The Spanish Origin of International Law,* pt. i, "Francisco de Vitoria and His Law of Nations" (1933).

(C. G. FK.)

VITÓRIA, a city and port of Brazil, capital of the state of Espirito Santo, on the west side of an island at the head of the bay of Espirito Santo. The population of the city in 1950 was 49,735.

The principal streets follow the water line, rising in terraces from the shore, and are crossed by narrow and steep streets. Many buildings are of the colonial type. The entrance to the bay is rather tortuous and difficult, but is sufficiently deep for the largest vessels. The harbour is not large. but is safe and deep, being completely shut in by hills. Large quays, piers, warehouses, etc., facilitate the handling of cargoes.

Vitória is a port of call for coasting steamers and a shipping port in the coffee trade. The other exports are lumber, sugar, rice and mandioca to home ports. A railway starting at Vitoria connects with Rio de Janeiro, 270 mi. to the southwest. Another line runs north and west into the important mineral region of Minas Gerais, for which it provides an outlet.

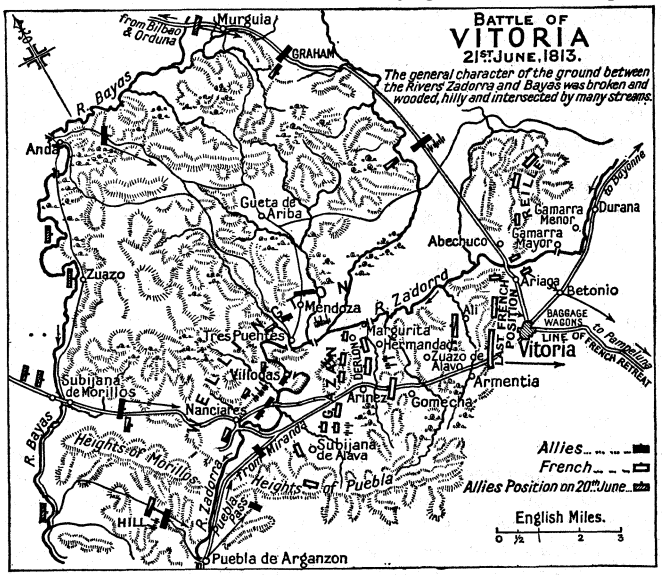
Vitória was founded in 1535 by Vasco Fernandes Coutinho, on the south side and nearer the entrance to the bay, and received the name of Espirito Santo. The old site is still occupied, and is known as Vila Velha (Old Town).

VITORIA, an episcopal city of N. Spain, capital of Álava province; on the Miranda de Ebro-Alsasua section of the Northern railways, among the southern outliers of the Cantabrian mountains, and on the left bank of the river Zadorra, a left-hand tributary of the Ebro. Pop. (1940) 44,341 (mun., 49,752). Vitoria was founded in 581 by Leovigild, king of the Visigoths; but its importance dates from the 10th century. In 1181 Sancho the Wise of Navarre granted it a charter and fortified it. The city is built on a hill 1,750 ft. high, and overlooks the plain of Alava. The cathedral of Santa Maria dates from 1181, but has been considerably spoiled by late additions: the church of San Miguel also dates from the 12th century; it has a beautiful altar, carved in wood by J. Velazquez and G. Hernandez, in the 16th century. Vitoria, from its favourable position on the main lines from Madrid to France and to the port of San Sebastian, is an important centre of trade in wine, wool, horses, mules and hardware. Nationalists captured it in the civil war of 1936–39.

Battle of **Vitoria.**—For the operations which preceded the battle of Vitoria see PENINSULAR WAR. On June 21, 1813, the French army in Spain (about 65,000 men with 150 guns), under King Joseph Bonaparte, held an extended position in the basin of Vitoria, south (with the exception of the extreme right) of the river Zadorra. The left rested on the heights of Puebla, north of the Puebla Pass, and Puebla de Arganzon, through which ran the Miranda-Vitoria-Bayonne road, Joseph's line of communication with France. Thence the line stretched to the ridge of Margarita, the troops so far being under General Gazan, with a second supporting line under D'Erlon between Arinez and Hermandad and a reserve behind Arinez. The right under Reille guarded the Bilbao-Vitoria road.

There were no troops between Hermandad and Ariaga, except a mass of cavalry near Ali. The Zadorra, fordable in certain spots only, was spanned by bridges at Puebla de Arganzon, Nanclares, Villodas, Tres Puentes, Mendoza, Abechuco and Gamarra Mayor, which French guns commanded; but, for some reason, none of these had been destroyed. The faults of the French position and their occupation of it were its extension; that it was in prolongation of and (on the right especially) very close to their line of retreat, so that if the right were driven back this line could be at once seized; that the centre was not strongly held; and that all bridges were left intact.

The Allies (nearly 80,000, with 90 guns), under Wellington, had moved from the river Bayas at daylight to attack Joseph, in



four columns. the right being under Hill (20,000, including Morillos's Spaniards), the right centre and left centre under Wellington (30,000) and the left under Graham (20,000, including Longa's Spaniards). As the columns marched across the intersected country between the Bayas and Zadorra, extending from near Puebla de Arganzon to the Bilbao-Vitoria road, they kept touch with each other; and as they neared the Zadorra the battle opened all along the line soon after 10 A.M. Wellington's instructions to Graham were to undertake no manoeuvre which would separate his column from those on the right; but, with this proviso, to seize the Vitoria-Bayonne road if the enemy appeared decidedly in retreat. Hill after a sharp contest gained the Puebla heights, too weakly held; and pushing through the pass carried the village of Subijana de Alava. The right centre column having reached Villodas, was waiting for Hill to gain further ground, when the bridge at Tres Puentes was observed to be unguarded, probably because it was commanded from the south bank; and, the French attention being now turned towards their flanks, it was surprised and rushed by Wellington with the Light division, supported quickly by cavalry and other troops, who maintained themselves on the south bank. Joseph's centre was partially forced, while his left was hard pressed by Hill; and, fearing that Gazan and D'Erlon might be cut off from Reille, he ordered them to withdraw to a ridge farther back, which they did, holding Arinez in front. Here there was no hard fighting; but, as Wellington had now passed three divisions, many guns and the cavalry (which, however, from the nature of the ground could be but little used) across the Zadorra, Margarita, Hermandad and Arinez soon fell to the Allies.

On the left, Graham, having turned the heights north of the Zadorra with Longa's Spaniards, seized Gamarra Menor close to the Bayonne road. He also with heavy loss carried Gamarra Mayor and Abechuco, but the bridges south of these villages, though more than once taken, were always recaptured by Reille. At length, when a brigade from the Allied centre had been pushed up from Hermandad against Reille's flank, he withdrew from the obstinately defended bridges, and before this Gazan and D'Erlon had also fallen back, fighting, to a third position on a ridge between Armentia and Ali west of Vitoria. Here, at about 6 P.M., they made a last stand, being compelled in the end to yield; and as Graham, having now crossed the bridges, was close to the Bayonne road, the main body of Joseph's army fled by a bad crossroad towards Pampeluna, abandoning artillery, vehicles and baggage (of which an enormous quantity was parked near Vitoria), Reille afterwards joining it through Betonia. The Allies then occupied Vitoria and pursued the French until nightfall. All Joseph's equipages, ammunition and stores, 143 guns, a million sterling in money, and various trophies fell into Wellington's hands, the French loss in men being nearly 7,000, that of the Allies over 5,000, of whom 1,600 were Portuguese and Spaniards. This decisive victory practically freed Spain from French domination. (C. W. Ro.)

VITRÉ, a town of northwestern France, in the department of Ille-et-Vilaine, on-a hill above the left bank of the Vilaine, 24 mi. E. of Rennes by rail. Pop. (1936) 7,298. Vitré belonged in the 10th century to the younger branch of the counts of Rennes. In 1295 it passed to Guy IX, baron of Laval, on his marriage with the heiress, and afterwards successively belonged to the families of Rieux, Coligny and La Trémoille. It was seized by Charles VIII in 1488. Protestantism spread under the rule of the houses of Rieux and Coligny; VitrC became a Huguenot stronghold; and a Protestant church was established, which was suppressed at the revocation of the edict of Nantes in 1685. The estates of Brittany, over which the barons of VitrC and of Léon alternately presided, met here several times. The town largely retains its mediaeval aspect. The ramparts on the north side and on the west, consisting of a machicolated wall with towers at intervals, are still standing. Only one gateway remains of the original 11th century castle; the rest was rebuilt in the 14th and 15th centuries and restored in recent times.

VITRIFIED FORTS, the name given to certain hill-forts of which the defenses consist entirely or to some extent of walls which have been subjected in a greater or less degree to the action of fire. Their form is determined by the contour of the summits which they enclose and generally the plan is simple. The walls vary in size, the vitrified portion being usually confined to a core extending from the top downward, though vitrifaction has been met with on the sides of the wall only, and in one known instance a narrow wall consolidated by vitrifaction was found in the heart of an earthen rampart. As a rule the vitrified mass appears to have been supported by a wall of unvitrified stone built up on one or both faces. No lime or cement has been found in any of these structures, all of them presenting the peculiarity of being consolidated to a greater or less extent by the fusion of the rocks of which they are built. This fusion, caused by the application of intense heat, is not equally complete in the various forts, or even in the walls of the same fort. In some cases the stones are only partially melted and calcined; in others their adjoining edges are fused so that they are firmly cemented together. In many instances pieces of rock are enveloped in a glassy enamel-like coating which binds them into a uniform whole; and at times, though rarely, the entire length of the wall presents one solid mass of vitreous substance.

Some 50 examples have been discovered in Scotland widely distributed. They are also found in Ireland, Lusatia, Bohemia, Silesia, Saxony and Thuringia; in the provinces on the Rhine, especially in the neighbourhood of the Nahe; in the Ucker Lake, in Brandenburg, where the walls are formed of burnt and smelted bricks; in Hungary; and in several places in France. They have not been found in England or Wales.

The following facts may be noted: — (I) The idea of strengthening walls by means of fire is not singular, or confined to a distinct race or area, as is proved by the burnt-earth enclosure of Aztalan, in Wisconsin, and the vitrified stone monuments of the Mississippi valley. (2) Many of the Primary rocks, particularly the schists, gneisses and traps, which contain large quantities of potash and soda, can be readily fused in the open air by means of wood fires—the alkali of the wood serving in some measure as a flux. (3) The walls are chiefly vitrified at the weakest points, the naturally inaccessible parts being unvitrified. (4) When the forts have been placed on materials practically infusible, as on the quartzose conglomerates of the old red sandstone, as at Craig Phadraic, and on the limestones of Dun Mac Uisneachain, pieces of fusible rocks have been selected and carried to the top from a considerable distance. (5) Many of the continental forts are so constructed that the fire must have been applied internally, and at the time when the structure was being erected. (6) Daubrée, in an analysis of vitrified materials taken from four French forts, which he submitted to the Academy of Paris in Feb. 1881, found the presence of natron in such abundance that he inferred that sea-salt was used to facilitate fusion. (7) In Scandinavia, where there are hundreds of ordinary forts, and where for centuries a system of signal fires was enforced by law, no trace of vitrifaction has yet been detected.

Great antiquity has been assigned to these forts, but tool marks indicating the use of iron implements have been found, which would suggest that the structures were in use as late as the early centuries of the Christian era. It has been suggested that they were built as refuges against the Norsemen, and much in the situation and character of the forts favours this supposition. The sites of the Scottish forts are so selected that they not only command what were the favourite landing-places of the vikings, but are the best natural defenses against attacks from the direction of the seacoast. In Saxony and Lusatia the forts are known as Schwedenburgen, and in the Highlands of Scotland as the fortresses of the *Feinne*—designations which also seem to point to an origin dating back to the times of the vikings.

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VITRIOL, a name given to certain hydrated sulfates and to sulfuric acid. Blue or roman vitriol is cupric sulfate; green vitriol is ferrous sulfate or copperas; red or rose vitriol is cobaltous sulfate; uranvitriol is a native uranium sulfate and white vitriol is zinc sulfate. Oil of vitriol is concentrated sulfuric acid (*q.v.*).

(J. B. Ps.)

VITRUVIUS (MARCUS VITRUVIUS POLLIO), Roman architect, engineer and author of the celebrated treatise De architectura. Little is known of Vitruvius' life, except what can be gathered from his writings. Although he nowhere identifies the emperor to whom his work is dedicated, it is likely that the first Augustus is meant and that the treatise was conceived after 27 B.C. Since Vitruvius describes himself as an old man, it may be inferred that he also was active during the reign of Julius Caesar. Vitruvius himself tells of a basilica he built at Fanum (now Fano).

De architectura was based on his own experience as well as on theoretical works by famous Greek architects such as Hermogenes (3rd century B.C.). It is divided into ten books, dealing with city planning and architecture in general; building materials; temple construction and the use of the Greek orders; public buildings (theatres, baths); private buildings; floors and stucco decoration; hydraulics; clocks, mensuration and astronomy; and civil and military engines. Vitruvius' outlook is essentially Hellenistic. His wish was to preserve the classical tradition in the design of temples and public buildings, and his prefaces to the separate books of his treatise contain many a pessimistic remark about the glories of contemporary architecture.

Most of what Pliny says in his *Natural* History about Roman construction methods and wall painting was taken from Vitruvius, though unacknowledged. Vitruvius' expressed desire that his name be honoured by posterity was, however, realized. Throughout the classical revival of the Italian Renaissance, his work was the chief authority studied by architects, and his precepts were accepted as final.

Bramante, Michelangelo and Vignola (*qq.v.*) were careful students of Vitruvius.

The best editions of De architectura are those of F. Krohn, "Bibliotheca Teubneriana" (1912) and V. Rose (new ed., 1899); see also H. Nohl, Index *Vitruvianus* (1876). For English translations see those by F. Granger (1931–34) and by M. H. Morgan (1914).

See Carl Axel Boethius, "Vitruvius and the Roman Architecture of His Age" in *Dragma Martino P. Nilsson dedicatum* (1939).

(H. HN.)

VITTEL, a watering place of northeastern France, in the *département* of Vosges, 31 mi. W. of Epinal by rail. Pop. (1954) 4,010. The cold saline and chalybeate waters are bottled and exported in large quantities. They are prescribed in cases of arthritis, dyspepsia, etc.

Vittel is a fashionable resort.

VITTORIA, a town of Sicily in the province of Ragusa, 95 mi. W.S.W. of Syracuse by rail (42 mi. direct), founded in the 17th century. It is a prosperous town in the centre of a fertile district, with the largest wine trade in Sicily. Population (1951) 39,741.

VITTORINO DA FELTRE (VITTORINO RAMBOLDINI or DEI RAMBOLDONI) (1378–1446), Italian educator, the teacher par excellence of the Renaissance, was born at Feltre, in Venetia. About 1396 he entered the University of Padua, where he remained for 20 years as student or teacher. In 1423 he was asked to become tutor to the Gonzaga children, the Gonzagas being then rulers of Mantua. This position he accepted upon the conditions that the school be located at some distance from the court and completely removed from political influence; that he have complete control of the children at all times; and that he be allowed to enroll other children as he saw fit. Both boys and girls from all over Europe attended the school. Like most teachers, Vittorino wrote little, but his pupils picture him as an extremely successful teacher who knew his pupils intimately, loved them, cared for their health and character as well as for their learning, adapted his work to their abilities and used no corporal punishment. He has been called the first modern schoolmaster. His school at Mantua was in essence the world's first boarding school—a place removed from the ordinary influences of life, where the children were watched over, cared for and guarded. It remains a model to the present day.

Vittorino died at Mantua on Feb. 2, 1446.

See W. H. Woodward, *Vittorino da Feltre and Other Humanist Educators* (1905).

(L. CE.)

VITTORIO VENETO, BATTLE OF. This is the title given to the battle or, more truly, campaign in which the Austrian forces on the Italian front were finally overthrown in Oct. 1918. Diaz's plan for the bigger offensive finally decided upon was to concentrate on the Piave front between Pederobba and Fagaré (east of Treviso), to cross the river and break through by way of Conegliano to Vittorio Veneto, dividing the Austrian V. and VI. Armies which held the river line from the sea to Valdobbiadene. The attack was fixed for Oct. 16, but bad weather and a rise of the Piave caused a delay.

Italian Plans.—It was decided to open the action with an attack by the IV. Army (nine divisions) in the Grappa sector, with the double object of drawing the enemy reserves from the Feltre sector and of breaking through in this direction. The attack on the Piave was to be carried out by three armies, the XII., VIII. and X., of which the first and last had been formed specially for this offensive. The XII. Army (one French division and three Italian) was commanded by Gen. Graziani, the commander of the French troops in Italy; and the X. Army (two British divisions and two Italian) by Lord Cavan.

The main drive was to be made by the VIII. Army (14 divisions), attacking from below Pederobba to Ponte della Priula. The XII. Army was to advance northward outside the Piave, while the X. Army was to attack the right wing of the Austrian V. Army and form "a defensive flank to cover and protect the principal manoeuvre of the VIII. Army" (Gen. Diaz's report). On the battle front from the Brenta to Fagaré were massed 41 divisions, 22 in line and 19 in reserve. Against this force the Austrians had 23 divisions in line and immediate reserve, and 10 more divisions within reach. The Piave-Grappa front was divided between two army groups: Boroević's Piave Group (V. and VI. Armies), from the sea to Valdobbiadene, and the newly formed Belluno Group, under Gen. Goglia, from Valdobbiadene to the Brenta. The disposition of the Austrian troops and guns showed a fear for the Grappa positions and a failure to divine the direction of the main Italian attack. In the Grappa sector the Belluno Group had eight divisions in line and three in immediate reserve, while the infantry was backed by some 1,200 guns. The Austrian VI. Army, on the other hand, with seven divisions in line and two in support, had only about 500 guns against a mass of over 2,000. Opposite Lord Cavan's X. Army the right wing of the Austrian V. Army had three divisions in line and one in support.

Allied Attack Opens.—The Italian IV. Army, under Gen. Giardino, attacked at dawn on Oct. 24, and though some headway was made the enemy put up a very stubborn resistance. Already a very fine piece of work had been carried out by British troops of the X. Army, who in the early hours of the same day occupied the northern part of the long shoal island of the Grave di Papadopoli, crossing the main channel in small flat-bottomed boats punted by Italian specialist troops *(pontieri)*, and driving back or capturing the enemy outposts. The general attack should have followed the next night, but a sudden rise in the river, which was coming down in heavy flood at 7m an hour, counselled delay. It was not until the night of Oct. 26, when the southern part of the Grave di Papadopoli had also been occupied by Italian troops of the X. Army, that the bridges began to be thrown across the river 'or the main attack.

The Crossing of the **Piave.**—Eleven crossing points were selected, one at Pederobba for the right wing of the XII. Army, seven on the VIII. Army front, and three for the X. Army, at the Grave di Papadopoli. The XII. and X. Armies threw their bridges successfully, but on the VIII. Army front only two of the seven sets of bridges could be established, both on the north of the Montello. Next day three bridgeheads were established: opposite Pederobba, north of the Montello, and opposite the Grave di Papadopoli. The most important advance was made in the latter sector, where the X. Army succeeded in advancing to a depth of over zm. on a front of about 4m. The British XIV. Corps took 3,500 prisoners and 2,100 were captured by the Italian VI. Corps.

This was the most successful advance of the day. The bridges of the VIII. and XII. Armies were all destroyed during the day. At Pederobba some headway was made, and the troops of the VIII. Army, who attacked towards Sernaglia, gained about a mile. But the right wing of the Army (VIII. Corps) was unable to throw its bridges, and only a detachment of storm-troops reached the left bank. There was a gap of some 6m. between the left wing of the VIII. Army and the British XIV. Corps, which formed the left wing of the X. Army, and the chief move in the general manoeuvre was checked. The VIII. Corps had been detailed to push straight for Vittorio Veneto, and the fact that it had been unable even to start its advance threatened to throw the whole battle out of gear.

No better fortune attended the efforts made on the following night to bridge the river east of the Montello. The swift current and the enemy guns defied all attempts to establish the bridges and the engineers suffered very heavy casualties. In spite of the initial successes, the situation was unsatisfactory, but after the first failure to cross the river east of the Montello, Gen. Caviglia, who commanded the VIII. Army and had the general direction of the attack, had detached the XVIII. Corps from his reserves to pass under the command of Lord Cavan, cross by the X. Army bridges, push north and clear the front of the troops who were held up. The move was entirely successful. The XVIII. Corps under Gen. Basso crossed the river in the early hours of Oct. 28 and attacked northward, while the rest of the X. Army continued its advance.

Position on Oct. 29.—At the close of Oct. 28 the XVIII. Corps had gained nearly 4m. and had crossed the railway north of the Priula bridges. The British XIV. Corps had gone right through the Austrian positions and had patrols out on the Monticano, while the Italian XI. Corps was threatening the enemy troops on the Lower Piave. The bridgehead was 10m. wide and 4m. deep. The XII. Army and the left wing of the VIII. had also made good progress, and at last the VIII. Corps was crossing the river, between Nervesa and Ponte di Priula. The prospects of the following day were bright, for the separation of the Austrian V. and VI. Armies was effected; and the VI. Army, heavily attacked in front, was seriously threatened on its left by Basso's XVIII. Corps.

On the evening of Oct. 29 an Italian flying column entered the town of Vittorio Veneto. The attacking armies had already taken 33,000 prisoners, and the situation of the Austrian troops on the Piave was hopeless. Next day resistance broke down, and the general retirement ordered on the 29th became a complete rout. The troops on Monte Grappa had hitherto held firm against the repeated attacks of the IV. Army, and had made many counter-attacks. But here too, on the night of Oct. 30, a retreat began that was to turn into a flight.

Austrian Collapse and Armistice.—Late on the evening of Oct. 30 the Austrian command announced that in view of the discussions regarding an armistice which were being conducted between Germany and the United States, "our troops fighting on Italian soil will evacuate the occupied region." On the same day the order for a general retreat was given, and that evening, in the Val Lagarina, Gen. Weber von Webernau, commander of the Austrian VI. Corps, made a formal demand for an armistice. Sext day he and his staff were taken to the Villa Giusti, near Padua, and discussions were begun. It was, of course, necessary to communicate with Versailles, where the Allied War Council was discussing a reply to Germany's demand for an armistice.

Meanwhile the fighting continued, and the Austrian armies crumbled away. The Italian VI. and I. Armies attacked in the Trentino, and the III. Army, which had crossed the Piave two days before, was already taking part in the pursuit of Boroević's broken divisions. On the night of Nov. 2–3, although the Armistice was not yet signed, the Austrian command issued an order for the cessation of hostilities. It was at first revoked by the Emperor Charles, but was reissued and reached the front on the morning of Nov. 3. The terms were only agreed on verbally on the afternoon of Nov. 3, and signed at 6 30 P.M.

Conclusion.—When hostilities ceased at 3 P.M. on Nov. 4, Italian troops were far up the Trentino and into Cadore, and to the east the line of the old frontier was passed and the middle waters of the Isonzo were reached. On Nov. 3 Trieste had been occupied from the sea. and half an hour before the expiration of the term fixed by the Armistice an Italian force was landed at Zara. More than 300,000 prisoners had already been counted by the Italians. and the total figure mas in the region of 500,000. A number of troops who had been cut off were allowed to pass the frontier after being disarmed, but not much more than half of the Austro-Hungarian troops on the Italian front reached the territory of the crumbling empire. All material was left behind. including about 7,000 guns. The Austro-Hungarian armies. in spite of bad food and growing depression, began by putting up a stout resistance The troops in the Grappa sector in particular not only resisted firmly but counterattacked nith great vigour, and punished the Italian 4th army very heavily. Giardino lost over 23,000 men. more than three-fifths of the total casualty list. which exceeded 35,000. (W. K. McC.)

VITUS, ST. According to the legend where he is associated with Modestus and Crescentia, by whom he had been brought up, St. Vitus suffered martyrdom at a very early age under the emperor Diocletian. Son of a Sicilian nobleman who was a worshipper of idols, Vitus was converted to the Christian faith without the knowledge of his father, was denounced by him and scourged. but resisted all attacks, on his profession. Admonished by an angel, he crossed the sea to Lucania and went to Rome, where he suffered martyrdom. His festival is celebrated on June 1j. The *Passion* of St. Vitus has no historical value, but his name occurs in the *Martyrologium hieronymianztm.* In 836 the abbey of Coroey, in Saxony, received his relics, and became a very active centre of his cult. In the second half of the 9th century the monks of Corvey, according to Helmold's *Chronica Slavorum,* evangelized the island of Rügen, where they built a church in honour of St. Vitus. The islanders soon relapsed, but they kept up the superstitious cult of the saint (whom they honoured as a god), returning to Christianity three centuries later. At Prague, too, there are some relics of the saint, who is the patron of Bohemia and also of Saxony, and one of the 14 "protectors" *(Nothelfer)* of the church in Germany. Among the diseases against which St. Vitus is invoked is chorea, also known as St. Vitus' dance. (H. De.)

VIVALDI, ANTONIO (1675?–1741), Italian composer and violinist. was the son of Giovanni Battista Vivaldi, a violinist in St. Marks, Venice. Although he was reputed to be one of the finest violinists of his day and is said to have been an influence upon J. S. Bach. Vivaldi suffered neglect until the 20th century when the discovery of many unpublished manuscripts led to a reestimation of his importance.

Vivaldi, known familiarly as *il prete rosso* (the "red priest"), studied under his father and, later, under Giovanni Legrenzi. In 1704 he began his long association with the Conservatory della Pietà in Venice, eventually becoming the concert master and director. The Pietà was a famous music school for girls, and it was there that Vivaldi composed many violin concertos. From the graded difficulty of these it has been assumed that they were used for instruction of his pupils. Most of Vivaldi's fame rests upon his violin concertos, but he also composed concertos for bassoon, flute, oboe, viola d'amore and for various combinations of instruments. In addition, his work contains many operas, concerti grossi and choral works. Bach arranged 16 of the concerti grossi for clavichord, 4 for organ and 1 for clavichords and strings.

In the years 1713–39 Vivaldi produced 39 different operas throughout Italy. Besides writing the music, he often employed the singers and dancers and handled the finances of the companies. Some of the operas contain arias written by other composers; notably, *La Rosmira* (1738) contains an aria by Handel. The operas were uneven in quality, however, some of them having been hastily composed or revised at the whim of Vivaldi's patrons.

VIVALDI, UGOLINO and **SORLEONE,** Genoese merchants connected with the first known expedition in search of an ocean route from Europe to India. According to the contemporary Genoese chronicler Jacopo Doria, Ugolino, with his brother Vadino. was in command of this expedition of two galleys, which he had organized in conjunction with Tedisio Doria, and which left Genoa in May 1291 with the purpose of going to India "by the Ocean Sea" and bringing back goods useful for trade. Planned for commerce, the enterprise also aimed at proselytism, as can be deduced from the presence of two Franciscan friars. In two well-built galleys, Ugolino and Vadino sailed down the bloroccan coast beyond Gozora (Cape Nun), in 28° 47′ N. latitude, after which nothing mas heard of them. From the scanty evidence available. it is not entirely clear whether the brothers aimed at finding the sea route to India by sailing westward or eastnard. although the latter seems more probable. Early in the next century Sorleone, son of Ugolino, is said by a 14th-century Spanish source of doubtful reliability to have undertaken a search for his father and possibly to have penetrated to Mogadoxo on the Somali coast. In 14jj another Genoese seaman, Antoniotto Usodimare, claimed to have met, near the mouth of the Gambia, a descendant of the survivors of the Vivaldi expedition; but this evidence. too, gossesses only limited value.

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VIVARINI, the surname of a family of painters of Paduan origin domiciled in the island of Murano (Venice) throughout the 15th century.

ANTONIO VIVARINI, the founder of the family studio, was born c. 1415 and died between 1476 and 1484. His career falls into two parts, in the first of which he worked mainly with his brother-in-law Giovanni d'Alemagna (d. 1450), while in the second he collaborated with his younger brother Bartolommeo. The earliest record of a painting executed jointly by Antonio and Giovanni d'Alemagna dates from 1441. Their main surviving altarpieces are found in the churches of S. Zaccaria (1443–44) and S. Pantaleone, Venice (1444). A large altarpiece executed in 1446 for the Scuola Grande della Carità is in the Xccademia. Venice, and a polyptych of 1448 is in the Brera gallery, Milan. Between 1447 and 1450 the two artists were resident in Padua. The styles of Antonio and Giovanni are not easily distinguished, but Antonio was certainly the dominant partner and ranks as the most important and prolific Venetian artist of the first half of the 15th century. The soft, rounded figures in his heavily ornamented polyptychs are influenced by Gentile da Fabriano and Jacobello del Fiore and. more superficially, by Masolino. The earliest work signed by Antonio and Bartolommeo Vivarini is a polyptych, now in the Bologna gallery, commissioned by Pope Nicholas V in 1450. This is couched in the same idiom as the paintings of Antonio's first period, but in later works. notably polyptychs at Arbe, Dalmatia (1458) and Pausula Marches (1462), the intervention of his more progressive younger brother resulted in the introduction of Renaissance elements into Antonio's style.

BARTOLOMMEO VIVARINI (c. 1432–*c.* 1499) was probably a pupil of his brother Antonio, with whom he collaborated after 1450. Unlike his brother, Bartolommeo was profoundly influenced by Paduan painting in the circle of Squarcione, and from his first dated work (1448) onward reveals a stronger feeling for plasticity and greater formal resource. A painting of St. John Capistrano (Louvre, Paris) of 1459 is typical of his austere and individual style. Contact with the paintings of Mantegna seems to have marked a turning point in Bartolommeo Vivarini's career and is first apparent in an altarpiece of 1464 in the Accademia, Venice. All his most distinguished works date from after this time; among these are altarpieces in SS. Giovanni e Paolo (1473), the Frari (1474) and S. Giovanni in Bragora (1478) in Venice and in the Accademia (1477). His last dated work is a triptych of 1491 at Bergamo, where he seems to have been active in his last years.

ALVISE (or LUIGI) VIVARINI, son of Antonio and nephew of Bartolommeo, was born about 1446 and died between 1503 and 1505. His earliest dated work is an altarpiece at Montefiorentino (Marches) of 1475. To the influence of his uncle Bartolommeo were added those of Antonello da Messina and Giovanni Bellini, apparent in an altarpiece of 1480 in the Accademia at Venice and in many later works. Between 1483 and 148j Alvise was at work in southern Italy, leaving altarpieces at Barletta (1483) and Naples (1485). In 1488 he was employed on paintings for the Sala del Maggior Consiglio of the ducal palace in Venice (lost). His last work, an altarpiece in the Frari begun in 1503, was completed by

Marco Basaiti. The historical importance of Alvise Vivarini has been overrated, and his surviving works reveal him as an imitative artist of lower quality and less originality than Giovanni Bellini or Cima da Conegliano. Some of his best works are his portraits.

See L. Testi, *Storia della Pittura Veneziana* (1909–15); also R. van Marle, *The Development of the Italian Schools of Painting*, vol. xvii, xviii (1935). (J. W. P.-H.)

VIVEKANANDA (NARENDRANATH DATTA) (1863–1902), Hindu saint and religious leader, founder of the Ramakrishna order, was born on Jan. 12, 1863, in Calcutta. He became a disciple of Ramakrishna (*q.v.*), who fulfilled his requirement for a teacher with direct experience of God whose teachings should not contradict reason. Ramakrishna enabled him to realize oneness with the Godhead and all created beings, subsequently inspiring him to see God in man and to regard service to man as the highest worship. As a wandering monk, Vivekananda discovered spirituality to be the heart of India. But he was appalled by the people's material backwardness, which he felt could be remedied through western science. He came to feel, too, that the west needed India's spiritual insights to control materialistic tendencies. He was thoroughly familiar with the human situation in both east and west. In 1893 Vivekananda represented Hinduism at the World's Parliament of, Religions in Chicago, where he preached the oneness of existence, the divinity of the soul, the nonduality of the Godhead and the harmony of religions.

Vivekananda inaugurated the Vedanta movement in the U.S. and visited England and the continent. On Dec. 9, 1898, he formally dedicated the chapel of the Belur Math, a monastery on the Ganges near Calcutta, which he established as headquarters of the Ramakrishna order, whose twin aims are individual salvation and the giving of "food, education and spiritual wisdom." The monks took up residence at the monastery on Jan. 2, 1899. He asked Indians to cultivate faith in themselves and emphasized renunciation and service as national ideals. Swami Vivekananda's message influenced many of India's leaders in India's national awakening in the 20th century and it became an enduring force in bringing east and west closer together. He died on Jan. 4, 1902, at the age of 39.

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VIVES, JUAN LUIS (1492–1540), Spanish humanist, eminent both in the field of educational theory and in psychology, was born in Valencia on March 6, 1492. After studies at Paris (1509–12) he was appointed professor of the humanities at Louvain (1519). Having dedicated his commentary of St. Augustine's *De Civitate Dei* (Basel, 1522) to Henry VIII of England, he went to England in 1523 and was appointed preceptor to Mary, princess of Wales. Taking up residence at Corpus Christi college, Oxford, he was made doctor of laws and gave lectures on philosophy. In 1527, however, he forfeited Henry's favour by opposing the royal divorce from Catherine of Aragon and was imprisoned for six weeks, after which he left England for the Netherlands, to devote himself prolifically to writing. He died at Bruges on May 6, 1540.

The works which brought Vives most fame in his own century were concerned with education. The two letters *De ratione studii puerilis* (the first addressed to Catherine of Aragon, the second to Charles Montjoye) were completed in England in 1523; the *Introductio ad sapientiam* (Eng. trans. by Richard Morison, *An Introduction to Wysedome*, London, 1540) and the *Satellitium sive Symbola* (dedicated to Princess Mary) were both dated from Bruges, where he had gone on a visit, in order to marry, in 1524. His *De institutione feminae Christianae* (Antwerp, 1524; Eng. trans. by Richard Hyrde, *The Instruction of a Christen Wonzan*, 1541) was also dedicated to Catherine of Aragon. His *De disciplinis libri xx* (Antwerp, 1531) contains the seven remarkable books "De causis corruptarum artium" ("On the Decay of Learning") and the five "De tradendis disciplinis" (Eng. trans. by Foster Watson, *On Education*, Cambridge, 1913). The *Exercitationes linguae latinae* (Breda, 1538; Eng. trans. by W. H. D. Rouse, *Scenes of School and College Life*, Oxford, 1931) are dialogues framed to interest schoolboys in Latin. All these works went through many editions.

Vives' claim to be regarded as a pioneer in psychology and in philosophical method rests on his *De anima et vita libri tres* (Basel, 1538), a work which to some extent anticipates that of the great thinkers of the century following his death by its emphasis on induction as a method of philosophical and psychological discovery. In book i Vives abjures the tradition of asking the metaphysical question "What is the soul?" by saying "What the soul is, is of no concern for us to know. What its manifestations are, is of great importance." Likewise in his discussion of the mind he does not refer to the mind's essence but concerns himself with its actions. His central idea is that knowledge is of value only when it is put to use. He then discusses association of ideas, the nature of memory, a proposed law of forgetfulness and the method of recall of an idea; explains the principle of mnemonics; and even touches on animal psychology. In book ii he describes the functions of the *simplex intelligentia* (simple apprehension); and in book iii he examines the emotions or passions.

BIBLIOGRAPHY.—Collected editions of Vives' works include those of Nicolaus Episcopius, 2 vol. (1555), of G. Majansius, 8 vol. (1782–90), and of J. B. Sentandreu (1930 *et seq.*). *See* also J. Corts Gran (ed.), *J. Luis Vives: antología* (1943). Studies include: G. Hoppe, *Die Psychologie von Juan Luis Vives* (1901); A. Bonilla y San Martin, *Luis Vives y la filosofía del Renacimiento*, 2nd ed. (1929); Foster Watson, *Vives and the Renascence Education of Wonzen* (1912), *Luis Vives, el Gran Valenciano* (1922); E. d'Ors *et al.*, *Vivès, humaniste espagnol* (1941); G. Marañón, *Luis Vives, un Español fuera de España* (1942); A. M. Salazar, *Iconografia de J. L. Vives durante los siglos XVI, XVII y XVIII* (1953).

VIVIANI, RENÉ (1863–1925), French politician, was born at Sidi-bel-Abbès, Algeria, on Nov. 8, 1863. In 1893 he was elected Socialist deputy for Paris and it was not until the close of his life that he left the chamber to enter the senate. In Oct. 1906 he was placed by Clemenceau at the head of the recently created ministry of labour. Viviani was responsible for the law with regard to workmen's pensions. In July 1909 when Briand succeeded Clemenceau as premier, Viviani continued to be minister of labour. In Oct. 1910, in consequence of the attitude adopted by the government in regard to the threatened railway strike, he tendered his resignation. In Dec. 1913 he became minister of public instruction in the Gaston Doumergue cabinet.

In June 1914 Viviani became premier and minister for foreign affairs. He was on his way back from Russia with Poincaré when the Austrian ultimatum was issued against Serbia on July 23. He immediately withdrew the French troops ten kilometres behind the frontier to prove France's pacific attitude. On Oct. 29, 1915, he was succeeded as premier by Briand, in whose government he became minister of justice. After the fall of the Briand cabinet in March 1917 he lived in retirement, but he accompanied Briand to the Washington conference in 1921 as one of the leading French delegates. He died on Sept. 7, 1925. (P. B.)

VIVIANITE, a mineral consisting of hydrated iron phosphate. When unaltered and containing no ferric oxide, the mineral is colourless, but on exposure to the light it very soon becomes of a characteristic indigo-blue colour. Crystals were first found in Cornwall by J. G. Vivian, after whom the species was named in 1817. The mineral had, however, been known earlier as a blue powdery substance, called blue iron-earth, met with in peat bogs, in bog iron ore or with fossil bones and shells. The formula is $Fe_3(PO_4)_2.8H_2O$. It crystallizes in the monoclinic system and the crystals possess a perfect cleavage parallel to the plane of symmetry and are usually bladed in habit; they are very soft, flexible and sectile. Vivianite is prepared artificially by mixing solutions of ferrous sulfate and sodium phosphate.

VIVISECTION: *see* ANIMAL EXPERIMENTATION.

VIZAGAPATAM (correctly VISAKHAPATNAM), a city and district in Andhra Pradesh, India. The city stretches along the coast 380 mi. N.E. of Madras. Pop. (1951) 108,042. The city, or fort, as it is called, is separated from the southern promontory, the Dolphin's Nose, by a small river which forms a bar when it enters the sea. A harbour was opened in 1933. An English factory was established early in the 17th century; it was captured by the French in 1757, but shortly afterward was recovered.

Waltair at the north end of the bay is the seat of Andhra university. Exports include manganese ore, peanuts and sugar.

VISAKHAPATNAM DISTRICT, with an area of 5,200 sq.mi., has a population (1951) of 2,072,698. It is a picturesque and hilly country, but for the most part unhealthful. The main part is occupied by the Eastern Ghats, whose slopes are clothed with luxuriant vegetation and forest trees. The principal crops are rice, millets. pulses and oilseeds, with some sugar cane, cotton, spices and tobacco. Much manganese is mined, and a little limestone, marble and graphite worked.

On the dissolution of the Mogul empire, Visakhapatnam formed part of the territory known as the Northern Circars, which were ceded to the East India company by treaties in 1765 and 1766. The agency was incorporated with the agencies of Ganjam and Godavari into a new division. In 1950 the district was bifurcated, the northern part forming the district of Srikakulam. (S. GL.)

VIZEU or VISEU, a Portuguese episcopal city at the terminus of a branch of the Figueira da Foz-Guarda railway. Pop. (1950) 13.099. The city stands near the ruins of the ancient Vacca, or Cava de Viriato, a Roman military colony founded by Decius Brutus and captured by Viriathus (2nd century B.C.). The administrative district of Vizeu (pop. [1950] 487,182; area 1,937 sq.mi.) coincides with the central and northern parts of the ancient province of Beira (*q.v.*).

VLAARDINGEN, a river port of the Netherlands, in the province of South Holland, on the Maas, 6 mi. W. of Rotterdam by rail. Pop. (1957 est.) 62.188 (mun.). An old town and the seat of a former margraviate belonging to the counts of Holland, Vlaardingen is the centre of the great herring and cod fisheries of the North sea.

VLACHS. The Vlach (Wallach) or Ruman people constitute a distinct division of 'the Latin family of peoples, widely disseminated throughout southeastern Europe, both north and south of the Danube, and extending sporadically from the Bug to the Adriatic. The total number of the Vlachs has been estimated at from 9,000,000 to 11,000,000. Of these the vast majority resided in the former kingdom of Rumania, as enlarged by World War I. South of the Danube, a diminishing number scattered over northern Greece under the name of Kutzo ("lame")-Vlachs, Tzintzars or Aromani. In Serbia this element was preponderant in the Timok valley, and in Istri it was represented by the Cici, who were largely Slavonized, as were entirely the kindred Morlachs of Dalmatia. In Bulgaria Vlachs settled chiefly in the western Rhodopes.

For the physical characteristics of the Vlachs and their historical development. *see* BALKAN PENINSULA: *Ethnology;* RUMANIA. All divisions of the Vlachs. whether inhabitants of Rumania or not. prefer to style themselves *Romani, Romeni, Rumeni* or *Aromani.* The name "Vlach" (Slav *Volokh* or *Woloch*, Greek *Vlachoi*, Magyar *Olóh*, Turkish *Iflók*), which is now used by the Rumans themselves, represents a Slavonic adaptation of a generic term applied by the Teutonic races to all Roman provincials during the 4th and 5th centuries.

The Vlachs claim to be a Latin people in the same sense as the Spaniards or Provençals—Latin by language and culture, and, in a smaller degree. by descent. This claim is generally accepted by ethnologists. The language of the Vlachs is Latin in structure and to a great extent in vocabulary; their features and stature would not render them conspicuous as foreigners in south Italy; and that their ancestors were Roman provincials is attested not only by the names "Vlach" and "Ruman" but also by popular and literary tradition. In their customs and folklore both Latin and Slavonic traditions assert themselves. Of their Roman traditions the Trajan saga, the celebration of the Latin festivals of the Rosalia and Kalendae, the belief in the *striga* (witch), the names of the months and days of the week, may be taken as typical examples. Some Roman words connected with the Christian religion, like *biserica (basilica)* = a church, *botez* = *baptizo, duminica* = Sunday, *preat (presbyter)* = priest, point to a continuous tradition of the Illyrian church. though most of their ecclesiastical terms, like their liturgy and alphabet, were derived from the Slavonic. In most that concerns political organization the Slavonic element is also preponderant, though there are words, like *impărat* = *imperafor*, and *domn* = *dominus*, which point to the old stock. Many words relating to kinship are also Latin. some, like *vitrig (vitricus)* = father-in-law, being alone preserved by this branch of the Romance family.

The centre of gravity of the Vlach people is north of the Danube in the almost circular territory between the Danube, Theiss and Dniester; and corresponds roughly with the Roman province of Dacia, formed by Trajan in A.D. 106. From this circumstance the popular idea has arisen that the Vlachs represent the descendants of the Ronianized population of Trajan's Dacia, which was assumed to have maintained an unbroken existence in Walachia, Transylvania and the neighbouring provinces under the dominion of a succession of invaders. The Vlachs of Pindus, and the southern region generally, were regarded as later immigrants from the lands north of the Danube. In 1871, E. R. Roesler published at Leipzig his *Romanische Studien,* in which he absolutely denied the claim of the Rumanian Vlachs to be regarded as autochthonous Dacians. He laid stress on the statements of Vopiscus and others as implying the total withdrawal of the Roman provincials from Trajan's Dacia by Aurelian, in A.D. 272, and on the nonmention by historians of a Latin population in the lands on the left bank of the lower Danube during their successive occupation by Goths, Huns, Gepidae, Avars, Slavs. Bulgars and other barbarian races. He found the first trace of a Ruman settlement north of the Danube in a Transylvanian diploma of 1222. His conclusions had to a great extent been already anticipated by F. J. Sulzer in his *Geschichte des Transalpinischen Daciens,* published at Vienna in 1781, and at a still earlier date by the Dalmation historian Lucius of Traü in his work *De Regno Dalmatine et Crontiae* (Amsterdam, 1666). They found a determined opponent in J. Jung of Innsbruck, who upheld the continuity of the Roman provincial stock in Trajan's Dacia! disputing from historic analogies the total withdrawal of the provincials by Aurelian; and the reaction against Roesler was carried still further by J. L. Pič, A. D. Xenopol of Jassy, B. P. Hasdeu, D. Onciul and many other Rumanian writers, who maintained that. while their own people north of the Danube represented the original Daco-Roman population of this region, the Vlachs of Greece were similarly descended from the Moeso-Roman and Illyro-Roman inhabitants of the provinces lying south of the river. On this theory the Vlachs occupied almost precisely the same territories in modern times as in the 3rd century. On the whole it may be said that the truth lies between the two extremes. Roesler is no doubt so far right that after 272, and throughout the early middle ages, the bulk of the Ruman people lay south of the Danube.

The earliest Hungarian historians who describe the Magyar invasion of the 9th century speak of the old inhabitants of the country as Romans, and of the country they occupied as *Pascua Romanorum;* and the Russian Nestor, writing about 1100, makes the same invaders fight against Slavs and Vlachs in the Carpathians. So far from the first mention of the Vlachs north of the Danube occurring only in 1222, it appears from a passage of Nicetas of Chonae that they were to be found already in 1164 as far afield as the borders of Galicia; and a passage in the *Nibelungenlied,* which mentions the Vlachs, under their leader Râmunc, in association with the Poles, cannot well be later than 1200.

Nevertheless, through the early middle ages the bulk of the Ruman population lay south of the Danube. It is there that this new Illyrian Romance people first rises to historic prominence. Already in the 6th century. as is shown from the place names such as Sceptecasas, Burgualtu, etc., given by Procopius, the Ruman language was assuming, so far as its Latin elements were concerned, its typical form. In the later campaigns of Commentiolus (587) and Priscus against the Avars and Slavs, the Latin-speaking soldiery of the eastern emperor made use of such Romance expressions as *torna frate!* ("turn, brother!"), or *sculca* ("out of bed") applied to a watch (*cf.* Ruman *a se culca* = Italian *coricarsi* + *ex-[s-]* privative). Next we find this warlike Ruman population largely incorporated in the Bulgarian kingdom, and. if we are to judge from the names Paganus and Sabinus, already supplying it with rulers in the 8th century. The blending and close contact during this period of the surviving Latin population with the

Slavonic settlers of the peninsula impregnated the language with its large Slavonic ingredient. The presence of an important Latin element in Albanian, the frequent occurrence of Albanian words in Rumanian and the remarkable retention by both languages of a suffix article may perhaps imply that both alike took their characteristic shapes in the same region. The fact that these peculiarities are common to the Rumans north of the Danube, whose language differs dialectically from that of their southern brothers, shows that it was this southern branch that throughout the early periods of Ruman history was exercising a dominating influence. Migrations. violent transplantation. the intercourse which was kept up between the most outlying members of the race, at a later period actual colonization and the political influence of the Bulgaro-Vlachian empire! no doubt contributed to propagate these southern linguistic acquisitions throughout that northern area to which the Ruman people was destined almost imperceptibly to shift its centre of gravity.

Byzantium, which had ceased to be Roman and had become Romanic. renewed its acquaintance with the descendants of the Latin provincials of Illyricum through a Slavonic medium, and applied to them the name of Vlach. which the Slav himself had borrowed from the Goth. The first mention of Vlachs in a Byzantine source is about the year 976, when Cedrenus (ii. 439) relates the murder of the Bulgarian tsar Samuel's brother "by certain Vlach wayfarers." at a spot called the Fair Oaks, between Castoria and Prespa. From this period onward the Ruman inhabitants of the Balkan peninsula are constantly mentioned by this name, and there are a series of political organizations and territorial divisions connected with the name of *Vlachia.* A short synopsis may be given of the most important of these, outside the limits of Rumania itself.

Political and Territorial Divisions.—I. The *Bulgaro-Vlach Empire.*—After the overthrow of the older Bulgarian tsardom by Basil "the Bulgar-slayer" (976–102j), the Vlach population of Thrace, Haemus and the Moesian lands passed once more under Byzantine dominion; and in 1185 a heavy tax, levied in kind on the cattle of these warlike mountain shepherds, stirred the Vlachs to revolt against the emperor Isaac Angelus. and under the leadership of two brothers. Peter and Asen, to found a new Bulgaro-Vlachian empire. which ended with Kaliman II in 125;. The dominions of these half-Slavonic, half-Ruman emperors extended north of the Danube over a great deal of what is now Rumania, and it was during this period that the Vlach population north of the river seems to have been most largely reinforced. The 13th-century French traveler Rubruquis speaks of all the country between the Don and Danube as *Asen's* land or *Blakia.*

2. Great *Walachia.*—It is from Anna Comnena, in the second half of the 11th century, that we first hear of a Vlach settlement, the nucleus of which was the mountainous region of Thessaly. Benjamin of Tudela, in the succeeding century, gives an interesting account of this Great Walachia, then completely independent. It embraced the southern and central ranges of Pindus, and extended over part of Macedonia. thus including the region in which the Roman settlers mentioned in the *Acts* of St. Demetrius had fixed their abode. After the Latin conquest of Constantinople in 1204, Great Walachia was included in the enlarged despotat of Epirus. but after passing under the yoke of the Serb emperor Dushan and other Serbian rulers in the 14th century, was finally conquered by the Turks in 1393. Many of their old privileges were accorded to the inhabitants. and their taxes were limited to an annual tribute. Since this period the Megalovlachites have been largely Hellenized, but they are still represented by the flourishing Tzintzar settlements of Pindus and its neighbourhood.

3. Liftle *Walachia* was a name applied by Byzantine writers to the Ruman settlements of Aetolia and Acarnania, and with it may be included "Upper Walachia." Its inhabitants are represented by the Tzintzars of the Aspropotamo and the Karaguni (Black Capes) of Acarnania.

4. The *Morlachs* (*Mavrovlachi*) of the *West.*—These are already mentioned as *Nigri Latini* by the presbyter of Dioclea (c. 1150) in the old Dalmatian littoral and the mountains of Montenegro, Herzegovina and North Albania. Other colonies extended through part of the old Serbian interior, where there is a region called Stara Vlaška or "Old Walachia." The great commercial staple of the east Adriatic shores. the republic of Ragusa. seems in its origin to have been a Ruman settlement. and many Vlach traces survived in its later dialect. Philippus de Diversis, u·ho described the city as it existed in 1440, says that "the various officers of the republic do not make use either of Slav or Italian. with which they converse with strangers, but a certain other dialect only partially intelligible to,us Latins," and cites words with strong Ruman affinities. In the mountains above Ragusa a number of Vlach tribes are mentioned in the archives of that city. and the original relationship of the Ragusans and the nomadic Alpine representatives of the Roman provincials, who preserved a traditional knowledge of the old lines of communication throughout the peninsula, explains the extraordinary development of the Ragusan commerce. In the 14th century the Mavrovlachi or Morlachs extended themselves toward the Croatian borders, and a large part of maritime Croatia and northern Dalmatia began to be known as *Morlacchia.* A Major *Vlachia* was formed about the triple frontier of Bosnia, Croatia and Dalmatia, and a "Little Walachia" as far north as Požega. The Morlachs were Slavonized.

5. Cici of *Istria.*—The extreme Ruman offshoot to the north-west is represented by the Cici of the Val d'Arsa and adjoining Istrian districts. They represent a 15th-century Morlach colony from the isle of Veglia, and had formerly a wider extension to Trieste and the counties of Gradisca and Görz. The Cici almost entirely abandoned their native tongue, which is the last remaining representative of the old Morlach, and forms a connecting link between the Daco-Roman (or Rumanian) and the Illyro- or Macedo-Roman dialects.

6. Rumans *of Transylvania and* Hungary.—As already stated, a large part of the Hungarian plains were, at the coming of the Magyars in the 9th century, known as *Pascua Romanorum.* At a later period privileged Ruman communities existed at Fogaras, where was a *Silva Vlachorum,* at Marmaros, Deva, Hatzeg, Hunyad and Lugos, and in the Banat were seven Ruman districts. Two of the greatest figures in Hungarian history, the 15th-century rulers John Corvinus of Hunyad and his son King Matthias. were due to this element. For its later history see TRANSYLVANIA.

VLADIKAVKAZ, Russian S.F.S.R.: see ORJONIKIDZE.

VLADIMIR, ST. (c. 956–101j). grand duke of Kiev and of all Russia, was the youngest son of Svyatoslav I and his mistress Malushka. In 970 he received Great Novgorod as his appanage. On the death of Svyatoslav in 972, a long civil war took place between his sons Yaropolk and Oleg, in which Vladimir was involved. From 977 to 984 he was in Scandinavia, collecting as many of the viking warriors as he could to assist him to recover Novgorod, and on his return marched against Yaropolk. On his way to Kiev he sent ambassadors to Ragvald, prince of Polotsk, to sue for the hand of his daughter Ragnilda. The haughty princess refused to affiance herself to "the son of a bondswoman," but Vladimir attacked Polotsk. slew Ragvald and took Ragnilda by force. Subsequently (980) he captured Kiev also; slew Yaropolk by treachery, and was proclaimed prince of all Russia. In 981 he conquered the Chervensk cities, the modern Galicia; in 983 he subdued the heathen Yatvyags, whose territories lay between Lithuania and Poland; in 98j he led a fleet along the central rivers of Russia to conquer the Bulgars of the Kama, planting numerous fortresses and colonies on his way. At this time Vladimir was a thoroughgoing pagan. He increased the number of the *trebishcha,* or heathen temples; offered up Christians (Theodore and Ivan, the protomartyrs of the Russian church) on his altars; had 800 concubines, besides numerous wives; and spent his whole leisure in feasting and hunting. He also formed a great council out of his boyars, and set his 12 sons over his subject principalities.

In the year 987, as the result of a consultation with his boyars, Vladimir sent envoys to study the religions of the various neighbouring nations whose representatives had been urging him to embrace their respective faiths. The result is amusingly described by the chronicler Nestor. Of the Moslem Bulgarians of the Volga the envoys reported "there is no gladness among them; only sorrow and a great stench; their religion is not a good one." In the temples of the Germans they saw "no beauty"; but at Constantinople. where the full festival ritual of the Orthodox Church was set in motion to impress them. they found their ideal. "We no longer knew whether we were in heaven or on earth, nor such beauty, and we know not how to tell of it." If Vladimir was impressed by this account of his envoys, he was yet more so by the offer of the emperor Basil II to give him his sister Anna in marriage. In 988 he was baptized at Kherson in the Crimea, taking the Christian name of Basil out of compliment to his imperial brother-in-lam; the sacrament was followed by his marriage with the Roman princess. Returning to Kiey in triumph, he converted his people to the new faith with no apparent difficulty. Crypto-Christians had been numerous in Kiev for some time before the public recognition of the Orthodox faith. The remainder of the reign of Vladimir was devoted to good works. He founded numerous churches, including the splendid *Dẹsyatinnuy Sobor* or "Cathedral of the Tithes" (989), established schools, protected the poor and introduced ecclesiastical courts.

With his neighbours he lived at peace, the incursions of the savage Petchenegs alone disturbing his tranquillity. His nephew Svyatpolk, son of his brother and victim Yaropolk, he married to the daughter of Boleslaus of Poland. He died at Berestova, near Kiev. while on his way to chastise the insolence of his son. Prince Yaroslav of Novgorod. The various parts of his dismembered body were distributed among his numerous sacred foundations and were venerated as relics. The Lniversity of Kiev has rightly been named after the man who both civilized and Christianized ancient Russia. His memory was also kept alive by innumerable folk ballads and legends. With him the Varangian period of Russian history ceases and the Christian period begins.

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VLADIMIR, a city and capital of Vladimir *oblast* (formed out of Ivanovo *oblast* in 1944), Russian Soviet Federated Socialist Republic. was known in history as Vladimir-on-the-Klyazma to distinguish it from Vladimir in Volhynia. It is picturesquely situated on the Klyazma and Lybed, in 56° 8' N., 40° 20' E. Pop. (1959) 154,000.

The town is a trading centre on the railway and river between Moscow and Gorki. Factories for knitted goods, fruit juice and bricks were established and oil-pressing and sawmilling industries were developed there. Other industries include the manufacture of plastic products, precision instruments and tractors. Extensive cherry orchards occupy the surrounding slopes; the custom arose of building in each orchard a small watchtower, with cords drawn in all directions to be shaken by the watcher when birds alight.

The citadel stands on a hill and contains two very old cathedrals —the Lspenskiy (restored in 1891). where all the princes of Vladimir were buried, and the Dmitrievskiy (1197; restored in 1834–35). Several churches date from the 12th century.

Vladimir first comes into notice in 1151, when Andrei Bogolyubskiy secretly left Vyshgorod—the domain of his father in the principality of Kiev—and migrated to the newly settled land of Suzdal, where he became (1157) grand prince of the principalities of Vladimir, Suzdal and Rostov. Although Ivan Kalita (1328–41) made Moscow the real head of the *Rus* states, Vladimir remained the coronation city of the grand princes until 1431, and Simeon the Proud. Ivan the Good, Dmitri of the Don and Vasili I were crowned there.

VLADIMIR, a former province of the Russian S.F.S.R., was divided among the Moscow, Yaroslavl, Ivanovo, Gorki and Ryazan regions. It did not coincide with the pre-1917 province of the same name.

VLADIMIRESCU, TUDOR (? –1821), Rumanian popular leader, was a native of Oltenia, of peasant origin but educated among the lesser nobility. He took part in the Serb uprising of 1804. In the Russo-Turkish wars of 1806–12 he led a body of irregular Rumanian troops known as *panduri*, was made a lieutenant in the Russian army and decorated. Having joined the Philiké Hetairia, the Greek revolutionary movement led by Alexander Ypsilanti (q v.), he organized a revolt in Wallachia at the beginning of 1821 to coincide with the Greek rising planned in Moldavia. Vladimirescu brought out his *panduri* even before Ypsilanti had crossed the Prut (Feb. 20, 1821), but the two risings, neither of which received Russian support, soon took on a different character. Vladimirescu's insurrection was at first mainly social, the peasants flocking to his standard against the boyars and indulging in wholesale pillage. but on reaching Bucharest in March he recognized the provisional government and joined forces with the more enlightened boyars to proclaim a Rumanian national crusade, thereupon curbing the excesses of his men. While Ypsilanti aimed at throwing off the Turkish yoke. Vladimirescu was willing to come to an accommodation with the Turks if they would throw out the Phanariotes and set up a national Rumanian government. Ypsilanti, entering Bucharest ten days after Vladimirescu, treated him as a traitor and had him assassinated.

(B. BR.)

VLADIMIR VOLHYNSKIY: *see* WLODZIMIERZ-WOLYNSKI, a town in the province of Volhynia, Poland.

VLADIVOSTOK, a port of Asiatic C.S.S.R.. capital of Primorski *oblast*, Russian Soviet Federated Socialist Republic, in 43° 11′ N., 131" 53' E. It stretches along the northern shore of the Golden Horn, on the slope of a ridge of hills extending westward to Amur bay It is an important city in the far eastern area; its easily accessible harbour, 4 mi. by 1 mi., kept open all the winter by icebreakers, made it the most important naval and commercial centre on the Russian Pacific coast. Pop. (1959) 283,000. A long stone mole for berthing and unloading ships was built at the port, where there are cargo-storage facilities and engineering and repairing yards for ships.

Major exports include timber and lumber. fish, vegetable oils, coal and grain. Industries in Vladivostok the chief base of Soviet whaling flotillas, fishing and crabbing, include fish and food canning and related industries. Airplanes and ships are also built there.

A hydrobiological station was established at Basargin peninsula in 1925. The city became the seat of various research and educational institutions, such as the Pacific Institute of Fisheries and Oceanography and a polytechnic institute.

Muraviev selected the site after the treaty of Aigun (1858) by which the district was ceded to Russia. In July 1860 the first settlers arrived there; the name Vladivostok means "dominator" or "ruler of the east." and the Russians gave concrete evidence of their intention to fulfill that promise when, 12 years later, they established, to the annoyance of Japan, their far eastern naval base there. It also became a major air base and during World Wars I and II was important as a supply port. A railway via Manchuria and the Trans-Baikal district reached the town in 1897, though the final link with the Trans-Siberian was not completed ill 1917. Radio stations and cable connection to Japan were established.

VLAMINCK, MAURICE DE (1876–1958), French painter and writer in the Fauve group, was born in Paris on April 4, 1876. He lived in and near country places most of his life, however, a fact which may account for his rugged and picturesque personality as well as his flair for nature. He became a musician, actor and cyclist as well as painter. His interest in art dates from 1895, with lessons in drawing and study of the Impressionists who were then being shown. During 1899–1900 he gave music lessons for a living and performed as an actor. At the same time he met André Derain, nith whom he shared studio quarters on the island of Chatou. The following year, in company with Derain. he was impressed by the Van Gogh exhibition at Bernheim's Paris gallery; he also met Henri Matisse that year and began to exhibit at the Salon des Indépendants. His first novel. *Grains au vent*, dates from this period (illustrations by Derain); two others were to come later. In 1905, in the famous "Bateau Lavoir" artist group, he met Pablo Picasso and Kees van Dongen. The same year (crucial for the beginning of the Fauve movement) Vlaminck joined with Matisse, Albert Marquet, Derain. Henri Manguin, Georges Kouault, van Dongen, etc., in their group showing at the annual Salon d'Automne, where the term "Fauve" or "wild beast" was first applied to their dynamic, vibrating canvas surfaces with their large bold areas of intense colour applied in a spontaneous, even violent manner. By 1908 Vlaminck gave up this type of painting in favour of the subdued melancholy of the Romantic landscapes.

Vlaminck died Oct. 11. 1958, near Paris.

See Klaus G. Perls, *Vlaminck* (1941) ; *M.* Gauthier, *Vlaminck* (1949) ; G. Duthuit, *The Fauvist Painters* (1950). (B. S. Ms.)

VLONE (Tosk dialect VLORË; Gheg VLONË; internationally known as VALONA), a seaport of Albania) lies at the northeast end of a gulf which is largely protected by mountains and by the island of Sazan (Saseno), the ancient Saso, and which provides sheltered anchorage under the lee of the Karaburun spit (2,700 ft.). Pop. (1955) 28,212. part Moslem. part Greek Orthodox, with a few Roman Catholics. The port itself is somewhat exposed and lacks breakwaters. Since World War II it has been improved and a new quay constructed. The pleasant, shady town, about 1½ mi. inland, is surrounded by hilly olive groves. The most important export from Vlone, crude oil from the Kucove and Patos oil fields, which were linked by pipeline to the loading point south of the port, was affected by the opening in 1957 of the oil refinery at Cerrik, near Elbasan. The export of natural bitumen from Selenice is also handled by the port. There are a fishing industry and a fish cannery. and olive oil and alcohol factories. Industries set up after World R'ar II included cement making and rice husking. A macadamizedroad links the port with Durres and Tirane.

Vlone (the ancient Avlon or Avlona) played an important part in Greek and Roman times and in the 11th- and 12th-century wars between Normans and Byzantines, and later changed hands between Venetians: Serbs and Turks. On Nov. 28, 1912. Ismail Bey Vlora proclaimed here the independence of Albania. In 1914 the Italians occupied Sazan and later Vlone itself. which they held until 1920, when they withdrew, retaining Sazan, the key to the Otranto strait. Vlone passed again to the Italians when they occupied Albania in April 1939, but, with the rest of the country. Vlone and Sazan reverted to the Albanians with the departure of the German forces in 1944. The historic ruined fortress of Kanine stands on a hill about 2½ mi. S. of the town. (D. R. O.-H.)

VOCATIONAL EDUCATION, or trade or industrial training, is the term applied to instruction that is intended to fit persons for specific industrial or commercial occupations. It may be secured in various ways: (1) learning on the job by the "pickup" method without educational supervision; (2) learning in shop-training departments or vestibule schools maintained by employers; (3) learning as indentured apprentices; (4) learning in trade, technical secondary, continuation or night schools; and (5) learning in shops and schools according to some co-operative arrangement between industrial establishments and the schools.

Vocational education in schools is a relatively modern development. Until the 19th century vocational education, except for the professions, was provided only by apprenticeship. In ancient Greece such instruction was regarded as unworthy of those who would become freemen, and a sharp distinction was drawn between vocational and liberal education. This distinction was perpetuated in the educational practice of western Europe; vocational education continued to be associated with low social status! while schools with classical curriculums were regarded as providing the education "necessary for a gentleman." The growth of industrialization stimulated a new attitude. however, and during the 19th century several leading European nations, notably Germany, began to recognize the importance of vocational instruction in the elementary and secondary schools. (X.)

United States.—Vocational education in the schools of the U.S received its first great stimulation in 1906, when the National Society for the Promotion of Industrial Education was organized for the purpose of extending vocational education throughout the U.S. It was active in securing passage of the Smith-Hughes act on Feb. 23, 1917. This act provided federal aid for public schools offering approved trade and industrial, agricultural and home-making courses of less than college grade to pupils 14 years of age and older. It also made provision for teacher training, civilian rehabilitation and vocational research. Subsequent acts—George-Reed (1929). George-Ellzey (1934). George-Deen (1936), George-Barden (1946)—and other special legislation increased federal appropriations to $28,500.000 annually and extended benefits to Alaska, Hawaii, Puerto Rico and the Virgin Islands.

Federal aids are administered by the U S. office of education through state boards designated by slate legislatures to prepare and develop vocational education programs that meet federal approval. Trade training is offered both through state schools, as in Massachusetts and New Jersey, and in local special vocational schools, vocational high schools or trade and technical schools. In Wisconsin the vocational and adult education program is administered by a state board of vocational and adult education through local boards of vocational and adult education in cities of 5,000 or more.

In industrial centres throughout the country trade apprenticeship is well established. Apprentices receive their practical instruction on their jobs and their related training in apprentice or vocational schools. The bureau of apprenticeship of the U.S. department of labor has developed indentured apprenticeship in co-operation with the states. In the second half of the 20th century there were more than 155.000 apprentices in the U.S and its possessions. The ten leading industrial states together had more than 95,000 of these apprentices.

Compulsory education laws and technological progress have raised the age and general school attainment of young people beginning employment. Industrial needs, too. changed and required an increasing number of technicians. Technical institutes were established to train them. In California, tno-year courses for technicians are offered as terminal courses in the local junior colleges to fill this need. Also, there was an increase in attendance at evening vocational schools on the part of older workers wishing to keep up with the changes occurring in their occupations. (W. F. R)

Great Britain.—In Great Britain the traditional prejudice against vocational training persisted longer than in most other European countries It influenced the opinion not only of adherents of liberal education but also of the workers, who feared that it might be used as a convenient method of recruiting cheap labour. Although in 1895 an important royal commission on secondary education, presided over by Lord Bryce. pleaded strongly for a more sympathetic approach to the education of craftsmen, the new grammar schools. established under the Education act of 1902. adhered to the liberal curriculum. A number of trade and junior technical schools mere established, honever, by local authorities and in 1938 a report of the Consultative Committee on Secondary Education (known as the Spens report) was able to point to the success of these ventures and reaffirm strongly the advocacy of secondary technical education contained in the Bryce report.

When the Spens report was first published the Trades Union congress urged that any move toward specialized training of a vocational character "should be made with great caution and without prejudice to the general education of the child." The success of ministry oi labour training schemes during World War II helped to allay the suspicion of vocational teaching after the age of 15, and there was a much wider recognition of its value to industry and commerce.

The Education act of 1944 made provision for county colleges which all young people who had left school were to attend for a day a week or its equivalent; and it was contemplated that the curriculum would include vocational training. Postwar economic conditions delayed the implementation of this important feature of the act; but in the second half of the 20th century, in addition to nearly 300 secondary technical schools that had become well established, there had been a notable increase of part-time technical education, helped by the increasing readiness of firms to release young workers for a day or half day each week for such training. As against the 40,000 thus released before World War

II, there were more than ten times as many young workers receiving part-time education in this way. Public opinion about vocational training at an appropriate age had changed considerably, and there was a growing acknowledgment of the truth of A. N. Whitehead's dictum that "the antithesis between a technical and a liberal education is fallacious." *See* TECHNICAL EDUCATION; APPRENTICESHIP; ADULT EDUCATION.

See also references under "Vocational Education" in the Index volume. (W. O. L. S.)

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VOCATIONAL REHABILITATION: *see* REHABILITATION, MEDICAL AND VOCATIONAL.

VODENA, meaning "city of waters" (Slav. *voda,* "water"), was the medieval name for the town of Edessa (originally ancient Aegae) in Greek Macedonia. *See* EDESSA. (D. M. N.)

VODKA (WODKA), the national distilled alcoholic beverage of Russia and Poland (in Polish the "*w*" has the "*v*" sound). The word means "little water," a diminutive, endearing term. Vodka was first produced in Russia in the 14th century. The spirits from which it was made were obtained from the agricultural product that was most abundant, and cheapest, locally. Wheat, rye, maize, potatoes, sugar beets or a combination of several of these were and still are employed.

In Russia and Poland the producers of vodka, instead of carrying out distilling operations, eventually came to buy highly rectified distilled spirits, which they further rectified by filtration through beds of vegetable charcoal. The purified spirit was next reduced, without being aged, to potable strength with distilled water and then was bottled. This is the traditional method followed today in Russia, Poland and elsewhere. The resultant product is colourless and without any specific flavour or taste. Potable strength in Russia has generally been 80 proof (40% alcohol by volume), although in Poland it is 90 proof (45% alcohol by volume). In both countries, small quantities are bottled at higher proofs. Before World War II, the consumption of vodka was confined almost entirely to Russia, Poland and the Baltic states. After World War II, however, the production and use of vodka increased enormously in other countries, particularly in the United States.

Each producing country or region has developed techniques for processing vodka from the raw materials most easily obtainable locally. In the United States and the United Kingdom great advances have been made in distillation from cereal grains, while in Russia and Poland techniques have been developed in distilling spirits from potatoes. Thus in Russia and Poland potato spirit vodkas are preferred, while in the United States vodka is produced almost entirely from grain spirits. United States federal regulations define vodka as "neutral spirits distilled from any material at or above 190 proof, reduced to not more than 110 proof and not less than 80 proof and after such reduction in proof, so treated . . . (with vegetable charcoal for at least 8 hours) . . . as to be without distinctive character, aroma or taste."

In Poland a product called zubrowka is made by steeping zubrowka grass in vodka. This gives the beverage a light yellowish tinge, an aromatic bouquet and a slightly bitter undertone.

The traditional Russian and Polish method of drinking vodka is neat (*i.e.,* straight) in glasses of about one ounce capacity and ice cold. In other countries, especially the United States, vodka is consumed in mixed drinks of all kinds. Some of the most popular are the screwdriver, a glass of orange juice with a jigger of vodka mixed in; the bloody mary, a glass of tomato juice with vodka; the Moscow mule, ginger beer with vodka added; vodka with tonic; and vodka martini.

See also ALCOHOLIC BEVERAGES, DISTILLED: *Classification of Potable Spirits.* (H. J. GN.)

VOGEL, SIR JULIUS (1835–1899), British colonial statesman, son of Albert Leopold Vogel, was born in London on Feb. 24, 1835, was educated at University College school, London, and emigrated to Victoria during the exciting years which followed the discovery of gold fields there. He became editor of a newspaper at Maryborough, stood for the legislative assembly and was defeated and in 1861 left Victoria, carried in the mining rush to Otago, N.Z., where much gold had just been found. Settling in Dunedin, he bought a half-share in the *Otago Daily Times* and was soon its editor and a member of the Otago provincial council.

He made his paper the most influential in the colony, and was returned to the house of representatives. In 1866 he was head of the Otago provincial executive; by 1869 he had made his mark in the New Zealand parliament and was treasurer in the ministry of Sir William Fox. He brought forward schemes for the construction of trunk railways and other public works. the purchase of land from the Maori tribes and the introduction of immigrants, all to be done with money borrowed in London. For the next six years he was the most powerful man in the colony. In 1875 he was knighted.

In 1874 Vogel. until that time a supporter of the Provincial system, decided to abolish it. In this, with the aid of Sir E. W. Stafford and Sir H. A. Atkinson, he succeeded. In the struggle, however, he broke with many of his old allies, and in 1876 suddenly left New Zealand to take the post of agent-general in London.

The last years of his life were spent in England. He died there, at East Molesey, on March 13, 1899.

VOGELSANG, KARL, FREIHERR VON (1818–1890), Roman Catholic German social reformer, was born at Liegnitz on Sept. 3, 1818. After studying law at Bonn, Rostock and Berlin, he entered the Prussian government service, but after the revolution of 1848 retired to his ancestral estate in Mecklenburg. Becoming a Catholic in 1850, he moved first to Cologne and later to Vienna, contributing to German and Austrian periodicals and newspapers.

Vogelsang's basic views were derived from a mixture of scholasticism and romanticism, the latter as interpreted by Adam Miiller. Condemning capitalism in terms similar to those of socialist writers, he advocated its replacement by a Christian order of society, culminating in a corporative system with self-government of the various socio-economic groups. Interest rates were to be abolished as much as possible. Farmers and artisans were to be organized in co-operatives with legal powers over their members; industrial organization was to follow similar lines, with the workers sharing in the profits. These views bear some similarity to those of the guild socialists. Some of his views were too deeply influenced by the romantic school to be realistic. His numerous articles, however, while more popular than scholarly, exerted great influence, and helped shape the ideas and actions of the Austrian Christian Social party as founded by Karl Lueger. Vogelsang died in Vienna on Nov. 8, 1890.

Vogelsang's more significant writings were edited by Wiard Klopp in *Die sozialen Lehren des Freiherrn von Vogelsang* (1894) and *Leben und Wirken des Sozialpolitikers Freiherr von Vogelsang* (1930). (F. A. Hs.)

VOGLER, GEORG JOSEPH (1749–1814), usually known as Abbé or Abt (Abbot) Vogler, German organist and music theorist, immortalized by Robert Browning's poem, was born in Würzburg on June 15, 1749, and was educated at the Jesuit college there. His father was a violinmaker and he learned to play the violin, organ and other instruments before he was ten, developing for himself an original system of fingering. In 1771 he went to Mannheim, where he composed a ballet for the elector, who sent him to study music in Italy, first at Bologna under Padre Martini (with whom he violently disagreed) and then in Padua with Francesco Vallotti. In 1773 he was ordained priest in Rome, becoming chaplain to the pope, knight of the Golden Spur and member of the academy of Arcadians. Returning to Mannheim in 1775, he was made court chaplain and second *Kapellmeister,* and started his first *Tonschule,* where he taught his own system of harmony, founded on the acoustical theories of Vallotti. In 1780 he followed the electoral court to Munich, where he became chief *Kapellmeister* in 1784, and during 1786–99 he held the post of court conductor in Stockholm, where he opened another school.

During these years, however, his chief work was the development of a simplified organ, based on Giuseppe Tartini's theory of harmonics, which he called the orchestrion. He traveled widely, giving lectures and demonstrations on it, and undertaking commissions to simplify existing organs by introducing free reeds and rearranging the pipes. He made a great reputation with pieces such as J. H. Knecht's "A Pastoral Festival Interrupted by a Storm." In 1807 he settled in Darmstadt at the invitation of the grand duke and opened his most successful school, where C. M. von Weber and G. Meyerbeer were among his pupils. His best works were his Symphony in C and the Requiem Mass, which he finished just before he died at Darmstadt on May 6, 1814; he also wrote several books on harmonics.

VOGT, JOHAN HERMAN LIE (1858–1932), Norwegian geologist and petrologist who pioneered the application of physical chemistry to the study of the origin of igneous rocks and ore deposits, was born at Tvedestrand on Oct. 14, 1858, the son of a physician; his mother was a sister of Marius Sophus Lie (*q.v.*), the celebrated mathematician. He was educated at the University of Christiania (Oslo), taking the diploma of mining engineer in 1880. In 1886 he was appointed professor of metallurgy at Christiania but moved to Trondhjem in 1912 to the chair of mineralogy and geology in the technical high school. He retired from this post in 1928.

His first important work, Studier ***over*** Slugger, appeared in 1884. In this he examined the crystallization phenomena of furnace slags and drew attention to the close resemblance in mineral constitution and texture these artificial products bore to some igneous rocks. His principal work on slags, Die *Silikatschmelzlösungen*, appeared in 1903–04. These studies served as a starting point in his endeavour to work out on broad lines the application of the known laws of solutions to the crystallization of igneous rock magmas, and his pioneer work did much to stimulate experimental research on quantitative lines which has followed. He died in Trondhjem on Jan. 3, 1932. (C. E. T.)

VOGTLAND or VOIGTLAND, a district of Germany, forming the southwest corner of the pre-World War II Land of Saxony and also embracing parts of Thuringia, was bounded on the north by the former principalities of Reuss, on the southeast by Bohemia, and on the southwest and west by Bavaria. Its character is generally mountainous, and geologically it belongs to the Erzgebirge range. It is extremely rich in mineral ores—silver, copper, lead and bismuth. The name denoted the country governed for the emperor by a *Vogt* (bailiff or steward).

VOGÜÉ, EUGENE MELCHIOR, COMTE DE (1848–1910). French author, was born at Nice on Feb 25. 1848. He served in the campaign of 1870, and on the conclusion of the war entered the diplomatic service, being appointed successively attaché to the legations at Constantinople and Cairo and secretary at St. Petersburg (Leningrad). He was almost the first to draw French attention to Dostoievski and his successors. He became a member of the French Academy in 1888. He died in Paris on March 24. 1910.

His works include: *Histoires orientalas* (1879) ; *Portraits du siècle* (1883) ; *Le Fils de Pierre le Grand* (1884) ; *Histoires d'hiver* (1885) ; *Le Roman russe* (1886) ; *Regards historiques et littéraires* (1892) ; *Coeurs russes* (1894) ; *Devant le siècle* (1896) ; *Jean d'Agrève* (1898) ; *Le Rappel des ombres* (1900) ; *Le Maître de la mer* (1903) ; *Maxime Gorky* (1905).

VOGUL (MANSI) are an ethnic minority people living in the northern Ural mountains. According to the Soviet census of 1959, they numbered about 6.000.

The language of the Vogul, and that of their eastern relatives. the Ostyaks (*q.v.;* Khanty), belongs, with Hungarian, to the Ugric group of the Finno-Ugric language family; Vogul and Ostyak are together referred to as Ob-Ugric (see FINNO-UGRIC LANGUAGES).

The Vogul are spread out over an enormous territory: the Khanty-Mansi national district—constructed into a subordinate unit of the Russian Soviet Federated Socialist Republic during World War II out of part of the Omsk region—occupies about 294,000 sq.mi. (The Ostyak-Vogul national district was established in 1930.) The capital is Khanty-Mansiysk, a town situated at the confluence of the Ob and Irtysh rivers.

Since the rivers of this region constitute the principal arteries for surface traffic and are also of dominant importance in Vogul subsistence (fishing), the four principal dialects are identified by the names of the rivers adjacent to which each group is spoken: Northern Vogul by the Sosva; Eastern Vogul by the Konda; Southern Vogul in a small enclave by the lower Tavda; and Western Vogul along three small tributaries of the upper Tavda—the Pelym, Vagil' and Lozva. These dialects differ rather substantially in terms of phonology, morphology and lexical stock, so that mutual intelligibility between, *e.g.,* a Sosva Vogul and a Tavda Vogul is just barely possible.

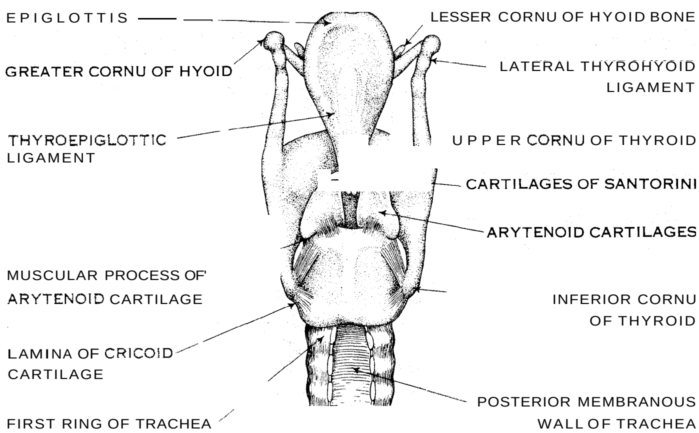
The Vogul were first mentioned by that name in Russian sources at the end of the 14th century. Throughout their history they were variously exposed to the cultural and political impact of several of their linguistic relatives (the Uralic Samoyeds and Syryenians), Turkic peoples (including the Tatars, who had a profound impact) and the Russians. Their contacts with the latter are millenary, although they have been formally subjected for about 400 years.

The majority of the people fish and hunt, but the Southern Vogul practise animal husbandry and the nomadic Northern Vogul keep reindeer. Vogul dwellings vary according to season from simple tents to more solid winter huts. For transportation they use boats and, in the winter, snowshoes or sleds. Since the middle of the 18th century, the Vogul increasingly became members of the Orthodox Eastern Church.

At the beginning of the 1930s collectivization began in the remote regions inhabited by the Vogul, and efforts were intensified to develop a literature. Although religious tracts were published before 1917 in the Konda dialect, the newly created literary language was based on the Sosva dialect. Since 1932, a number of schoolbooks and other works (folklore collections, children's literature, political pamphlets) appeared in Vogul. Instruction in Vogul schools on the elementary level was (1960s) conducted in the mother tongue. (T. A. SB.)

VOICE is the sound produced by the vibrations of the vocal folds or cords. tno ligaments or bands of fibrous elastic tissue situated in the larynx. It is to be distinguished from speech. which is the production of articulate sounds intended to express ideas. (See SIXGING; PHONETICS; PRONUNCIATION.)

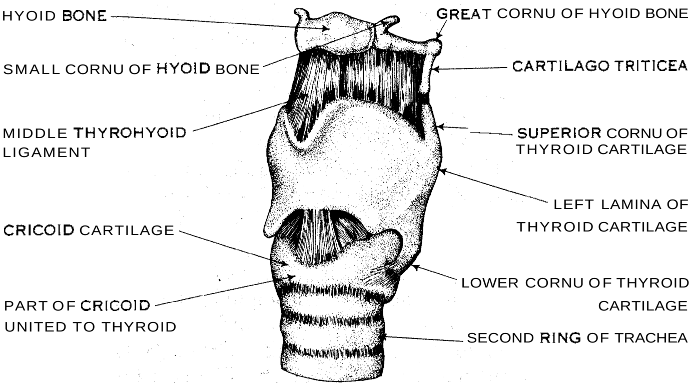
Physiological Anatomy.—The larynx is a valve guarding the entrance to the trachea. In man it is used as the organ of voice. It is situated in the neck where it forms a well-marked prominence in the middle line (see details under RESPIRATORY SYSTEM, ANATOMY OF). It consists of a framework of cartilages, connected by elastic membranes or ligaments. and it contains two important structures knonn as vocal folds or cords. The latter. if brought into apposition, can be blown apart by an expiratory blast of air; a consequent fall in pressure in the trachea allows the folds to come into contact again; repetition of this action allows puffs



FROM H. GRAY, "ANATOMY OF THE HUMAN BODY," 27TH ED., 1959; REPRODUCED BY PERMISSION OF LEA & FEBIGER, PHILADELPHIA

FIG. 1.—LIGAMENTS AND CARTILAGES OF THE LARYNX. POSTERIOR VIEW

of air to escape rhythmically from the larynx into the pharynx and out by the mouth or nose with the production of a note.



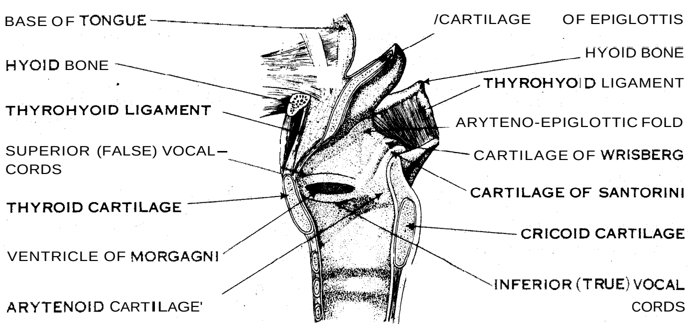
FROM H GRAY "ANATOMY OF THE HUMAN BODY," 27TH ED , 1959, REPRODUCED BY PERMISSION OF LEA & FEBIGER, PHILADELPHIA

FIG. 2.— LIGAMENTS AND CARTILAGES OF THE LARYNX, ANTEROLATERAL VIEW

The cartilages form the framework of the larynx. They consist of three single pieces (the thyroid, the cricoid and the cartilage of the epiglottis) and of three pairs (two arytenoids, two corniculate cartilages of Santorini and two cuneiform cartilages or cartilages of Wrisberg) (see fig. 1 and 2). The epiglottis, the corniculate and cuneiform cartilages and the apexes of the arytenoids are composed of yellow or elastic fibro-cartilage, while the cartilage of all the others is of the hyaline variety, resembling that of the costal or rib cartilages. These cartilages are bound together by ligaments, some of which are seen in fig. 1 and 2, while the remainder are represented in fig. 3. The structures specially concerned in the production of voice are the inferior thyroarytenoid folds, or true vocal folds. These are composed of fine elastic fibres attached behind to the anterior projection of the base of the arytenoid cartilages, *processus vocalis* (see fig. 3) and in front to the middle of the angle between the wings or laminae of the thyroid cartilage. They are continuous with the lateral cricothyroid ligaments which form the *conus* elasticus (see fig. 3).

The cavity of the larynx is divided into an upper and lower portion by the narrow aperture of the glottis or chink between the edges of the true vocal folds, the *rima* glottidis. Immediately above the true vocal folds, between these and the false vocal cords, there is on each side a recess or pouch termed the ventricle of Morgagni, and opening from each ventricle there is a still smaller recess, the laryngeal saccule, which passes for the space of half an inch between the superior vocal cords inside and the thyroid cartilage outside, reaching as high as the upper border of that cartilage at the side of the epiglottis. The upper aperture of the larynx is bounded in front by the epiglottis, behind by the summits of the arytenoid cartilages and on the sides by two folds of mucous membrane, the aryteno-epiglottic folds.

The rima glottidis, between the true vocal folds, in the adult male measures about 23 mm., or nearly an inch from front to back, and from 6 to 19 mm. across its widest part, according to the degree of dilation. In females and in males before puberty the anteroposterior diameter is about 17 mm. and its transverse diameter about 11.5 mm. The membranous vocal folds of the adult male are in length about 15 mm., and of the adult female about



FROM L. TESTUT, "TRAITE D'ANATOMIE HUMAINE," G DOIN ET CIE., ÉDITOURS, PARIS

FIG. 3.— SAGITTAL SECTION OF THE LARYNX, RIGHT HALF

11 mm. The larynx is lined with a layer of epithelium which is closely adherent to underlying structures, especially over the true vocal folds. The cells of the epithelium, in the greater portion of the larynx, are of the columnar ciliated variety, and by the vibratory action of the cilia mucus is driven upward; over the true vocal folds, however, the epithelium is squamous. Numerous mucous glands exist in the lining membrane of the larynx, especially in the epiglottis. In each laryngeal pouch there are from 60 to 70 such glands.

Muscles of the Larynx. — The muscles of the larynx forming, with the arytenoid cartilages, the *rima* glottidis, tighten or relax, and approximate or separate the vocal folds. Besides certain extrinsic muscles — sternohyoid, omohyoid, sternothyroid and thyrohyoid — which move the larynx as a whole, there are intrinsic muscles which move the cartilages on each other. These muscles are the cricothyroid, the posterior cricoarytenoid, the lateral cricoarytenoid, the thyroarytenoid, the interarytenoid and the arytenoepiglottidean.

Cricothyroid.—This is a short thick triangular muscle. its fibres passing from the cricoid cartilage obliquely upward and outward to be inserted into the lower border of the thyroid cartilage and to the outer border of its lower horn. When the muscle contracts, the cricoid and thyroid cartilages are approximated.

Thyroarytenoid.—This muscle is divided by anatomists into two parts, one, the internal, lying close to the true vocal cord, and the other, external, immediately within the ala of the thyroid cartilage. Many of the fibres of the anterior portion pass from the thyroid cartilage with a slight curve (concavity inward) to the vocal process at the base of the arytenoid cartilage. They are thus parallel with the true vocal fold, and when they contract the arytenoids are drawn forward if the posticus muscles are relaxed; but if the arytenoid cartilages are braced back contraction of the muscle increases the elasticity of the margins of the glottis. The arrows in fig. 4[C] indicate how the cords are shortened by unopposed contractions of the thyroarytenoid; the external fibres also rotate the vocal processes inward, and thus help in approximating the folds.

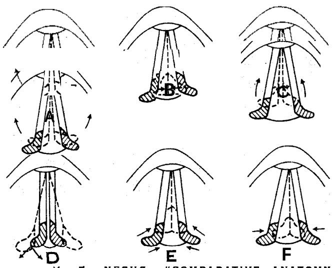
Cricoarytenoids.—The posterior and lateral cricoarytenoid muscles have antagonistic actions and may be considered together. The posterior cricoarytenoids arise from the posterior surface of the cricoid cartilage and, passing upward and outward, are attached to the outer angle of the base of the arytenoid; some fibres arise from the lateral aspect of the cricoid, to be inserted into the body of the arytenoid. On the other hand, the lateral cricoarytenoids arise from the upper border of the cricoid as far back as the articular surface for the arytenoid, pass backward and upward, and are also inserted into the outer angle of the base of the arytenoid before the attachment of the posterior cricoarytenoid. To the inner angle of the triangular base of the arytenoid are attached, as described above, the true vocal folds; and to the outer angle the two muscles in question. The posterior cricoarytenoids draw the outer angles backward and inward, rotating the inner angles, or vocal process, outward; the outermost fibres of the muscles draw the arytenoids away from one another and widen the rima glottidis. This action is opposed by the lateral cricoarytenoids, which draw the outer angle forward and outward, rotate the inner angles inward, and thus approximate the cords. In fig. 4[A] the arrows indicate the direction of action of the lateral cricoarytenoid, and the dotted lines show the positions to which its contraction brings the folds and vocal processes. Fig. 4[D] shows the action of the posterior cricoarytenoid in rotating outward the vocal processes of the arytenoid cartilages.

Interarytenoids.—These pass from the one arytenoid cartilage to the other, and in action these cartilages will be approximated and slightly depressed. In fig. 4[B] the arrows indicate the direction of action of the interarytenoid, while the dotted lines show the positions of the folds and vocal processes on its contraction.

In fig. 4[E] is shown the combined action of unopposed sphincteric muscles, as performed during swallowing; the action of the sphincteric group in phonation, opposed by dilator group of posticus muscles, is shown in fig. 4[F].

Aryteno-Epiglottidean Muscles. — These arise near the outer angles of the arytenoid; their fibres pass obliquely upward, decussate and are inserted partly into the outer and upper border of the opposite cartilage, partly into the aryteno-epiglottic fold, and partly join the fibres of the thyroarytenoids. In action they assist in bringing the arytenoids together, while they also constrict the upper aperture of the larynx.

Voice Registers. — The voice may be divided into the lower or chest register, the higher or head register and the small or falsetto register. Since all the resonators respond to the production of sound at the glottis, these terms are 'misleading. In singing, the voice changes in volume and in quality in passing from one register into another. In the lower registers the membranous vocal folds vibrate, while the arytenoids remain stationary and in apposition. The whole mass of inferior thyroarytenoid fold — consisting of mucous membrane, fatty elastic connective tissue and underlying muscle — vibrates. In the falsetto voice the vocal folds are approximated and the *rima glottidis* is short and of an elliptical shape; only the margins of the inferior thyroarytenoid folds vibrate. The small register is a variant of the falsetto; in it only a part of the membranous glottis is blown open.



V. E. NEGUS, "COMPARATIVE ANATOMY AND PHYSIOLOGY OF THE LARYNX," 1950, WILLIAM HEINEMANN, LTD.

FIG. 4.—ACTION OF INTRINSIC MUSCLES OF THE LARYNX (*see* TEXT)

The pitch of the voice appears to depend on the relation of the elasticity of the glottal margins —as determined by the degree of contraction of the thyroarytenoid muscles—to the pressure of air expelled from the trachea. The pitch can be raised by an increase of the former while the latter remains almost unchanged, or vice versa; probably an increase of elasticity is accompanied by slightly raised air pressure in the changes of pitch in the chest register. In the head register it appears that the innermost fibres only of the thyroarytenoid muscles are in contraction, rise of pitch being produced principally by rise of air pressure.

In 1950 a theory was propounded in France that considered the production of sound at the glottis to be due to rhythmical contraction and relaxation of the marginal muscles, in response to a series of stimuli arriving in the recurrent laryngeal nerves. The fact that a pitch of more than 1,000 cycles per second can be attained presents difficulties, but the authors of the theory explained this as overcome by a diphasic or triphasic method of stimulation. Sir Charles Sherrington demonstrated that if muscles are stimulated more than 67 times per second tetanic contraction is produced; experiments with animals, by means of a piezoelectric transducer or with a selenium cell responding to light shining through the glottis, prove that the thyroarytenoid muscles of the larynx may respond rhythmically to stimuli below a rate of 110 per second, but that above this rate tonic contraction occurs, as is supposed to occur in the usually accepted myoelastic theory of phonation.

Laryngoscopy.—By means of the laryngoscope it is possible to see the condition of the *rima glottidis* and the folds in passing through all the ranges of the voice. In 1807 P. Bozzini first showed that it was possible to see into the dark cavities of the body by illuminating them with a mirror! and in 1829 W. Babington first saw the glottis. In 1855 Manuel Garcia investigated his own larynx and that of other singers, and three years later L. Tiirck and especially J. N. Czermak perfected the laryngoscope. In 1883 Lennox Browne and Emil Behnke obtained photographs of the glottis in the living man. By using the stroboscope B. Oertel, A. Musehold, T. S. Flatau, J. Hegener and G. Panconcelli-Calzia enormously improved the technique of laryngoscopy. The endoscope devised by Flatau and the autophonoscope originated jointly by Panconcelli-Calzia enable extensive observations on the larynx to be carried out while the mouth is closed.

Other apparatus employed for investigating the mechanism of the voice includes the breathing flask of H. Gutzmann, the spirometer, the stethograph and pneumograph (used in connection with the manometer and the phonetic kymograph), all of which are employed for investigating breathing. For observing the action of the vocal folds there have been employed, in addition to the laryngoscope, the strobolaryngoscope and the endoscope, manometric flames, the *Polsterpfeife* of F. Wethlo, resonators, gramophones, microphones and oscillographs. For studying the supraglottal resonators radiograms are taken. Other methods of study are the cathode-ray oscillograph and the piezoelectric transducer.

Action of the Vocal Folds. — The best view of the larynx is obtained with the tongue flat, while attempting to sing the vowel "ee," for this opens out the cavity immediately above the larynx. If the larynx is examined stroboscopically the vocal folds are seen to be alternately opening and closing along the ligamentous portions in the chest notes. In falsetto, part of the glottis is permanently open with the edges of the cords vibrating. In whisper the space between the arytenoids is open. Should this occur during phonation, it constitutes a faulty mechanism producing breathy voice: n-hich is particularly to be avoided in singing.

J. Wyllie affirmed in 1865 that the false vocal cords play the chief part in the closure of the glottis during expiration. Lauder Brunton and J. T. Cash confirmed Wyllie's results and further thought that the function of the false vocal cords was to close the glottis and thus fix the thorax for muscular effort. From the evidence of comparative anatomy, and from observations made on men, it has been demonstrated that in fixation of the thorax, the vocal folds are the important factor. By means of their closure air is prevented from entering the lungs and as the thorax is to a certain extent unable to expand, because of this obstructive mechanism, the ribs tend to come to rest whereby a fixed origin is afforded to the various groups of muscles which move the arms.

The conditions that define the attributes of the human voice are in essentials similar to those of musical instruments in general. The source of energy is the lungs. By them the air is forced under pressure through the glottis causing the vocal folds to move rhythmically, thereby producing a musical note. This musical note is a tone complex of simple harmonic vibrations some of which are modified by the sub- and supraglottal cavities acting as resonators. It is the train of sound waves thus modified. issuing from the mouth. which gives rise to vowels and voiced consonants. Such sound waves can be and sometimes are produced to a limited extent by an indrawn current of air actuating the vocal cords.

To what extent the infraglottal cavities (*e.g.*, the trachea and chest cavity) influence the quality of the glottal note is undetermined. Investigators are however agreed that among the supraglottal cavities the effect of the sinuses (*e.g.*, the maxillary sinus. the ethmoidal cells. sphenoidal sinus and frontal sinus) is negligible owing to their small and variable size, unfavourable positions and minute openings. The expression "sinus tone production" would thus appear to be devoid of justification. Nor can there be any question of directing the voice to a definite point in the buccal cavity. as the dimensions of the mouth cavity, in comparison with the wave length of sound, are too small for reflection to be possible.

Attributes of Voice. — Voiced sounds may be described in terms of their physical constitution and the impression they make on a listener, Their physical description is given in terms of fundamental frequency, harmonic structure and intensity. In the listener, impressions of different kinds are broadly correlated with these physical dimensions. The fundamental frequency of the voiced sound is mainly responsible for the sensation of pitch. the harmonic structure for impressions of quality or timbre, and the intensity of the sound waves for the loudness of the sound.

Fundamental Frequency.—During the production of voice, the vocal folds perform repeatedly a rhythmical opening and closing that gives rise to a musical tone. Each opening of the folds produces a small puft of air or pulse. the repetition rate of which determines the fundamental frequency of the voiced sound. commonly expressed in cycles per second. This frequency depends on the mass, length and elasticity of the folds and on the pressure acting upon them. Increase of pressure in the expiratory air current leads to a rise in the frequency of vibration.

The vocal folds are tightened if the arytenoid cartilages are braced back by contraction of the cricothyroid and posterior crico-arytenoids, and the thyroarytenoids will then give elasticity to the margins of the glottis so that they will recoil after being blown apart. The greater the degree of contraction the higher this elasticity becomes. All the muscles except the cricothyroid (which is innervated by the superior laryngeal) receive nerve filaments from the inferior or recurrent laryngeal branch of the vagus, the fibres being derived from the accessory roots. Both the abductor and adductor nerves come therefore from the inferior laryngeal.

At puberty, the development of the male larynx causes the folds to become more elongated than in women, in the ratio of 3 to 2, so that the male voice is of lower pitch and is usually stronger. During puberty the larynx grows rapidly, and the voice of a boy breaks in consequence of the lengthening of the folds, generally falling an octave or so in pitch.

Castration, performed before puberty, prevents the male growth changes and leaves a high-pitched voice; a eunuch can therefore sing in a treble or soprano range. but with greater power than a woman, owing to his bodily bulk and lung capacity.

In speech, the fundamental frequency ranges from about 80 cycles per second in men's voices to about 400 c.p.s. in women's. The range covered in singing is considerably wider, from about D (74 c.p.s.) in bass voices up to F'" (1.408 c.p.s.) in soprano voices. Exceptional cases are sometimes reported in which singers produce frequencies as low as 44 and as high as 2.048 c.p.s. The ranges of the main types of voice used in music are shown in musical notation in fig. 5.

The Italian soprano Lucrezia Agujari (1743–83) is said to have sung C"". a feat rivaled by Ellen Beach Yaw-Goldthwaite. Dame Nellie Melba ranged from B flat to F'". The lowest note, E below the fourth ledger line in the bass clef (44 cycles per second), is said to have been sung by Gaspard Foster.

Hainzonic *Structure*.—The physical character of voiced sounds is dependent on the wave motions produced by vibration of the vocal folds and on the modifications of these wave motions by the sub- and supraglottal cavities. It is difficult to obtain direct evidence as to the exact form of the sound waves emitted by the larynx, but it can be deduced that this is essentially a pulse wave of approximately triangular wave form; this means that the larynx generates a fundamental frequency (determined by the period of the opening and closing of the vocal folds) and an extended series of harmonic frequencies, each an exact multiple of the fundamental. This frequency complex is radiated from the larynx into the associated cavities and the relative amplitude of the harmonic components is modified by the natural frequency and the resonance characteristics of these cavities. The harmonic structure of voiced sounds can thus be modified by the singer or speaker by changing the disposition of the resonating cavities. The commonest example of such differences in quality or timbre is provided by the production of different vowel sounds. Supposing that the larynx

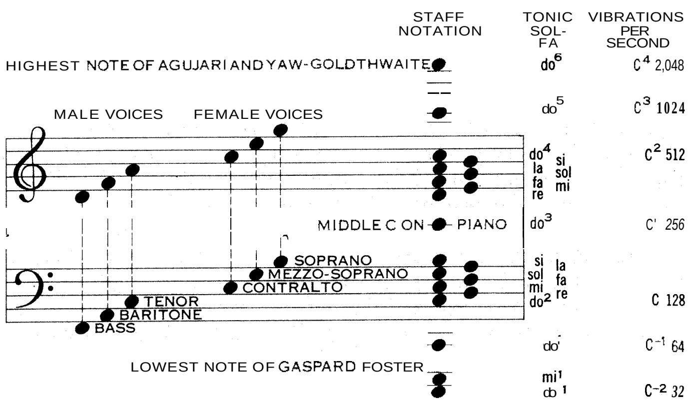


FIG. 5.—COMPASS OF HUMAN VOICE

produces a fundamental frequency of 100 c.p.s. and a long series of harmonics of frequency 200 c.p.s., 300. 400. 500, etc. If the speaker or singer wishes to produce the vowel "a." as in "hard," he disposes the supraglottal cavities so as to allow the greatest amplitude to frequencies in the region of 800–1 200 c.p s. In order to change to the vowel "e." as in "head," he changes the cavities so as to allow greatest amplitude to harmonics in the region of 600–2,000 c p.s. As long as the same disposition of the resonating cavities is maintained, the speaker produces the "same" vowel, even though the fundamental frequency may be changing.

Other differences of quality in voiced sounds, such as that peculiar to a given speaker or singer, are also largely determined by the resonating cavities. Research has indicated, however, that the nature of the larynx tone itself plays an important part in this matter. High-speed pictures of the vocal folds in action, taken by means of a laryngoscope, have provided much information about the modes of vibration of the folds and the time pattern of their movement. The relation between the open phase and the closed phase of the movement, the degree to which the folds are approximated, the manner in which the closure begins and ends, all are known to vary from speaker to speaker and from moment to moment. Since these factors help to determine the sound generated in the larynx, they also affect the harmonic structure of the voiced sound.

Intensity.—The intensity of voiced sounds, like their harmonic structure, is a function both of the action of the vocal folds and of the resonating cavities. The greater the amplitude of movement of the folds, and the longer the period for which they remain open in each cycle, the greater the intensity of the resulting sound. These two features of vocal-fold vibration in turn depend upon the efficiency with which the pressure of air supplied by the lungs is used to set and maintain the folds in vibration. The intensity of the voiced sound will also depend on the amplitude allowed to the various harmonics by the resonating cavities.

The level of energy output during speech or song is relatively low. The mean intensity of conversational voice at three feet from the speaker is about 60 decibles above the common reference level of .0002 dynes per square centimetre; the mean power in speech is hence of the order of 10^{-10} w.

Methods of Investigation.—The principal method of exploring the physical character of voiced sounds is frequency analysis, usually carried out with the aid of electronic filters which allow the passage of frequency components within a certain restricted frequency band and thus permit the registering of the energy level or intensity at any part of the frequency range. Such a filtering device, together with a suitable means of displaying or recording intensity levels, is known as a sound spectrograph. This instrument contains either a bank of filters, each covering a part of the frequency range, or a single adjustable filter which can be made to cover different parts of the range in succession. The voiced sound is applied to the filters, either directly through a microphone and amplifier or from a sound recording, and the intensity level in each filter band at succeeding instants is registered. A common type of sound spectrograph affords a three-dimensional display in which the passage of time is represented on the horizontal axis, the frequency range covered by the analysis on the vertical axis, and variations in intensity are shown by gradations from light to dark in the pattern; a dark trace indicates high intensity level in the filter covering the corresponding section of the frequency range. Often a choice of filter band width is provided; two commonly used values are 45 c.p.s. and 300 c.p.s. If a filter of 45 cycles band width is used, then the total frequency range is divided into sections each 45 cycles wide and the resulting pattern shows variations in the energy level in each section with time. Such an analysis will give the intensity of each separate harmonic for any complex tone having a fundamental higher than 45 c.p.s. This system is commonly used in the study of singing and other musical sounds where good frequency resolution is needed. If a filter band width of 300 c.p.s. is used, then all the energy within each band of 300 cycles is added together and registered. In this case the separate harmonics are not recorded but there is improved time resolution. This type of analysis is often used in the study of speech sounds.

Differences Between Singing and Speech.—The principal physical differences between singing and speech are to be found in the time pattern of variations. In singing, a particular fundamental frequency and a given harmonic structure are maintained for much longer periods than in speech, and changes in intensity are made much more slowly. In speech, the fundamental frequency varies continuously, so much so that it is unusual to find succeeding cycles of vocal-fold movement that occupy exactly the same time. The harmonic structure of speech sounds, too, is changing all the time since the movements of articulation are continuous and hence the cavity shapes are being continuously modified. Intensity changes in speech take place frequently and abruptly and are imposed by the syllabic structure of speech.

Voice Quality in Singing. — The personal taste and experience of the listener must play a large part in any judgments of a singing voice, but since a certain number of singers are widely recognized as of the first rank, it is possible by a physical study of the sounds produced by them to indicate some factors which are important. Two such factors are certain features of harmonic structure and the presence of vibrato. In voices of good quality the higher harmonics, in the range 2,000–6,000 c.p s. or even higher, are generally found to be of considerable intensity and, further, their reinforcement can be controlled by the singer In *mezza-voce* singing the intensity of these harmonics is much reduced, but it is increased in forte passages. Often in singing a phrase or a whole passage in one key, the singer will select and reinforce a particularly high harmonic that fits in well with the key, and will keep this harmonic sounding throughout the phrase or passage despite the changes of fundamental frequency demanded by the melody. This may well be one physical component of what is often referred to as "line" in singing The vibrato in good voices generally consists of regularly repeated fluctuations in fundamental frequency, often accompanied by some fluctuation in intensity. The fluctuations take place very regularly, usually about six or seven times a second. The total change in fundamental frequency varies from singer to singer, but it may produce a change of pitch up to one-quarter tone above and below the true pitch of the note.

Voiced Sounds in Speech. — The main function in speech of the sound produced by the vocal folds is to act as a carrier wave which is modified, or modulated, by the action of the articulatory mechanism. The sound of voice provides the carrying power and the audibility of speech; the intensity of the sound is modulated by the syllabic action of the articulators. Each syllable contains a section of high intensity, the vowel, on each side of which is a section of lower intensity, a consonant. In the production of vowels, the supraglottal cavities provide a relatively open air passage, and during the production of consonants this passage is either partially or completely closed. For certain consonants, the voiced sounds such as "b," "z," "v," etc., the vocal folds continue to vibrate and for others, the voiceless sounds such as "t," "f," "s," etc , the larynx vibration ceases altogether.

One of the main functions of the larynx tone in speech is to convey the intonation of the message. In English, for example, the difference between a statement and a question, between a command and a request, is carried to a great extent in normal speech by variation in the frequency of the vocal-fold vibrations. This is only one illustration of the fact that a speaker's emotional attitude is expressed largely through the larynx tone and particularly through variation in its frequency. In certain languages known as tone languages, which include many Oriental and African languages, variation in larynx frequency may also contribute to semantic distinctions; *i.e.,* the difference between a high and a low pitch in a given word may function very much like the difference between the vowel "i" and the vowel "a," for example.

An important function of the articulatory mechanism. is to change the harmonic structure of the voiced sound produced by the larynx. Each English vowel is characterized by regions of high intensity known as formants. The most important formants are produced by the pharyngeal cavity behind the tongue (formant 1) and by the front mouth cavity (formant 2). The frequency regions for the formants of southern English vowels are given in the table.

Diphthongs are produced by making a rapid movement from one vowel in the direction of another, and in this case there is a marked change of formant frequencies.

Certain English consonants are, from the physical point of view, very similar to vowels and are characterized by formants. These are the sounds "1" and "r," the semivowels "j" and "w" and the nasals "m," "n" and "ng." The last three are articulated with the soft palate in the lowered position and hence they have a prominent third formant provided by the nasal cavity. The remaining consonants require a second sound source in addition to the larynx. In the plosive consonants. "p," "b," "t," "d," "k," "g," the sound is generated by the lips or tongue making a sudden explosive moment; in the fricative consonants, "f," "v," "θ," "ð," "s," "ʃ," "ʒ," "h," the air passage is narrowed at some point to cause audible friction on the passing of air from the lungs.

Artificial Production of Speech Sounds. — There are a number of devices, usually known as speech synthesizers, for the artificial production of speechlike sounds. These are essentially electrical analogues of the human speech mechanism and consist of electronic circuits that provide a pseudolarynx tone, a means of modifying the harmonic structure of this tone and a noise source with which to simulate consonant sounds. The larynx tone generator usually produces a pulse tone of approximately triangular wave form in nhich the pulse rate can be varied over an appropriate range. The tone is then fed into resonant circuits (formant generators) that function as the resonating cavities in speech and change the relative amplitude of the harmonics in the larynx tone, thus giving rise to formants. Noise from the noise generator is either mixed with the larynx tone or used independently to produce consonant sounds. Speech synthesizers provide a highly controllable source of speechlike sounds and are particularly good for determining experimentally the importance of various physical characteristics in the perception and recognition of speech sounds.

TABLE.—*Formant Frequencies of Southern English Vowels*

Vowel symbol	As in	Formant 1 c.p.s.	Formant 2 c.p.s
i:	heed	375	2250
ɪ	hid	425	2125
e	head	500	2000
a	had	700	1850
a:	hard	800	1225
o	hot	625	1000
o:	hoard	500	800
u	hood	450	875
u:	who	375	625
ʌ	hut	750	1250
ə:	herd	550	1350

Substitutes for the Larynx. — Laryngectomized subjects can develop a capacity for producing sounds nhich in essentials resemble normal voice. H Burger and L. Kaiser of Amsterdam first reported a case nhere a pseudolarynx had been developed in the esophagus. The vicarious lung was the stomach. and the lips of the pseudoglottis were actuated by ejecting air mhich had previously been swallowed. The subject could sing, speak and use the telephone. Indeed, vocally, he carried on like a normal person. It is recognized that the esophagus is the receptacle for air and that air is aspirated and not actually swallowed.

Attempts have also been made nith more or less success to supply the voice element in speech by means of vibrating reeds of rubber or thin metal The best known of these devices is the MacKenty-Western Electric Artificial Larynx. By using it the subject is able to direct the expiratory current on to a rubber reed when voicing is required. An electric vibrator, applied to the outer wall of the pharynx. can be used to produce sound in the cavity by forced resonation; the sound is then resolved into articulate speech by the resonators and stops. A somewhat similar vibrator is used to carry sounds directly into the mouth.

The voice of man represents a very great achievement in respect of volume, range and quality. The study of comparative anatomy explains why various changes have taken place in the structure of the mouth, the pharynx and the larynx. the majority designed for purposes other than vocalization; many of these variations have led to reduced efficiency in respiratory exchanges, in olfaction and in deglutition. but they have at the same time benefited man in respect of speech and song.

Comparative anatomy shows at the same time that a very simple apparatus is sufficient for the production of voice and that the remarkable development in the human race is due not chiefly to anatomical structure but rather to increase of intellect.

Man has made the best use of the apparatus available and in return his intelligence has developed to a high degree as a result of his ability to express ideas.

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VOILE, a sheer dress material produced from wool, cotton or silk. It is characterized by a light, open and netlike structure based essentially on the principle of the plain calico weave. and produced from warp and weft yarns with an abnormal degree of twist. irrespective of the class of material from which it is spun. The yarn employed may be either single or folded in the warp series or in the weft series, or in both series of threads; and it may be spun with a greater or lesser amount of twist.

See also COTTON MANUFACTURE: *Varieties* of Cotton *Products.*

VOIT, CARL VON (1831–1908), German physiologist, helped lay the foundations for the modern knowledge of metabolism and nutrition. Born in Amberg, Bavaria, Oct. 31, 1831, he studied with Justus von Liebig and Friedrich Wöhler and was professor of physiology in Munich from 1863 to 1905. He was a founder (1865) of the *Zeitschrift* fur Biologie. Voit raised to a high level the technique of balance studies in which the ingestion and excretion of foodstuffs are determined quantitatively. The painstaking techniques he developed and. the principles he laid down for such studies are still followed. His most important early studies were on nitrogen balance. He and Max von Pettenkofer (*q.v.*) built the first metabolism machine large enough to hold a human being. Using this apparatus they showed that carbon dioxide production is proportional to the rate of muscular activity. They also made the first accurate determination of the energy requirements of man. Such determinations are now generally known in terms of a daily caloric requirement for a given level of activity. Voit died in Munich on Jan. 31, 1908. (P. F. C.)

VOITURE, VINCENT (1597–1648), French writer who exercised a twofold influence on the style of 17th-century literature. Born at Amiens, where he was baptized on Feb. 23. 1597, he completed his education in Paris and early made the acquaintance of the aged Malherbe and J. Guez de Balzac. A regular visitor at the Hôtel de Rambouillet from *c.* 1625, he did much to enliven the proceedings there. Having attached himself to Gaston, duc d'Orléans, he followed him into exile in 1632 and was sent to Spain to negotiate on his behalf. On his return to France, however, in 1634, he was elected to the Académie Française, and in 1636 he composed an eloquent and statesmanlike letter in defense of the cardinal de Richelieu's policy. The government sent him on a state mission to Tuscany in 1638. Voiture died in Paris on May 26, 1648.

Voiture's poems are not without beauty, and his letters are full of witty and subtle allusions that the narrow circle of the Hôtel de Rambouillet could enjoy. These letters were not meant to be printed and so should not be judged as if they were written for the general public. It was Voiture who taught French writers how to combine sentiment and wit, passion and irony, in the manner known as la belle *galanterie.* It was he also who finally succeeded in freeing French poetry from Petrarch's influence. For this he relied partly on the example set by the Hôtel de Rambouillet. partly on his remarkable knowledge of Spanish poetry (G. Lanson. in an article in the *Revue d'histoire littéraire de* France, 1897, shows that he must have read Gbngora, Cristbbal de Castillejo and Hurtado de Mendoza), the characteristics of which he adapted to suit French taste. He was likewise well read in Italian poetry, One of his Best-known sonnets, "La Belle Matineuse," reflects Annibale Caro's influence together with Góngora's.

For the controversy about his sonnet "Uranie" see BENSERADE, ISAAC DE.

Voiture also did much to promote the revival of the old style of ariting exemplified by Clément Marot and the *Amadis* romances. It was he who induced the Parisian salons to write verse in imitation of Marot and to compose chronicles in "old language." This aspect of his work was not a peculiar eccentricity but a reaction against the contemporary tendency to impose a rational and bourgeois outlook on literature. The element of romance is a most important factor in French 17th-century literature, and its survival in the golden age of classicism was due mainly to Voiture.

There is an edition of Voiture's collected works by A. Ubicini, 2 vol. (1853).

See E. Magne, *Voiture et l'Hôtel de Rambouillet,* 2 vol (1929–30); A. Adam, *Histoire de la littérature française au XVIIe siècle,* vol. i (1948) (AE A)

VOIVODE, a title in use among Slavonic peoples, meaning literally, leader of an army (Sl. *voi,* host, army; voditi, to lead; cf, Med. Gr. boebodos) and so applied at various periods and in various eastern European countries to rulers, governors or officials of varying degree. As voda it is best known as the title of the princes of Moldavia and Walachia. In Poland, as *wojewoda* (sometimes latinized as *palatinus*), it is still used as the title of the governor of a province (*wojewodztwo*). In the kingdom of Serbia *vojvod* was the highest military rank.

VOLAPÜK, a constructed language first published in 1880 by a south German cleric. Johann Martin Schleyer (1831–1912). It rapidly gained wide support but the popularity of the language soon declined on account of dissensions among its supporters and the competition of other more easily learned constructed languages; *e.g.,* Esperanto.

Volapiik vocabulary consists largely of English and Romance words, so distorted by phonological simplification that most are not immediately identifiable (*e.g.* Volapiik, "world language" = genitive of vol (Eng. "world") + *pük* (Eng. "speak"). Nouns have four cases marked by suffixes (nom. [zero], accus. -i, gen. -a, dat. -e), plur. -s (*e.g.,* fats, "fathers," gen. *fatas,* etc.). Borrowed words are undeclined, but preceded by an article el (not used with Volapük words) as a case/number marker (*e.g.,* el Edelweiss, *elas* Edelweiss, etc.). Adjectives are derived from nouns by suffixed -ik (gud, "goodness," *gudik,* '(good"), normally undeclined and following their noun. When, however, they precede, they are declined (*e.g., manas* gudik or *gudikas manas,* "of good men"). Numerals are mostly arbitrary monosyllables (*bal,* tel, kil, fol, *lul,* etc.) with suffixes marking ordinals. fractions, etc. Pronominal morphemes (independent, or suffixed as personmarkers to verbs) include informal and formal second person forms (*ol/ols,* "you," sing./plur. informal, *or/ors,* "you," sing./plur. formal) and other complexities. Verbs can carry personal suffixes (*löfob,* "I love," *löfols,* "you love," etc.), six tense prefixes (alofob, "I loved," ilofob, "I had loved," etc.), a passive prefix (palofob, "I was loved") and optative, imperative, conditional, infinitive and participial suffixes.

See also UNIVERSAL LANGUAGE.

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VOLCAE, an ancient Celtic people in the province of Gallia Narbonensis, who occupied the district between the Garumna (Garonnej, Cerbenna mons (Cévennes), and the Rhodanus, corresponding roughly to the old province of Languedoc. They were divided into the Arecomici on the east and the Tectosages on the west, separated by the river Arauris (Hérault). The Volcae were free and independent, had their own laws, and' possessed the *ius* Latii. The chief town of the Tectosages was Tolosa (Toulouse); of the Arecomici, Nemausus (Nimes); the capital of the province was Narbo Martius (Narbonne).

VOLCANISM. This article deals with the processes and activity that take place at and are associated with volcanoes, including not only those at the earth's surface but also those associated with volcanic conduits at shallow levels within the earth's crust. They accompany and result from the rise of molten rock, known as magma, or the gases liberated from magma, to the surface of the earth. For discussion of lava flows and pyroclastic rocks, volcanic land forms and the distribution of volcanoes *see* VOLCANO.

ORIGIN OF MAGMA

Although some deep-seated rocks once thought to have resulted from consolidation of magma are now known to form by recrystallization in the solid state (granitization), the existence of magma is unquestionable. At active volcanoes it can be seen issuing from within the earth, sometimes very rapidly and in great quantity. It once was believed that beneath the solid crust, much of the earth is molten. Studies of earthquake waves passing through the earth and of the behaviour of the earth under tidal stresses, however, indicate that the outer 1,400 mi. of the earth is essentially solid. Large bodies of matter with properties like those of liquids as we know them at the surface of the earth must be absent, and magma must be restricted to isolated pockets of relatively small size.

Neither the place nor the manner of origin of magma is known with any certainty. Measurements in wells and mines show that temperature increases with increasing depth within the earth. The rate of increase is not the same at all places. but on an average it is about 1° C. for each 100 ft. Under laboratory conditions volcanic rocks melt at temperatures of 1,000° to 1,500° C., and in nature the presence of gases would be expected to make the melting temperature somewhat lower. Thus, if the rate of temperature increase continues approximately the same at greater depth as in the upper 2 mi., rocks at depths of less than 30 mi. are at temperatures under which they would melt if surface conditions prevailed. However, pressure also increases downward within the earth, and it is believed that this increase of pressure raises the melting point sufficiently so that the rocks remain solid despite the high temperature. Presumably, if in any way the pressure on the hot rocks at depth can be relieved locally, part or all of. the constituents of the rock will melt and form a magma, although the mechanism of such relief of pressure is not clear.

It is generally believed that magma forms at relatively shallow levels in the earth, probably within the upper few tens of miles. Earthquakes preceding some eruptions of Hawaiian volcanoes come from depths of 20 to 25 mi., and suggest that the magma may originate at about that depth. It is interesting that the temperature of erupting Hawaiian lavas is in the range that would be expected at depths of 20 to 25 mi. if the average near-surface temperature gradient continues that far.

The heat within the earth probably is partly residual irom the original formation of the earth. No doubt part of it also is the result of breakdown of radioactive elements within the earth. However, erupting lavas and volcanic gases are not unusually radioactive as compared to other rocks of the earth's surface. It is unlikely that radioactive heat plays a direct part in the generation of magma.

At depth magma may be completely liquid. Commonly, however, it contains suspended grains (phenocrysts) of minerals that have crystallized from it. and it may also contain other solid fragments of rock (xenoliths) torn irom the walls of the enclosing chamber. As it approaches the surface cooling commonly results in further crystallization and an increase in the amount of phenocrysts. Also, as pressure decreases and crystallization progresses, gases that were dissolved in the liquid begin to separate out as bubbles. At that stage the magma consists of three physical phases: liquid melt, solid phenocrysts and xenoliths, and bubbles of gas.

The bubbles of gas are lighter than the enclosing liquid, and rise through it. As they rise, they encounter other bubbles and coalesce with them, so that they increase in size both by expansion as they rise into regions of lesser pressure, and by coalescence. Many of the bubbles reach the top of the magma body and escape from it. either below or at the surface of the earth. However, the escape is impeded by the surface tension and viscosity of the enclosing liquid, and a considerable pressure. of gas in the bubble may be required before the gas can burst its way free. The escape of each tiny bubble thus is a miniature explosion, and the bursting of large high-pressure bubbles from very viscous magma produces violent explosions. During some of the strongest explosions of Asama volcano in Japan, explosive pressures as great as 8,000 lb. per square inch have been calculated. Most volcanic explosions appear. however, to involve lower pressures.

The range of chemical composition of the igneous rocks that result from consolidation of magmas is discussed in the article PETROLOGY, and briefly in VOLCANO. However, the consolidated rock represents only part of the original magma. Most of the gas escapes before consolidation. The chemical composition of the gas phase of magma is not well known, partly because of the extreme physical difficulties encountered in collecting gases directly from the vents of erupting volcanoes. Most of the great cloud of gas poured out during a volcanic eruption consists of steam, but a very large proportion of the steam may come from heating of water in older rocks adjacent to the volcanic conduit, rather than from any deep-seated magmatic source. Thus, during the eruption of Hekla volcano, in Iceland, during 1947–48, and that of Paricutin volcano, Mexico, during the years 1943–52, most of the water in the great eruption clouds appears to have been derived from the body of ground water that saturated the rocks forming the bases of the volcanoes.

The best collections of volcanic gases have been those made by T. A. Jaggar at Kilauea volcano. Hawaii, in 1919. The gases were collected directly from blisters on the surface of the active lava lake. The average composition of 14 samples was: water 70.75%, carbon dioxide 14.07%, carbon monoxide 0.40%, hydrogen 0.33%, nitrogen 5.45%, argon 0.18%, sulfur dioxide 6.40%, sulfur trioxide 1.92%, sulfur 0.10% and chlorine 0.05%. Part of the abundant water may have come irom shallow ground water; and almost certainly some came from near-surface oxidation, by atmospheric oxygen, of hydrogen rising from depth.

Gases trapped in rocks during consolidation resemble in composition those collected at Kilauea, except that chlorine and fluorine commonly are more abundant. Gases liberated at most continental volcanoes also appear generally to be richer in chlorine and fluorine than those of Kilauea. Thus. the great eruption of Katmai volcano, Alaska, in 1912, liberated into the atmosphere such quantities of hydrochloric and hydrofluoric acid that clothes hanging on lines as far away as Chicago were damaged.

PHYSICAL PROPERTIES OF MAGMAS

The temperature of molten lava reaching the earth's surface ranges from about 700° to 1,200° C. At Kilauea the very hot lava issuing directly from the feeding conduits and forming the cores of lava fountains has a temperature (determined by means of optical pyrometers) generally ranging between 1,100° and 1,150° C.. though sometimes dropping as low as 1,050°. The lava lake at Kilauea in 1917 was found by Jaggar to have temperatures ranging from 910° to 1,170°. Similar temperatures were found during the 1938–40 eruption of Nyamlagira, in central Africa. At both places still higher temperatures in the throats of small cones resulted from burning of escaping gases. At Kilauea these temperatures were as high as 1,350°, high enough to cause remelting of the rock in the wall of the throat. The lowest temperature at which Hawaiian basaltic lavas continue to flow appears to be about 700° C.

More siliceous lavas may be erupted at temperatures somewhat lower than 1,000° C.. but the greater violence characterizing these eruptions makes difficult any accurate measurement of the temperature of the lava as it leaves the vent.

The viscosity of Hawaiian lava where it leaves the vent is about 1,000 poises (approximately 100,000 times that of water). As the flows progress down slope the viscosity increases, reaching about 10,000 poises at distances of several miles from the vent. These are among the most fluid of erupting lavas. During the 1947 eruption of Hekla volcano. Iceland, the viscosity of the lavas was about 10,000 poises at the vent, increasing to 500,000 poises and more at the advancing fronts of the flows. More siliceous lavas are even more viscous. Some are so viscous that they can scarcely flow, and pile up around and over their vents to form volcanic domes and spines. (*See* VOLCANO.)

TYPES OF VOLCANIC ERUPTIONS

Some lavas rise to the earth's surface and flow out quietly. at times in great volume. Gas bubbles out of the lava easily and quietly, though great fountains of molten lava may shoot hundreds of feet into the air. Bombs (*see* VOLCANO) falling back to the ground are still fluid, and flatten out on impact to form thin pancakelike masses. There is very little explosion, and pyroclastic material forms only a very small percentage of the total. Most of the material pours out as thin fast-moving lava flows, that may spread to great distances from their vents. Outbreaks of this sort are called Hawaiian-type eruptions. because they are characteristic of the volcanoes of the Hawaiian Islands. The lava flows build broad domical shield volcanoes.

The lava that produces Hanaiian-type eruptions is very fluid and probably always is of mafic composition (basalt and related rocks). The gas content of the erupting magma is low. During eruptions of Kilauea and Mauna Loa, in Hawaii, the total gas content is estimated to be only about 1% by weight.

An interesting, though minor, phase of Hawaiian-type volcanism is the lava lake. The best known example is that which existed in Halemaumau crater, at Kilauea, most of the time during the century from 1823 to 1924. Very fluid lava rose at vents near the centre of the lake, and flowed outward across the lake surface to sink at the edges, and presumably set up a return circulation toward the centre along the lake floor. Permanent fountains of liquid lava marked the vents through which lava rose from depth. From time to time breaking up and foundering of the thin crust that formed on the lake resulted in spectacular displays of secondary fountains, caused by the release of gas trapped in the foundering crusts. A lava lake similar to that formerly occupying Halemaumau crater has been reported to exist in the crater of Nyiragongo volcano, in Belgian Congo. However, lava lakes are not always present at volcanoes of Hawaiian type.

Eruptions of still more fluid magma, probably also poorer in gas than Hawaiian-type eruptions, have produced the flood basalts that cover vast areas in several parts of the world (*see* VOLCANO).

More explosive eruptions appear to result from both greater viscosity of the magma and greater gas content. The larger amounts of gas, unable to escape as readily into the atmosphere, accumulate greater and greater pressure. On escaping, they tear the magma into shreds, and throw them high into the air. Eruptions of only moderately viscous material throw up bombs that are still sufficiently plastic to take on rounded or spindlelike shapes in the air, but which are too completely frozen to flatten out on striking the ground. Ordinarily, the spindle-shaped bombs are accompanied by much more abundant irregularly shaped fragments of cinder. These are called Strombolian-type eruptions, because they are characteristic of much of the activity of Stromboli in Italy. Simultaneously with the pyroclastic ejections from the crater, lava flows may pour out at the foot of the cone, as during the activity of Paricutin volcano in Mexico.

Eruptions of Vulcanian type are still more explosive and throw up many angular blocks that either were already solidified in the crater, or were too viscous to take on rounded shapes in the air. The ejection of blocks typically is accompanied by a great cloud of ash-laden gas. Associated lava flows are short and thick, or may be entirely absent. This type of eruption is named for Vulcano, an island volcano lying north of Stromboli off the west coast of Italy.

There are all gradations from one type of eruption to another, and a single volcano may exhibit activity of different types in successive eruptions, or even at different vents during the same eruption.

Sometimes pressure is relieved on a magma column at considerable depth within the volcanic conduit. A rapid vesiculation (puffing up) of the magma results, and the liberated ash-laden gas rushes up through the conduit with great velocity and volume, corrading (wearing away or abrading) the walls of the conduit and coring out the cone. This occurred, for instance, during the 1906 eruption of Vesuvius, when for about 20 hours a great column of gas rushed forth, rising almost vertically 6 mi. into the air, and boring out an open cylindrical throat 1,500 ft. across within the cone. During the eruption lava flows were poured out on the lower slopes of the volcano and great quantities of fragmental material was hurled out by explosion, but F A Perret has estimated that the weight of gas given off was far greater than that of liquid and solid material. The lavas of Vesuvius are mafic. and of relatively low viscosity. The explosiveness of the eruption illustrates the fact that at least in some instances the abundance of gas may be more important than composition and viscosity of the lava in determining the character of eruption

Probably related in mechanism to the great outrush of gas during the 1906 eruption of Vesuvius are great paroxysmal eruptions that throw out enormous volumes of pumice and ash and commonly are accompanied by the collapse of the summit of the volcanic cone to form a *caldera.* For some reason vesiculation spreads rapidly through great volumes of magma, and the violent expansion tears the escaping magma to bits. The greatest known volcanic eruption of historical times, that of Tambora in Indonesia, in 1815, was of this sort. The explosions blew about 35 cu mi of debris over the surrounding area, and the resultant collapse reduced the height of the mountain from about 13,000 to 9,300 ft. These stupendous eruptions are known as Plinian eruptions, after the elder Pliny, the Roman natural historian who lost his life while investigating the great eruption of Vesuvius that destroyed the city of Pompeii in A D 79.

Certainly resembling in mechanism the Plinian eruptions, and often constituting a phase of them, are glowing avalanches or clouds (from the French, *nuées ardentes)* and froth flows. Glowing avalanches occur also in Pelean eruptions, named for the eruption of Mt. Pelée in Martinique. West Indies, in 1902, and characterized by the growth of a volcanic dome attended by the generation of downrushing, exceedingly mobile avalanches of incandescent material above which rise spectacular convoluting clouds of dust. The froth flows are similarly mobile masses of incandescent pumice and pumiceous ash. Although differing somewhat in mode of origin, the glowing avalanches and froth flows unquestionably are very similar in their mechanism of motion and the cause of their great mobility Each particle in the flows and avalanches. and in the dust clouds that rise above them, is actively liberating gas, and the expanding gaseous envelope is pushing against similar envelopes surrounding neighbouring particles, hence the rapidly expanding and nearly frictionless character of the flow that gives it its great mobility Such flows and avalanches may attain speeds as great as 100 mi. an hour. They are exceedingly destructive, killing all living things in their paths. In 1902 the cloud of incandescent ash accompanying an avalanche of this sort swept down onto the city of St. Pierre, at the foot of Mt. Pelée. and within a few seconds wiped out its entire population of 30,000 persons.

Fumaroles and Solfataras. — Gases continue to issue between eruptions at active and dormant volcanoes, and from slowly cooling thick lava flows. The gases resemble in composition those liberated during eruptions, steam being by far the most abundant. The water probably is very largely of meteoric origin, derived from relatively shallow bodies of ground water or from rain seeping into the rock. Mixed with the steam are other gases Iiberated from underlying magma or from the cooling rock. They include chlorine, fluorine, sulfur, carbon dioxide and small amounts of the common metals and alkaline earths.

The places where these gases are given off are called fumaroles (*q.v.*). The halogen gases (chlorine and fluorine) and the metals are most prominent in the hottest fumaroles, with temperatures of 300° to 600° C. Deposits around them typically include chlorides of iron, aluminum and ammonium. In the cooler fumaroles (100°–200° C.) the sulfur gases predominate and the vents commonly are surrounded by deposits of native sulfur. These sulfur-producing fumaroles are known as solfataras (*q.v.*). Still cooler fumaroles, known as mofettes, may yield largely carbon dioxide. Pools of carbon dioxide accumulating in hollows on the land suriace may form lethal traps for animals. or even humans.

One of the most famous fumarole areas is the Valley of Ten Thousand Smokes (q v.) in Alaska. There, in 1912, a froth flow several hundred feet thick poured down the valley. In the years immediately afterward the surface of the flow was covered with fumaroles (hence the name of the valley). Many of them were very hot. E. G. Zies reported that the gases given off consisted of about 98% water (mostly of meteoric origin), with lesser amounts of hydrochloric, hydrofluoric, and boric acids, and carbon dioxide. Traces of lead, zinc, molybdenum, copper, arsenic, antimony, tin, silver, cobalt, thorium, bismuth, selenium and tellurium were found in the deposits around the fumaroles. Zies computed that during the years 1919–21 about 1,250,000 tons of hydrochloric acid and 200,000 tons of hydrofluoric acid were being discharged into the atmosphere annually from fumaroles in the valley. Activity of the fumaroles gradually diminished, and has now almost ceased.

At the low temperature end, fumaroles grade into thermal (hot) springs and geysers (spouting hot springs).

Pneumatolysis.—Below the earth's surface escaping magmatic gases alter the rocks with which they come in contact. (See GRANITE; PETROLOGY.) New minerals are formed by the addition of such volatiles as boron, chlorine, fluorine and water; and large amounts of silica may be deposited, partly as a replacement of the older rocks (silicification). These changes commonly are associated with the formation of ore deposits (*q.v.*). See also GEOCHEMISTRY. Geochemistry of the Lithosphere.

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VOLCANO, an opening in the earth's crust through which molten rock or gases or both reach the surface, and the structure formed by the escape of the material. The structure commonly is a hill or mountain, which may be broadly rounded or may rise in the graceful conical form of a Mt Fuji; or it may be a depression. The form depends largely on the physical conditions of the erupting material and the strength of the eruption. This article deals with the products of volcanic eruptions, the structures built by them and their distribution. For discussion of the processes involved see VOLCANISM.

Molten rock material is known as magma, and rocks formed by its consolidation are called igneous rocks. (*See* PETROLOGY.) Magma appears to originate at comparatively shallow levels within the earth, perhaps most commonly at depths of 10 to 30 mi. It may rise only part way to the surface, congealing within the earth's crust under an insulating cover of other rock and cooling slowly to form coarse-grained rocks such as granite (*q.v.*). These are knoun as intrusive igneous rocks. If, however, it is intruded to very shallow levels, or extruded onto the surface, it cools quickly to form fine-grained rocks such as basalt (*q.v*); or it may be chilled so rapidly that little or no crystallization can take place and volcanic glass results (see RHYOLITE). Igneous rocks formed on the earth's surface are known as extrusive, or volcanic, rocks.

Most of the minerals of igneous rocks are silicates, and the principal chemical component of igneous rocks is silica (SiO_2). The proportion of silica ranges from about 40% to 75% In general, as the proportion of silica decreases that of certain other oxides. notably those of magnesium, calcium and iron. increases. Rocks containing a large proportion of silica are termed siliceous, or acid; those containing a small proportion of silica and large proportions of magnesia and iron oxide are termed mafic, or basic. (See also GEOCHEMISTRY: Geochemistry of *the Lithosphere.*)

The physical properties of magma vary with differences in its chemical composition (including the abundance of gas) and its temperature. Most important is viscosity, on which, together with the abundance of gas, to a large extent depend the behaviour of the intruding or erupting magma, the character of the volcanic eruption and the form of the edifice built by it. In general siliceous magmas are extremely viscous, whereas mafic magmas are comparatively fluid.

LAVA FLOWS

Magma poured out onto the surfaceof the earth forms a lava flow, and the rock produced by its consolidation is known as lava rock, or simply as lava. Several types of lava flows can be recognized, though actually the types are intergradational.

Pahoehoe and Aa Flows.—Mafic lavas such as basalt characteristically form the types of flows known by the Hawaiian names, pahoehoe and aa. Pahoehoe lava flows are characterized by smooth, gently undulating or broadly hummocky surfaces. Locally the thin still-plastic crust of the flow has been dragged and wrinkled, by liquid lava flowing beneath it, into tapestrylike folds and rolls resembling twisted rope or cable. Pahoehoe flows are fed almost wholly internally by streams of liquid lava flowing through natural pipes known as lava tubes formed by freezing of the surrounding lava in less active parts of the flow. As the supply decreases toward the end of the eruption the liquid lava may drain out of the tube, leaving it partly or wholly empty. There are thus formed tunnellike caves that may extend for thousands of feet, or even for miles. Typically, the margin of a pahoehoe flow advances by protruding one small toe after another, so that the movement of the flow front somewhat resembles that of a giant amoeba.

In contrast to pahoehoe, the surface of an aa flow is exceedingly rough, covered with a layer of partly loose, very irregular spiny fragments commonly called clinker. Aa flows are fed principally by rivers of liquid lava flowing in open channels. Typically, such a feeding river forms a narrow band, 25 to 50 ft. wide, along the centre line of the flow, with broad fields of less actively moving clinker on each side of it. Repeated overflows may build narrow walls, or levees, along the edges of the channel. The active portion of the borders and front of the flow is a layer of still pasty incandescent lava beneath the clinker layer, along which the black clinker is passively rafted. At the front of the flow, clinker from the top rolls down and is overridden by the pasty layer, so that the motion of the advancing front resembles that of an endless track on a tractor.

Thin basaltic laval flows generally contain many holes, or vesicles, left by bubbles of gas frozen into the congealing liquid. The vesicles may be filled by deposition of mineral matter from percolating solutions. forming amygdules (from the Greek meaning "almond shaped"); and the lava is then said to be amygdaloidal. Thick flows, which remain hot for long periods, may lose most of their gas before the lava congeals and the resulting rock may be dense, with few vesicles.

Pahoehoe and aa flows may be identical in chemical composition. In fact, it is common for a flow that leaves the vent as pahoehoe to change to aa as it progresses downslope. The reason for the change is not wholly clear in detail, but it is known to be a function of the viscosity of the liquid as related to the amount of internal turbulence. The greater the viscosity, and the greater the stirring of the liquid (as by rapid flow down a steep slope), the greater the tendency for the material to change from pahoehoe to aa. The reverse change does not occur.

Block Lava and Brecciated **Flows.**—Lavas of less mafic (basic) composition commonly form a somewhat different type of flow, known as a block lava flow. These resemble aa in having tops consisting largely of loose rubble, but the fragments in the rubble are less spinose than those of aa and of more regular shape, most of them polygons with fairly smooth sides. Block lava flows are especially characteristic of volcanic rocks of intermediate composition, known as andesites from their widespread occurrence in the Andes mountains.

Flows of more siliceous lava tend to be even more fragmental than block flows. Apparently the escape of gas from the cooling and crystallizing magma causes a series of minute explosions all through the flow, thoroughly shattering the lava into a mass of blocks which, however. are little separated from each other. Brecciated flows of this sort are well exposed along some of the highways crossing the central part of the Sierra Nevada in California.

Sand Flows.—An extension of the same process results in a complete tearing apart of the cooling viscous lava into a mass of predominantly sand-sized shreds of pumiceous glass. These shreds, each surrounded by an expanding cushion of gas, form an exceedingly mobile sand flow or froth flow that may rush downslope to distances of many miles at speeds as great as 100 mi. per hour. They are closely related in mechanism and behaviour to the glowing avalanches (see VOLCANISM). When they come to rest they may be so hot that the glassy fragments become partly, or even largely. melted together, forming what is called welded tuff or ignimbrite. Flows of this sort have formed enormous widespread deposits in New Zealand, Sumatra, western United States and elsewhere, but none has ever been observed actually in process of formation. In 1912 one of these sand flows was erupted in the Valley of Ten Thousand Smokes (*q.v.*), in Alaska, but there were no witnesses to the event.

Volume. — Some lava flows attain great extent and volume. One immense basalt flow in the Columbia river region of northwestern United States is more than 100 mi. long and 50 mi. wide, and has an average thickness of about 400 ft. Thus, its volume is about 400 cu.mi. Lava flows with volumes greater than 0.25 cu.mi. are rare, however. The largest eruptions of Mauna Loa volcano; in Hawaii, have produced flows with volumes of approximately 0.1 cu.mi., covering areas of more than 30 sq.mi. The greatest known flow of historic times was erupted in southern Iceland in 1783. It had a volume of approximately 2.9 cu.mi.

PYROCLASTIC ROCKS

The fragmental products of volcanic explosions are known as pyroclastic (from the Greek *pyr,* "fire," and *klastos,* "broken") rocks. Gas separating out of the magma as it approaches the earth's surface tends to expand and force its nay out of the enclosing liquid. Lavas of high fluidity exert little restraining effect on the gas, which is able to escape freely into the atmosphere, but from lavas of greater viscosity it escapes less readily. In highly viscous lavas the gas in the confined bubbles may attain so high a pressure that when it finally bursts its way free it produces a violent explosion. The explosion expansion of the gas may, in fact, completely disrupt the upper part of the column of rising magma, and eject it onto the earth's surface as a shower of fragments. In general, eruptions of fluid mafic magmas produce only small amounts of pyroclastic material in relation to the volume poured out as lava flows, whereas eruptions of viscous siliceous magmas may consist wholly of exploded material.

Depending on the strength of the explosion and the viscosity and degree of consolidation of the lava, the ejected fragments vary greatly in size, form and consistency. The relatively weak explosions characteristic of mafic magmas throw up showers of material so liquid that much of it is still molten when it strikes the ground. 'These still-molten fragments partly fuse together to form mounds of agglutinate. Less fluid lava forms accumulations of loose fragments of frothy material known as scoria, or cinder, because of its superficial resemblance to the cinder produced by burning coal in a furnace. (Neither volcanic cinder nor volcanic ash are, however, formed by combustion.) Commonly the mild explosions of mafic magma throw out long strings and blobs of liquid material that harden in the air to ribbonlike or droplike forms. The ribbons break up during flight or on striking the ground. Thicker portions of the ribbons often form spindle-shaped masses, or masses resembling in shape a summer squash. Threads of natural spun glass. formed by chilling of filaments of liquid lava drawn out behind blobs thrown out by explosion. are known as Pele's hair, after Pele, the Polynesian goddess of volcanoes.

More violent explosions of more viscous magma produce angular fragments that exhibit little or no evidence of shaping during flight. Some of the angular fragments are derived from a crust of semisolid or solid lava that forms on the top of the liquid, and others are pieces of older rock torn from the walls of the vent. The stronger explosions also produce much larger amounts of fine debris. Extreme vesiculation produces a rock froth knon-n as pumice (*q.v.*), which may be light enough to float readily in water.

Pyroclastic fragments commonly are classified principally on the basis of size. Fragments larger than $1\frac{1}{4}$ in. are known as volcanic bombs if they have rounded outlines acquired during flight, or as blocks if they are angular. Those between $1\frac{1}{4}$ and $\frac{1}{6}$ in. in average diameter are known as lapilli, and material smaller than $\frac{1}{6}$ in. constitutes volcanic ash and dust. When the mixture of volcanic ash and dust becomes lithified into a firm rock, it is called tuff (*q.v.*). Aggregations principally composed of bombs are called agglomerate (*q.v.*), and those of blocks are called breccia (*q.v.*). Cinder may contain fragments of all sizes, from ash to bombs.

A commonly overlooked agent of much importance in volcanic activity is mudflow. During violent eruptions large amounts of ash may accumulate on the slopes of the volcanic cone. and sometimes on nearby mountains. If this ash becomes saturated with water from heavy rains. it may rush down the mountainside at great speed, sometimes as much as 60 mi. an hour, sweeping with it all sorts of debris encountered in its path, and sometimes causing great damage to human property and life. The mudflow comes to rest as a deposit composed of a helter-skelter mixture of ash, blocks of old and new lava rock. tree trunks and other organic matter. Such mudflow deposits are extensive around the bases of many volcanoes, as for instance Mayon, in the Philippines.

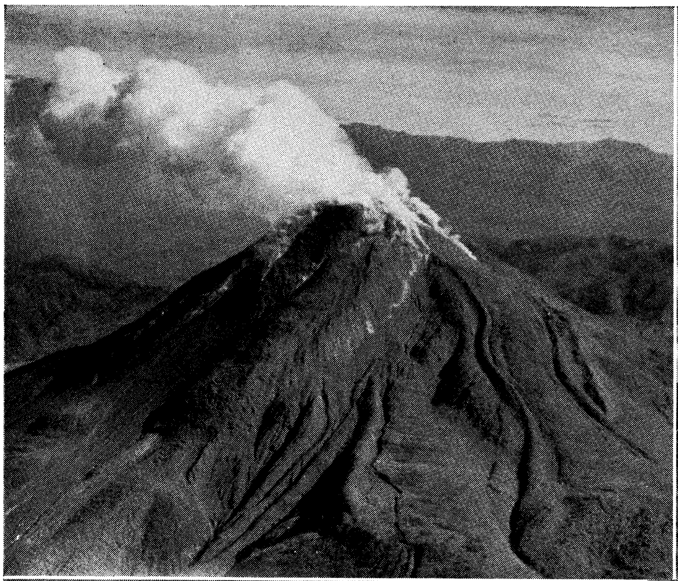
VOLCANIC LAND FORMS

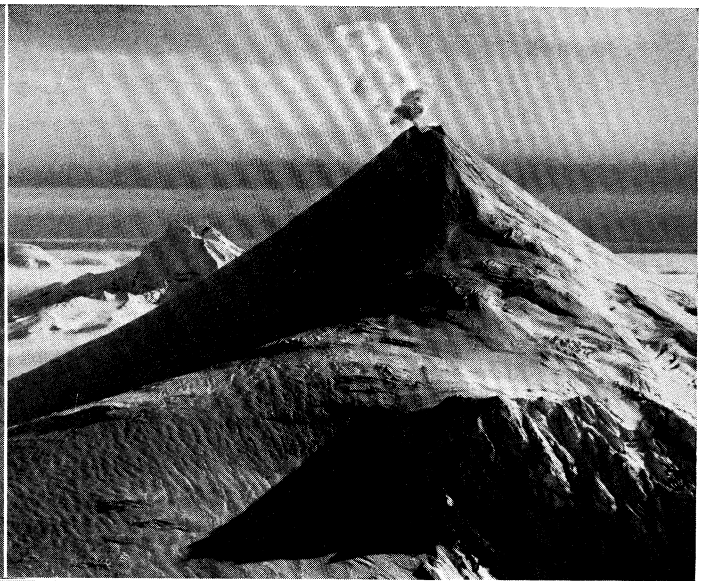
Flood **Basalts.**—Fluid mafic lavas usually erupt quietly, with little explosion, and the flows spread to great distances from the vents. In some parts of the earth such flows have been erupted over wide areas from innumerable fissures. These flood basalts have built broad nearly flat accumulations, sometimes called plateaus. although they are not always at high elevations. Such an area is the Columbia river plain east of the Cascade range in Oregon and Washington. There the Columbia river lavas cover an area of about 100,000 sq.mi., and have a volume of about 35,000 cu.mi. This stupendous accumulation consists of hundreds of flows, averaging between roo and zoo it. thick. As mentioned above, some individual flows cover areas of more than 1,000 sq.mi. Just to the east. the Snake river plain is a similar accumulation of somewhat younger lavas. Occasionally broadly rounded mounds on the surface of the plain mark the sources of the latest flows, but mostly the surface is only gently undulating and nearly horizontal. Other areas of flood basalts are in Patagonia, and in the Deccan region of India. A similar mass of nearly horizontal basalt flows once occupied much of the area of the northeastern Atlantic ocean. Remnants of it still can be seen in Scotland and Ireland, the Faeroes and Iceland.

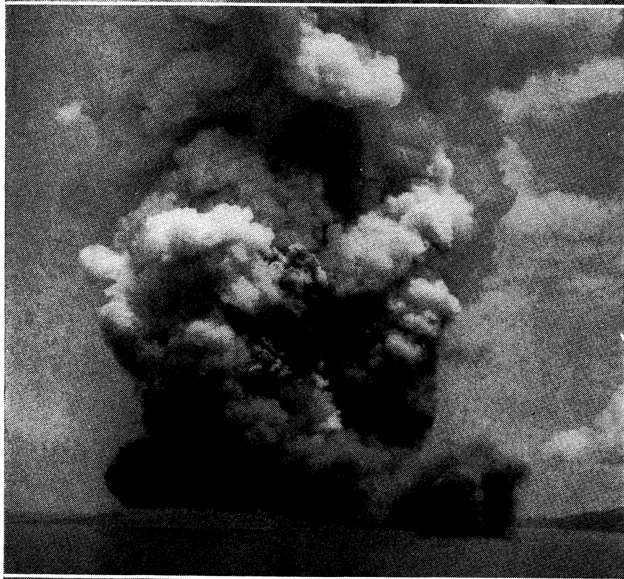
Shield Volcanoes. — Where. instead of being widely scattered, repeated eruptions of fluid lava are concentrated in a restricted area, there results a gently sloping. broadly rounded cone of lava flows known as a shield volcano (because of a supposed resemblance in profile to the round shields of ancient Germanic warriors). Shield volcanoes range in size from small hills, a few tens of feet: high, to the largest individual mountains on earth. Thus Mauna Loa, a typical shield volcano forming part of the Island of Hawaii, has a bulk of about 10,000 cu.mi., and rises 30.000 ft. above its base at the sea floor. Small shield volcanoes may be built wholly by overflows at the summit of the heap, but the bigger ones are formed in large part by eruptions from series of fissures that extend down the flanks of the mountain. Shield volcanoes consist overwhelmingly of lava flows. Rows of spatter cones, formed of agglutinate, and small cinder cones form along the vent fissures and a few thin beds of ash lie between the lava flows, but pyroclastic material makes up at most only a few per cent of the bulk of the mountain.

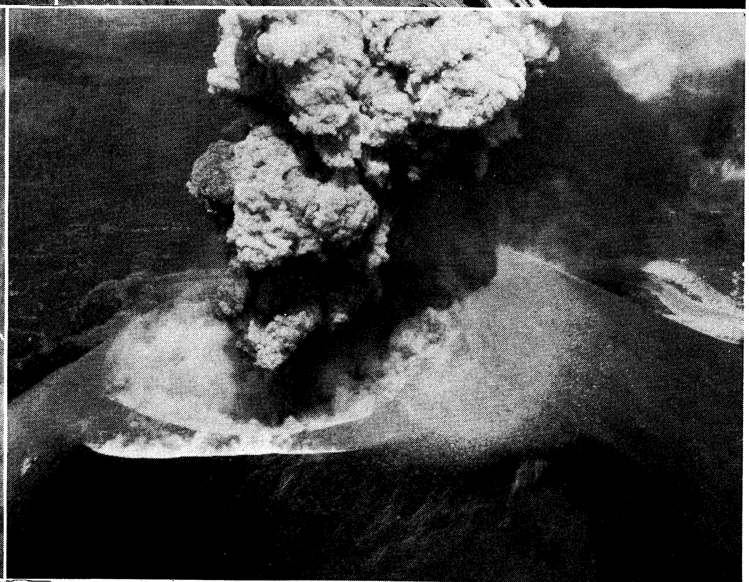
Shield volcanoes are widely distributed over the earth. The classical examples are in Iceland. The great mountains that project above sea level as the Hawaiian Islands are principally shield volcanoes. Many small shield volcanoes are associated with thin widespread lava flows east of the Cascade range in southern Oregon and northeastern California.

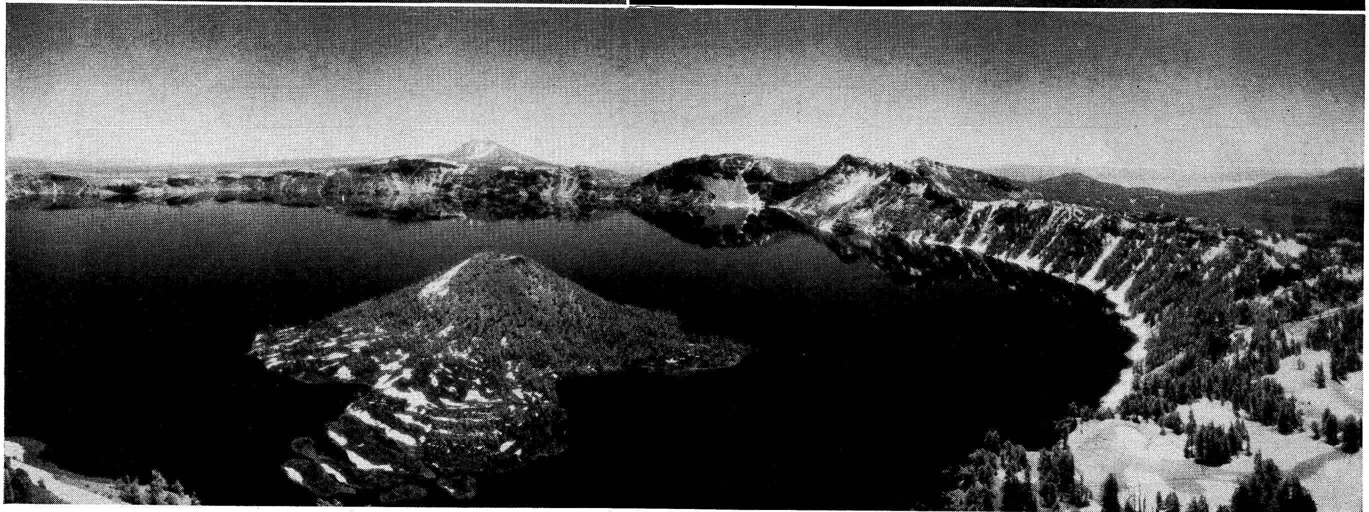
Cinder Cones. — More explosive eruptions of mafic and intermediate lavas commonly build sizeable cinder cones at the heads of the flows. The falling cinder accumulates around the vent, gradually building a conical hill with a bowl-shaped crater at the top, and commonly a gap (breach) at one side through which











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VOLCANOES OF THE WORLD

Top left: Mt. Bagana, Bougainville, Solomon Islands, showing discharge of lava from summit crater of a composite cone. Well-defined levees border the path of the flow

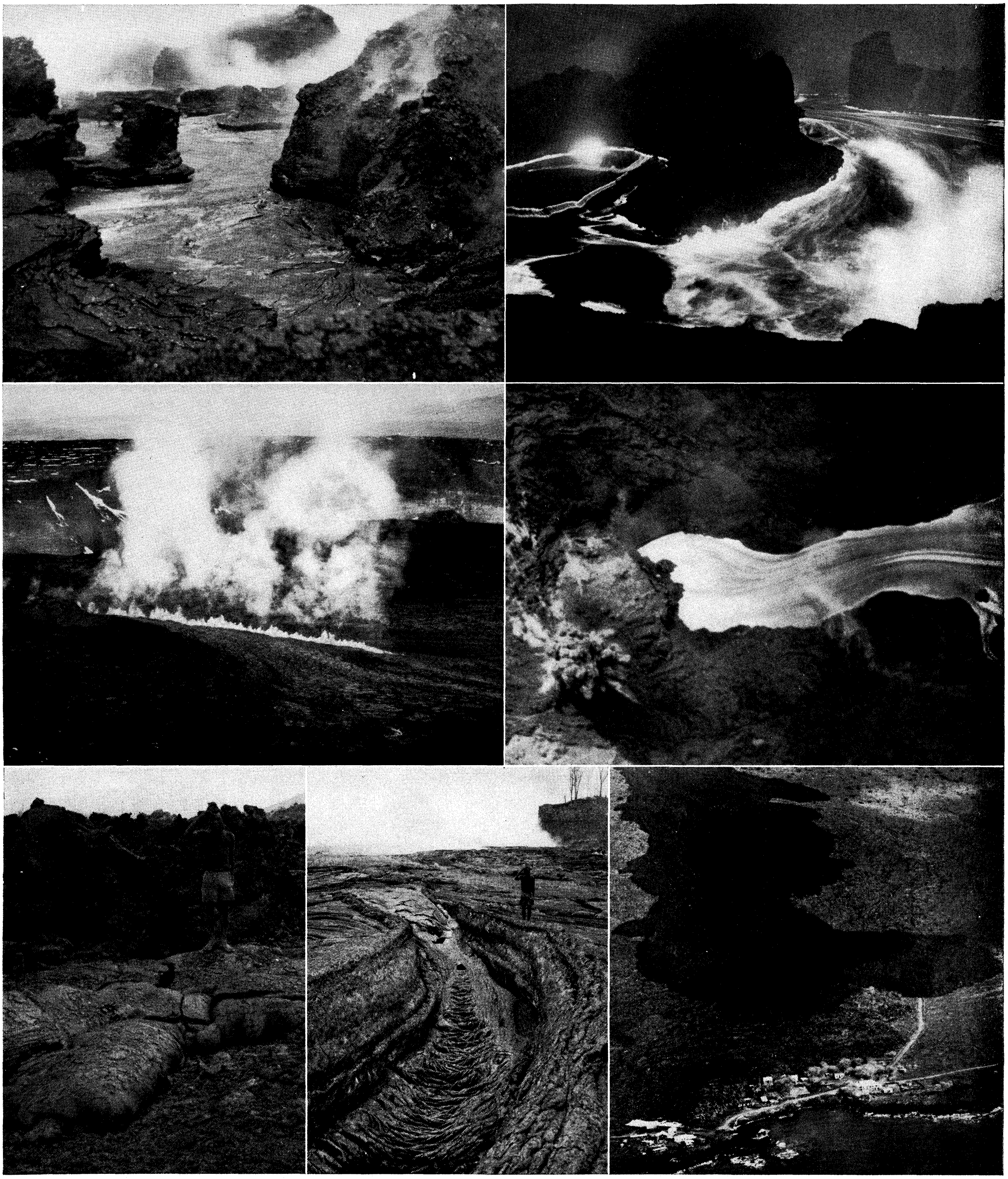
Top right: Shishaldin volcano, Unimak Island, Alaska

Centre left: Eruption of Anak Krakatoa, Sunda Strait, May 1, 1933, showing the steam cloud projected vertically and the ash cloud directed downward

Centre right: Paricutin volcano, Mexico, in eruption, July, 31, 1945

Bottom: Crater Lake, Oregon, an example of a caldera formed by collapse. Island was formed by later cinder cone

VOLCANO



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LAVA FLOWS OF HAWAII AND THE BELGIAN CONGO

Top left: Lava lake of Kilauea, Hawaii, as it appeared during its active period, 1919-20

Top right: Kilauea lava lake at night, with glowing lava

Centre left: Eruption in Mokuaweoweo, crater of Mauna Loa, Hawaii, 1940, showing fountains of incandescent lava spouting from the fissure. Such fountains may reach a height of several hundred feet

Centre right: Aerial view of a lateral vent in the Mauna Loa eruption of May 1942

Bottom left: Smooth, or pahoehoe, lava flow (foreground) partially covered by later aa, or clinkery, flow (background). Nyamlagira volcano, Belgian Congo, 1938 eruption

Bottom centre: Ropy surface of pahoehoe flow; Nyamlagira

Bottom right: Lava stream from Mauna Loa approaching village of Hoopuloa, Hawaii, during eruption of 1926. The village was completely destroyed escaped the lava to form the flow. However, the lava does not necessarily escape through a breach in the cone wall, but may pass under the side of the cone in a tunnel established before the cone was built or bored through the cone wall at a later date. The steepness of the outside of the cone is determined by the slope at which the loose cinder can stand in equilibrium. Cinder cones may be only a few tens of feet high, or they may grow to a height of 1,000 ft. or more, like that of Paricutin vblcano in Mexico. They are numerous in nearly all volcanic districts. Although they are composed of loose or only moderately consolidated cinder many of them are surprisingly enduring features of the landscape, because rain falling on them sinks into the highly permeable cinder instead of running off down their slopes to erode them.

Composite Volcanoes. — Most volcanoes consist of alternations of lava flows, poured out from the summit crater or from vents on the flanks of the cone, with layers of cinder, bombs, lapilli and ash. These are known as composite volcanoes. Typically, they form cone-shaped mountains that may be several thousand feet high, and have a volume of several tens of cubic miles. Thus the big composite volcanoes Rainier and Shasta in the Cascade range of northwestern United States rise respectively about 9,000 and 12,000 ft. above their bases, and attain altitudes of more than 14,000 ft. above sea level. Each has a bulk of nearly 100 cu.mi. Some composite volcanoes are graceful cones of unsurpassed beauty and grandeur. Shishaldin, in the Aleutian Islands, is one of these. Others are Mayon, in the Philippines, and Mt. Fuji in Japan. However, the construction of such perfect cones depends on a rarely attained combination of circumstances and most composite cones are far less regular than Fuji or Mayon.

Domes. — Lava reaching the earth's surface may be so viscous that it cannot flow away readily, and piles up around the vent to form a steep-sided mound known technically as'a volcanic dome. Sometimes domes are formed by repeated outpourings of short flows from a summit vent, and sometimes very viscous (but still liquid) lava is pushed up from the vent like a short protrusion of toothpaste from a slightly squeezed tube. Most commonly, however, the initial small extruded mass is gradually expanded by new lava being pushed up into its interior. Fractures forming in the chilled shell of the expanding dome may allow small flows to escape onto its flanks or around its base, but for the most part the growth is simply a slow swelling. As the dome grows the expanding crust breaks up, and pieces of it roll down to form a heap of angular rock fragments (breccia) around its base. Continued crumbling of the shell of the dome may result in a heap of debris that nearly buries the solid portion of the dome.

Domes are widespread in volcanic districts. They may grow in the summit craters of composite cones, in lateral craters, or completely away from any crater. The lava forming them is usually of siliceous character. Domes may attain heights of several hundred feet and diameters of several thousand feet. One of the largest known is the dome that makes up Lassen peak, in Lassen Volcanic National park, California. The Lassen dome is about 2 mi. in diameter at its base and more than 2,000 ft. high, with a volume of about $\frac{2}{5}$ cu.mi. The Chaos crags, just north of Lassen peak, are a row of spectacular domes formed within the last few hundred years. Explosions at the base of one of the domes undermined it and allowed it to collapse, forming the great hummocky landslide deposit known as the Chaos Jumbles.

Spines. — Commonly, lava is squeezed out through breaks in the carapace of the growing dome, much as metal is extruded through dies to make wire. If the lava is sufficiently viscous it forms relatively slender steep-sided projections known as spines. The surface of a dome may bristle with dozens of these spines, a few feet to a few tens of feet high. Rarely, much larger spines are formed. During the 1902 eruption of Mt. Pelée, on the Island of Martinique in the West Indies, a great spine was protruded from a growing dome in the summit crater of the volcano and within a few months rose to a height of nearly 1,000 ft. above the dome (which itself rose nearly 1,000 ft. above the crater floor). However, soon after it reached its maximum height, explosions around its base caused it to collapse. Like the great "needle" of Mt. Pelée, most spines are short-lived, soon crumbling to heaps of angular debris on the surface of the dome.

Craters and Calderas. — Thus far only features of positive relief have been considered, but volcanic land forms may also be negative. The commonest negative form is the crater. In a general sense, all more or less bowl-shaped volcanic depressions may be called craters, but in modern technical literature the term generally is restricted to the smaller depressions, up to about a mile in diameter. Larger depressions are termed *calderas* (meaning "caldron" in Spanish). Most craters are formed by explosion. They are found most commonly at the summit of volcanic cones, but others occur on the flanks of cones, or even wholly unassociated with cones. They may be blasted through the surface of the cone after the latter has been built, but more commonly they are formed over the vent during the formation of the cone. The showers of fragmental material fall back to earth around the vent, gradually building the cone, but directly above the vent the accumulation of material is prevented by the repeated explosions, and a crater in the cone is the result. In spatter cones the welded material stands at high angles, and the crater may have nearly vertical sides; but in cones of cinder or ash the loose material slides in to form the funnel shape typical of craters.

Of the craters not associated with cones, probably the best known are the many small craters blasted by low temperature volcanic explosions in the nearly horizontal nonvolcanic rocks of the Eifel (*q.v.*) region in Germany. Many of these contain beautiful little blue lakes, or *maare,* and the name *maar* has been widely applied to similar explosion craters in flat-lying rocks in other regions. The rim of ejected fragmental material around the crater often is very low and inconspicuous.

Calderas usually, if not always, form by collapse of the top of a volcanic cone or group of cones because of removal of the support formerly furnished by an underlying body of magma. In shield volcanoes of mafic lavas this removal of magma from a chamber beneath the top of the cone may result from eruption at some level low on the cone flank, or simply from intrusion into the lower part of the volcanic structure. The *calderas* of shield volcanoes are relatively small. That of Kilauea, in Hawaii, is 2.5 mi. long, 2 mi. wide and 500 ft. deep.

Larger *calderas* form by collapse of composite volcanoes. These result generally, if not always, from rapid emptying of the underlying magma reservoir by voluminous eruptions of pumice and pumiceous ash, thrown high in the air and scattered over the surrounding countryside or rushing down the slopes of the cone in fiery glowing avalanches. At the end of the eruptions the top of the mountain has disappeared, leaving in its place a great hole. It once was believed that the top of the mountain had been blown away by the explosions, but study of the material thrown out shows that only a little of the vanished part of the cone can be accounted for in that way. Most of it has simply dropped into the void left by the escaping magma. In 1883 Krakatoa (*q.v.*) volcano, in Indonesia, exploded in one of the most violent eruptions of historic times and its collapse formed a *caldera* on the sea floor (accompanied by giant tidal waves that took the lives of thousands of persons on the shores of neighbouring islands).

Other *calderas* are found in most of the major volcanic districts. One of the best known and best studied is that of Crater lake, in Oregon (*q.v.*). There, following the collapse, the great hole in the top of the mountain was gradually filled with water from rainfall and melting snow and renewed eruptions within it poured out lava flows and built the cinder cone of Wizard Island. The Crater lake *caldera* is about six miles in diameter. Probably the largest *caldera* yet described is that in the Jemez (Valle Grande) mountains of northwestern New Mexico, with an average diameter of more than 16 mi.

The term *caldera* generally is reserved for depressions of fairly regular, circular or oval outline. Their shape presumably is governed by the nearly circular horizontal cross section of the underlying body of magma. Other depressions. of markedly angular or irregular outline, also occur in volcanic districts, and commonly are of even larger size than *calderas.* Their angular outlines, and particularly angular re-entrants around their edges. indicate that their shape is governed by pre-existing tectonic structures, such as joints and faults resulting from deformation of the earth's crust, in the underlying older rocks. They therefore are referred to as volcano-tectonic depressions. As in the case of *calderas* of the Crater lake and Krakatoa type, their collapse appears to be at least partly related to the rapid extrusion of voluminous froth flows of siliceous lava, forming extensive deposits of welded tuff. Examples are the Rotorua-Taupo basin in New Zealand, and the basin of Lake Toba in Sumatra. each with an area of over 1.000 sq.mi. and associated with hundreds of cubic miles of welded tuff.

DISTRIBUTION OF VOLCANOES

Probably there is no part of the earth's surface that has not. at some time in the past. been the site of volcanic activity. Indeed, some regions such as the British Isles that we would hardly think of today as volcanic have formerly experienced violent and long-continued volcanic activity.

At present, however, the active and recently active volcanoes are concentrated largely in a great belt encircling the Pacific ocean and a shorter belt extending from the Solomon Islands through New Guinea and Indonesia. The active volcanoes of the Mediterranean region often are regarded as lying on an extension of the latter belt. The greatest concentration of active volcanoes in the world is in Indonesia. where 78 have erupted within historic time and 29 others are still actively giving off gas at fumaroles and solfataras (see VOLCANISM). Of the Indonesian volcanoes probably the best known is Merapi, the "Fire mountain" of central Java, glowing avalanches and mudflows from which have taken thousands of lives. Both the circumpacific and the Indonesian belts of volcanoes correspond with zones of active orogeny, in which the earth's crust has been crumpled and heaved up into mountains during recent geologic times.

Many other active and recently extinct volcanoes are scattered over the earth's surface outside these two main belts. In the Pacific basin they are found in the Hawaiian, Samoan and Galapagos islands; in the Atlantic basin in Iceland, the Azores, the Canary and Cape Verde islands; in the Indian ocean in Réunion, Heard and Kartala islands. The Italian district includes the famous volcanoes Vesuvius, Stromboli and Etna, as well as the one that gave its name to all the rest—Vulcano. Farther east. Santorini lies in the Grecian archipelago. and the less well-known Argaeus and Nimrud are found in the mountains of Asia Minor. Ararat, of Biblical fame, is an extinct volcano. In Africa, volcanoes are associated with the great rift valleys. in which lie lakes Albert, Tanganyika and Rudolf; and others lie near the Red sea, and far to the west in the Cameroons. Even ice-bound Antarctica has its active volcano, Aft. Erebus, on the edge of McMurdo sound.

The continental United States is commonly thought of as immune from volcanic activity, but actually the Cascade range in the northwestern part of the country is part of the circumpacific "ring of fire" and contains many recently extinct volcanoes and several that should be considered active. The tremendous eruption that produced Crater lake occurred only about 6,000 years ago. About a dozen eruptions can be counted in the Cascade range since the early part of the 19th century. The most recent of these, at Lassen peak. California, during the years 1914 to 1917, produced violent explosions, great glowing avalanches, flows of mud and a small lava flow.

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VOLCANO ISLANDS (KAZAN-RETTO), three small volcanic islands in the western Pacific ocean, located south of the Bonins and north of the Marianas between 24° and 26° N. and 141° and 143° E. In north-south sequence, they are Kita-Iō-jima (San Alexander). Iō-jima (Sulfur) and Minami-Iō-jima (San Augustine). Unclaimed until the arrival of Japanese fishermen and sulfur miners in 1887. they were claimed formally by Japan in 1891.

Iō-jima (usually appearing in English as Iwo Jima) is the largest (20 sq km.; 11.5 sq.mi) and has a large stretch of level land that was converted into a military airfield during World War II. It was captured from the Japanese by U.S. forces in 1945 after a bloody assault. The few Japanese residents were removed to Japan in 1944. Under the Japanese peace treaty (1951), the U.S. exercises full poner and jurisdiction over the islands, with Japan retaining residual sovereignty. See IWO JIMA. (J. D. EE.)

VOLE, a name employed for several genera of rodents allied to the rats and mice and included in the family Muridae. The two common English forms are better known as the water rat and the short-tailed field mouse. Voles may be distinguished from rats and mice by their small eyes, blunt snouts. stouter build. inconspicuous ears. short limbs and tail and less brisk movements. They also differ in the structure of the cheek teeth. The European field vole (*Microtus agrestis*) is about the size of a mouse and does considerable damage to crops and garden produce. The water vole (*M. amphibius*) is larger, diurnal and aquatic. Largely vegetarian. it will also eat insects. mice and young birds. It is absent from Ireland, but extends from England to China. Numerous other species occur in Europe. north Asia and North America, while fossil voles occur in the Pliocene. (*See* RODENTIA.)

VOLENDAM, a small fishing village of the Netherlands in the province of North Holland. adjoining Edam. It is remarkable for its quaint buildings and the picturesque costume of the villagers, who are of a singularly dark and robust type. Many artists have been attracted to settle here. Volendam had its origin in the building of the great sea dam for the new waterway to Edam in the middle of the 14th century. On the seaward side of the dike are some houses built on piles in the style of lake dwellings. Pop. (1957 est.) 9,477.

VOLGA (Tatar: Etil, Itil or Atel; Finnish: Rsu; in ancient times Rha and Oarus), the longest and most important. river of European Russia, and the longest river of Europe. Its length is 2.293 mi.; its drainage area covers 532,818 sq.mi. and includes middle and eastern Russia. as well as part of southeastern Russia. The Volga rises on the Valdai plateau at a height of 665 ft., in a small spring in 57° 15' N., 32° 30' E., west of Lake Seliger, flows through several small lakes, and after its confluence with the Runa. enters Lake Volga. Below that lake is a dam storing 10,000.000.000 cu.ft. of water, making possible the deepening of the channel as far as the Sheksna during dry periods. After receiving the Sheksna the Volga flows southeast along a broad valley, consisting of a string of former wide lake beds, with a depth of 150–200 ft., in Permian and Jurassic deposits. It receives numerous tributaries from the north including the Unzha (339 mi.). The Oka from the southwest (605 mi.) rises in Orel, near the sources of tributaries of the Don and Dnieper, and receives the Upa, Zhizdra. Ugra, Moskva and Klyazma (left), and the Tsna with the Moksha (right).

The Oka and Volga unite at Nizhniy-Novgorod, and the Volga then enters a broad lacustrine depression which must have communicated with the Caspian in postpliocene times. Its low-water level in this section is only 190 ft. above sea level. and its width ranges from 350 to 1,750 yd. Islands appear and disappear each year after the spring floods. The Sura. bringing a volume of 2,700 to 22.000 cu.ft. per second enters on the right, as do the Svyaga and many smaller tributaries. The Volga then turns southeastward and descends into another lacustrine depression, receiving the Kama, volume 52,500 to 144,400 cu.ft. per second. below Kazan, along which come the products of the Ural mining region. Remains of molluscs still extant in the Caspian occur in this depression and in the lower Kama. The Volga then flows south-southwest, making a great bend at Samara to avoid the Zheguli extension of the Russian plateau. The Volga at Samara is only 54 ft. above sea level. Along the whole of the bend, cliffs fringe the right bank, which the river is constantly undercutting, while from the left bank extends a great plain intersected by former channels of the river. At Volgograd (Tsaritsyn) the river reaches its extreme southwestern limit and is only 45 mi. from the Don. In 1928 the Soviet government accepted estimates for the construction of a canal with sluices on the Don, to link these two rivers; the canal was completed in 1951. The river then turns sharply to the southeast, flowing through the low Caspian steppes. A few miles above Volgograd it sends off a branch, the Akhtuba, which accompanies it to the' sea for 330 mi. Low hills skirt the right bank, but on the left it anastomoses freely with the Akhtuba and often floods the country for 15 to 35 mi.

Efforts are being made to control the Volga there to lessen the annual washing away of fertile alluvial gardens. The delta begins 40 mi. above Astrakhan and contains about 200 mouths. The Volga is constantly eroding its banks, especially during the spring floods, and towns and loading ports are constantly being moved back, consequently the volume of suspended matter deposited on the Caspian shores is great; the level of that sea rises during the Volga floods.

Navigation. — Thereare six sections of the river for navigation. (1) From the Upper Volga dam, 75 mi. from the source, to Tver. There rapids and shallows are numerous, and this part is exclusively used for floating rafts. (2) From Tver to Rybinsk, which is the real head of Volga navigation. In this section the main traffic consists of barges for local trade; to June 20, vessels drawing 2 ft. may use the river, but after that date 1 ft. 9 in. is the maximum possible draft, and the river becomes increasingly shallow, so that navigation may cease altogether. The influence of the Upper Volga dam may give an extra 9 in. of depth. Above Rybinsk the Volga is joined by the Mologa, and at Rybinsk by the Sheksna, which is navigable and which is linked by the Marii and Württemberg canals with the basins of the Neva and Northern Dwina respectively. Fifteen thousand vessels entered the port per annum. (3) From Rybinsk to Nizhniy-Novgorod, 349 mi., the normal draught of vessels is 3 ft. 6 in., but in years of low water, navigation may be completely suspended in July and August. In this section are 30 commercial landing stages and 20 harbours suitable for wintering vessels. (4) From Nizhniy-Novgorod to Kazan, 299 mi., the normal draught is 5 ft. There are 40 commercial landing stages and 40 harbours, only 10 of the latter being really iceproof. (5) Kazan to Volgograd, 938 mi., normal draught 7 ft. There are 37 commercial landing stages and 28 harbours, 6 of which are really safe and iceproof. (6) Volgograd to the Caspian is divided into two parts (i.) Volgograd to Astrakhan, 343 mi. where the navigation is still of the river type and (ii.) Astrakhan to the Caspian, 71 mi., a stretch of nontidal estuary, difficult for navigation, where continuous dredging is necessary to ensure even 8-ft. depth.

The great drawbacks to navigation are (1) the long winter frost, during which the river and its tributaries become sledge routes, the ice lasting from 90 to 160 days; the average date of breakup of ice is April 11 at Tver, the 25th at Kostroma, the 16th at Kazan, the 7th at Volgograd and March 17 at Astrakhan (2) the shallowness of the river during late summer and the frequent formation of islands and their dissolution during flood time.

Fisheries. — The network of shallow and still *limans* or cutoffs in the delta of the Volga and the shallow waters of the northern Caspian, freshened as these are by the water of the Volga, the Ural, the Kura and the Terek, is exceedingly favourable to the breeding of fish, and as a whole constitutes one of the most productive fishing grounds in the world. As soon as the ice breaks up in the delta innumerable shoals of roach (Leuciscus *rutilus*) and trout (*Lucio-trutta leucichthys*) rush up the river. They are followed by the great sturgeon (Acipenser hztso), the pike, the bream and the pike perch (*Leucioperca* sandra). Later on appears the Caspian herring (*Clupea* caspia). which formerly was neglected, but has now become more important than sturgeon; the sturgeon A. *stellatus* and "wels" (*Silurus glanis*) follow, and finally the sturgeon Acipenser giildenstadtii, so much valued for its caviare. In search of a gravelly spawning ground the sturgeon go up the river as far as Sarepta (250 mi.). The lamprey, extensively pickled, the sterlet (*A.* ruthenus), the tench, the gudgeon and other fluvial species also appear in immense numbers.

History. — The Volga was probably known to the early Greeks, though it is not mentioned previous to Ptolemy. According to him, the Rha is a tributary of an interior sea, formed from the confluence of two great rivers, the sources of which are separated by 20° of longitude. The Arab geographers throw little light on the condition of the Volga during the great migrations of the 3rd century, or subsequently under the invasion of the Huns, the growth of the Khazar empire in the southern steppes and of that of Bulgaria on the middle Volga. In the 9th century the Volga basin was occupied by Finnish tribes in the north and by Khazars and various Turkish races in the south. The Slavs, driven perhaps to the west. had only the Volkhov and the Dnieper, while the (Mohammedan) Bulgarian empire, at the confluence of the Volga with the Kama, was so powerful that for some time it was an open question whether Islam or Christianity would gain the upper hand, and Islam is strong in modern Kazan. But, while the Russians were driven from the Black sea by the Khazars, and later on by a tide of Ugrian migration from the northeast, a stream of Slavs moved slowly toward the northeast. down the upper Oka, into the borderland between the Finnish and Turkish regions. After two centuries of struggle the Russians succeeded in colonizing the fertile valleys of the Oka basin; in the 12th century they built a series of fortified towns on the Oka and Klyazma; and finally they reached the mouth of the Oka, there founding (in 1222) a new Novgorod — the Novgorod of the Lowlands, now Nizhniy-Novgorod. The great lacustrine depression of the middle Volga was thus reached; and when the Mongol invasion of 1239–42 came, it encountered in the Oka basin a dense agricultural population with many fortified and wealthy towns — a population which the Mongols found they could conquer, but were unable to drive before them as they had done so many of the Turkish tribes. This invasion checked, but did not stop, the advance of the Russians down the Volga. Two centuries elapsed before the Russians covered the 300 mi. which separate the mouths of the Oka and the Kama and took possession of Kazan.

With the capture of Kazan (1552) the Russians found the lower Volga open to their boats, and eight years afterward they were masters of the mouth of the river at Astrakhan. Two centuries more elapsed before the Russians secured a free passage to the Black sea and became masters of the Sea of Azov and the Crimea; the Volga, however, was their route.

VOLGOGRAD (STALINGRAD until 1961) oblast of the Russian Soviet Federated Socialist Republic, U.S.S.R., lies in the lower Volga region and covers an area of 44,054 sq.mi. Pop. (1959) 1,853,928. Both the Volga and Don cross the oblast. The Volga there has no significant tributaries, but below Volgograd its course is paralleled by its main distributary, the Akhtuba, with a broad flood plain of innumerable old courses and cut-off lakes in between. The northern part of the *oblast* is drained by tributaries of the Don, notably the Khoper, Buzuluk, Medveditsa and Ilovlya. Within the oblast are parts of the Tsymlyansk reservoir on the Don and the Volga reservoir (Volzhskoye Vodokhranilishche) on the Volga. The Volga is flanked on the west by the Volga Uplands, which reach 1,178 ft. in the north. South of Volgograd the line of the upland is continued as the Yergeni. West of the Khoper and Don are further low uplands which represent the extreme southeastern extension of the Central Russian Upland. Between the uplands and again east of the Volga are level plains. The climate is dry and continental; the annual rainfall varies from 14 in. in the west to 12 in. in the east and is irregular, with frequent droughts. Summers are hot, with July average temperatures about 75° F. In early summer scorching sukhovei winds are common. January temperatures average about 15°. Most of the oblast lies in the dry steppe zone, with a natural vegetation of grass and some sage on chernozem soils, and has almost all been plowed. This has given rise to severe soil erosion and gullying, especially on the uplands. Saline soils are common, particularly in the Trans-Volga (Zavolzhye) and the south. Forests occur only as groves on the flood plains; shelter belts have been planted round the Tsymlyansk reservoir.

More than half the population are urban dwellers living in 13 towns and 24 urban districts; over half of these live in the administrative centre of Volgograd. Other towns are small, the largest being Kamyshin (55,000), a river port on the Volga, and Volzhski (67,000), an entirely new town built across the Volga from Volgograd in connection with the barrage. The bulk of the population lives along the rivers and in the northern lowland. Industry is largely concentrated in Volgograd, the other towns being chiefly concerned with processing agricultural products. Petroleum is obtained in the extreme north round Bakhmet'yevka and Zhirnovsk and at Frolovo, northwest of Volgograd, where it occurs together with natural gas. China clays are widespread, as are building sands and glass sands. Salt is obtained from Lake El'ton in the Trans-Volga.

Agriculture is of great importance, but it suffers severely from the climatic conditions and soil erosion. Irrigation is needed but by the early 1960s had been little developed outside the Volga-Akhtuba flood plain and the neighbourhood of the Tsymlyansk reservoir. The waters of the Volgograd reservoir were also intended to serve this purpose. The chief crop is wheat, mostly spring wheat, but there is winter wheat also. Millet, maize (corn) and sunflowers are widely grown, while the *oblast* is part of the main area for mustard in the U.S.S.R. Along the Volga uplands north of Volgograd market gardening (especially fruit, melons and other vegetables) and dairying are well developed. In the south and the Trans-Volga cattle and sheep rearing is important.

The region was occupied in the 5th century by the Finno-Turkic Bulgars, who were in the 10th century driven northward by the Khazars. Later it formed part of the empire of the Tatar Golden Horde, one section of which was incorporated in the khanate of Astrakhan. The Russians in 1557 conquered Astrakhan and in 1589 erected the fort of Tsaritsyn (the present Volgograd), but the real absorption of the region into Russia involved a century of struggle nith the nomads of the Volga. In the reign of Catherine II, the Russian peasants. Cossacks and dissatisfied native tribes rebelled (1773–75) under the leadership of E. I. Pugachev. After the 1917 revolution there was much disorder in the region before it was pacified. It was formerly a *krai* (territory) containing Ralmyk Autonomous *oblnst* until it was created Stalingrad *oblast* in 1936. The Germans occupied part of the area during R'orld War II. (R. A F.)

VOLGOGRAD (TSARITSYN until 1925 and STALINGRAD until 1961), a city and *oblnst* centre of the Russian Soviet Federated Socialist Republic. U.S.S R., stands on the high right bank of the Volga, where its course makes a bend from south-southwest to southeast, 580 mi. E. of Moscow. Pop. (1959) 591.000. Tsaritsyn was established in 1589, soon after the Russian conquest of the banks of the Volga, as a fortress to protect the newly acquired lands. It soon became a major transshipment point for goods portaged across the narrow neck of land which there separates the Volga and Don. Suleiman the Magnificent and Peter the Great both planned to link the rivers by a canal. In 1918. during the Civil War, a major engagement was fought there between the Red and the White armies. which prevented the forces of Adm. A. V. Rolchak and Gen. A. I. Denikin from joining up. The town was named Stalingrad after J. V. Stalin, who organized its defense. One of the decisive battles of World War II took place there, when the Germans, at the limit of their advance, attempted from Aug. 1942 to Feb. 1943 to capture the town and cross the Volga. After bitter fighting in Stalingrad itself, which reduced the city to rubble, the German salient was cut off and an entire army group of 350.000 men annihilated. In 1943 a sword of honour was presented to the "steel-hearted citizens of Stalingrad" by King George VI in token of the homage of the British people. Rebuilt and repopulated after the war, the town's importance greatly increased by the opening (1952) of the Volga-Don canal, immediately to the south, and by the completion (1960) of the giant barrage and 2,500,000-kw. hydroelectric station on the Volga immediately to the north.

Following the denunciation of Stalin, the town was renamed Volgograd in 1961. The modern city and its suburbs extend for nearly 40 mi. along the Volga. Its industries include metallurgy, with the "Red October" steel plant and engineering works, producing tractors, excavators, petroleum equipment and steel cables. There is a large shipyard. Sawmilling and timber-working use logs rafted down the Volga. Building materials produced include cement, ferroconcrete items, bricks, tiles and fireproof materials. Agricultural products of the region provide the raw material for leather and footwear, clothing, canning, jam making. flour milling, brewing, distilling, butter- and fat-making industries. Natural gas, exploited locally from 1953, and by-products from the oil refinery built in 1957 serve as the basis for a new but rapidly growing chemical industry. Railways link Volgograd to Moscow. Saratov, Astrakhan. Krasnodar and the Donets Basin. There are institutes of medicine. civil engineering. teaching, mechanics and municipal economics in the city. (R. A. F.)

VOLHYNIA, formerly a province of Poland. having on the north the province of Polesie, on the west Lublin, on the south Tarnopol provinces, and on the east Russia. It now forms a part of the Volyn *oblast* in the Ukrainian Soviet Socialist Republic, U.S.S.R. Area, 7,683 sq.mi.

It is a plain. washed by the Bug and the tributaries of the Prypet, viz., the Turija. Stochod, Styr, Goryn and Slucz, flowing north from the southern uplands. The north is part of the Polesian forest area, the rest is fertile soil. The chief towns are Luck, Ostróg, Rowno, Dubno, Kowel and Krzemieniec. Pop. (1959) 890,456.

VOLITION, in psychology. *See* FREE WILL; PSYCHOLOGY.

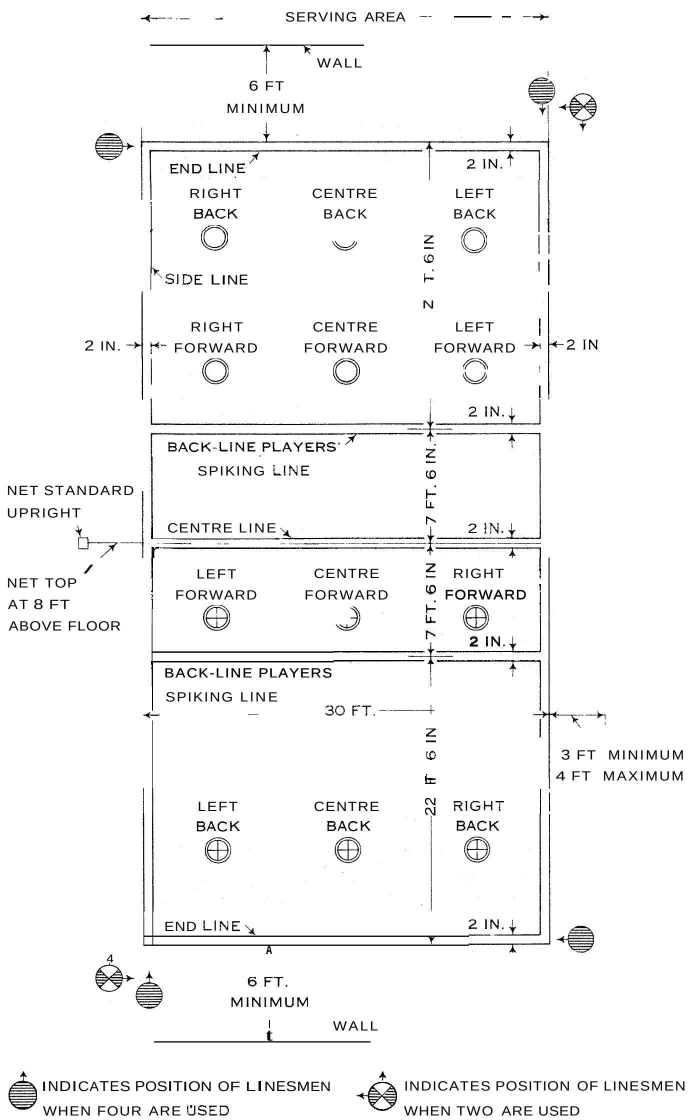
VOLLEYBALL, a game between two teams of players in which a large inflated ball. 26 or 27 in. in circumference, is batted ("volleyed") back and forth across a net, without touching the ground. The game was originated in the United States in 1895 by William G. Morgan while he was physical director at the Young Men's Christian association of Holyoke. Mass. Designed as an indoor sport for businessmen who found basketball too vigorous, it soon proved to have much wider appeal and was introduced into schools, playgrounds and other organizations in the C.S. and foreign countries. World Wars I and II also helped popularize it.

The first rules for the game were written by Mr. Morgan and printed in the first edition of the *Handbook of the Athletic League of the Y.M.C.A.s of North America* (1897). In 1916 rules were issued jointly by the Y.M.C.A. and the National Collegiate Athletic association in the Spalding Blue Cover series. In 1922 the first national U.S. tournament was conducted by the Brooklyn Central Y.M.C.A. of New York.

The United States Volleyball association (U.S.V.B.A.) was formed in 1928 and was recognized as the rules-making governing body in the U.S. The International Volleyball federation was organized in 1947. World volleyball championships (for men in Prague. Czechoslovakia, 1949; for men and women in Moscow, 1952; and in Paris, 1956) did much to standardize and unify playing rules and officiating. In 1957 volleyball was accepted by the International Olympic committee as one of the approved sports for Olympic competition.

The Game.——Volleyball can be played indoors or outside, requires a minimum of space and equipment and can be played by both sexes. The following description is based on the official game as defined in the U.S.V.B.A. rules (the International rules, used in Great Britain, differ only in minor details).

The game is played on a smooth surface on a court 30 ft. wide by 60 ft. long. clearly marked with 2-in. lines. (The lines are placed within the court.) A centre line divides the court into two 30 x 30 ft. spaces. one of which is selected by or assigned to each of the two competing teams. Players may step on but not beyond the centre line. A line $7\frac{1}{2}$ ft. from and parallel to the centre line is marked in each half of the court to indicate the point in front of which a back court player may not stand to drive the ball over the net with great power. (In official U.S.V.B.A. games the drive, "spike" or "kill!' may be performed by players only when they are in the three forward positions. In many recreational games this rule need not apply and the line is therefore omitted from the court.) A tightly stretched net, 3 ft. wide and 32 ft. long, is placed across the court exactly above the centre line; official heights are 8 ft. for men, 7 ft. 6 in. for women and high school students and 7 ft. for younger players. A 2-in. vertical tape marker should be placed across the full width of the net directly above each side boundary line of the court. These markers enable the officials to determine whether served or played balls are legal.



BY COURTESY OF U S VOLLEYBALL ASSOCIATION AND NATIONAL BOARD OF YOUNG MEN S CHRISTIAN ASSOCIATIONS

STANDARD VOLLEYBALL COURT, SHOWING POSITIONS OF PLAYERS. THE COURT IS 60 FT. BY 30 FT.

A minimum space 6 ft. wide around the entire court is needed to permit freedom of action, eliminate hazards from obstructions and allow space for net support posts and the referee's stand. There should be a clear area above the court at least 20 ft. high to permit the ball to be served or received by a team and played across the net without obstruction.

U.S.V.B.A. rules stipulate that the ball should be spherical and have a rubber bladder with a 12-piece laceless leather case or a rubber case, weigh not less than 9 nor more than 10 oz., be inflated to a pressure of not less than 7 nor more than 8 lb. if leather cased or not less than 5 nor more than 7 lb. if rubber cased. It should be balanced to provide smooth flight through the air.

A team consists of six players who take general positions in two rows. Positions in the row closer to and facing the net are left forward, centre forward and right forward. Positions of the second row of players are left back, centre back and right back. (In recreational games where there are more than six on a team, players may be arranged in three rows.) At the start of a match the two team captains draw lots for choice of serve or court. Play is started when the right back of the serving team steps outside his back line and bats the ball with a hand, fist or arm over the net into the opponents' half of the court. The opponents must receive the ball and return it across the net in a series of not more than three contacts with the ball. The ball must not touch the floor, and a player may not touch the ball twice in succession. (This neans that the ball may be returned by a single player or may be played by two or three players in the process of returning it.) A player continues to serve until his team makes an error, commits a foul or completes a game. When the service changes ("side out") the receiving team becomes the serving team and its players rotate clocknise one position; the right forward shifting to the right back position and then serving from any place behind the rear line. Only the serving team can score, points being awarded for errors and fouls of the receiving team such as hitting the ball out of bounds. failing to return the ball, etc. No point is awarded when "side out" is declared. Only one point at a time is scored for a successful play.

A game is won by the team that first scores 15 points or has scored the most points after 8 min. of play, whichever occurs first, provided the ninning team is ahead by 2 or more points. If a winner has not been determined at the end of 8 min., play continues regardless of time until a 2-point lead has been gained by one team. A match is two games out of three.

BIBLIOGRAPHY —*Official Volleyball Guide,* published annually by U.S.V.B A., contains the official rules for the U.S. and Canada, notes on International rules that differ and articles on the game. The Division for Girls and Women's Sports of the American Association for Health, Physical Education and Recreation publishes *Volleyball Guide* biannually Both include bibliographies and lists of audio-visual teaching aids.
(H. T. FD)

VOLNEY, CONSTANTIN FRANÇOIS CHASSEBOEUF, COMTE DE (1757–1820), French savant, was born at Craon (Maine-et-Loire) on Feb. 3, 1757, of good family. He was at first surnamed Boisgirais from his father's estate, but afterward assumed the name of Volney. He spent about four years in Egypt and Syria, and published his *Voyage en Egypte et en Syrie* in 1787, and his *Considérations sur la guerre actuelle des Turcs* in 1788. He was a member both of the States-General and of the Constituent Assembly. In 1791 appeared *Les Ruines,* ou *méditations sur les révolutions des empires,* an essay on the philosophy of history. Volney tried to put his politico-economic theories into practice in Corsica. where in 1792 he bought an estate. He was thrown into prison during the Jacobin triumph, but escaped the guillotine.

In 1795 he undertook a journey to the United States, where he was accused in 1797 of being a French spy sent to prepare for the reoccugation of Louisiana by France. He was obliged to return to France in 1798. The results of his travels took form in his *Tableau du climat et du sol des États-Unis* (1803). He was not a partisan of Napoleon, but, being a moderate man, a savant and a liberal, was impressed into service by him and eventually made a count and put into the senate. At the restoration Volney was made a peer of France. He became a member of the institute in 1795. He died in Paris on April 25. 1820.

VOLO (VÓLOS), a seaport of Greece, on the east coast of Thessaly, at the head of the gulf to which it gives its name. Pop. (1951) 51.144. It is connected by rail nith the Athens-Salonika railway at Larissa (Lárisa). The anchorage is safe, vessels loading and discharging by lighters. The *Kastro* (citadel) marks the site of Pagasae. whence the gulf took the name of Sinus Pagasaeus or Pagasicus. There the Argonautic expedition was said to have sailed. In the 4th century it flourished under the tyrant Jason of Pherae. Two miles south stand the ruins of Demetrias. one of the "Fetters of Greece." founded 290 B.C. by Demetrius Poliorcetes and a favourite residence of Macedonian kings.

VOLOGAESES, or VOLOGASES, the name of five Parthian kings.

VOLOGAESES I, son of Vonones II by a Greek concubine, succeeded his father in A.D. 51. He gave the kingdom of Media Atropatene to his brother Pacorus and occupied Armenia for another brother, Tiridates. This led to a long war with Rome

(54–63), which was ably conducted by the Roman general Corbulo. The power of Vologaeses was weakened by an attack by the nomadic Dahae and Sacae, a rebellion of the Hyrcanians and the usurpation of his son Vardanes II. At last a peace was concluded, by which Tiridates was acknowledged as king of Armenia, but had to become a vassal of the Romans; he went to Rome, where Nero gave him back the diadem; from that time an Arsacid dynasty ruled in Armenia under Roman supremacy. Vologaeses was satisfied with this result and honoured the memory of Nero, though he stood in good relations with Vespasian also, to whom he offered an army of 40,000 archers in the war against Vitellius.

Soon afterward the Alani invaded Media and Armenia; Vologaeses applied in vain for help to Vespasian. It appears that the Persian losses in the east also could not be repaired; Hyrcania remained an independent kingdom. Vologaeses I died in 79/80. His reign is marked by a decided reaction against Hellenism; he built Vologaesocerta (Balashkert) in the neighbourhood of Ctesiphon with the intention of drawing to this new town the inhabitants of the Greek city Seleucia.

VOLOGAESES II appears in history in 1051106 as one of the rival claimants to the throne of the Parthian king Pacorus. He seems to have been able to persist in this claim throughout the reign of Osroes, on whose death in 128/129 the greater part at least of the succession was secured to him. He maintained himself against another rival, Mithradates, and died in 147.

VOLOGAESES III came to the throne in 148. Under him, the unity of the empire was restored, but he was attacked by the Romans under Marcus Aurelius and Verus (162–165). In this war Seleucia was destroyed and the palace of Ctesiphon burned down by Avidius Cassius (164); the Romans even advanced into Media. In the peace, northwestern Mesopotamia was ceded to the Romans. Vologaeses III died in 192. He is probably the king Volgash of the Parsee tradition, preserved in the *Dinkart,* who gathered the writings of Zoroaster.

VOLOGAESES IV first appears in 191 as a rebel against Vologaeses III, whom he succeeded in 192. He was attacked by Septimius Severus in 195, who advanced into Mesopotamia, occupied Nisibis and plundered Ctesiphon (199), but attempted in vain to conquer Hatra; in 202 peace was restored. He died in 2071208.

VOLOGAESES V succeeded his father Vologaeses IV in 2071208. Soon after his accession his brother Artabanus V, the last Arsacid king, rebelled against him and became master of the greater part of the empire. But Vologaeses V maintained himself in a part of Babylonia; his dated coins reach down to A.D. 222/223.

See further PERSIA: *History: The Parthian Empire; N. C.* Debevoise, *A Political History of Parthia (1938).*

VOLOGDA, an *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R. Area 56,178 sq.mi. Pop. (1959) 1,307,000. The *oblasts* of Archangel, Gorky, Yaroslavl, Kalinin and Leningrad fringe it, as does the Karelian Autonomous Soviet Socialist Republic. Much of it was under ice during the Glacial epoch, and it is a region of boulder clay, marsh, lakes and streams. The largest lakes are Kubensk and Lacha, and the rivers include the Sukhona, flowing northwest from Lake Kubensk, and the upper course of the Onega and of the Vaga, both flowing northward, the former into the Arctic ocean and the latter joining the northern Dvina. Nearly half of the region is covered with coniferous forest, densest in the north, and there are vast marshes. The south has been largely cleared of forest and in spite of the poor soil and difficult climatic conditions, crops are raised.

The chief crops are winter rye and oats. Barley, flax, potatoes, summer wheat, grasses, peas and hemp are also grown in small quantities. Cultivation provides 30% of the region's income, stock raising and its dependent industries, 40%. Dairy cattle, of the Kholmogory breed in the north and Yaroslavl in the south, are raised. Horses, sheep and pigs are also raised. Poultry raising was being developed. The timber industry is well developed; there are paper manufactures and cellulose and wood pulp factories. The Sukhona is a navigable waterway linking with the northern Dvina, and there is a canal linking Lake Kubensk with the Sheksna.

Vologda.—Vologda is the chief town of the *oblast,* on the Vologda river above its confluence with the navigable Sukhona river, 59° 14' N., 39° 43' E. Pop. (1959) 138.000. The town has railway and steamer repair yards, manufactures agricultural implements, leather, beer, pottery, glass and cement. It grew rapidly after the railway developed, and numerous local products are exported to Archangel, Leningrad and Moscow.

Its trade is very ancient; it was founded as a colony of Novgorod in 1147, when the fur trade was at its height. The Tatars, in alliance with the prince of Tver, plundered it in 1273, but it soon recovered. Moscow and Novgorod disputed possession of it until 1447, when it was definitely annexed to the former. The opening of Archangel as a port in 1553 made it the chief depot for goods for the north. It was devastated by the Poles in 1613 and by plague in 1648. With the foundation in 1703 of St. Petersburg (Leningrad) trade went via the Baltic and Vologda declined, but developed again after the building of the railway to Archangel.

VOLSCI, ancient Italian people who were prominent in the history of the first century of the Roman republic. They then inhabited the partly hilly, partly marshy district of the S. of Latium, bounded by the Aurunci and Samnites on the S., the Hernici on the E., and stretching roughly from Norba and Cora in the N. to Antium in the S. They were among the most dangerous enemies of Rome, and frequently allied with the Aequi (*q.v.*). From the little town of Velitrae (Velletri) in the Volscian territory, the birthplace of Augustus, comes a very interesting though brief inscription dating probably from early in the 3rd century B.C. It is cut upon a small bronze plate (now in the Naples museum), which must have once been fixed to some votive object.

The name *Volsci* belongs to the -CO- group of tribal names in the centre, and mainly on the west coast, of Italy, all of whom were subdued by the Romani before the end of the 4th century B.C.; and many of whom were conquered by the Samnites about a century or more earlier. They are, from south to north, *Osci, Aurunci, Hernici, Marruci, Falisci;* with these were no doubt associated the original inhabitants of *Aricia* and of *Sidici-num,* of *Vescia* among the *Aurunci,* and of *Labici* close to Hernican territory. The same formative element appears in the adjective *Mons Massicus,* and the names *Glanica* and *Marica* belonging to the Auruncan district, with *Graviscae* in south Etruria, and a few other names in central Italy. With these names must clearly be judged the forms *Tusci* and *Etrusci,* the names given to the Etruscans by the folk among whom they settled. The Samnite and Roman conquerors tended to impose the form of their own group-name, namely the suffix -NO-, upon the tribes they conquered; hence the *Marruci* became the *Marrucini,* the *Arici* became *Aricini.* The conclusion suggested is that these -CO- tribes occupied the centre and west coast of Italy at the time of the Etruscan invasion; whereas the -NO- tribes only reached this part of Italy, or at least only became dominant there, long after the Etruscans had settled in the peninsula.

In the name *Volsci,* the older form *Volusci* contains the word meaning "marsh," since the change of *velos-* to *volus-* is phonetically regular in Latin. The name *Marīca* ("goddess of the salt-marshes") among the Aurunci also appears on the coast of Picenum and among the Ligurians; Stephanus of Byzantium identified the Osci with the Siculi who were kinsmen of the Ligures. In marshy places this *-co-* or *-ca-* suffix is used. Besides the *Aurunci, dea Marica* and *intempestaeque Graviscae* (Virg., *Aen.*, x, 184), we have the *Ustica cubans* of Horace *(Odes,* i, 17, 11), the *Hernici* in the Trerus valley, *Satricum* and *Glanica* in the Pomptine marshes. *See* ITALIC DIALECTS.

VOLSINII, an ancient town of Etruria, Italy. The older Volsinii occupied in all probability the isolated tufa rock, so strongly defended by nature, upon which in Roman times stood the town which Procopius calls Ourbibentos *(Urbs vetus,* the modern Orvieto). It had, and needed, no outer walls, being surrounded on all sides except the southwest by abrupt tufa cliffs; but a massive wall found by excavation on the southwest side of the town may have belonged to the acropolis. An Etruscan temple of the 4th century B.C. stood near the northeast extremity of the plateau. It measured 72 by 54 ft. and had three *cellae;* and at the foot of the hill on the north a large Etruscan necropolis was found dating from the 5th century B.C. The tombs, constructed of blocks of stone and arranged in rows divided by passages, often had the name of the deceased on the façade. Many painted vases, etc., were found; some were placed in the Museo Civico at Orvieto. Tombs with paintings were also found at Settecamini to the southwest of the town on the way to Bolsena. Volsinii was reputed the richest of the 12 cities of Etruria. Wars between Volsinii and Rome are mentioned in 392, 308 and 294 B.C. Zonaras states that the city was destroyed by Fulvius Flaccus in 265-264 B.C. and removed elsewhere, though the old site continued to be inhabited. The new city was certainly situated on the hills on the northeast bank of the Lake of Bolsena (*Lacus Volsiniensis*), 12 mi. W.S.W. of Orvieto, where many important antiquities were found.

See P. Perali, *Orvieto Etrusca* (Rome, 1928), who proposes to identify Orvieto with the ancient *Fanum Voltumnae*.

VOLSTEAD, ANDREW J. (1860–1947), U.S. congressman, born in Goodhue county. Minn. He was admitted to the bar in 1884 and then set up his practice at Granite Falls. Minn. Volstead was a member of the 58th to 67th congresses (1903–23), 7th Minnesota district. He was the author of the Farmers' Co-operative act and of the Volstead act. the first step in the struggle to enforce the 18th amendment to the constitution regarding the prohibition of intoxicating liquors. The Volstead act was passed Oct. 18. 1919, over the president's veto. Its most drastic feature, and the one most criticized. was the definition of intoxicating liquors as beverages containing "one-half of one per centum or more of alcohol by volume." Volstead was active as a legal adviser in the enforcement of prohibition until the amendment u-as repealed in 1933. Volstead died Jan. 20, 1947.

VOLTA, ALESSANDRO GIUSEPPE ANTONIO ANASTASIO (1745–1827), Italian physicist, celebrated as a pioneer of electrical science, after whom the "volt" is named, was born at Como on Feb. 18, 1745. He was successively appointed a teacher of physics at Como (1774) and to the newly founded chair of physics at Pavia in 1779. In 1777 and again in 1782 he journeyed through Switzerland. France, Germany. Holland and England, and became acquainted with many scientific celebrities. In 1791 he received the Copley medal of the Royal society. In 1801 Napoleon called him to Paris to show his experiments on contact electricity. and a medal was struck in his honour. He was made a senator of the kingdom of Lombardy. In 181j the emperor of Austria made him director of the philosophical faculty of Padua. In 1819 he retired and settled in his native town. where he died on March 5, 1827. A statue was erected to his memory at Como. For Volta's electrical work and his place in the history of discovery, see ELECTRICITY; also VOLTMETER.

VOLTA, the largest river of the Guinea coast west of the Niger, with a length of 710 mi. Its mouth and most of its basin are in Ghana. It has two main upper branches, the Black Volta and the White Volta: both rising in the grassy plateau country of French West Africa north of the coastal forest belt. The Black Volta rises in about 11° N., 5° 10′ W., flows northeast to about 13° N., and then turns south. From about 11° N. to 9° N. it forms the boundary between Ghana and the Ivory Coast. After turning eastward it is joined by the White Volta at about 1° W., 8° 40′ N. It then flows southeast across a wide lowland basin to its junction with the Oti and from there southward to break across the coastal range near the river port of Akuse. Thence it runs eastward to the head of its delta.

The whole Volta system has had a complex history. All three of the main rivers — the Black Volta, White Volta and Oti — have cut back across the plateau escarpment and captured streams formerly flowing to the middle Niger. The alternation of well-graded reaches in wide valleys with rapids in narrow defiles, and the frequent abrupt changes of direction, all point to the composite character of the river.

The Volta rivers are little used for transport. Water levels vary greatly in accordance with the seasonal rainfall. Heavy surf breaks on a bar across the main mouth and this prevents the entry of any but shallow-draft vessels. Rapids just above Akuse limit navigation to about 50 mi. below that point. Work was begun in 1954 on the new port of Tema, 40 mi. W. of the mouth, which, when completed, would be the port for the eastern region, and would also handle imported raw materials and the aluminum for export from the Volta River project. This major scheme, first proposed in 1938, to use the Volta waters for power production, was under active consideration in the late 1950s. The dam at Ajena 70 mi. upriver from the sea and 45 mi. from Tema could impound, at a level of 250 ft., a lake 225 mi. long and covering over 3,000 sq.mi., and would produce a generating capacity estimated at 660,000 kw. Kine-tenths of this would be used in an aluminum smelter treating bauxite from the western regions Surplus power would be available for industrial and private purposes and for rail traction, and uater for much-needed irrigation. In 1956 a steel arch bridge over the Volta was completed at Adomi, linking the Eastern Region and Trans-Volta Togoland. It has a span of 805 ft. and carries a two-lane roadway and footpaths. (T. HER)

VOLTAIRE (the pen name for FRANÇOIS MARIE AROUET) (1694–1778), was born on Nov. 21, 1694, at Paris, and mas baptized the next day. His father was François Arouet, a notary; his mother was Marie Marguerite Daumart or D'Aumard. Both father and mother were of Poitevin extraction. but the Arouets had been for two generations established in Paris. the grandfather being a prosperous tradesman. François was the fifth child of his parents. Little is known of the mother, who died when François was only seven years old. She pretty certainly was the chief cause of his early introduction to good society, the abbé de Chbteauneuf (his sponsor in more ways than one) having been her friend.

The abbé instructed him early in belles-lettres and deism, and Franqois showed when still a child a faculty for facile verse making. At the age of ten he was sent to the Collège Louis-le-Grand, which was under the management of the Jesuits, and remained there till 1711. It was his whim, as part of his general liberalism, to depreciate the education he received: but it seems to have been a sound and good education. Nor can there be much doubt that the great attention bestowed on acting — the Jesuits kept up the Renaissance practice of turning schools into theatres for the performance of plays both in Latin and in the vernacular — had much to do with his lifelong devotion to the stage. It must have been during his earliest school years that the celebrated presentation of him by his godfather to Ninon de Lenclos took place, for Ninon died in 1705. She left him 2,000 fr. "to buy books with."

In Aug. 1711, at the age of 17, Franqois returned home, and the usual battle followed between a son who desired no profession but literature and a father who refused to consider literature a profession at all. For a time Franqois submitted, and read law at least nominally. The abbé de Châteauneuf died before his godson left school, but he had already introduced him to the famous and dissipated coterie of the Temple. His father tried to break him off from such society by sending him in the suite of the marquis de Châteauneuf, the abbé's brother, to The Hague. There he met a certain Olympe Dunoyer ("Pimpette"), a girl apparently of respectable character and not bad connections, but a Protestant, penniless, and daughter of a literary lady whose literary reputation was not spotless. His father stopped any idea of a match by procuring a lettre de *cachet*, which, however, he did not use. François, who had been sent home, submitted. and for a time pretended to work in a Parisian lawyer's office; but he again manifested a faculty for getting into trouble — this time in the still more dangerous way of writing libellous poems — so that his father was glad to send him to stay for nearly a year (1714–15) with Louis de Caumartin, marquis de Saint-Ange, in the country. When he returned to Paris, he was forthwith introduced to a less questionable and even more distinguished coterie than Vendôme's, to the famous "court of Sceaux," the circle of the beautiful and ambitious duchesse du Maine. It seems that he lent himself to the duchess's frantic hatred of the regent Orléans, and helped to compose lampoons on that prince. At any rate. in May 1716 he was exiled, first to Tulle, then to Sully. Allowed to return, he again fell under suspicion of having been concerned in the composition of two violent libels and on May 16, 1717, was sent to the Bastille. He there recast Oedipe, began the Henrzade and determined to alter his name. Ever after his exit from the Bastille in April 1718 he was known as Arouet de Voltaire, or simply Voltaire, though legally he never abandoned his patronymic. Probably the name is an anagram on "Arouet le jeune," or "Arouet l. j."

A further "exile" at Chbtenay and elsewhere succeeded the imprisonment, and though Voltaire was admitted to an audience by the regent and treated graciously he was not trusted. *Oedipe* was acted at the Théâtre Français on Nov. 18 of the year of release. It had a run of forty-five nights, and brought the author not a little profit. With these gains Voltaire seems to have begun his long series of successful financial speculations. But in the spring of next year the production of Lagrange-Chancel's libels, entitled the *Philippiques,* again brought suspicion on him. He was informally exiled, and spent much time with Marshal Villars, again increasing his store of "reminiscences." He returned to Paris in the winter, and his second play, *Artémire,* was produced in February 1720. It was a failure. In December 1721 his father died, leaving him property (rather more than four thousand livres a year), which was soon increased by a pension of half the amount from the regent. In return he offered himself as a secret diplomatist to Dubois.

His visiting espionage, as unkind critics put it—his secret diplomatic mission, as he would have liked to have it put himself—began in the summer of 1722, and he set out for it in company with a certain Madame de Rupelmonde, to whom he as usual made love, taught deism and served as an amusing travelling companion. He stayed at Cambrai for some time, where European diplomatists were still in full session, journeyed to Brussels, went on to The Hague, and then returned. The *Henriade* had got on considerably during the journey. During the late autumn and winter of 1722–23 he abode chiefly in Paris, taking a kind of lodging in the town house of M. de Bernières, a nobleman of Rouen, and endeavouring to procure a "privilege" for his poem. In this he was disappointed, but he had the work printed at Rouen nevertheless, and spent the summer of 1723 revising it. In November he caught smallpox and was very seriously ill. The book was privately printed in the spring of 1724. His third tragedy, *Mariamne* was a failure. The regent had died shortly before, not to Voltaire's advantage; for he had been a generous patron. Voltaire had made, however, a useful friend in another *grand seigneur,* as profligate and nearly as intelligent, the duke of Richelieu, and with him he passed 1724 and the next year chiefly, recasting *Mariamne* (which was now successful), writing the comedy of *L'Indiscret,* and courting the queen, the ministers, the favourites and all who seemed worth while. The end of 1725 brought a disastrous close to this period of his life. He was insulted by the chevalier de Rohan, replied with his usual sharpness of tongue, and shortly afterwards, when dining with the duke of Sully, was called out and bastinadoed by the chevalier's hirelings, Rohan himself looking on. Nobody would take his part, and at last, nearly three months after the outrage, he challenged Rohan, who accepted the challenge, but on the morning appointed for the duel Voltaire was arrested and sent for the second time to the Bastille. He was kept in confinement a fortnight, and was then packed off to England in accordance with his own request. Voltaire revenged himself on the duke of Sully for his conduct towards his guest by cutting Maximilien de Béthune's name out of the *Henriade.*

Voltaire's visit to England lasted about three years, from 1726 to 1729. George II., who succeeded soon after his arrival, was not fond of "boetry," but Queen Caroline was, and international jealousy was pleased at the thought of welcoming a distinguished exile from French illiberality. The Walpoles, Bubb Dodington, Bolingbroke, Congreve, Sarah, duchess of Marlborough, Pope, were among his English friends. He made acquaintance with, and at least tried to appreciate, Shakespeare. He was much struck by English manners, was deeply penetrated by English toleration for personal freethought and eccentricity, and gained some thousands of pounds from an authorized English edition of the *Henriade,* dedicated to the queen. But he visited Paris now and then and gained full licence to return in the spring of 1729.

He was full of literary projects, and immediately after his return he is said to have increased his fortune immensely by a lucky lottery speculation. The *Henriade* was at last licensed in France; *Brutus,* a play which he had printed in England, was accepted for performance, but kept back for a time by the author; and he began the celebrated poem of the *Pucelle,* the amusement and the torment of a great part of his life. At the end of 1730 *Brutus* did actually get acted. Then in the spring of the next year he went to Rouen to get *Charles XII.* surreptitiously printed, which he accomplished. In 1732 another tragedy, *Ériphile,* appeared, with the same kind of halting success which had distinguished the appearance of its elder sisters since *Oedipe.* But at last, on the 13th of August 1732, he produced *Zaïre,* the best (with *Mérope*) of all his plays, and one of the ten or twelve best plays of the whole French classical school. Its motive was borrowed to some extent from *Othello,* but that matters little. In the following winter the death of the comtesse de Fontaine-Martel, whose guest he had been, turned him out of a comfortable abode. He then took lodgings with an agent of his, one Demoulin, in an out-of-the-way part of Paris, and was, for some time at least, as much occupied with contracts, speculation and all sorts of means of gaining money as with literature.

In the middle of this period, however, in 1733, two important books, the *Lettres philosophiques sur les Anglais* and the *Temple du goût* appeared. Both were likely to make bad blood, for the latter was, under the mask of easy verse, a satire on contemporary French literature, especially on J. B. Rousseau, and the former was, in the guise of a criticism or rather panegyric of English ways, an attack on everything established in the church and state of France. The book was condemned (June 10th, 1734, the copies seized and burnt, a warrant issued against the author and his dwelling searched. He himself was safe in the independent duchy of Lorraine with Emilie de Breteuil, marquise du Chbtelet, with whom he began to be intimate in 1733. The château of Cirey, a half-dismantled country house on the borders of Champagne and Lorraine, was fitted up with Voltaire's money and became the headquarters of himself, of his hostess, and now and then of her accommodating husband. Many pictures of the life here, some of them not a little malicious, survive. It was not entirely a bed of roses, for the "respectable Emily's" temper was violent, and after a time she sought lovers who were not so much *des cérébraux* as Voltaire. But it provided him with a safe and comfortable retreat, and with every opportunity for literary work. In March 1735 the ban was formally taken off him, and he was at liberty to return to Paris, a liberty of which he availed himself sparingly.

At Cirey he wrote indefatigably and did not neglect business. The principal literary results of his early years here were the *Discours en vers sur l'homme,* the play of *Alzire* and *L'Enfant prodigue* (1736), and a long treatise on the Newtonian system which he and Madame du Chbtelet wrote together. In the first days of his sojourn he had written a pamphlet with the title of *Treatise on Metaphysics.* Of metaphysics proper Voltaire neither then nor at any other time understood anything, and the subject, like every other, merely served him as a pretext for laughing at religion with the usual reservation of a tolerably affirmative deism. In March 1736 he received his first letter from Frederick of Prussia, then crown prince only. He was soon again in trouble, this time for the poem of *Le Mondain,* and he at once crossed the frontier and then made for Brussels. He spent about three months in the Low Countries, and in March 1737 returned to Cirey, and continued writing, making experiments in physics (he had at this time a large laboratory), and busying himself with iron-founding, the chief industry of the district. The best-known accounts of Cirey life, those of Madame de Grafigny, date from the winter of 1738–39; they are somewhat spiteful but very amusing, depicting the frequent quarrels between Madame du Chbtelet and Voltaire, his intense suffering under criticism, his constant dread of the surreptitious publication of the *Pucelle* (which nevertheless he could not keep his hands from writing or his tongue from reciting to his visitors), and so forth. Frederick, now king of Prussia, made not a few efforts to get Voltaire away from Madame du Châtelet, but unsuccessfully, and the king earned the lady's cordial hatred by persistently refusing or omitting to invite her. At last, in September 1740, master and pupil met for the first time at Cleves, an interview followed three months later by a longer visit. .Brussels was again the headquarters in 1741, by which time Voltaire had finished the best and the second or third best of his plays, *Mérope* and *Mahomet*. *Mahomet* was played first at Lille in that year; it did not appear in Paris till August next year, and *Mérope* not till 1743. This last was, and deserved to be, the most successful of its author's whole theatre. During these years much of the *Essai sur les moeurs* and the *Siècle de Louis XIV*. was composed. He also returned, not too well-advisedly, to the business of courtiership, which he had given up since the death of the regent. He was much employed, owing to Richelieu's influence, in the fêtes of the dauphin's marriage, and was rewarded, through the influence of Madame de Pompadour on New Year's Day 1745 by the appointment to the post of historiographer-royal, once jointly held by Racine and Boileau. In the same year he wrote a poem on Fontenoy, he received medals from the pope and dedicated *Mahomet* to him, and he wrote court *divertissements* and other things to admiration. But Voltaire, who had been for years the first writer in France, had been repeatedly passed over in elections to the Academy. He was at last elected in the spring of 1746, and received on the 9th of May. Then the tide began to turn. His favour at court had naturally exasperated his enemies. He had various proofs of the instability of his hold on the king during 1747 and in 1748. He once lay in hiding for two months with the duchesse du Maine at Sceaux, where were produced the comedietta of *La Prude* and the tragedy of *Rome sauvke*, and afterwards for a time lived chiefly at Lunéville; here Madame du Chbtelet had established herself at the court of King Stanislaus, and carried on a liaison with Saint-Lambert, an officer in the king's guard. In 1749 she died after the birth of a child.

After Madame du Chbtelet's death Voltaire had some idea of settling in Paris, but mischief was the very breath of his nostrils. He went on writing satiric tales like *Zadig*. He engaged in a foolish and undignified struggle with Crébillon *père* (not *fils),* a rival set up against him by Madame de Pompadour, but a dramatist who, in part of one play, *Rhadamiste et Ze'nobie,* has struck a note of tragedy in the grand Cornelian strain, which Voltaire could never hope to echo. *Semirame* (1748), *Oreste* (1750) and *Rome sauvée* itself were all products of this rivalry.

All this time Frederick of Prussia had been continuing his invitations. Voltaire left Paris on June 15, 1751, and reached Berlin on July 10. It is certain that at first the king behaved altogether like a king to his guest. He pressed him to remain; he gave him (the words are Voltaire's own) one of his orders, twenty thousand francs a year, and four thousand additional for his niece, Madame Denis, in case she would come and keep house for her uncle. His residence in Prussia lasted nearly three years. It was quite impossible that Voltaire and Frederick should get on together for long. Voltaire was not humble enough to be a mere butt, as many of Frederick's led poets were; he was not enough of a gentleman to hold his own place with dignity and discretion; he was constantly jealous both of his equals in age and reputation, such as Maupertuis, and of his juniors and inferiors, such as Baculard D'Arnaud. He was greedy, restless, and in a way Bohemian. He tried to get D'Arnaud exiled, and succeeded. He got into a quite unnecessary quarrel with Lessing. He had not been in the country six months before he engaged in a discreditable piece of financial gambling with Hirsch, the Dresden Jew. He was accused of something like downright forgery—that is to say, of altering a paper signed by Hirsch after he had signed it. The king's disgust at this affair (which came to an open scandal before the tribunals) was so great that he was on the point of ordering Voltaire out of Prussia, and Darget the secretary had no small trouble in arranging the matter (February 1751). Then it was Voltaire's turn to be disgusted with an occupation he had undertaken himself—the occupation of "buckwashing" the king's French verses. However, he succeeded in finishing and printing the *Sibcle de Louis XIV.,* while the *Dictionnaire philosophique* is said to have been devised and begun at Potsdam. But Voltaire's restless temper was brewing up for another storm. In the early autumn of 1751 La Mettrie, one of the king's parasites, and a man of much more talent than is generally allowed, horrified Voltaire by telling him that Frederick had in conversation applied to him (Voltaire) a proverb about "sucking the orange and flinging away its skin," and about the same time the dispute with Maupertuis, which had more than anything else to do with his exclusion from Prussia, came to a head. Maupertuis got into a dispute with one Konig. The king took his president's part; Voltaire took Konig's. But Maupertuis must needs write his *Letters,* and thereupon (1752) appeared one of Voltaire's most famous, though perhaps not one of his most read works, the *Diatribe du Docteur Akakia.* Even Voltaire did not venture to publish this lampoon on a great official of a prince so touchy as the king of Prussia without some permission, and if all tales are true he obtained this by another piece of something like forgery—getting the king to endorse a totally different pamphlet on its last leaf, and affixing that last leaf to *Akakza.* Of this Frederick was not aware; but he did get some wind of the *Diatribe* itself, sent for the author, heard it read to his own great amusement, and either actually burned the ms. or believed that it was burnt. In a few days printed copies appeared. Frederick put Voltaire under arrest for a time. After repeated reconciliations followed by fresh difficulties Voltaire at last left Potsdam on the 26th of March, 1753. It was nearly three months afterwards that the famous, ludicrous and brutal arrest was made at Frankfort, on the persons of himself and his niece, who had met him meanwhile. The whole situation was at last put an end to by the city authorities, who probably felt that they were not playing a very creditable part. Voltaire left Frankfort on July 7, and travelled to Colmar.

Voltaire's second stage was now over in his sixtieth year. He had been, in the first blush of his Frankfort disaster, refused, or at least not granted, permission even to enter France proper. At Colmar he was not safe, especially when in January 1754 a pirated edition of the *Essai sur les moeurs,* written long before, appeared. Permission to establish himself in France was now absolutely refused. Nor did an extremely offensive performance of Voltaire's—the solemn partaking of the Eucharist at Colmar after due confession—at all mollify his enemies. His exclusion from France, however, really meant exclusion from Paris and its neighbourhood. In the summer he went to Plombières, and after returning to Colmar for some time journeyed in the beginning of winter to Lyons, and thence in the middle of December to Geneva. Voltaire had no purpose of remaining in the city, and almost immediately bought a country house just outside the gates, to which he gave the name Les Délices. He was here practically at the meeting-point of four distinct jurisdictions—Geneva, the canton Vaud, Sardinia and France, while other cantons were within easy reach; and he bought other houses dotted about these territories, so as never to be without a refuge close at hand in case of sudden storms. At Les Délices he set up a considerable establishment, which his great wealth made him able easily to afford. He kept open house for visitors; he had printers close at hand in Geneva; he fitted up a private theatre in which he.could enjoy what was perhaps the greatest pleasure of his whole life—acting in a play of his own, stage-managed by himself. His residence at Geneva brought him into correspondence (at first quite amicable) with the must famous of her citizens, J. J. Rousseau. His *Orphelin de* la *Chine,* performed at Paris in 1755, was very well received; the notorious *La Pucelle* appeared in the same year. The earthquake at Lisbon, which appalled other people, gave Voltaire an excellent opportunity for ridiculing the beliefs of the orthodox, first in verse (1756) and later in the (from a literary point of view) unsurpassable tale of *Candide* (1759). All was, however, not yet quite smooth with him. Geneva had a law expressly forbidding theatrical performances in any circumstances whatever. Voltaire had infringed this law already as far as private performances went, and he had thought of building a regular theatre, not indeed at Geneva but at Lausanne. He undoubtedly instigated D'Alembert to include a censure of the prohibition in his *Encyclopédie* article on

"Geneva," a proceeding which provoked Rousseau's celebrated Lettre *à D'Alembert sur les* spectacles. As for himself, he looked about for a place where he could combine the social liberty of France with the political liberty of Geneva, and he found one.

At the end of 1758 he bought the considerable property of Ferney, on the shore of the lake, about four miles from Geneva, and on French soil. Many of the most celebrated men of Europe visited him there. In spite of these interruptions he wrote much and conducted an immense correspondence, which had for a long time once more included Frederick, the two getting on very well when they were not in contact. Above all, he now, being comparatively secure in position, engaged much more strongly in public controversies, and resorted less to his old labyrinthine tricks of disavowal, garbled publication and private libel. The suppression of the *Encyclopédie,* to which he had been a considerable contributor, and whose conductors were his intimate friends, drew from him a shower of lampoons directed now at "l'infâme" (see infra) generally, now at literary victims, such as Le Franc de Pompignan, or Palissot or at Fréron, an excellent critic and a dangerous writer, who had attacked Voltaire from the conservative side, and at whom the patriarch of Femey, as he now began to be called, levelled the farce-lampoon of *L'Écossaise.*

Here, too, he began that series of interferences on behalf of the oppressed and the ill-treated which is an honour to his memory. Volumes and almost libraries have been written on the Calas affair, and we can but refer here to the only less famous cases of Sirven (very similar to that of Calas, though no judicial murder was actually committed), Espinasse (who had been sentenced to the galleys for harbouring a Protestant minister), Lally (the son of the unjustly treated but not blameless Irish-French commander in India), D'Étalonde (the companion of La Barre), Montbailli and others.

In this way Voltaire, who had been an old man when he established himself at Ferney, became a very old one almost without noticing it. The death of Louis XV. and the accession of Louis XVI. excited even in his aged breast the hope of re-entering Paris, but he did not at once receive any encouragement, despite the reforming ministry of Turgot. A much more solid gain to his happiness was the adoption, or practical adoption, in 1776 of Reine Philiberte de Varicourt, a young girl of noble but poor family, whom Voltaire rescued from the convent, installed in his house as an adopted daughter, and married to the marquis de Villette. Her pet name was "Belle et Bonne," and nobody had more to do with the happiness of the last years of the "patriarch" than she had. It is doubtful whether his last and fatal visit to Paris was due to his own wish or to the instigation of his niece, Madame Denis. At the end of 1777 and the beginning of 1778, he had been carefully finishing a new tragedy—Zrhne—for production in the capital. He started on Feb. s, and five days later arrived at the city which he had not seen for 28 years.

He was received with immense rejoicings, not indeed directly by the court, but by the Academy, by society and by all the more important foreign visitors. About a fortnight after his arrival, age and fatigue made him seriously ill, and a confessor was sent for. But he recovered, scoffed at himself as usual, and prepared more eagerly than ever for the first performance of *Irène,* on March 16. At the end of the month he was able to attend a performance of it, which was a kind of apotheosis. He was crowned with laurel in his box, amid the plaudits of the audience, and did not seem to be the worse for it. He even began or proceeded with another tragedy—Agathocle—and attended several Academic meetings. But such proceedings in the case of a man of eighty-four were impossible. To keep himself up, he exceeded even his usual excess in coffee, and about the middle of May he became very ill. On May 30, the priests were once more sent for—to wit, his nephew, the abbé Mignot, the abbé Gaultier, who had officiated on the former occasion, and the parish priest, the curé of St. Sulpice. In a state of half-insensibility he petulantly motioned them away, dying in the course of the night. The result was a difficulty as to burial, which was compromised by hurried interment at the abbey of Scellières in Champagne, anticipating the interdict of the bishop of the diocese by an hour or two. On July 10, 1791 the body was transferred to the Pantheon, but during the Hundred Days it was once more, it is said, disentombed, and stowed away in a piece of waste ground. His heart, taken from the body when it was embalmed, and given to Madame Denis and by her to Madame de Villette, was preserved in a silver case, and when it was proposed (in 1864) to restore it to the other remains, the sarcophagus at Sainte Genevibve (the Pantheon) was opened and found to be empty.

In person Voltaire was not engaging, even as a young man. His extraordinary thinness is commemorated, among other things, by the very poor but well-known epigram attributed to Young, and identifying him at once with "Satan, Death and Sin." In old age he was a mere skeleton, with a long nose and eyes of preternatural brilliancy peering out of his wig. He never seems to have been addicted to any manly sport, and took little exercise. He was sober enough (for his day and society) in eating and drinking generally; but drank coffee, as his contemporary, counterpart and enemy, Johnson, drank tea, in a hardened and inveterate manner. It may be presumed with some certainty that his attentions to women were for the most part platonic; indeed, both on the good and the bad side of him, he was all brain. Conversation and literature were, again as in Johnson's case, gods of his idolatry. He was good-natured when not crossed, generous to dependents who made themselves useful to him, and indefatigable in defending the cause of those who were oppressed by the systems with which he was at war. But he was inordinately vain, and totally unscrupulous in gaining money, in attacking an enemy, or in protecting himself when he was threatened with danger. Voltaire's works, and especially his private letters, constantly contain the word "l'infiime" and the expression (in full or abbreviated) "écrasez l'infiime." This has been misunderstood in many ways—the mistake going so far as in some cases to suppose that Voltaire meant Christ by this opprobrious expression. No careful and competent student of his works has ever failed to correct this gross misapprehension. "L'infâme" is not God; it is not Christ; it is not Christianity; it is not even Catholicism. Its briefest equivalent may be given as "persecuting and privileged orthodoxy" in general, and, more particularly, it is the particular system which Voltaire saw around him, of which he had felt the effects in his own exiles and the confiscations of his books, and of which he saw the still worse effects in the hideous sufferings of Calas and La Barre.

Works.—Vast and various as his work is, its vastness and variety are of the essence of its writer's peculiar quality. The divisions of it have long been recognized, and may be treated regularly.

The first of these divisions in order is the theatre. Between fifty and sixty pieces (including a few which exist only in fragments or sketches) are included in his writings, and they cover his literary life. It is at first sight remarkable that Voltaire, whose comic power was undoubtedly far in excess of his tragic, should have written many tragedies of no small excellence in their way, but only one fair second-class comedy, *Nanine.* His tragedies, on the other hand, are works of extraordinary merit in their own way. Zaire, among those where love is admitted as a principal motive, and Mkrope, among those where this motive is excluded and kept in subordination, yield to no plays of their class.

As regards his poems proper, of which there are two long ones, the Henriade and the Pucelle, besides smaller pieces, of which a bare catalogue fills fourteen royal octavo columns, their value is very unequal. The Pucelle is extremely desultory; it is a libel on religion and history. But it is amusing. The minor poems are as much above the Pucelle as the Pucelle is above the Henriade. It is true that there is nothing, or hardly anything, that properly deserves the name of poetry in them—no passion, no sense of the beauty of nature, only a narrow "criticism of life," only a conventional and restricted choice of language, a cramped and monotonous prosody, and none of that indefinite suggestion which has been rightly said to be of the poetic essence. But there is immense wit, a wonderful command of such metre and language as the taste of the time allowed to the poet, a singular if somewhat artificial grace, and great felicity of diction.

The third division of Voltaire's works in a rational order consists of his *prose romances* or *tales.* In these admirable works more than in any others that the peculiar quality of Voltaire—ironic style without exaggeration—appears. That he learned it partly from Saint Evremond, still more from Anthony Hamilton, partly even from his own enemy Le Sage, is perfectly true, but he gave it perfection and completion. If one especial peculiarity can be singled out, it is the extreme restraint and simplicity of the verbal treatment. Voltaire never dwells too long on this point, stays to laugh at what he has said, elucidates or comments on his own jokes, guffaws over them or exaggerates their form. The famous "pour encourager les autres" is an typical example, and indeed the whole of *Candide* shows the style at its perfection.

The fourth division of Voltaire's work, the *historical,* is the bulkiest of all except his correspondence, but it is far from being among the best. The small treatises on Charles XII. and Peter the Great are indeed models of clear narrative and ingenious if somewhat superficial grasp and arrangement. The so-called *Siècle de Louis XIV.* and *Siècle de Louis XV.* (the latter inferior to the former but still valuable) contain a great miscellany of interesting matter, treated by a man of great acuteness and unsurpassed power of writing, who had also had access to much important private information. But even in these books defects are present, which appear much more strongly in the singular olla-podrida entitled *Essai sur les moeurs,* in the *Annales de l'empire* and in the minor historical works. These defects are an almost total absence of any comprehension of what has since been called the philosophy of history, the constant presence of gross prejudice, frequent inaccuracy of detail, and, above all, a complete incapacity to look at anything except from the narrow standpoint of a half-pessimist and half self-satisfied *philosophe.*

To his own age Voltaire was pre-eminently a poet and a philosopher; the unkindness of succeeding ages has sometimes questioned whether he had any title to either name, and especially to the latter. His largest *philosophical* work, at least so called, is the curious medley entitled *Dictionnaire philosophique,* which is compounded of the articles contributed by him to the great *Encyclopédie* and of several minor pieces. No one of Voltaire's works shows his anti-religious or at least anti-ecclesiastical animus more strongly. The various title-words of the several articles are often the merest stalking-horses, under cover of which to shoot at the Bible or the church, the target being now and then shifted to the political institutions of the writer's country, his personal foes, etc., and the whole being largely seasoned with that acute, rather superficial, common-sense, but also commonplace, ethical and social criticism which the 18th century called philosophy. The book ranks perhaps second only to the novels as showing the character, literary and personal, of Voltaire; and despite its form it is nearly as readable.

In general *criticism* and *miscellaneous* writing Voltaire is not inferior to himself in any of his other functions. Almost all his more substantive works, whether in verse or prose, are preceded by prefaces of one sort or another, which are models of his own light pungent *causerie;* and in a vast variety of nondescript pamphlets and writings he shows himself a perfect journalist.

There remains only the huge division of his *correspondence,* which is constantly being augmented by fresh discoveries, and which, according to Georges Bengesco, has never been fully or correctly printed, even in some of the parts longest known. In this great mass Voltaire's personality is of course best shown, and perhaps his literary qualities not worst. His immense energy and versatility, his adroit and unhesitating flattery when he chose to flatter, his ruthless sarcasm when he chose to be sarcastic, his rather unscrupulous business faculty, his more than rather unscrupulous resolve to double and twist in any fashion so as to escape his enemies,—all these things appear throughout the whole mass of letters.

When sympathy and dislike are both discarded or allowed for, he remains one of the most astonishing, if not exactly one of the most admirable, figures of letters. His great fault was an inveterate superficiality. But this superficiality was accompanied by such wonderful acuteness within a certain range, by such an absolutely unsurpassed literary aptitude and sense of style in all the lighter and some of the graver modes of literature, by such untiring energy and versatility in enterprise, that he has no parallel among ready writers anywhere. Not the most elaborate work of Voltaire is of much value for matter; but not the very slightest work of Voltaire is devoid of value in form. In literary craftsmanship, at once versatile and accomplished, he has no superior and scarcely a rival.

Bibliography.—For the many editions of Voltaire's works, *see* G. Bengesco, *Bibliographie de Voltaire* (4 vols., Paris, 1882–90). For Voltaire's life and works, *see* the essays of Thomas Carlyle and of Lord Morley (1872); M. Desnoiresterres, *Voltaire et la société française* (1867); F. Espinasse, *Voltaire* (1882) with bibliography; J. Churton Collins, *Voltaire in England* (1886); J. R. Lounsbury, *Shakespeare and Voltaire* (1902); G. Lanson, *Voltaire* (1906); F. Caussy, *Voltaire, seigneur de village* (1912); A. S. Hurn, *Voltaire et Bolingbroke* (1915); G. M. C. Brandes, *F. de Voltaire* (1916); J. M. Robertson, *Voltaire* (1922); R. Aldington, *Voltaire* (1925); A. Bellesort, *Essai sur Voltaire* (1925); F. Vezinet, *Autour de Voltaire* (1925); C. B. Chase, *The Young Voltaire* (1926); E. Henriot, *Voltaire et Frédéric II.* (1927). Recent English versions of Voltaire's shorter writings are: *Zadig and other romances* (trans. A. I. Woolf and W. S. Jackson, 1926); *Candide and other romances* (trans. R. Aldington, 1927); V. Thaddeus, *Voltaire, Genius of Mockery* (1928); Alfred Noyes, *Voltaire* (1936).

VOLTERRA (anc. *Volaterrae*), a town and episcopal see of Tuscany, Italy, in the province of Pisa, from which it is 51 mi. by rail S.E., and 35 by road W.N.W. from Siena. Pop. (1936) 11,704 (town); 20,638 (commune). It stands on a commanding olive-clad eminence 1,785 ft. above sea-level, with a magnificent view over mountains and sea (the latter some 20 m. distant), and is surrounded by the massive remains of its ancient walls of large, roughly-rectangular blocks of stone, some 4½ m. in circuit, enclosing an area which must have been larger than was actually needed for habitation. Tombs of the later Villanova period (end of the 9th century B.C.) have been found within its circuit, but only at the north-west extremity. Here the clay of which the hill is formed is gradually giving way, causing landslips and the collapse of buildings, notably of the abbey church of S. Salvatore (1030) and SS. Giusto e Clemente. The mediaeval town occupies only the southern portion of this area. The most important relic of its Etruscan period is the Porta dell' Arco, an archway 20 ft. high, the corbels of which are adorned with almost obliterated heads. Volterra contains many picturesque mediaeval towers and houses. The Palazzo dei Priori (1208–57), containing the picture gallery, is especially fine, and the Piazza Maggiore in which it stands most picturesque. The museum contains a valuable collection of Etruscan antiquities, especially cinerary urns from ancient tombs of alabaster, with the figure of the deceased on the lid, and reliefs from Greek myths on the front. They belong to the 3rd and 2nd centuries B.C. The cathedral, enlarged and adorned by Pisan artists in 1254, has a fine pulpit of that period, and on the high altar are sculptures by Mino da Fiesole; it contains several good pictures. The sacristy has fine carvings. The baptistery (1283) has a font by Andrea Sansovino, and a ciborium by Mino da Fiesole. Both these buildings are in black and white marble. S. Francesco has frescoes of 1410, and S. Girolamo terra-cottas by Giovanni della Robbia and pictures. The inhabitants are chiefly employed in the manufacture of vases and other ornaments from alabaster found in the vicinity.

Volaterrae (Etruscan *Velathri)* was one of the most powerful of the 12 confederate cities of Etruria. During the war between Marius and Sulla it withstood the latter's troops for two years in 82–80 B.C. In the 12th and 13th centuries it enjoyed free institutions; in 1361 it fell under the power of Florence. It rebelled, but was retaken and pillaged in 1472.

See C. Ricci, *Volterra* (Bergamo, 1905); R. MacIver, *Villanovans and Early Etruscans* (Oxford, 1924) 63–65. (T. A.)

VOLTMETER, an instrument which indicates the difference of the electric potential between its terminals on a scale graduated in volts. Legally, the (international) volt is the electromotive force which produces a current of one (international) ampere in a resistance of one (international) ohm. This volt is equal to $1{\cdot}00049 \times 10^8$ absolute C.G.S. units. Voltmeters are always connected in parallel across the points whose potential difference is required to be measured, and, since it is essential not to disturb this potential difference, they must have a high resistance so that they may pass only a very small current. They may be divided into two classes: (1) electrostatic: (2) electrokinetic. Electrostatic voltmeters depend for their action on the fact that when two conductors are at different potentials they attract each other with a force which varies as the square of the potential difference between them. Such voltmeters have the advantage of possessing an infinite resistance, but they are not very suitable for the measurement of small voltages (*e.g.*, 100 volts). Electrokinetic voltmeters are simply high resistance galvanometers, and measure potential differences in terms of the minute currents which pass through them when they are connected to the points whose potential differences are required. (See INSTRUMENTS, ELECTRICAL MEASURING.)

VOLTURNO, a river of central Italy, which rises in the neighbourhood of Alfedena in the central Apennines of Samnium, runs south as far as Venafro, and then southeast. After a course of about 75 mi. it receives, about 5 mi. E. of Caiazzo, the Calore. The united stream now flows west-southwest'past Capua (ancient Casilinum), where the Via Appia and Latina joined just to the north of the bridge over it, and so through the Campanian plain, with many windings, into the sea. The direct length of the lower course is about 31 mi., so that the whole is slightly longer than that of the Liri, and its basin far larger (2,106 sq.mi. with a length of 109 mi. in a straight line and a discharge of 40 cu.m. per second at the mouth). The river has always had considerable military importance. and the colony of Volturnum (no doubt preceded by an older port of Capua) was founded in 194 B.C. at its mouth on the south bank by the Romans; it is now about one mile inland. A fort had already been placed there during the Roman siege of Capua, in order. with Puteoli, to serve for the provisioning of the army. The river was navigable as far as Capua.

On Oct. 1, 1860, the Neapolitan forces were defeated on the south bank of the Volturno, near S. Maria di Capua Vetere, by the Piedmontese and Garibaldi's troops, a defeat which led to the fall of Capua.

VOLUNTEERS, a general term for soldiers who are not professionals and are not permanently embodied under arms in times of peace. The idea of a large organized volunteer force seems to have originated in England at the time of the Militia bill of 1757, which was amended in 1758 to allow the militia captains to accept volunteers instead of the ordinary militiamen who were compulsorily furnished pro rata by each parish. In 1778 the volunteers were still voluntary substitutes for militiamen, though formed in separate companies of the militia unit, but volunteer corps soon began to form themselves independently of the militia.

These volunteers, disbanded in 1783, were promptly revived when the French Revolutionary Wars produced a new enemy. When the danger of invasion was at its height the force numbered 380,000 men, or $3\frac{1}{2}\%$ of a population that already kept up a regular army and a militia In 1808 was formed the local militia, in which enlistment and training were both stricter and better defined, and the greater part of the volunteers transferred themselves to this body. By 1812 the local militia reached a strength of 215,000 as against the 70,000 of the remaining volunteers. With the general peace of 1814 almost all these forces disappeared. After an interval of nearly half a century the warlike attitude of France caused British citizens once more to arm for the protection of their country.

The enrollment of the volunteer force took place at first under the old statute (44 Geo. III). The main provisions of that act, however, were found inapplicable to the altered conditions under which invasion was now possible. A new act (Volunteer act, 1863) was soon passed, the most important provision of which was that expected invasion should constitute a sufficient reason for the sovereign to call out the volunteers, in lieu of the old condition, which required the actual appearance of the enemy. This was modified in 1900 during the South African War by a further enactment allowing the authorities to call out the volunteers at times of "imminent national danger and great emergency." In 1907–08 the whole force was recast and organized along with the yeomanry (*q.v.*) into the new territorial force.

See TERRITORIAL ARMY.

The United States until World War I depended largely upon volunteers in case of national emergency. In the War of 1812 volunteers. rangers and militia numbered 471.622 as against 56,032 regulars. In the Mexican War a call for 50,000 volunteers was quickly responded to, but lack of food and transportation caused thousands of volunteers to be left behind or sent home. In the Civil War, both sides started with the volunteer system and later began conscription (q v.). The chief difficulties about the volunteer system were the short enlistment terms and the fact that the law gave the governors of states the right to appoint the officers of volunteer regiments. In the Spanish-American War the president was authorized to call out volunteers for a two-year term. Under this act about 220,000 volunteers were raised; together with 60,000 regulars, they formed the United States army during the war. The Volunteer Army bill of April 25. 1914, stipulated that all officers were to be appointed by the president.

In World War I the United States definitely abandoned the volunteer system and resorted to a selective draft. Nevertheless the Selective Service act permitted voluntary enlistment by persons between 18 and 40, and left enlistment freely open to persons registered for the draft, provided that such registrants had not yet been called up for examination by their local boards. Regulations issued Dec. 15, 1917, however. prohibited voluntary enlistment for draft registrants. In Aug. 1918 further volunteering of any kind ceased by order of the war department. Down to that time voluntary enlistments in the various army components had numbered 877.458, while the total for the navy and marine corps was 490,418. In 1940 the approach of World War II raised the question of a peacetime draft in congress, and a Selective Service bill became law on Sept. 16.

During World War II, in order to promote the most effective mobilization and to eliminate waste of manpower arising from disruptive recruitment, volunteer recruitment ceased by executive order on Dec. 5, 1942. This order provided that no male person who had reached 18 years but mas under 38 years of age should be inducted into the enlisted personnel of the armed forces, except under provisions of the Selective Training and Service act of 1940, as amended. Involuntary inductions began in Nov. 1940 and totaled approximately 950,000 before war was declared in Dec. 1941. Total inductions from Nov. 1940 to Oct. 31, 1946, were 10,110,104. Approximately 66% of those who served in the armed forces during World War II were registrants inducted through selective service. Among the remainder, a large proportion were influenced to enlist or seek commissions because of their liability to be drafted.

The passage by congress of the Selective Service act of 1948 was unprecedented, as the United States never before had had compulsory military service in peacetime. The act provided for the operation of selective service on a limited scale and was utilized as a partial source of manpower during the Korean war of 1950–53. Under joint agreement of the armed forces, registrants could volunteer for enlistment provided they had not received their preinduction notice from selective service.

The Reserve Forces act of Aug. 9, 1955, provided for the enlistment of volunteers in the reserve components of the armed forces, Males 17 to $18\frac{1}{2}$ years of age were, with written parental consent at age 17 years, permitted to enlist for a special six months' active duty training. This training period was followed by three years of attendance at weekly reserve unit assemblies and at two-week annual summer camps, with consequent draft deferment. High school student volunteers, upon enlistment, were deferred automatically from reporting for the six months' training duty until graduation or attainment of the age of 20 years. The older volunteers who enlisted were six-year enlistees with 24 months' active duty training and consequent reserve unit membership and deferment. Critical specialists, over $18\frac{1}{2}$ years of age, certified as such by selective service, were enrolled for eight years to be served after completion of three months' training duty. These persons were deferred from the draft during the period of their enlistment.

Volunteers as Political Weapons. — In the 1950s the use of "volunteers" as political factors in international relations came to the fore. During 1950–53 hundreds of thousands of volunteers of the Chinese People's Republic substantially aided the North Korean communists in combat against the United Nations forces in the Korean conflict. In the Suez crisis of 1956, the U.S.S.R. offered volunteer soldiers and airmen to help Egypt in the struggle against Israel, Britain and France. This overt threat of Soviet intervention was averted by the United Nations security council's prompt sending to Egypt of a hastily improvised police force composed of soldiers of certain other member nations.

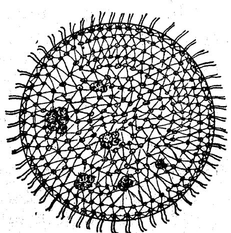
For related articles, *see* also MILITIA; TRAINING, MILITARY.

See M. A. Kreidberg and M. G. Henry, *History of Military Mobilization in the U.S. Army* (1955). (V. N.)

VOLUSENUS, FLORENTIUS [FLORENCE WOLSON, or WOLSEY, in later writers WILSON, though in letters in the vernacular he writes himself VOLUSENE] (*c.* 1504–*c.* 1547), Scottish humanist, was born near Elgin about 1504. He studied philosophy at Aberdeen, went to Paris, and became tutor to Thomas Wynter, reputed son of Cardinal Wolsey. He paid repeated visits to England, where he was well received by the king, and, after Wolsey's fall, he acted as one of Cromwell's agents in Paris. In Paris he knew George Buchanan, and found patrons in Jean, Cardinal de Lorraine and Jean du Bellay. He was to have gone with Du Bellay on his mission to Italy in 1535, but illness kept him in Paris. As soon as he recovered he set out on his journey, but stopped at Avignon, where Sadolet made him master in the school at Carpentras. Volusenus paid frequent visits to Lyons, probably also to Italy, where he had many friends, perhaps even to Spain. In 1546 he set out to return to Scotland, but died at Vienne in Dauphiné in 1546 or early in 1547. Volusenus was a great admirer of Erasmus, but he criticized the purity of his Latin and also his philosophy. His own philosophy is Christian and Biblical rather than classical or scholastic. He takes an independent view of Christian ethics and ultimately reaches a doctrine as to the witness of the Spirit and the assurance of grace which breaks with the traditional Christianity of his time and is based on ethical motives akin to those of the German reformers. His linguistic studies embraced Hebrew, Greek and Latin. His reputation rests on the beautiful dialogue, *De Animi Tranquillitate,* first printed by S. Gryphius at Lyons in 1543. From internal evidence it appears to have been composed about that time, but the subject had exercised Volusenus for many years. The dialogue shows Christian humanism at its best, and the verses which occur in it and the poem which concludes it give Volusenus a place among Scottish Latin poets, but it is as a Christian philosopher that he attains distinction.

The dialogue was reissued at Leyden in 1637 by the Scots writer David Echlin, whose poems, with a selection of three poems from the dialogue of Volusenus, appear, with others, in the famous Amsterdam collection *Delitiae Poetarum Scotorum hujus aevi,* printed by Blaev in 2 vol. in 1637. Later editions of the dialogue appeared at Edinburgh in 1707 and 1751 (the latter edited by G. Wishart). All the reissues contain a short life of the author by Thomas Wilson, advocate, son-in-law and biographer of Archbishop Patrick Adamson. Supplementary facts are found in the letters and state papers of the period, and in Sadolet's *Letters.*

VOLVOX, fresh-water, chlorophyll-bearing colonial organisms assigned by zoologists to the Mastigophora (Protozoa), by botanists to the Chlorophyceae (Algae). (*See* ALGAE: *Classification.*) In different species, the hollow colony ranges from ellipsoidal to spherical, measures about 0.25 to 3.0 mm. and contains approximately 500 to 50,000 flagellates.



ADAPTED FROM HYMAN, "THE INVERTEBRATES" (MCGRAW-HILL)

VOLVOX MAGNIFIED 60 TIMES

Each flagellate is covered with a cellulose layer and an outer gelatinous matrix. Except in *V. aureus,* the matrix is discontinuous so that interfaces, usually hexagonal, are visible externally. Asexual colonies contain biflagellate somatic cells and 8 to 60 reproductive cells (gonidia), which produce daughter colonies. In sexual colonies, developing ova or spermatozoa replace gonidia.

Volvox thus illustrates differentiation of somatic and reproductive cells, a phenomenon considered significant in tracing evolution of higher animals from Protozoa. In certain species, somatic flagellates appear to be joined by cytoplasmic strands.

In temperate climates *Volvox* thrives in the spring and apparently disappears in late summer or autumn, passing the winter as an encysted zygote. In the spring, excystment occurs as the zygote develops into a first-generation colony. The young colony turns itself inside out (inversion) so that the anterior ends of the component flagellates face outward. At maturity, daughter colonies are produced. These colonies, and often one or more succeeding generations, reproduce asexually, but sooner or later (*e.g.,* fourth or fifth generation) gametes are developed. Separate colonies yield spermatozoa and ova in heterothallic species, male colonies usually being smaller than females. Each colony produces both ova and spermatozoa in homothallic species, spermatozoa being liberated before ova reach maturity. Fertilization results in zygotes, each of which encysts. Released after death of the colony, zygotes sink to the bottom. Thick-walled zygotes, formed late in the season, serve as winter resting stages. (R. P. H.)

VONDEL, JOOST VAN DEN (1587–1679), Dutch poet, was born at Cologne, Ger., on Nov. 17, 1587. His father, a hatter, was an exile from Antwerp on account of his Anabaptist opinions; but he returned to Holland when Joost was about ten years old, and settled in Amsterdam, where he carried on a hosiery business. Joost was the eldest son and was expected to succeed to his father's shop. He was early introduced to the chamber of the Eglantine, however, and devoted most of his time to poetry and study.

When the elder Vondel died he married Maaiken de Wolf, and seems to have left the management of his affairs in her capable hands. He read the French contemporary poets, and was especially influenced by the *Divine Sepmaine* of Guillaume du Bartas; he made some translations from the German; he was soon introduced to the circle gathered in the house of Roemer Visscher, and with these friends began to make a close study of classical writers. His first play, *Pascha of de Uyttocht der Kinderen Israels uit Egypte* (1612) marked the beginning of a long and brilliant literary career. (*See* DUTCH LITERATURE.) After the production of his political drama of "Palamedes, or Murdered Innocence" (1625), which expressed his indignation at the judicial murder of Johan van Oldenbarneveldt in 1619, Vondel was forced to go into hiding, but the Amsterdam magistrates eventually satisfied themselves with exacting a small fine. In the following years he issued a number of satires against the extreme Calvinists, and he entered into close relationship with Hugo Grotius. Vondel had long been attracted by the aesthetic side of the Roman Catholic Church, and this inclination was perhaps strengthened by his friendship with Marie Tesselschade Visscher, for the Visscher household had been Catholic and liberal. Tesselschade's husband died in 1634; Vondel's wife died in 1635; and the ties between the two were strengthened by time. Vondel eventually showed his revolt against the Calvinist tyranny by formally embracing the Roman Catholic faith in 1640. The step was ill-received by many of his friends, and Pieter Hooft forbade him the hospitality of his castle at Muiden. In 1657 his only surviving son, who was entrusted with the hosiery business, mismanaged affairs and had to take ship for the Netherlands Indies, leaving his father to face the creditors. Vondel had to sacrifice his small fortune, and became a government clerk. He was pensioned after ten years' service, and died on Feb. 5, 1679.

The more important of his 32 dramas are: *Hierusalem Verwoest* ("Jerusalem Laid Desolate") (1620); *Palamedes, of Vermoorde onnooselheyd* ("Palamedes, or Murdered Innocence") (1625); *Gijsbreght van Aemstel* (1637); *De Gebroeders* (1640), the subject of which is the ruin of the sons of Saul; *Joseph in Egypten* (1640); *Maria Stuart, of gemartelde majesteit* (1646); the pastoral of *De Leeuwendalers* (1648); *Lucifer* (1654); *Salmoneus* ("Solomon") (1657); *Jephtha* (1659); *Koning David in Ballingschap* ("King David in Banishment"), *Koning David hersteld* ("King David Restored") and *Samson* (1660); *Batavische Gebroeders,* the subject of which is the story of Claudius Civilis (1663); *Adam in Ballingschap* ("Adam in Exile") (1664), after the Latin tragedy of Hugo Grotius. He also wrote translations from the tragedies of Seneca, Euripedes and Sophocles; didactic poems, and much lyrical poetry besides what is to be found in the choruses of his dramas. His complete works were edited by Van Lennep. 12 vol. (1850–69). A bibliography (1888) was published by J. H. W. Unger, who revised Van Lennep's edition in 1888–94. *Lucifer* was translated into English verse by L. C. van Noppen (1898).

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VONIER, ANSCAR (1875–1938), Benedictine abbot of Buckfast abbey, England, a prominent theologian, author and preacher, was born Nov. 11, 1875. in Ringschnait. Ger. He was educated in Germany, France and England before becoming a Benedictine at Buckfast (1893), where he was ordained to the priesthood (1898). After receiving his doctorate in philosophy (1900) at St. Anselm's, Rome, he taught at both Buckfast and St. Anselm's. When he was not yet 31 years old. Vonier was elected (1906) abbot of Buckfast, and immrdiately began his greatest work, the total reconstruction of the abbey church. The work was done by the monks themselves—usually five or six of them—and took 25 years (1907–32). After 32 years as abbot, Vonier died at Buckfast, Dec. 26. 1938.

He wrote 15 books. *The Human Soul and Its Relations With Other Spirits* (on the soul's nature, origin and destiny), *The Spirit and the Bride* (on the Holy Spirit) and *The Personality of Christ* (on the mystery and significance of the Incarnate Word) are some of his best works, but the most important was *A Key to the Doctrine of the Eucharist,* mhich explains his theory of the sacrifice of the Mass. His collected works were published in three volumes in 1952–53. Vonier was at his best, however, as a preacher. Although not a polished speaker, he was most effective because of his clarity, his doctrinal solidity and especially his sincerity.

See Ernest Graf, *Anscar Vonier, Abbot of Buckfast (1957).*

(T. G. O'C.)

VONNOH, ROBERT WILLIAM (1858–1933), C S. portrait and landscape painter, was born in Hartford, Conn , Sept. 17, 1858. He studied art at the Massachusetts Normal Art school and taught there after his graduation (1879–81). In 1881 he went to Paris. where he was a pupil of Gustave Boulanger and Jules Lefebvre at the Académie Julian. He returned to the United States and taught at the Cowles Art school, Boston, 1884–85; at the Boston Museum of Fine Arts school, 1885–87; and in the schools of the Pennsylvania Academy of the Fine Arts, Philadelphia, 1891–96, and again, 1918–20. He received the Proctor portrait prize of the National Academy of Design (1904), as well as a number of other medals and awards for his work. He is represented in the Pennsylvania Academy of Fine Arts, the Metropolitan Museum of Art, New York city, and in numerous other galleries. His portraits are generally considered to excel his other paintings, although some of his landscapes are highiy regarded. He died at Nice, France, Dec. 28, 1933.

His second wife. BESSIE POTTER VONNOH (1872–1954), a sculptress, aas born in St. Louis, Mo., Aug. 17, 1872. and studied sculpture under Lorado Taft. She became a member of the National Sculpture society (1898) and of the National Academy of Design (1921). She is represented in the Art institute, Chicago, the Metropolitan Museum of Art, New York city, and elsewhere.

VONONES (on coins ONONES), the name of two Parthian kings. VONONES I, eldest son of Phraates IV, was in Rome as a hostage when. on the assassination of Orodes II (*c* A.D. T), the Parthians applied to Augustus for a new king of the house of Arsaces. Augustus sent them Vonones, who. however, could not maintain himself: educated as a Roman, he was despised as a slave of the Romans.

Another Arsacid, Artabanus (I1 or III, depending on the interpretation of Trogus Pompeius, xli; *cf.* N. C. Debevoise, *Political History of Parthia,* Chicago, 1938, p. 16. n. 66), connected with the powerful Dahae and king of Atropatene, was invited to the throne and. after an initial defeat. expelled Vonones. The coins of Vonones (m-ho always used his proper name) date from A.D. 8–12. those of Artabanus II begin in A.D. 10. Vonones fled into Armenia and became king there. But Artabanus demanded his deposition, and Augustus, not wanting a Parthian war, removed Vonones into Syria, where he was kept in custody. When he tried to escape. A D. 19, he was killed by his guards.

VONONES II, governor of Media. succeeded King Gotarzes in A.D 51 (perhaps they were brothers), but died after a few months and was succeeded by his son Vologaeses I.

VOODOO (VODUN, a god or spirit, from the Fon language of Africa) is the name of the religion practised in poverty-ridden rural areas of Haiti. Developed by slaves brought to the island by the French during the late 17th to early 19th centuries, Voodoo has the basic features of African religion. especially that of the people of Dahomey. It also has ingredients from native West Indian cults and employs bits from Roman Catholic liturgy, sacraments and sacramentals, despite the opposition of the church. Parallel religions of African origin are Santería in Cuba, Obeah in Jamaica and Orisha in Brazil. Long presented by journalists as cannibalistic, sexually orgiastic and sorcery-ridden, Voodoo has been studied more sympathetically since the 1920s by anthropologists, musicologists and interpreters of folk dance, as well as by psychical researchers interested in the apparent clairvoyance and mediumship of its priests. As a religion. Voodoo has been characterized by modern observers in terms varying from "decadent superstitious syncretism" to "authentic expression of divine archetypes in pure and classic form."

Central to Voodoo is the worship of *loa,* chiefly divine beings of the African pantheon but also ancestors who have been deified. Since most Voodooists are practising Roman Catholics who view their total religious life as a unity, the *loa* are loosely identified with various saints. Each *loa* has its ceremonial colour, its day of the week, its ritual invocations and songs, its sacred emblem to be drawn on the ground and above all its characteristic behaviour when possessing a devotee (*see* POSSESSION). For in Voodoo services the divine beings are expected to select subjects to put into unconscious trance, and then to be incarnated briefly in them for styiized dance, supernatural counsel, feats with fire, feasting and on special occasions the acceptance of animal sacrifices (chickens. goats and bulls). Unlike African practice, which has each person susceptible of possession by only one divine being nhich claims him for a lifetime. Voodoo practice allows an individual's possession by various *loa* at different times, although those of his family inheritance dominate. Guidance and aid from the *loa* may be further sought through dreams and through the mediumship of adepts: in domestic Voodoo, an elder of the family; in cult society Voodoo, an initiated and divinely called male *hungan* or female *mambo.* These latter figures are the centres of voluntary autonomous congregations which they serve as priest, counselor, healer, political guide and lodge-master, with the aid of their acolytes. Each such leader provides the congregation with a sanctuary. though it be only a shed, where there may be celebrated nighttimes after work the elaborate prescribed rites, accompanied by sacred drums beating in intricate rhythms. Such congregational worship is public, but Voodoo also has its traditions of private magic supposedly worked by sorcerers, including the use of curse charms, the creation of zombis or living dead, and the bloodsucking of werewolves; one of the functions of the *loa* is supposedly to protect the faithfui from these.

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(Ha. H. B.)

VOORHEES, DANIEL WOLSEY (1827–1897), U.S. lamyer and politica1 leader. was born in Butler county, O., on Sept. 26, 1827, of Dutch and Irish descent. During his infancy his parents removed to Fountain county, Ind., near Veedersburg. He graduated at Indiana Asbury (now De Pauw) university, Greencastle, Ind., in 1849; was admitted to the bar in 1850, and began to practise in Covington, whence in 1857 he removed to Terre Haute. From 1858 to 1860 he was U.S. district attorney for Indiana. In 1861–66 and in 1869–73 he was a Democratic representative in congress; and in 1877–97 he was a member of the U.S. senate.

During the Civil War he seems to have been affiliated with the Knights of the Golden Circle, but he was not so radical as Vallandigham and others. He was a member of the committee on finance throughout his service in the senate, and his first speech in that body was a defense of the free coinage of silver and a plea for the preservation of the full legal tender value of greenback currency, though in 1893 he voted to repeal the silver purchase clause of the Sherman act. He had an active part in bringing about the building of the congressional library.

He was widely known as an effective lawyer, especially in jury trials. In allusion to his unusual stature he was called "the Tall Sycamore of the Wabash." He died in Washington, D.C., on April 10, 1897.

Some of his speeches were published under the title *Forty Years of Oratory* (2 vol.. 1898), edited by his three sons and his daughter, with a biographical sketch by T. B. Long.

VORARLBERG, the most westerly *Bundesland* of Austria, with an area of 1,005 sq.mi.

Physical Geography. — The southern boundary is formed by the limestone range of the Rhatikon Alps (Scesaplana. 9,734 ft.) and part of the crystalline Silvretta massif (Piz Buin, 10.879 ft.). North of the Kloster valley the dolomitic limestone builds the western end of the Lechtal Alps, rising above 8,850 ft., which merge, beyond the Walser valley, into the heights of the Bregenzerwald. The southern slopes of these are of dolomite and more than 6.500 ft. in height but northward the limestone is replaced by the softer sandstones, marls and conglomerates of the Flysch zone with a general softening of the landscape. In this region, near Bregenz, lignite occurs, but elsewhere power is obtained from the mountain streams, rich in falls and fed by plentiful annual precipitation (80 in.).

The climate in the Rhine valley, sheltered and mild, influenced by the foehn (south wind), suits vine and fruit cultivation and its influence stretches far up the fertile tributary valley of the Ill. Of the total area about 88% is productive land but of this 30% is occupied by forests and only 3½% is cultivated ground, the remainder being natural or artificial pasture. Cattle rearing and the production of milk are therefore important and in this respect Swiss influence is more evident than elsewhere in Austria. So, too, the industrial development of Vorarlberg reflects Swiss contacts, for the manufacture of textiles, particularly cotton goods, has grown with the advantage of cheap power. The building of the Arlberg railway (1880–84) effected a considerable strengthening of the economic and political interests of Vorarlberg with the remainder of Austria.

The population is Roman Catholic and German in speech (95%), although in the 17th century Ladin, a Rhaeto-Romance language, was generally spoken. Vorarlberg had 145,000 inhabitants in 1910 and 193,657 in 1951. More than one-third live in the four towns of the province (1951 census): Bregenz (cap.) 20,277; Dornbirn, 22,532; Feldkirch 15,115; Bludenz 10,178.

History.—Vorarlberg is a modern name for the various counties or lordships in the region which the Habsburgs (after they secured Tirol in 1363) succeeded in purchasing or acquiring — Feldkirch (1375, but Hohenems in 1765 only), Bludenz with the Montafon valley (1394), Bregenz (in two parts, 1451 and 1523) and Sonnenberg (1455). After the annexation of Hohenems (its lords having become extinct in 1759), Maria Theresa united all these lordships into an administrative district of Hither Austria, under the name Vorarlberg, the governor residing at Bregenz. In 1782 Joseph II transferred the region to the province of Tirol. The lordship of Blumenegg was added in 1804, but in 1805 all these lands were handed over, by virtue of the peace of Pressburg, to Bavaria, which in 1814 gave them all back, save Hoheneck. In 181j the administrative arrangements were made which lasted until 1918.

After World War I the population voted by a great majority for union with Switzerland (May 11, 1919), but neither the Helvetic government nor the Allies lent encouragement to this transfer of allegiance. Vorarlberg became one of the nine Austrian *Bundeslander*. From April 1938, when Austria was annexed to Germany, Vorarlberg with Tirol formed a *Gau*, but in 1945 it became an Austrian *Bundesland* again.

See N. Krebs, *Die Ostalpen und das heutige Österreich* (Stuttgart, 1928); A. Helbok, *Geschichte Vorarlbergs von der Urzeit bis zur Gegenwart* (1927).

VORONEZH, a region *(oblast)* of the Russian Soviet Federated Socialist Republic. bounded on the south by the Ukrainian Soviet Socialist Republic. U.S S R., and the Kamensk *oblast,* on the east by the Balashov *oblast,* on the north by the Lipetsk *oblast* and on the west by the Kursk *oblast.*

Voronezh occupies the southern slopes of the central Russian plateau (450–700 ft.), and its surface is hilly and intersected by deep ravines in the west, where two ranges of chalk hills separated by the broad Don valley run north and south. East of the Don river is a low plain through which flow the Voronezh and the Bityug. its two left-bank tributaries. Glacial clays with erratic boulders and lacustrine clays and sands cover much of the area. There is an abundant supply of chalk and kaolin clay for pottery. The magnetic anomaly existing in Kursk extends into the southwest of Voronezh and indicates the presence of deep-seated iron ore beds. The soils are mainly black earth formed on loess; they vary in character from the rich black earth with a high humus content of the southern "feather-grass" steppe through the meadow steppe of the centre to the *lyesostep* of the north. This latter is black earth on which forest spread with moister conditions; the forest disappeared, through reckless cutting, and the black earth there was reduced in humus quantity to 4% to 6%. Tree cutting had a disastrous effect in the west and centre for the spring streams frequently washed away fields and roads.

Until World War I Voronezh was mainly an agricultural area and only 6% of its population was urban. Factory industries mere few and included flour milling, oil pressing, distilling, brickmaking, leather- and ropeworks. From 1928 the region was included in the Soviet industrialization program and by 1940 it had many engineering and chemical plants. Its area then was 26,400 sq.mi. and its population was 3,551.009.

In Jan. 1955 the Voronezh region lost about one-fourth of its area when its eastern and northern parts were respectively included in the new regions of Balashov and Lipetsk reducing the total land area to 20,232 sq.mi. The number of Voronezh *rayons* or districts was reduced from 84 to 49. The population in 1959 was 2,363,000 and the chief towns were Voronezh, Liski, Ostrogozhsk, Buturlinovka and Rossosh.

Voronezh, the capital of the region, is situated on the navigable Voronezh river, 15 mi. N. of its confluence with the Don, in 51° 42' N., 39° 10' E. The site was occupied in the 11th century by a Khazar town, deserted during the 14th and 15th centuries. The Russians built a fort there in 1586, which was burned by the Tatars in 1590, but rebuilt. Peter the Great, using the then abundant oak forests of the region, built a flotilla of boats for the conquest of Azov. The town was destroyed by fire in 1703, 1748 and 1773, but each time arose again. In 1897 it had a population of 84,146, which grew to 326,836 in 1939, and 454,000 in 1959. Before World War I the city of Voronezh had a foundry, three distilleries and a few steam-powered flour and oil mills. In 1940 it had ten times more industrial workers than in 1914. It also had 12 institutions of higher education, including a university, which was opened in 1915, during World War I, when the University of Tartu or Dorpat (now in Estonia) was transferred to Voronezh. During World War II Voronezh was occupied by the Germans from July 7, 1942, to Jan. 25, 1943, and the front line ran through the city, along the Voronezh river. The fighting reduced the town to ruins. It was reconquered by Col. Gen. F. I: Golikov and by 1953 Voronezh was entirely rebuilt. (K. SM.)

VORONOFF, SERGE (SERGHEI VORONOV) (1866–1951), Russian-born French surgeon known for his studies in grafting of glands, was born at Voronezh on July 10, 1866. He served as chief surgeon of the Russian hospital in France during World War I, much of his surgery being devoted to bone grafting. In 1921 he became director of experimental surgery at the Collège de France, Paris. where he carried out experiments in grafting glands into sheep. with a view to improving their physique and the quality of their wool. Voronoff attracted world attention nith his claim to have rejuvenated elderly men by transplantation of young human or monkey testicular tissue *(see* REJUVENATION). In 1937 he claimed in a report to the Société de Pathologie Comparée that intelligence and physical gronth of backward children could be improved by grafts of thyroid glands of monkeys

Among his published works were *Life, a Study of the Means of Restoring Vital Energy* (1921); *The Study of Old Age and My Method of Rejuvenation* (1926); and *Conquest of Life* (1932).

Voronoff, who had become a French citizen in 1897, died at Lausanne, Switz., on Sept. 1, 1951.

VORONTSOV or WORONZOFF, the name of a Russian family, various members of which are distinguished in Russian history.

MIKHAIL ILLARIONOVICH VORONTSOV (1714–1767), Russian imperial chancellor, was the first to become prominent. At the age of 14 he was appointed a Kammer junker at the court of Elizabeth Petrovna. whom he materially assisted during the famous coup d'état of Dec. 6, 1741, uhen she seized the Russian throne. In Jan. 1742 he was married to Anna Skavronskaya, the cousin of the empress, and in 1744 he was created a count and vice-chancellor. His jealousy of Count Aleksey Bestuzhev-Ryumin (1744–58) induced him to participate in Count Lestocq's conspiracy against that statesman.

The empress' affection for him (she owed much to his skilful pen and still more to the liberality of his rich kinsfolk) saved him from the fate of his accomplices, but he lived in a state of semieclipse during the domination of Bestuzhev-Ryumin. On the disgrace of Bestuzhev-Ryumin, Vorontsov was made imperial chancellor in his stead.

Though well meaning and honest, Vorontsov as a politician was singularly timorous and irresolute, and always took his cue from the court. Thus, under Elizabeth he was an avowed enemy of Prussia and a warm friend of Austria and France; yet he made no effort to prevent Peter III from reversing the policy of his predecessor. Yet he did not lack personal courage, and he endured torture rather than betray his late master after the revolution of July 9, 1762. He greatly disliked Catherine II, and at first refused to serve under her, though she reinstated him as chancellor. When he found that the real control of foreign affairs was in the hands of Nikita Panin, he resigned from his office (1763).

To judge from Vorontsov's letters, he was a highly cultivated man.

ALEXANDER ROMANOVICH VORONTSOV (1741–1805), Russian imperial chancellor, nephew of the preceding and son of Count Roman Vorontsov, represented Peter III for a short time at the court of St. James's. Catherine II made him a senator and president of the department of trade; but she never liked him, and ultimately (1791) compelled him to retire from public life. In 1802 Alexander I summoned him back to office and appointed him imperial chancellor.

The Vorontsovs had always insisted on the necessity of a close union with Austria and Great Britain, in opposition to Panin and his followers, who had leaned on France or Prussia until the outbreak of the revolution made friendship with France impossible. Vorontsov was also an implacable opponent of Napoleon. The rupture with Napoleon in 1803 is mainly attributable to him. He retired in 1804.

His "Memoirs of My Own Times" (Rus.) was printed in vol. vii of the *Vorontsov Archives.*

SEMEN ROMANOVICH VORONTSOV (1744–1832), Russian diplomatist, brother of Alexander Romanovich, distinguished himself during the first Turkish War of Catherine II at Larga and Kagula in 1770. In 1783 he was appointed Russian minister at Vienna, but in 1785 was transferred to London where he lived for the rest of his life.

During Catherine's second Turkish War he contributed to bring about the disarmament of the auxiliary British fleet which had been fitted out to assist the Turks, and in 1793 obtained a renewal of the commercial treaty between Great Britain and Russia. Subsequently, his policies profoundly irritated the empress. On the accession of Paul he was raised to the rank of ambassador extraordinary and minister plenipotentiary, and received immense estates in Finland.

Neither Vorontsov's detention of the Russian squadron under Makarov in British ports nor his refusal, after the death of Bezborodko, to accept the dignity of imperial chancellor could alienate the favour of Paul. It was only when the emperor himself began to draw nearer to France that he began to consider Vorontsov as incompetent to serve Russia in England, and in Feb. 1800 all the count's estates were confiscated. Alexander I on his accession at once reinstated him, but ill-health and family affairs induced him to resign his post in 1806.

MIKHAIL SEMENOVICH VORONTSOV (1782–1856) Russian prince and field marshal, son of the preceding, spent his childhood and youth with his father in London.

During 1803–04 he served in the Caucasus under Tsitsianov and Gulyakov. He served in the campaigns of 1805–07 against Napoleon, against the Turks in 1809–11 and nith Bagration's army in 1812. In 1814, at Craonne, he brilliantly withstood Napoleon in person. He was the commander of the corps of occupation in France from 181j to 1818. In 1823 he was appointed governor general of New Russia, as the southern provinces of the empire were then called. He was the first to start steamboats on the Black sea (1828).

The same year he succeeded the wounded Menshikov as commander of the forces besieging Varna. which he captured on Sept. 28. In the campaign of 1829 he took measures to prevent the spread of the plague from Turkey to Russia. In 1844 Vorontsov was appointed commander in chief and governor of the Caucasus with plenipotentiary powers. For his brilliant campaign against Shamyl, and especially for his difficult march through the dangerous forests of Ichkerinia, he was raised to the dignity of prince. By 1848 he had captured two-thirds of Daghestan. and the situation of the Russians in the Caucasus, so long almost desperate, was steadily improving. In the beginning of 1853 Vorontsov retired. He was made a field marshal in 1856, and died the same year at Odessa.

VOROSHILOV, KLEMENTIY EFREMOVICH (1881–), Soviet army officer and government official, was born at Verkhneye. Ekaterinoslav (later Dnepropetrovsk) province, Ukraine, on Jan. 23. 1881, the son of a workman. .

He joined the Russian Social Democratic party in 1903, and in 1906 was a delegate to the Stockholm congress of the Bolsheviks. He spent most of the period from 1907 to 1914 in prison or exile. In 1918 he organized the 5th Ukrainian Red army which marched from Lugansk to Tsaritsyn (later Stalingrad). He defended Tsaritsyn against A. I. Denikin's White Russian army and from that period dated his devotion to Joseph Stalin. who was the political commissar on the front. In 1919 Voroshilov became a member of the Ukrainian Communist government and commander of the 14th army in the Ukraine. In 1921 he was appointed commander of the North Caucasian military area and in Rlay 1924 commander of the Moscow military area. In the meantime he continued to rise in the party organization: in 1921 the 10th congress elected him a member of the central committee and from Jan. 1926 he was a member of its Politburo. From 1925 to 1940 he was a deputy chairman of the council of people's commissars (from 1946 of ministers) and from July 1941 a member of the five-man State Defense committee.

One of the most successful field commanders in the civil war, Voroshilov, who never received military training as a staff officer, did-badly in June–Sept. 1941 as commander of the northwestern (Leningrad) front. On Jan. 21. 1945, he signed the armistice with Hungary on behalf of the Allied (Soviet) command, and up to March 1946 was chairman of the Allied Control commission in Budapest.

In Oct. 1952 the 19th congress of the Communist party of the Soviet Union re-elected him to its central committee, which two days later elected him a member of its presidium. On March 6, 1953, after Stalin's death. Voroshilov was appointed chairman of the presidium of the supreme soviet of the U.S.S.R., a function equivalent to that of the head of state.

Voroshilov continued as "president" of the U.S.S.R. after Georgi M. Malenkov, Stalin's successor. was replaced (Feb. 1955) as chairman (premier) of the U.S.S.R. council of ministers by Nikolai A. Bulganin; and after Bulganin was in turn replaced (March 1958) by Nikita S. Khrushchev. In May 1960 Voroshilov resigned at the age of 79 and was replaced by Leonid I. Brezhnev.

VOROSHILOVGRAD (formerly known as LUGANSK), a city of the Ukrainian Soviet Socialist Republic, on the small Lugan river. 10 mi. from its confluence with the northern Donets. in 48° 35' N., 39° 19' E. It is situated on the railway in the Lugan mining district of the Donets, which consists of the Lisichansk coal mining region and the Gorodishche anthracite mines. Coal was known to exist in the time of Peter the Great, but was not worked until 1795, when an Englishman. Gascoyne. established the town's first ironworks for supplying the Black sea fleet. Its distance from the sea proved a difficulty and the works were closed until the Crimean War, when shot, shell and gun carriages were again produced. After 1923 the town developed rapidly and its population in 1956 was estimated at 251,000 as against 34.175 in 1900. Industries developed there include smelting, engine building and enamel works, the manufacture of timber saws and ball bearings and flour milling and brewing industries. During World War II Voroshilovgrad was occupied by German forces, 1941–43...

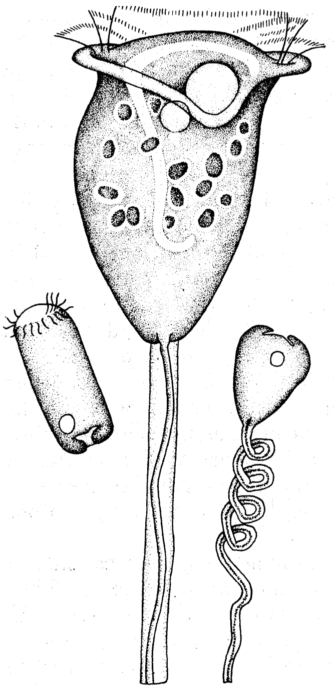
VÖROSMARTY, MIHÁLY (1800–1855), Hungarian poet, a leading figure of Hungarian literary life during the era of reforms (1825–49). Born on Dec. 1, 1800, at Nyék, into a family of impoverished nobles, he soon had to provide for himself. From the age of 15 as a schoolboy and later while studying law, he supported himself by private tutoring. He first attempted to write poetry during his school days and he never ceased to write. In 1825 he published an epic. written in hexameters. *Zalán futása*, describing the conquest of Hungary by Árpád, and the defeat of Zalán who had previously ruled the country. The epic. in ten cantos, has great artistic merit but its resounding success was caused also by the general patriotic upsurge of the period which clamoured for a work describing the glorious past of the nation.

Vorosmarty belonged to the group of writers led by Károly Kisfaludy, and he was a regular contributor to the literary periodical *Aurora*. In 1828 Vorosmarty became the full-time editor of a well-known magazine: the *Tudományos Gyűjtemény*, and his is the curious privilege of being the first Hungarian man of letters to make a living — admittedly a modest one — out of literature.. Vorosmarty's influence and fame was steadily growing, but he had little practical sense and what influence he exerted was through the authority of his genius and the unpretentious integrity of his character. In 1830 he became the first member of the newly founded Hungarian academy. Vorosmarty mas the best dramatist of his time. His early work was strongly influenced by German and French romantic drama but in 1830 he produced a really great work, *Csongor és Tünde*, a symbolic fairy-tale. He married late, in 1843, and his wife Laura Csajághy inspired some beautiful poems, among which *A merengőhöz* ("To a day-dreamer," 1843) is outstanding. Having achieved fame, reasonable material comfort and a happy marriage Vorosmarty was in a position to look forward to a contented old age, when the War of Independence (1848–49) shattered his life. An ardent partisan of Kossuth, he embraced the national cause and became a member of parliament. During the repression which followed, Vorosmarty had to go into hiding and lived with his three children in great misery. His personal misfortune and the tribulation of his country affected his mind and though he was still able to produce some splendid poems, such as *Vén cigány* ("The Old Gypsy." 1854), he was unable to continue his former activity. He died at Pest on Nov. 19, 1855.

Vorosmarty played a most important part in the development of Hungarian literature. By purifying it from overwhelming classical and German influence, he made it national not only in language but also in spirit. His ardent love of Hungary pervaded all his works as it directed all his life. It was with him that literature in Hungary became really Hungarian and, at the same time, reached maturity. (Ds. SR.)

VORTEX: *see* WHIRLPOOL.

VORTICELLA, the generic name of protozoa identified by a bell-shaped or cylindrical body with a conspicuous wreath of cilia on the oral end and a contractile unbranched stalk on the aboral end, usually without cilia between the oral and aboral ends. Vorticellas are very cosmopolitan. They eat bacteria and small protozoa, live in fresh and salt water, often in clusters attached to aquatic plants, surface scum, submerged objects or various aquatic animals. Although often found in clusters, each vorticella's stalk is fastened independently. The stalk consists of an external sheath that contains a fluid and a spirally arranged contractile thread. In its contracted condition the stalk-thread is shortened and the sheath is coiled like a corkscrew.



AFTER NOLAND AND FINLEY, "TRANSACTIONS." AMERICAN MICROSCOPICAL SOCIETY (1931)
VORTICELLA ONE-CELLED ANIMAL FOUND IN PONDS
Greatly magnified. Adult (centre) and immature forms

Vorticellas reproduce by longitudinal fission and conjugation. After fission, one of the two animals keeps the original stalk; the other grous a temporary wreath of cilia at the aboral end, detaches itself and migrates. Propelled by the temporary cilia, the migrant chooses a place for attachment, grows a stalk and loses the temporary cilia. In conjugation one small special migrant (microconjugant) finds a special attached *Vorticella* (macroconjugant) and the two conjugants amalgamate completely, forming one organism in a sexlike union that eventually leads to fission.

C. G. Ehrenberg wrote the modern description of *Vorticella* in 1838. The first description, 1676, was by Anthony van Leeuwenhoek. Later August Johann Rösel (1755) and C. Linnaeus (1767) described vorticellas. Approximately 200 species are known. They belong to the family Vorticellidae but may be called peritrichs. Their close peritrich relatives, *Carchesium* and *Zoothamnium*, are occasionally mistaken for vorticellas. (H. E. F.)

VOSGES, an upland *département* of eastern France, formed in 1790 chiefly by territory previously belonging to Lorraine, together aith portions of Franche-Comté and Champagne, and bounded north by Meurthe-et-Moselle. northeast by Bas-Rhin, east by Haut-Rhin, southeast by the territory of Belfort, south by Haute-Saône, nest by Haute-Marne and northwest by Meuse. Pop. (1954) 372,523; area 2,279 sq.mi. The Vosges mountains form a natural boundary on the east, their highest French eminence, the Hohneck, attaining 4,465 ft. The Monts Faucilles traverse the south of the department in a broad curve declining on the north into elevated plateaus, on the south encircling the upper basin of the Saône. This chain, dividing the basins of the Rhône and the Rhine, forms part of the European watershed between the basins of the Mediterranean and Atlantic. The Moselle and the Meuse, tributaries of the Rhine, have the largest drainage areas in the department; a small district in the northwest sends its waters to the Seine, the rest belongs to the basin of the Rhône. The Moselle rises in the Col de Bussang in the extreme southeast, and in a north-northwesterly course of about 70 mi. in the department receives the Moselotte and the Vologne on the right; the Mortagne and Meurthe on the right and the Madon on the left bank also belong to this department though they join the Moselle outside its borders.

The elevation and the northward exposure of the valleys make the climate severe, and a constant dampness prevails, owing both to the abundance of the rainfall and to the impermeability of the subsoil. The minter average temperature reduced to sea level is 34° to 35°, the summer average temperature being 66° to 68°. The rainfall varies from 28 in. to 60 in., according to the altitude. Arable farming flourishes in the western districts where wheat, oats, beetroot, tobacco, hops, potatoes and hemp are largely grown. The vine is cultivated on the river banks, to best advantage on those of the Moselle. Pasture is abundant in the mountainous region, where cheese-making is carried on to some extent, but the best grazing is in the central valleys. Forests, which occupy large tracts on the flanks of the Vosges, cover about one-third of the department, and are a principal source of its wealth. Sawmills are numerous in the Vosges and the manufactures of furniture, sabots, brushes and wood-working in general are prominent industries. The department has mines of lignite and stone quarries of various kinds. There are numerous mineral springs, notably those of Contrexéville, Plombières, Vittel, Bains-les-Bains, Martigny-les-Bains and Bussang. Metal goods are made, but the manufacture of textiles is the chief industry, comprising the spinning and aeaving of cotton, wool, silk, hemp and flax, and the manufacture of hosiery and of embroidery and lace, Mirecourt (pop. [1954] 4,619), which also makes musical instruments, being an important centre for the two last. The department forms the diocese of St. Dié (province of Besançon), has its court of appeal and educational centre at Nancy, and belongs to the district of the XX army corps. It is divided into three arrondissements of Épinal, the capital, Neufchâteau and St. Dié, with 29 cantons and 532 communes.

VOSGES, a mountain range stretching along the west side of the Rhine valley, from Basel to Mainz, a distance of 150 mi. They are similar to and closely associated with the Black Forest. The ranges are similar in geological formation and are portions of the same structural unit, for the Rhine valley which separates them lies in a rift valley of Tertiary age. In addition both have fine forests on their lower slopes, above which are open pasturages and rounded summits of a uniform altitude; both have a steep fall to the Rhine and a gradual descent on the other side. The Vosges in their southern portion are mainly of granite, with some porphyritic rocks, and a red sandstone (occasionally 1,640 ft. thick) which on the western versant is named "grès Vosgien."

Orographically the range is divided into four sections: the Grandes Vosges (62 mi.), extending from Belfort to the Col de Saales; the Central Vosges (31 mi.), between the latter and the Col de Saverne; the Lower Vosges (30 mi.) from thence to the source of the Lauter; and the Hardt Mts. (*q.v.*). The rounded summits of the Grandes Vosges are called "ballons." The departments of Vosges, Haute Saône, and Haut-Rhin and Belfort territory meet at the Ballon d'Alsace (4,094 ft.). Then northward the average height of the range is 3,000 ft., the highest point, the Ballon de Guebwiller (Gebweiler), or Sultz, rising east of the main chain to 4,672 ft. The Col de Saales is 1,824 ft. high. The central section is both lower and narrower than the Grandes Vosges, Mont Donon (3,307 ft.) being the highest summit. The Rhine and Marne Canal and the Paris-Strasbourg railway traverse the Col de Saverne. There are motor roads over the passes of Bussang (Remiremont to Thann), the Col de la Schlucht (3,737 ft.) (Gérardmer to Munster), the Bonhomme (St. Dié to Colmar) and the pass from St. Dié to Ste. Marie-aux-Mines. The Lower Vosges are a sandstone plateau ranging from 1,000 to 1,850 ft. high, and are crossed by the railway from Hagenau to Sarreguemines, defended by the fort of Bitche.

The annual rainfall is much higher and the mean temperature much lower in the western than in the eastern versants while on the latter the vine ripens to a height of 1,300 ft.; but its only rivers here are the Ill and other shorter streams. The Moselle, Meurthe and Saar all rise on the Lorraine side. Moraines, boulders and polished rocks testify to the existence of glaciers which formerly covered the Vosges. The lakes, surrounded by pines, beeches and maples, the green meadows which provide pasture for large herds of cows, and the fine views of the Rhine valley, Black Forest and snow-covered Swiss mountains combine to make the district picturesque.

VOSS, JOHANN HEINRICH (1751–1826), German poet, remembered chiefly for his translations of Homer. was born at Sommersdorf in Mecklenburg on Feb. 20, 1751, the son of a farmer. After some time as a private tutor, he went to Gottingen in 1772 at the invitation of H. C. Boie (*q.v.*), whose attention he had attracted by poems contributed to the *Gottinger Musenalmanach.* Here he studied theology (briefly) and philology, and became one of the leading spirits of the famous *Gottinger Hainbund.* In 1775 Boie handed over to him the editorship of the *Gottinger Musenalmanach,* which he continued to issue for several years. In 1777 he married Boie's sister Ernestine. From 1778 to 1802 Voss was headmaster of schools. first at Otterndorf, Hanover (where he began to translate the *Odyssey),* then at Eutin; but he found the work uncongenial and gave it up, living as a private scholar in Jena. In 1805 he moved to Heidelberg where he mas given a professorship in classical philology, which allowed him to devote himself to his translations. An ardent rationalist, he waged an exasperated and embittered struggle against the younger romantics (Arnim. Brentano, Creuzer) and against his childhood friend F. L. Stolberg, a convert to Roman Catholicism. He became more and more lonely and died on March 29, 1826, in Heidelberg.

Voss published his collected poems in 1802. As a lyricist he wrote mainly songs, odes, elegies and pastoral idylls in the style of Klopstock and the ancients. His idyll *Luise* (1795), which portrays with naturalistic ease the life of a country pastor's family, inspired Goethe to write *Hermann and Dorothea.* Voss is chiefly famous. however, for his translations. The *Odyssey* (1781) and *Iliad* (1793), particularly, achieved permanent importance. Voss was regarded by Goethe and other German poets as an authority on classical metres; but his pedantic regard for the niceties of form and language led him in his later translations to strain his medium on behalf of exactitude. His classical authors included Virgil (1789 ff.), Ovid (1798) and Horace (1806). He also translated *A Thousand and One Nights* (1781–85) and, with his sons Heinrich and Abraham, Shakespeare's plays (1818–29).

J. H. Voss's *Sämtliche poetische Werke* came out in 1835 (new ed. 1850). A good selection, with biography, is in A. Sauer, *Der Gottinger Dichterbund,* vol. 1 (*Kürschner's Deutsche Nationalliteratur*, vol. 49, *1887).* His *Briefe* have also appeared, 4 vol. (1829–33).

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VOSSIUS (Voss), **GERHARD JOHANN** (1577–1649), German classical scholar and theologian, was the son of Johannes Voss. a Dutch Calvinist pastor, and was born in a village near Heidelberg, where his father had found refuge. But Voss was unwelcome among the Lutherans, and returned with his son to Holland. Gerhard was educated at the university of Leyden, where he became the lifelong friend of Hugo Grotius, and studied classics, Hebrew, church history and theology. He was rector (1600–14) of the high school at Dort, and then director of the theological college at Leyden (1614–19). He came under suspicion of heresy, and escaped expulsion from his office only by resignation (1619). In 1618 he had published his history of Pelagian controversies, which his enemies considered favoured the views of the Arminians or Remonstrants. In 1622, however, he was appointed professor of rhetoric and chronology, and subsequently of Greek, in the university. He declined invitations from Cambridge, but accepted from Archbishop Laud a prebend in Canterbury cathedral without residence, and went to England to be installed in 1629, when he was made LL.D. at Oxford. In 1632 he left Leyden to become professor of history in the newly founded Athenaeum at Amsterdam.

Vossius died on March 19, 1649.

Vossius was amongst the first to treat theological dogmas and the heathen religions from the historical point of view. His principal works are *Historia Pelagiana sive Historiae de controversiis quas Pelagius eiusque reliquiae moverunt* (1618); *Aristarchus, sive de arte grammatica* (1635 and 1695; new ed. in two vols., 1833–35); *Etymologicum linguae Latinae* (1662; new ed in two vols, 1762–63); *Commentariorum Rhetoricorurn oratoriarum institutionum Libri VI* (1606 and often); De *Historicis Graecis Libri III* (1624); *De Historicis Latinis Libri III* (1627); *De Theologia Gentili* (1642); *Dissertationes Tres de Tribus Symbolis, Apostolico, Athanasiano et Constantinopolitano* (1642). Collected works published at Amsterdam (6 vols., 1695–1701).

See p. Nicéron, *Mémoires pour servir à l'histoire des hommes illustres,* vol. xiii (1730); Herzog's *Realencyklopadie,* art. "Vossius."

VOTING: see ELECTORAL SYSTEMS; VOTING BEHAVIOUR.

VOTING BEHAVIOUR. This term deals with the people's choice—why do people vote as they do? In most of the democratic countries of the west, large numbers of citizens eligible for the ballot do not vote at all, and the decision to support one candidate rather than another is by no means based simply and directly on individual consideration of the political issues involved. Most research on the topic centres on the social and psychological factors underlying voting decisions. Although it mainly reflects U.S. practice in presidential elections, such research does perhaps provide some insight into voting behaviour generally.

According to the traditional view of voting as presented in classical texts of democratic theory, inspired by the political views of the 18th-century Enlightenment, the voter is supposed to be interested in politics and to express that interest by broad, continuous and critical attention to the flow of electoral news and talks in the communication mediums. He is supposed to be well informed on campaign issues, events and personalities; to give impartial, rational consideration to the issues at hand; to judge political proposals in the light of general principles dictated by the public interest; and to discuss political matters with his fellow voters so that a wide popular debate on the issues will be held, led by the candidates themselves. The key words used to describe the voter in political theory are such terms as informed, interested, rational, principled. That is what the voter is supposed to be like; what is he really like?

Influence of Social Status.—First, as to the basis of voting: people's votes are closely tied to their social position. In this way, the vote serves as the political projection and expression of a country's social fabric. In the United States in the second half of the 20th century, there were three major factors of a sociological character that affected the vote decision:

1. Ecological, *i.e.,* environmental differences in viewpoint, reflecting the distinctive regional outlooks of, for instance, the south or New England or such residential differences as the suburb against the metropolis.

2. Socioeconomic status, under which are included such characteristics as class, occupation, income level and class identification (*i.e.,* the voter's feeling as to what class he belongs to, regardless of where "objective" criteria place him). There is, however, substantial deviation between the class-predicted vote and actual vote. Substantial numbers do not vote with their class—and there are probably more deviants from the "labour vote" than from the corresponding "business vote."

3. Ethnic or "minority" characteristics such as race, nationality and, importantly, religion. This factor receives less overt attention, possibly because of its greater social sensitivity. The plain fact is that the two-party vote in the U.S., at least in national elections, can be closely tied to the ethnic identification of the voters. This is true not only of Negro-white differences but also differences in voting behaviour between native born and foreign born, between groups of diverse national origin and finally between Protestants on the one hand and Catholics and Jews on the other. Indeed, there is good reason to believe that the influence of religion on vote—simply in the sense of religious membership or identification—is stronger than the class or socioeconomic difference. If there is a "class vote" in the U.S. there is a "religious vote" as well.

But that is not the whole story. In part, such political differences by strata, whatever their historical origins, are sustained by the day-to-day personal relations in the family, in the work place and among friends. First, there is a hereditary vote—the child following the politics of the parents—and there is near unanimity on political questions inside the family, within as well as between generations. Similarly, there is high political agreement among friends and among co-workers. In short, the typical voter is encapsulated in a congenial and harmonious atmosphere in which political preferences are communicated to him informally and indirectly in a socially reinforcing manner.

In addition, there is the continuity provided by the "party habit," *i.e.,* the tendency to go along with the same selection made earlier, partly as a way of justifying one's preceding vote decisions.

Small wonder, then, that voting preferences are usually quite stable. Most voters do not change their minds during a presidential campaign, and large numbers do not change from one election to the next. It typically requires a substantial change in one's social position, either relatively or absolutely, to effect a major change in vote—for example, for the society, a depression that stirs up the political situation enough to challenge the preferences of many; for the group, a politically tinged event such as regional unemployment or the threat of racial desegregation; for the individual, an upward movement in occupational mobility that involves shifts in residence, friendships, standards of living and social judgment.

Shifts in Party Allegiance.—But some people do change their votes; who are they? Evidence suggests that they are the less partisan-minded voters who are relatively indifferent to the above considerations, or are subject to conflicting group claims on their loyalty. Certainly only a minority in the United States are highly interested, by any reasonable definition, in the political scene in normal times, and the most partisan individuals are precisely the people who change their votes least frequently and with greatest difficulty. The less interested are the less partisan, and as such they are less likely to have their vote based solidly on the types of characteristics noted above; they may be subject to social cross pressures on their vote, having a foot in each camp, so that the outcome of the election means less to them. For example, wealthy members of an ethnic group may be under such cross pressures: their wealth may incline them in one direction and their ethnic status in the other. Their personal associations tend to be in the same situation, and so reinforce the conflict. There are always a number of people so situated that the election results are seen by them to be of little personal consequence. They are the people who tend not to follow the progress of the campaign in newspapers and on television or radio; who are most influenced by their personal contacts with friends and party workers; who are least concerned about the issues of the campaign; and who settle their vote late in the campaign.

Thus voting behaviour creates a striking spectacle in which the most interested and most knowledgeable are the least open to persuasion, most of them knowing well ahead of the campaign, long before either candidates or platforms are selected, how they will vote.

On the other hand, those most subject to change are the least involved and the most likely to shift their preference on frivolous grounds.

Issues.—As to the content of politics, the important issues appear to be of two kinds—what have been called "position" issues and "style" issues. The former are typically of an economic sort, having to do with taxation, farm prices, labour-management relations and similar matters; that is, they are tied quite clearly to the socioeconomic position of the voter and they appeal to him, and have consequences for him, in that connection. Style issues deal more with matters of political taste, *e.g.,* civil liberties, prohibition, immigration, intergroup relations or government corruption; they are more likely to be tied to ethnic and regional considerations. Style issues are probably more likely to be crucial when position issues are quiescent, and the great historical issues, like slavery, contain elements of both.

At any given time, only a few issues are really in contention insofar as public attitudes are concerned. The adherents of opposing sides actually agree on a large number of matters of political importance—what the issues are, what is likely to happen, what criteria to judge by, what the rules of the political game are. The partisans differ on those issues that happen to be in the "political gateway" at the moment, for example, the rich man-poor man issues of the New Deal era. But neither the electorate, nor probably the system, can handle more than a few issues at any given time in a large and heterogeneous country.

U.S. Presidential Campaigns.—Now how does a brief presidential campaign in the U.S. reflect this view of the basis of voting, the stability of political preferences, and the content of the political program?

The campaign defines which issues shall be prominent, and even dominant, and each side seeks to get its definition accepted rather than its opponent's. One effect of this effort is that partisans increasingly agree with their own candidate by resolving "inconsistent" opinions in favour of the central party opinion, and even by misperceiving the candidates' positions on subsidiary issues in order to bring them into harmony with one's own preferences. Thus over-all, the campaign organizes many small disagreements into one big disagreement, namely, which party shall hold power. What starts as a mass of diverse opinions, with cleavages running every which way in the electorate, is organized by the campaign into a single basic difference of opinion between the two sets of party supporters.

The campaign reinforces the faithful: it recharges the interest of the already convinced and provides them with the political rationale currently active. The partisan tends to select his own side's material from that provided by communications mediums. Thus, the campaign not only reguarantees his basic vote but also transforms many partisans into effective personal campaigners within their own circles. The campaign brings into action the latent votes of those predisposed to one or the other side through their social identifications and associations; it thus "brings out" the vote, but only in a particular direction. It converts the doubtful, who, though few, often carry the balance of power in close elections.

The campaign has the polarizing effect of promoting consensus within social groups and cleavage between them. Under its impact, people come to agree more with people like themselves, in socioeconomic or ethnic terms, and to disagree more with people on the other side.

Thus, it is seen, the foundations of American political parties are in social groups with inter- and intragenerational solidarity, and political interests and social traditions reinforce one another by means of the campaign.

In summary, as it has been said,

The usual analogy between the voting "decision" and the more or less carefully calculated decisions of consumers or business men or courts may be quite incorrect. For many voters political preferences may better be considered analogous to cultural tastes—in music, literature, recreational activities, dress, ethics, speech, social behavior. Consider the parallels between political preferences and general cultural tastes. Both have their origin in ethnic, sectional, class, and family traditions. Both exhibit stability and resistance to change for individuals, but flexibility and adjustment over generations for the society as a whole. Both seem to be matters of sentiment and disposition rather than "reasoned preferences." While both are responsive to changed conditions and unusual stimuli, they are relatively invulnerable to direct argumentation and vulnerable to indirect social influences. Both are characterized more by faith than by conviction and by wishful expectation rather than careful prediction of consequences. . . . (Bernard Berelson *et al., Voting, a Study of Opinion Formation in a Presidential Campaign,* pp. 310–311, Chicago: University of Chicago Press, 1954.)

Implications for Democratic Theory.—Finally, what are the implications of this description of voting behaviour for the political theory of democracy? Some of the "requirements" for the democratic citizens were noted above, yet we find that taken by and large the citizens do not fulfill the standards. Substantial proportions of the electorate are not particularly interested in political matters, or well informed on them. They vote their class or regional or even religious interests rather than "the public interest." There is often little that is specifically political in the considerations that lead to their vote; the decision often arises out of a pervasive group understanding rather than a process of ratiocination. Indeed, it can be said that for many citizens the decision as to how to vote is not really an individual matter at all but a kind of collective decision in which a whole group of people, from the family to the social stratum, work their way to a final position without much conscious and deliberative thought.

This image of voting violates traditional ideals of democratic participation, yet the system works. What can be said about this seeming discrepancy?

The political philosophy we have inherited has given more consideration to the virtues of the typical citizen of the democracy than to the working of the system as a whole . . . Liberal democracy is more than a political system in which individual voters and political institutions operate. For political democracy to survive, other features are required: The intensity of conflict must be limited, the rate of change must be restrained, stability in the social and economic structure must be maintained, a pluralistic social organization must exist, and a basic consensus must bind together the contending parties. (Berelson *et al., ibid.)*

The classical tradition, in this view, demanded political virtue of the citizen in too extreme, too doctrinal and too general a form. What is required is a voting population that is not homogeneous but heterogeneous in its political quality. For example, as the system requires conciliation of opposing interests, it is facilitated by the people who are indifferent to political matters and thus provide a cushion between the partisans. As the system requires stability, it is furnished by the voters with strong party loyalties. As the system requires flexibility, it is facilitated again by the low-interest changers.

The need for heterogeneity arises from the contradictory functions we expect our voting system to serve. We expect the political system to adjust itself and our affairs to changing conditions; yet we demand too that it display a high degree of stability. We expect the contending interests and parties to pursue their ends vigorously and the voters to care; yet, after the election is over, we expect reconciliation. We expect the voting outcome to serve what is best for the community; yet we do not want disinterested voting unattached to the purposes and interests of different segments of that community. We want voters to express their own free and self-determined choices; yet, for the good of the community, we would like voters to avail themselves of the best information and guidance available from the groups and leaders around them. We expect a high degree of rationality to prevail in the decision; but were all irrationality and mythology absent, and all ends pursued by the most coldly rational selection of political means, it is doubtful if this system would hold together.

In short, our electoral system calls for apparently incompatible properties—which, although they cannot all reside in each individual voter, can (and do) reside in a heterogeneous electorate. What seems to be required of the electorate as a whole is a distribution of qualities . . . (Berelson *et al., ibid.)*

In this way the countless acts of voting behaviour performed by millions of individual voters add up to a working political system.

See also Electoral Systems.

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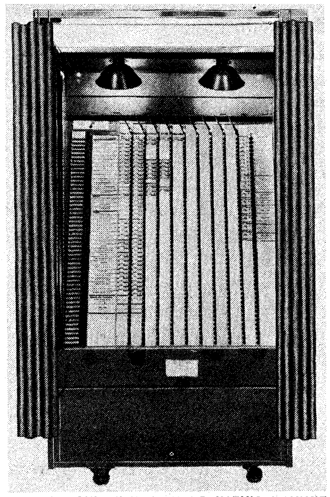
(B. R. B.)

VOTING MACHINES, devices that record and count votes cast in an election. Each voting machine is a complete polling booth and is surrounded with curtains to insure privacy. The entire list of candidates and referendum questions appears on the face of the machine in much the same way as on a paper ballot. Wear each candidate's name and near each question there is a pointer that the voter may move into position to indicate his preference. All machines also provide space for write-in votes. Within the machine are counters that record and count the votes for each candidate and question.

In using a voting machine the voter first steps into the booth and either pulls a lever or flips a switch that closes the curtains around him and simultaneously "opens" the machine to record his vote. He then moves the levers adjacent to the names of the candidates he wishes to support and the questions he wishes to vote on. If he makes a mistake or changes his mind while he is still in the booth he may raise any of the levers that he has moved and vote for a different candidate. When finished. he reverses the main lever or snitch; this returns the pointers to their original position, opens the curtains and registers his vote Each candidate's total vote accumulates throughout the election so that the final count is ready the moment the polls close and can be dispatched to central headquarters immediately. Each voting machine is inspected by the election officials before the voting begins and is sealed after the polls have closed and the total vote has been recorded.



BY COURTESY OF THE SHOUP VOTING MACHINE CORP.

A MODERN VOTING MACHINE WITH VERTICAL LISTING

Though voting machines have been used in Brazil. Cuba and the Netherlands, the United States is the only country in the world that has used them extensively. It is the only large and wealthy nation with enough elections of the right type to make their manufacture and use practical from an economic standpoint. Voting machines are most useful when the ballot lists many offices to be filled and many proposals to be voted on, though an extremely long ballot may exceed the capacity of the machines. In Great Britain, because of the short ballot and infrequent elections, voting machines have not found favour. In the United States, where a federal system is combined with the separation of powers, short terms of office, nomination by direct primaries and the exercise of local self-government. there is a multitude of elections. Nominal filing fees, the tradition of the long ballot and the availability of the initiative and referendum insure an even greater number of candidates and issues. And the system of majority representation permits the use of a voting machine of basically simple design.

Chief among the advantages claimed for voting machines are the folloning: (1) The results of an election are instantly available in every precinct. (2) The count is accurate. (3) The possibility of fraud or error is greatly reduced. (4) Because of the lessened opportunity for fraud or error, recounts are seldom called for and. when necessary, may be completed quickly and at little cost. (5) The machine prevents the voter from spoiling his ballot either by putting an "X" in the wrong place or by voting for more candidates than the law allows. (6) Over a period of years, election costs can be considerably reduced. partly through savings in the printing of tons of paper ballots and partly through economies resulting from the need for fewer election officials. Net savings are usually sufficient to amortize the cost within from 12 to 15 years. long before the expiration of the life of the machines.

Yet objections to the use of voting machines are raised. Those nho oppose their use point out that the initial cost is substantial—$1 500 to $1.800 for each machine. To this original cost must be added the expense of storage and, unless they are stored at the polling places. the cost of transporting them to and from the polling places at election time. The machines may reduce the possibility of fraud and error but. it is argued, they do not entirely eliminate it. It is also argued that machines discourage voting. Many voters. it is said. are reluctant to use the machines because they are unfamiliar with their operation and distrustful of them. In some elections, particularly primaries, there may be so many parties and candidates to be voted on that they cannot all be listed on the machines. In such cases paper ballots must be used instead of the machines. Some difficulty also arises in adapting machines to elections based on complicated systems of proportional representation (*q.v.*) nherein the voter may indicate a series of preferences rather than absolute choices. Machines can be designed to record and measure such preferences but their greater complexity, plus the limited market for them. has thus far made their manufacture commercially impracticable. Further difficulties arise in making provision for absentee voters to use voting machines.

Historical Background.— The first use of voting machines in the United States occurred in Lockport, N.Y., in 1892, when the Jacob H. Myers machine was used. Four years later voting machines were used in Rochester, N.Y. Although they were successful. the early machines developed slowly. chiefly because some nere defective in manufacture or were improperly installed and serviced. In some states the legality of voting machines was questioned on the ground that the state constitutional requirement that voting be "by ballot" meant that a paper ballot must be used. With rare exceptions, the courts rejected this line of argument.

During the first decade of the 20th century the various companies engaged in the production of voting machines were combined into a single firm in Jamestown. N.Y., known since 1923' as the Automatic Voting Machine company. This firm had the field to itself until the expiration of certain basic patents in 1929 opened the way a few years later for the Shoup Voting Machine company, the only other firm in the business.

It was estimated that approximately 100,000 machines manufactured and sold by these two companies were used in the election in Nov. 1960. Available in several sizes and operated either electrically or manually, they attained their most economical use in precincts having approximately 450 voters. The two makes have many similarities but it is perhaps worth noting that the older and more widely used Automatic machine employs horizontal listing and has its counters located in back while the Shoup models use vertical listing, after the manner of the paper ballots-used in most states. and have their counters in front directly under the names of candidates.

The use of voting machines in the U.S. depends upon state legislative action specifying conditions for their use and setting forth requirements the machines must meet. The machines are normally required to give the voter the same opportunities for choice allowed by the secret paper ballots. Use of machines, usually made optional nith local authorities, is mandatory in New York, Rhode Island. Connecticut. Delaware. Maryland and Louisiana. As of 1960, only Idaho, South Dakota and Alaska had made no provision for them. In that year it was estimated that about 60% of all U.S. voters cast their votes on machines.

See Spencer D Albright, *The American Ballot (1942)*; *The Book of the States* (biennial). (J. A. V.)

VOTKINSK, a town in the Udmurt Autonomous Soviet Socialist Republic, Russian Soviet Federated Socialist Republic, U.S S.R., on a tributary of the Kama river in 57° 5′ N., 53° 55' E. Pop. (1959) 59.000. It manufactures agricultural machinery and has railway and shipbuilding yards; it is the terminus of a branch railway

VOUET, SIMON (1590–1649), French painter, who established in France a modern baroque style of decorative painting, was born in Paris on Jan. 9, 1590. He formed his style in Italy, where he lived from 1612 to 1627 He began as a follower of Caravaggio in Rome but tended to use ampler, more idealized forms in the 1620s. The Sacchetti "Allegory of Intellect, Memory and Will" (1625) exemplifies this latter phase.

He returned to Paris in 1627 at the request of Louis XIII, who named him his first painter, and thereafter Vouet secured almost all the important commissions there, dominating the city artistically for 15 years and exercising an enormous influence. A new bourgeois class now had the means to build expensive town houses and wanted an artist able to manage large decorative schemes. Vouet supplied what nas needed. Engravings and surviving panels show that he had carefully studied Italian illusionistic ceiling decorations; for example, his work in the Château Chilly derived from Guercino's "Aurora"; that at the Hôtel Séguier (completed 1640) from S'eronese.

Vouet's original contribution was a baroque flourish and unity of organization. His other principal undertakings were in the Hôtel Bullion and Richelieu's palace at Rueil. He died in Paris on June 30, 1649.

His religious paintings of the early 1630s, for example, the "St. Charles Borromeus" (Brussels), show him to have been an artist with as developed a baroque style as any of his contemporaries in

Europe except Rubens—a style tempered, however, with characteristically French restraint. The "Madonna" in the Ashmolean museum, Oxford, and the "Diana" at Hampton Court palace well illustrate his soft, smooth and idealized modeling, his sensuousness, his use of bright colours and also his debilitating facility. See also PAINTING: France: 17th and 18th Centuries.

See Anthony Blunt, *Art and Architecture in France 1500–1700* (1953). (M. W. L. K)

VOW, a special obligation which a person voluntarily takes upon himself beyond and above regular religious duties and ceremonial, and often separate from them. A vow is usually taken in view of extraordinary circumstances and involves putting forth unusual effort or refraining from doing some usual actions. Its purpose is to overcome certain dangers, to ensure particular benefits or to serve as a means of spiritual self-discipline. The special intensity of practice and the individual voluntary character of a vow set it off from regular religious observances, such as the Christian observance of Lent and Moslem keeping of Ramadan (holy month), even though these are seasons of self-denial. If a person voluntarily binds himself to additional self-denial or duties during these seasons, however, such measures could be called vows.

Vows are to be found in almost all religious traditions. The Old Testament records many vows, among them that of Jephthah to sacrifice the first living being from his house to greet his return if God would grant him victory in battle (Judg. xi, 30–31). Hindus individually often vow special fasting or offerings to priests and gods on their sacred days.

It is common in Buddhism for laymen to take upon themselves some of the extra practices of monks, such as eating no solid food after midday and avoiding worldly entertainment for a day, week or month.

In addition to these there is also the long-term or even lifetime vow, particularly among special religious sects or orders. Among the Hebrews the Nazirites vowed not to cut their hair nor drink wine, sometimes for life (Num. vi). A Roman Catholic priest vows himself to chastity, and vows of chastity, poverty and obedience are taken in Roman Catholic religious orders and congregations. A Hindu sadhu (holy man) may vow never to lie donn to sleep. The Buddhist monk gives up all personal possessions except a few living necessities, begs his food and devotes himself to meditation and study. These are organized patterns of religious living; yet persons enter them voluntarily and live in them a life of erfort or self-denial, much beyond the standard required of ordinary believers. Hence such a life may be called a life of vow-fulfillment.

See also MONASTICISM. (W. L. KI.)

VRATSA, the capital of the district of Vratsa, Bulg., on the northern slope of the Stara Planina and on a small subtributary of the Danube. Pop. (1556) 26,582. Vratsa is an archiepiscopal see. Wine, leather and gold and silver filigree are manufactured, and there is a school of sericulture.

VRSAC (VERSEC), a town of Serbia, in the province of the Vojvodina, Yugos. Population (1961) 31,551, comprising Serbs, and Magyars. It is famous for its red wines and brandy. Large quantities of maize are grown in the district and some wheat and oats. There are flour mills and distilleries in the town, which also manufactures distilling and general mill machinery. It has a handsome church and is the seat of a Greek Orthodox bishop. During the revolution of 1848–49 the Hungarians defeated the Serbs there in 1848 and were themselves defeated and the town occupied by the Austrians in 1849.

During World War II the town, after the German invasion of Yugoslavia in 1941. was again under Hungarian control.

VUILLARD, JEAN EDOUARD (1868–1940), French artist, born in Cuiseaux, France, became famous for his paintings of French gardens and interiors.

In later years he painted the portraits of public men, including Camille Chautemps and Yvon Delbos.

His paintings were exhibited throughout Europe, and there were occasional exhibitions of them in the United States. His works were acquired by the Metropolitan Museum of Art in New York city and by museums of Buffalo, N.Y., and Cleveland, O.

Vuillard died in La Baule, France. on June 21, 1940.

VULCAN, the Roman god of fire (Volcanus), particularly in its destructive aspects as volcanoes or conflagrations. It is very doubtful that he was properly a deity of smiths, but poetically he is given all the attributes of the Greek Hephaestus (*q.v.*) and Virgil gives an elaborate description of his workshop (*Aeneid,* book viii, lines 416 ff.). His worship in Italy is undoubtedly very ancient. At Rome he had his own priest (*flamen*) and a festival on Aug. 23, the Volcanalia, which was marked by a rite of unknown significance. the heads of Roman families threw small fish into the fire, perhaps an appeasement offeringof creatures normally beyond the god's reach. The celebration took place in the Volcanal (area Volcani) in the northwest corner of the forum where fishermen brought fresh fish from the Tiber to sell on the occasion.

A second festival of Vulcan is indicated in the calendars on May 23.

He was invoked to avert fires, as his epithets Quietus and Mulciber (fire allayer) and his associations with Stata Mater, Ops Opifera and the Nymphae suggest. Since he was a deity of destructive fire his temples were properly located outside the city. As the city of Rome grew to embrace the Volcanal, a newer shrine including a temple was built in the Campus Martius outside the walls sometime before 214 B.C.

Vulcan was particularly revered at Ostia, where his was the principal cult.

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VULCANIZATION: see RUBBER: PRODUCTION AND MANUFACTURE; TIRE.

VULCI, an ancient town of Etruria, about 10 mi. N.W. of Tarquinii. The circuit of the walls measures about 4 mi., and scanty traces of them and of Roman buildings within them still exist. The Ponte della Badia over the Fiora, a bridge with a main arch of 66-ft. span, 98 ft. above the stream, is also Roman. An aqueduct passes over it.

About 1½ mi. above a dam was built for a hydroelectric plant to provide at least 6,000 h.p. The former wealth of the town is mainly proved by the discoveries made in its extensive necropolis—Greek vases, bronzes, etc.—many of which are now in the Vatican.

In 1828–56 more than 15,000 tombs were opened. These were entirely subterranean, but some of the chamber tombs were later re-examined and cleared. There is one great tumulus, the Cuccumella, and a few smaller ones. The frescoes from the François tomb, illustrating Greek and Etruscan myths, were preserved in the Museo Torlonia at Rome. Vulci was one of the 12 cities of Etruria. Coruncanius triumphed over the people of Vulsinii and Vulci in 280 B.C.

See S. Gsell, *Fouilles* dans *la nkcropole de Vulci* (Paris, 1891), for the excavations of 1889 (with copious references to earlier publications); Bendinelli in *Notizie degli Scavi,* p. 342 *et seq.* (1921).

VULGATE, a Latin version of the Bible prepared in the 4th century by St. Jerome and so called from its common use in the Roman Catholic Church (see BIBLE: Translations).

VULPIUS, CHRISTIAN AUGUST (1762–1827), German author, was born at Weimar on Jan. 23. 1762, and was educated at Jena and Erlangen. In 1790 he returned to Weimar, where Goethe. who had entered into relations with Vulpius' sister Christiane Vulpius (1765–1816), whom he later married. obtained employment for him. There Vulpius began. in imitation of Christian Heinrich Spiess. to write a series of romantic narratives. Of these, about 60 in number, his Rinaldo Rinaldini (1797), the scene of which is laid in Italy during the middle ages, was considered the best.

In 1797 Vulpius was given an appointment at the Weimar library, of which he became chief librarian in 1806. Me died at Weimar on June 25, 1827.

VULTURE, the name applied to a group of birds whose best-known characteristic is that of feeding on carrion. The American forms belong to the family Cathartidae and include the condor (*q.v.*), the California condor *(Gymnogyps californianus)*, the king vulture (*Sarcoramphus papa)* with a gaudily coloured head, the turkey buzzard or turkey vulture *(Cathurtes aura)* and the black buzzard, black vulture or carrion crow (*Coragyps atratus)*, the last two being familiar birds in southern United States. They resemble the European vultures in habits.

Old world vultures belong to the hawk family (Accipitridae). The cinereous vulture *(Aegypius monachus)* inhabits tropical and subtropical zones from the Straits of Gibraltar to China. The Egyptian vulture or pharaoh's hen (*Neophron percnopterus*), which ranges over most of Africa and thence to India, is a remarkably foul feeder. Numerous other species are known from Africa and southern parts of Europe and Asia.

Vultures have the head and neck bare of feathers. They locate food by sight rather than scent. When one circling bird descends to a corpse, others see and quickly follow. Vultures, gorged with food, are often unable to take flight. (G. F. Ss.)

VYATKA, R.S.F.S.R.: *see* KIROV.

VYAZMA, a town of the Russian Soviet Federated Socialist Republic, U.S.S.R.. in Smolensk *oblast,* at 55° 11' N., 34° 19′ E., at the confluence of the Berba and Vyazma rivers. It is a railway junction and has leather, oil pressing and match factories.

In the 11th century Vyazma was a trade centre linked with Narva on the Gulf of Finland. It was captured by Lithuania in the 15th century, but later became Russian. From 1611 to 1634 it was under Polish rule. Population (1956 est.) 26,700.

VYCPÁLEK, LADISLAV (1882–), Czech composer, was born at Vrsovice, near Prague, Feb. 23, 1882. One of the most serious and intellectual of modern composers, he leaned strongly toward mysticism and sacrificed both colour and euphony where necessary to polyphonic requirements.

His cantata Of *the Last Things of Man* (1921) may be described as a spiritual protest against the materialism that prevailed after World War I. It is based on Moravian folk music and consists of choruses and soprano and bass solos. Other works include a string quartet, opus 3; several sets of songs, among which were *Forebodings and Visions, Festivals of Life, In God's Palm* and *The Awakening;* Moravian folk songs and ballads and pianoforte pieces. Vycpalek joined the staff of the library of Prague university in 1907 and was appointed keeper of the music department in 1922, from which post he retired in 1942.

VYRNWY (FYRNWY), an artificial lake or reservoir in the northwest of Montgomeryshire, north Wales, 825 ft. above sea level. The lake, largest in Wales, is 5 mi. long and nearly 1 mi. wide. It was constructed in 1880–90 to supply Liverpool with water by damming the Vyrnwy river, a tributary of the Severn.

VYSHNI VOLOCHEK, a town of the Russian Soviet Federated Socialist Republic in the Kalinin *oblast,* in 57° 38' N.. 34° 33' E., on the Moscow-Leningrad railway and on the Vyshnevolotsk navigation system, constructed by Peter the Great in 1703–09 to connect the upper Volga with the Neva. The Mariinsk system largely superseded it. Sawmilling became the chief industry in this forested district, but textile, glass and brewing industries also were established there. Pop. (1956 est.) 60,000.

W THIS letter, as its name implies, was the letter *u* or *v*, which were identical until comparatively recent times, doubled and used by the Norman scribes to represent the English bilabial semivowel (modern *w*), which had previously been represented in the Saxon hands by a runic letter. The sound did not occur in the Romance languages. Latin had possessed it, but it had passed in imperial times into the voiced labial spirant (modern *v*). A separate symbol was thus required to represent the English sound, and the French preferred the doubling of one of their own letters to the use of the rune.

(B.F.C.A.; J.W.P.)

WA, a tribe inhabiting northeast Burma, between the Salween and the Nam Hsin rivers. They claim to be autochthonous and may represent the aborigines of northern Thailand and of Indo-china; old records and travelers (*e.g.*, McLeod in 1837) speak of them as the original inhabitants. Their village sites are still found covered with jungle. The people are short and dark. and may have Negrito blood in them. though speaking a Mon-Khmer language. They are popularly divided into wild and tame. The wild Wa are head hunters. Outside every village is an avenue of huge oaks. Along one side is a line of posts facing toward the path with skulls fitted into niches, cut sometimes in front sometimes behind the post. when there is a hole in front, through which the skull is visible. Skulls must be added annually if the crops are to be good; those of distinguished and pious men are the most efficacious. and head hunting (*q.v.*) takes place during the sowing season. Villages are high on the slopes of hills, usually on a knoll or spur. The only entrance is through a tunnel 30 to 100 yd. long, of which there are usually two at opposite sides of the village, about 5 ft. high. and so narrow that two persons cannot pass freely. sometimes winding slightly to prevent gunfire; the path is studded with pegs to prevent a rush. Tattooing is occasional only; divination is performed with chicken bones; dogs are eaten; polygamy is permitted. monogamy prevails and the tame Wa have five clans presumably exogamous.

See Scott & Hardiman. *Gazetteer of Upper Burma, etc.* (1900).

WAALS, JOHANNES DIDERIK VAN DER (1837–1923), Dutch physicist: who was awarded the 1910 Nobel prize in physics for his researches on the equations of conditions of gases and fluids, was born at Leiden, Nov. 23. 1837. A self-taught man who took advantage of the opportunities offered by the University of Leiden. he first attracted notice in 1873 with his treatise *Over de continuiteit van den gas-en vloeistoftoestand* ("On the Continuity of the Liquid and Gaseous State"), by which he gained his doctor's degree. He taught physics at various schools, and in 1877 he was appointed professor of physics in the University of Amsterdam, a post which he retained until 1907. Van der Waals built up a kinetic theory of the fluid state, he combined the determination of cohesion in Laplace's theory of capillarity with the kinetic theory of gases, and this led to the conception of the continuity of the liquid and gaseous states. Using this as a starting point he arrived at an equation of state which gave an explanation of critical phenomena and fitted in very well with the experimental observations of Andrews on carbon dioxide. Continuing this work he tried to arrive at an equation which would be the same for all substances. He eventually did this by using the values of the volume, temperature and pressure divided by their critical values. This led van der Waals to his statement of the "law of corresponding states" which enabled Sir James Dewar and Kammerlingh Onnes to determine the necessary data in the liquefaction of the permanent gases. He also discovered the law of binary mixtures. He died in Amsterdam on March 9, 1923. *See* also LIQUEFACTION OF GASES.

WABASH RIVER. The largest southward-flowing tributary of the Ohio river. the Wahash river rises in Grand lake in western Ohio. It follows a generally westward course across Indiana and eventually swings southward near the western boundary of the state. The total length of the Wabash is 475 mi.; for the last 200 mi. it serves as the boundary between Indiana and Illinois.

The Wabash drains an area of slightly more than 33.000 sq.mi. and has a number of important tributaries. The largest left-bank tributary is the White river, which drains a large portion of southern Indiana. The right-bank tributaries include the Little Wabash, Embarrass. Tippecanoe and Vermillion rivers. At Mt. Carmel, Ill. (75 mi. above the mouth of the river). the average rate of flow is 27.650 cu.ft. per second. The flow rate rises to a maximum of 127,000 cu.ft. per second in February and declines to a minimum of 3,990 in October.

During the 18th century the Wabash was well-known to the French in America, and it served them as an important transportation link between Louisiana and Quebec. After the War of 1812 the Wabash basin was rapidly developed by settlers from the eastern states and from Europe, and the river continued as an important artery of trade, both for flatboats and river steamers. River navigation almost completely disappeared after the coming of the railroads in the 1850s. Only the lower 75 mi. of the river is now utilized for barges carrying petroleum, sand and gravel.

The Wabash basin contains some of the richest commercial grain and livestock farm land in the American midwest. and its cities are well-known manufacturing and service centres. The most important communities on the river are Terre Haute, Lafayette and Vincennes.

Cities and industries located along the river's banks use the Wabash for water supply purposes. (R. R. D.)

WACE, ROBERT (?) (1100?–1175?), Anglo-Norman chronicler, was born in Jersey. He studied at Caen; he became personally known to Henry I, Henry II and the latter's eldest son Prince Henry; from Henry II he received a prebend at Bayeux and other gifts. Except for these facts he is known to us only as the author of two metrical chronicles in the Norman-French language Of these the earlier in date is the *Romun de Brut,* completed in 1155, which is said to have been dedicated to Eleanor of Aquitaine (ed. A. J. V. Le Roux de Lincy, 2 vol., Rouen. 1836–38). This is a free version of the Latin *Historia Britonum* by Geoffrey of Monmouth, in rhyming octosyllables; it was rendered into English, shortly after 1200, by Layamon, a Mass priest of Worcestershire, and is also largely used in the rhymed English chronicle of Robert Mannyng. Wace's second work, the *Roman de Rou,* written between 1160 and 1174, has a less fabulous character than the *Brut,* being a chronicle of the Norman dukes from Rollo to Robert Curthose. It has been ably dissected by Gustav Korting (*Über die Quellen des Roman de Rou*, Leipzig. 1867), who shows that it is mainly based upon Dudo and William of Jumièges. There is also reason for thinking that Wace used the *Gesta regum* of William of Malmesbury. Where Wace follows no ascertainable source for the material in his chronicles he must be used with caution. Undoubtedly he used oral tradition; but he also seems in various instances to have given free play to his imagination.

The *Roman* de Rou is written in rhyming octosyllables, varied by assonanced alexandrines. It has been edited by F. Pluquet (2 vol. and supplement, Rouen, 1827–29) and more completely by H. Andresen (2 vol., Heilbronn, 1877–79). (H. W. C. D.)

WACHSMUTH, CHARLES (1829–1896), U.S. paleontologist, born in Hanover, Germany. Sept. 13, 1829. In 1865 he paid a visit to Europe, where he decided to devote all his energies to the elucidation of the crinoidea, and did so with signal success. He made further extensive collections, and, together with Frank Springer (1848–1927), he published a series of papers on their studies of crinoids, also an extensive monograph on the *Revision of the paleocrinoida* (1879–86). After Wachsmuth's death on Feb. 7, 1896, appeared *The North American Crinoidea Canzerata* (2 vol. and atlas, 1897).

WACKENRODER, WILHELM HEINRICH (1773–1798), German writer, the fellow student of Ludwig Tieck (q *v.*) at Erlangen and Gottingen. Wackenroder inspired his friend with his own enthusiasm for the art of the middle ages. They aent to Berlin in 1794, and after the breach with Nicolai there in 1796, to Dresden The relation between medieval art and religion is the theme of Wackenroder's *Herzensergiessungen eines Kunstliebenden Klosterbruders* (1797). His early death, in 1798, was a great blow to his friend, who completed Wackenroder's fragmentary works.

See Wackenroder's *Werke und Briefe,* ed., in 2 vol., by F. von der Leyen (1910); P. Koldewey, *Wackenroder und sein Einfluss auf Tieck* (1904).

WACO, a city in north-central Texas, U.S., and seat of McLennan county, is situated on the former site of a Hueco Indian village, about 94 mi. S. of Dallas. Waco was an important Brazos river crossing on cattle trails after the Civil War. Originally an agricultural centre, it still depends partly on crops and livestock but a strong diversified industry has been added, including tire and glass manufacturing and smaller industries. It is a key highway hub for national and state roads. Settled in 1849 and incorporated in 1856, Waco adopted manager-commission government in 1924.

Baylor university, the largest Southern Baptist college, with medical branches at Dallas and Houston. moved to Waco in 1886–87 from Independence, Tex.. where it had been chartered in 1845 by the republic of Texas. Baylor's Armstrong-Browning library is noted for its collection of Robert and Elizabeth Browning lore Paul Quinn college, Texas' first Negro college, was established at Waco in 1872.

A violent tornado devastated Waco the afternoon of May 11, 1953. killing 114 persons, injuring 597 and doing more than $40,000 000 worth of property damage. The U.S. 12th air force headquarters, James Connally base and a U.S. Veterans' mental hospital are in Waco. Cameron park, 680 wooded acres, is one of the state's largest. A $2,000 000 Masonic Memorial temple is the site of annual Grand Lodge of Texas sessions. A steel-cable suspension bridge over the Brazos, opened in Jan. 1870. is still in use. Lake Waco, formed in 1923 by damming the Bosque river, is a popular recreational area just west of the city. Yearly weather temperatures vary considerably, but the mean annual average is about 67° F. and rainfall averages 30 to 35 in.

The population of Waco was 97,808 in 1960, an increase of 15.5% over 1950; that of the Waco standard metropolitan statistical area comprising McLennan county was 150.091, an increase of 15.3%. For comparative population figures *see* table in **TEXAS**: *Population.* (T. E. T.)

WAD, a black, earthy mineral consisting mainly of hydrated manganese dioxide, has been of importance as an ore of manganese. It varies considerably in chemical composition, and contains different impurities, often in large amount. A variety containing much cobalt oxide is called asbolite. while lampadite is a cupriferous variety. It is very soft, readily soiling the fingers, and may be considered as an earthy mixture composed chiefly of pyrolusite or psilomelane (*qq.v.*). It results from the decomposition of other manganese minerals and is often deposited in marshes ("bog manganese") or by springs. The name wad is of uncertain origin, and has been applied also to graphite.

WADAI, a region of north central Africa, is bounded north by the Sahara and east by Darfur province of Sudan, West and southwest it extended to Kanem and Bagirmi and southeast to Dar Runga. Formerly an independent Mohammedan sultanate, it was conquered by the French in 1909–10 and now forms part of the Republic of the Chad. By the French it was divided into the departments of Wadai and Batha. Total area about 91.000 sq.mi. Population (1951 est. natives only): Wadai, 461.400; Batha, 329,900.

Physical **Features.**—Wadai is for the most part a flat, dreary plain, about 1,500 ft. in altitude, part of the clay zone which covers much of the basin of Lake Chad. It is, however, traversed by ranges of hills nhich rise another 1,000 ft., and east and north is encircled by mountains—part of the ranges which stretch in a rough semicircle from Tibesti to Darfur. In the northeast Dar Tama rises to a plateau of 2.500 to 3,000 ft., with the peak of Niéré reaching 3,937 ft. The plains are mostly bush covered, but in places this gives way to long grass, with parklike regions in the west. The surface is often sandy, but there are considerable areas of black-cotton soil. To the south and east the land rises, and there are large forests, which, northward along the Darfur frontier, thin down to scrub. The northern region, bordering the Sahara, is semiarid, though much of it, watered by intermittent streams, affords good pasturage. There, on the northwest confines of Wadai, are remarkable sand ridges of fantastic shape—hollow mounds, pyramids. crosses, etc., which are characteristic of the Libyan desert. There are also sandstone rocks of varying colours—red, blue, pink, white, black—presenting the aspect of ruined castles, ramparts and churches. In the extreme northeast are some intermittent streams. with an easterly flow. There the Wadi Homr, in 16" N., marks the limit of vegetation—beyond, northward. is absolute desert. South of it are many similar wadis, their banks covered with thick thorn bush. And 75 mi. S. of Wadi Homr is a lake, 2 mi. long by 500 yd. wide, called Undur. This desert lake dries up for half the year. Apart from this northeast region, the country forms part of the Chad drainage area. The streams which rise in the northeastern districts, of which the Batha (more than 300 mi. long) is the largest, flow west, the Batha ending in a depression, about 200 mi. E. of Lake Chad, called Lake Fittri. Another stream, the Wadi Rime, with a more northerly course, goes in the direction of Chad, but ends in swamps in the clayey soil. The rivers of Dar Runga—a forested district south of Wadai proper—flow westward toward the Shari, but, save the Bahr Salamat. none reaches it. About 100 mi, above the Salamat-Shari confluence is Lake Iro. joined to the Salamat by a short channel.

The flora includes timber trees, numerous dum palms. mimosa, acacia, the tamarind, and many kinds of grasses. The cotton plant grows wild. and a species of wild coffee tree reaches 50 to 60 ft. and yields excellent berries. Among animals are large herds of gazelle; baboons are common. and elephants are found in the forest. Ostriches are found in the north, where the lion is also occasionally seen. Of birds, the most conspicuous are cranes (white, black and crested); storks are also common in some regions. Of domestic animals. the camel is common in the northern district, elsewhere the bull is used for transport. Horses, cattle, sheep and goats are numerous. Caterpillars are sometimes a plague, and there are visitations of locusts.

Inhabitants and Trade.—The inhabitants consist of Negroid and Negro tribes. Arabs, Fula, Tibbu and half-castes. The Maba, the dominant race, are said to be of Nubian origin; they live chiefly in the northeastern district, and in the days of the sultanate were allied with the Arab tribes, known in Wadai as Zoruk (dark) and Homr (red).

The capital, Abeshr, in the northeast, set on a plain surrounded by hills, is a town of two-storied mud brick buildings with flat, battlemented roofs and a fine market square. From Abeshr a caravan route crosses the Sahara via the Kufra oases to Bengasi in Cyrenaica. Another route, on the pilgrim way from west Africa to Mecca, goes east through Darfur to Khartoum. Maize, millet, cotton and indigo are cultivated, and cloth is woven. There is also an industry in leather goods. Ivory and ostrich feathers used to be taken to Tripoli by the desert route, together with small quantities of coffee and other produce. This trade has greatly decreased. There is a trade in cattle, horses and coffee with the Republic of the Sudan, with the regions to the south and with Nigeria.

Until the French conquest, Wadai mas a great centre of the slave trade. Slaves were obtained by raiding and in the form of tribute from Bagirmi, Kanem and other countries once dependent on Wadai.

History.—Wadai early became a meeting ground of Negro and Arab culture. Eastern influences and the Mohammedan religion ultimately obtained predominance, though the sovereignty of the country reverted to the Negro race. It was sometimes tributary to and sometimes the overlord of the neighbouring countries, such as Bagirmi and Kanem. It was made known to Europe by the writings of the Arab geographers, but it was not until Nachtigal's visit in 1873 that accurate knowledge of the land and people was obtained. About 1640 a Maba chieftain named Abd-el-Kerim conquered the country, driving out the Tunjur, a dynasty of Arabian origin. Thereafter Wadai suffered from many civil and foreign wars. The Senussi brotherhood, introduced by Mohammed Sherif, sultan from 1838 to 1858, gained a dominant position in Wadai.

In the last decade of the 19th century the French advancing from the Congo made their influence felt in Wadai, and by the Anglo-French declaration of March 21. 1899 Wadai was recognized as within the French sphere. Tnat state was then torn by civil wars. The Sultan Ibrahim was murdered in 1900, and Ahmed Ghazili became sultan. He ordered one of his rivals, the Emir Acyl, to be blinded, whereupon Acyl fled westward and entered into friendly relations with the French. A few months later (Dec. 1901) Ahmed was dethroned. With Doud Murra, who then became sultan, the French endeavoured to come to an understanding, and in Nov. 1903 the Wadaians agreed to recognize the possession of Bagirmi, Kanem, etc., by France. However, in the spring of 1904, acting, it is believed, at the instigation of the Senussi, the Wadaians attacked French posts in the Shari region and carried off many slaves. Intermittent fighting continued for years. It resulted in strengthening the position of the French and of their ally Acyl, and in 1908 Doud Murra, again, it is stated, at the instigation of the Senussi, proclaimed the *jihad*. His army was split up under *aguids* (feudal lords), and was beaten in detail.

By 1912 Wadai had been completely pacified by the French and the once powerful sultanate was abolished, though the sultans of the petty states, such as Dar Tama, between Wadai and Darfur retained their authority under French protection. In the years 1913 and 1914 a terrible famine caused immense loss of life. Col. Jean Tilho says "the population of Wadai, put by Nachtigal at more than 2,000,000 in 1872, had fallen to 300,000 when I went that way [in 1917]." Abeshr then "retained few traces of its ancient splendour," though it was later gradually rebuilt by the French. Wadai was but little affected by Senussi activity during World War I. The occupation of Darfur by the Sudan government in 1916 led to better order in the borderlands, and to the demarcation of the frontier in 1923. The French had rigorously suppressed slave trading, but other trade gradually increased, especially with the Sudan.

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WADDINGTON, WILLIAM HENRY (1826–1894), French statesman, was born at St. Remi-sur-l'Avre (Eure-et-Loir) on Dec. 11, 1826. He was the son of a wealthy Englishman who had established a large spinning factory in France and had been naturalized as a French subject. After receiving his early education in Paris, he mas sent to Rugby, and thence to Trinity College, Cambridge. He undertook travels in Asia Minor, Greece and Syria, the fruits of which were published in two *Mémoires,* crowned by the Institute, and in his *Mélanges* de *numismatique et de philologie* (1861). His other archaeological works include the *Fastes de l'empire romain,* and editions of Diocletian's edict and of Philippe Lebas's Voyage *archéologique* (1868–1877). He was elected in 1865 a member of the Académie des Inscriptions et Belles-Lettres.

After standing unsuccessfully for the department of the Aisne in 1865 and 1869, Waddington was returned by that constituency at the election of 1871. He was minister of public instruction in the short-lived cabinet of May 19, 1873, and in 1876, having been elected senator for the Aisne, he was again entrusted by Dufaure with the ministry of public instruction. His most important project, a bill transferring the conferment of degrees to the state, passed the Chamber, but was thrown out by the Senate. He continued to hold his office under Simon, with whom he was overthrown on seize *mai* 1877. (See SIMON, JULES FRANÇOIS.)

Waddington was minister of foreign affairs under Dufaure and a French plenipotentiary at the Berlin Congress. He obtained, from Lord Salisbury, a promise that Great Britain in return for Cyprus would allow France a free hand in Tunis. Early in 1879 Waddington succeeded Dufaure as prime minister but held office only by sufferance of Gambetta, and had to retire in December. In 1883 he accepted the London embassy, which he continued to hold till 1893, showing an exceptional tenacity in defence of his country's interests. He died on Jan. 13, 1894. His wife, an American lady, whose maiden name was Mary A. King, wrote some interesting recollections of their diplomatic experiences—Letters of *a* Diplomatist's Wife, *1883–1900* (New York, 1903), and Italian Letters (London, 1905).

WADE, BENJAMIN FRANKLIN (1800–1878), American statesman, was born near Springfield, Mass., on Oct. 27, 1800, of Puritan ancestry. He was reared on a farm, receiving little systematic education, and in 1821 he removed with his family to Andover, in the Western Reserve of Ohio. In 1825 he began the study of law at Canfield, was admitted to the bar in 1827, and began practice at Jefferson, Ashtabula county, where from 1831 to 1837 he was a law partner of Joshua R. Giddings, the anti-slavery leader. From 1851 until 1869 he was a member of the U.S. Senate, first as an anti-slavery Whig and later as a Republican. In the Senate Wade was from the first an uncompromising opponent of slavery, his bitter denunciations of that institution and of the slaveholders receiving added force from his rugged honesty and sincerity. His blunt, direct style of oratory and his somewhat rough manners were characteristic. After the outbreak of the Civil War he was one of the most vigorous critics of the Lincoln administration. He advocated the immediate emancipation and arming of the slaves, the execution of prominent southern leaders, and the wholesale confiscation of Confederate property. In 1864, with H. W. Davis (*q. v.*), he secured the passage of the Wade-Davis Bill (for the reconstruction of the southern States), the fundamental principle of which was that reconstruction was a legislative, not an executive, problem. This bill was passed by both houses of Congress, just before their adjournment, but President Lincoln withheld his signature. Soon afterward (Aug. 5) Wade and Davis published in the New York Tribune the famous "Wade-Davis Manifesto," a vituperative document impugning the President's honesty of purpose and attacking his leadership.

As long as President Johnson promised severe treatment of the conquered South, Wade supported him, but when the President definitively adopted the more lenient policy of his predecessor, Wade became one of his most bitter and uncompromising opponents. In 1867 he was elected president *pro tem* of the Senate, thus becoming acting vice president. He voted for Johnson's conviction on his trial for impeachment, and for this was severely criticized, since, in the event of conviction, he would have become president; but Wade's whole course before and after the trial would seem to belie the charge that he was actuated by any such motive. After leaving the Senate he resumed his law practice He died at Jefferson, O., on March 2, 1878.

See A. G. Riddle, *Life of Benjamin F. Wade* (Cleveland, O., 1886).

WADE, GEORGE (1673–1748), British field-marshal, was the son of Jerome Wade of Kilavally, Westmeath, and entered the British army in 1690. He was present at Steinkirk in 1692, and in 1695 he became captain. In 1702 he served in Marlborough's army, earning particular distinction at the assault on the citadel of Liége. After service in Portugal, Minorca, and Spain, Wade, as major-general, was military governor at home during the Jacobite rebellion of 1715. He twice detected important Jacobite conspiracies, and on the second occasion procured the arrest of the Swedish ambassador in London, Count Gyllenborg. In 1719 he was second in command of the land forces in the "conjunct" military and naval expedition to Vigo. In 1724 he was sent to the Highlands where he began the system of metalled roads which is commemorated in the lines—

> Had you seen these roads before they were made,
> You would lift up your hands and bless General Wade.

Wade superintended the construction of 40 stone bridges and with great tact. disarmed the clans. In 1742 he was made a privy councillor and lieutenant general of the ordnance, and in 1743 field marshal. In this year he commanded the British contingent in Flanders, and was associated in the supreme command with the duke d'Aremberg, the leader of the Austrian contingent. The campaign, as was to be expected when the enemy was of one nation, superior in numbers and led by Saxe, was a failure, and Wade, who was 70 years of age and in bad health, resigned the command in March 1744.

King George II promptly made him commander in chief in England. and in that capacity Field Marshal Wade had to deal with the Jacobite insurrection of 1745, in which he was utterly baffled by the perplexing rapidity of Prince Charles Edward's marches. On the appointment of the duke of Cumberland as commander in chief of the forces, Wade retired. He died on March 14, 1748.

WADELAI, a village in the British protectorate of Uganda on the west bank of the Nile. 1 mi. N. of the mouth of the Ora river. It was first visited by Lieut. H. Chippindall, an assistant of C. G. Gordon, in March 1875. Now largely abandoned, it was a much disputed place during the mahdi rebellion. In 1885 Emin Pasha made it his fortified headquarters (the old perimeter trench may still be seen in an air photograph).

For three years Wadelai was the headquarters of the Egyptian Equatorial province. After Emin Pasha's withdrawal with Sir Henry Stanley in 1889. Wadelai remained under the control of the mutinous troops commanded by Fadi el Mula Bey, who eventually enlisted in Belgian service. Following the Anglo-Belgian agreement of May 12, 1894. Wadelai became a station of the Congo Free State; in 1910, a year after the death of King Leopold II, ruler of the Congo Free State, it was incorporated into the Anglo-Egyptian Sudan, and in 1914 it was finally transferred to Uganda. (H. A. WF.)

WADHWAN, a town in Zalawad district, Bombay state, India; pop. (1951) 23,381. It is a manufacturing and railway centre approximately 60 mi. N.E. of Rajkot and about 100 mi. W.N.W. of Baroda.

The petty state of WADHWAN (area 242 sq.mi.; pop., 1941, 50,915). of which the town was capital. was within the Eastern Kathiawar subagency of the combined Baroda, Western India and Gujarat states agency prior to its absorption into the state of Saurashtra on Feb. 15, 1948, and part of Bombay state in 1956.

WADI HALFA or HALFA, a town of Sudan on the right bank of the Nile. About 6 mi. above the town is the second cataract, and on the west bank of the Nile opposite Wadi Halfa are the ruins of the ancient Egyptian city of Buhen. Wadi Halfa is the northern terminus of the Sudan railway and the southern terminus of a steamboat service on the Nile, which, running to Shellal (Aswan), connects there with the Egyptian railways. Pop. (1956) 11,006.

WAFER. A thin flat cake or biscuit. As articles of stationery, wafers consist of thin, brittle, adhesive disks. used for securing papers together and for forming a basis for impressed official seals.

These wafers are made of a thin paste of very fine flour, baked between wafer irons over a charcoal fire till the thin stratum of paste becomes dry and brittle and the flour starch is partly transformed into glutinous adhesive dextrin. The cake is cut into round disks with suitable steel punches.

WAFER ASH (Ptelea trifoliata), a small North American tree of the rue family (Rutaceae, *q.v.*), called also shrubby trefoil and hop tree! found from New Tork and southern Ontario to Nebraska and south to Florida, Arizona and Mexico, and often planted for ornament.

While often shrubby, the plant sometimes grows to a height of 2j ft. and bears strong-smelling, long-stalked trifoliate leaves and greenish-white flowers in dense clusters. The somewhat hoplike fruit is a nearly orbicular samara with a membranous, netted-veined wing. about three-quarters of an inch broad.

WAGER: see GAMBLING AND BETTING.

WAGES. Wages are the remuneration for the expenditure of effort in the production of goods and services. In precise economic terminology, wages are the price of labour. The effort of the wage earner may be physical, mental or a combination of the two; it may be under another's direction or may be of a managerial and decision-making character. But whatever his specific occupation, the wage earner supplies some form of human contribution to production, and wages are the reward for this contribution. If wage earnings of individuals are added together in order to obtain the total wage bill of an economy, the resulting total determines how much of the national product goes to labour and how much is available, by implication, to the other factors of production — natural resources (land) and capital.

Because all except the most rudimentary economies exhibit specialization and differentiation in the kinds and amounts of labour contributed by the various individual wage earners, there are wide differences in the wage rates received by individual workers. The wage structure of a national economy — the schedule of wage payments within it—is thus highly complex.

Not only is any given national wage structure characterized by conspicuous wage differences, but these differences themselves vary from country to country and within a given country over a period of time. Such variation may be ascribed in part to differences in technology and methods of production as well as to differences in the composition of the total output of the economy. Job classifications which are significant in one economy are often found to be unimportant in another that is in a different stage of technological advancement.

Wages represent the major if not the sole source of money income for a large portion of wage earners. The wage structure of an economy, therefore, is one important determinant of the distribution of income prevailing in it.

The general level of wages can be taken as a useful estimate, at least, of the average economic well-being. Similarly the differentials in the wage structure: which determine the way in which the total labour income is distributed among its recipients. correspond approximately to differences in living standards. Viewed in this light, wages have social as well as economic implications by virtue of their impact on the welfare and conditions of life of wage earners.

A distinction is frequently made between money and real wages. The term "money wages" refers to the amount in dollars and cents, or other appropriate monetary units, that workers receive. The term "real wages" refers to the quantity of goods and services that can be purchased with money wages. Thus real wages involve a relationship between money wages and the retail price level or the cost of living.

THEORIES OF WAGES

The general level of real wages in an economy depends on three factors: the size of the total national product; the portion of the product accruing to labour; and the size of the labour force. These three wage determinants are not independent, however, and a major point of difference between various wage theories lies in their varying premises as to the interrelations between the basic factors.

All economic theories are conditioned, moreover. by the institutions of the economy in which they are conceived, and wage theories in particular are derived in part from the role that wages play in the functioning of the economy.

Pre-19th-Century Theories. — The wage theory of St. Thomas Aquinas, a leading representative of medieval thought, was a natural outgrowth of his philosophy of 'a static society characterized by rigid class structure. The "just wage" of St. Thomas was included in his general concept of "just prices" and indeed was developed as a central element in it. In this doctrine customary practice played the dominant role, and competitive forces were for the most part excluded. Thus the just wage was defined as that which permitted its recipient to live in a manner appropriate to his position in society. Although this doctrine was associated with a social organization based on status, its implication that the worker's cost of living should be a first charge on production had an interesting echo in the minimum-wage legislation of the 20th century.

In the tradition-oriented society envisaged by St. Thomas, wages had a single function — that of distributing income. The type of work an individual performed, as well as his place of work, was largely predetermined by his birth.

In a dynamic economy, however, wages have a second function — that of allocating labour to the various occupations and productive enterprises. As employers bid for labour and as workers seek employment, pressures are created that produce alterations in the wage structure. The effects of such pressures were discernible even in the middle ages, despite the fact that custom, guild rules and city and state regulations were important wage determinants in that period.

The mercantilists — economists who flourished in the period of commercial development and the emerging nation-states — were more preoccupied with commerce and the balance of trade than with wages. Wages entered their writings primarily as a cost of production, and the low-wage doctrine which they tended to espouse was linked with their emphasis on the importance of maintaining favourable positions in foreign trade.

The physiocrats — 18th-century economists credited with introducing the doctrine of *laissez* faire — emphasized agriculture as the natural economic activity of man. Such physiocrats as François Quesnay and Anne Robert Jacques Turgot believed that the landless labourer was in so unfavourable a bargaining position relative to the employer that his wage would never far exceed the level of bare subsistence.

Adam Smith, the greatest and most influential advocate of a free-enterprise economy, did not develop a precise theory of wages. Instead, he anticipated in the Wealth of Nations (1776) a variety of later theories. Wages depend. he said in effect, on supply and demand, on the competition of workers for jobs and of employers for labour. This competition presumably is desirable, as a manifestation of the pursuit of individual self-interest through which members of society are led "as by an invisible hand" to make the greatest contribution to the national wealth. Thus by piecing together various passages of the Wealth of Nations one discovers a foreshadowing of the doctrine that wage rates established by competition lead to an optimum allocation of labour. But this was implied only, for Smith also asserted that in the bargaining bet een employers and labour the advantage lies almost invariably with the employer. He pointed, also, to the propensity of employers to unite in attempts to reduce wages.

Subsistence Theory of Wages. — The earliest of the modern wage theories, the subsistence theory, was also the gloomiest. In its most stark and primitive form, it stated that real wages tend to hover about the bare minimum required for physical subsistence. The subsistence theory had already appeared in the writings of the mercantilists — Thomas Mun, for example — as well as in those of some of the physiocrats. It remained for David Ricardo, an English economist, to formulate the theory precisely and in an internally logical fashion.

Ricardo deduced the subsistence theory of wages from the population theories of a contemporary, Thomas Robert Malthus. Malthus had maintained that population, if unchecked, tends to double itself about every 25 years, while food supply, produced under conditions of diminishing returns, increases more slowly.

In Ricardo's view any increase in real wages could be only temporary. With higher wages, living standards would rise and population would expand proportionately. The increase in the supply of labour would again push wages down to the point of bare subsistence. Thus in the long run all temporary gains in real wages would be wiped out by an increase in the amount of labour. The subsistence theory held sway for a number of years. Its pessimistic conclusions caused Thomas Carlyle to speak of "the dismal science of economics."

Malthus and Ricardo lived at a time early in the Industrial Revolution when population in western countries was growing at an extraordinarily rapid rate and when technological development was in its infancy. Later trends proved conclusively that their premises have no general validity. Population did not continue to increase at the predicted rate. technological advance led to greatly increased productivity and real wages rose substantially. The Ricardian thesis may contain more than a grain of truth, however, when applied to some of the less-industrialized areas of the world.

Though Ricardo formulated a blunt statement of the subsistence theory, he—as well as Malthus — also advanced a suggestion which sensibly attenuated it. He implied that, in countries where expanding productivity had permitted workers to become accustomed to a standard of living above that required for physical subsistence, the birth rate might tend to adjust itself to this fact,

The subsistence theory in its unmodified form recurred, however, in the works of Karl Marx, whose intellectual debt to Ricardo was considerable. Marx, however, regarded the subsistence theory not as universally valid but as descriptive of wages under capitalism. Ferdinand Lassalle, another important 19th-century figure in the development of socialist thought, likewise enunciated this doctrine, which he termed the "Iron Law of Wages" under capitalism.

Wages Fund Doctrine. — Around the middle of the 19th century, as the subsistence theory approached the end of its vogue, the wages fund doctrine was developed. It became prominent in the writings of John Stuart Mill and his contemporaries. The doctrine was to some extent an outgrowth of the concept of capital developed by Nassau William Senior. He regarded capital as abstinence from consumption, and as providing the fund from which employers advance wages to labourers.

The wages fund doctrine held that the total amount available for wages is constant in the short run. Thus the average wage of workers is determined by this constant fund divided by the number of workers. In its simplest form, the doctrine held that the wage fund or total wage bill is predetermined by the money that employers of labour set aside for wages.

It was believed that in the long run the wage fund would increase in proportion to the growth of capital. A larger amount of savings and investments would lead to a larger predetermined wage fund and therefore to higher wages.

The wages fund doctrine was never as clear-cut as the subsistence theory of wages. Given its premises, the subsistence theory was valid. In contrast, the wages fund doctrine as expressed by its proponents was full of ambiguities, and the meanings of its terms were frequently unclear.

It was not until the end of the 1860s. however, that the doctrine was seriously questioned. Among the writers who attacked it were William Thomas Thornton, a British economist, and Francis Amasa Walker, a U.S. economist, both of whom criticized the theory on technical grounds.

Another reason for the vigorous criticism of the theory was that it provided little hope of raising wages through union activities. If there was indeed a predetermined wage fund, the only hope of improving the lot of labour lay in patiently awaiting either the accumulation of capital or a decrease in the number of workers among whom the fund was divided.

At a time when labour unrest was conspicuous in England, this conclusion of the theory could not fail to attract attention. Mill himself recanted the wages fund theory in 1869 in a famous review of Thornton's book, On Labour. This action contributed to the decline of the theory's influence.

It must be conceded, however, that there is a germ of truth in the wages fund doctrine. Wages are certainly related to productivity, and availability. of capital is one factor determining productivity. The fatal weakness of the doctrine, however, lay in its failure to show that there is a determinate wage fund. It failed to establish any inevitable quantitative relationship between a wage fund and the amount of capital or between the total national product and the proportion of the product that goes to labour.

Marginal Productivity Theory. — The subsistence theory of wages and the wages fund doctrine each focused attention on a single determinant of wages — labour supply and demand, respectively. The marginal productivity theory, on the contrary, was an ambitious attempt to explain not only the general level of wages but the entire wage structure of a highly competitive economy in terms of the interaction of supply and demand. Developed toward the end of the 19th century, it gained such general acceptance among economists that it practically replaced all other wage theories. The 20th century, however, witnessed a considerable revolt against both its applicability and the conclusions following from it. Even so, it remained a widely held theory of wages; for one reason, because its most severe critics were not able to offer an acceptable alternative.

Rudiments of the theory can be found in the writings of several precursors, notably in those of the German economist, Johann Heinrich von Thunen. which appeared in 1826 but attracted little notice. More importantly. the theory rests on general methods of marginal analysis that were the contribution of the Austrian school of economists in the last half of the 19th century. A well-rounded statement of the marginal productivity theory of distribution to all productive factors, including labour, was first developed toward the end of the 19th century by the British economist, Philip Henry Wicksteed. and by the U.S. economist, John Bates Clark.

In its treatment of supply, the marginal productivity theory embodies elements that are common to all 20th-century wage theories, as follows: The supply of labour to an economy depends on the number of individuals who want to work and are available for work, the efficiency of workers and the hours of employment. Each of these factors is subject to substantial long-run variations. On the basis of available data, however, it appears unlikely that the total labour supply at any time is significantly altered by changes in the general wage structure. On the other hand, the supply of labour to a firm, an occupation, an area or an industry is closely related to the prevailing wage structure. In describing this relationship, economists use the term "mobility." Labour mobility is the tendency for workers to move from job to job in response to relative advantages in the terms of employment. If labour is highly mobile, differences in wages between two firms, all other things being equal, cause workers to move from the low-wage to the high-wage firm until the differentials are eliminated. Wage differences, however, are not the sole factor that may induce worker movement. Differences in working conditions or in the ease or attractiveness of jobs may also account for worker behaviour which is characterized by mobility.

On the other hand, purely random movement is not so characterized. It must be emphasized that mobility is not gauged by the amount of movement, but by the degree to which existing job differences call forth worker movement.

The distinguishing characteristics of the marginal productivity theory appear in the analysis of the demand for labour. The analysis begins by considering the individual business firm, the basic productive unit in the economy. The largest and most significant portion of labour is hired by firms which produce goods and services for sale to consumers or to other producers. The demand for labour on the part of such employers exists because of the value of labour's contribution to the output of the firm.

In the simplest case, it is assumed that the firm can sell all its output at a certain price—a price independent of the amount produced by the single firm. Furthermore, it is assumed that the firm can hire any amount of the type of labour it requires at a certain rate—a rate on which its own decision has no effect.

Given these assumptions, the theory predicts the amount of labour a firm will employ. The familiar law of diminishing returns plays an essential role. This law, applied to labour, states that (all other things remaining equal) the net addition to total output which is obtained by hiring an additional employee decreases, at least beyond a certain point, as the number of employees increases. Here enters the marginal product from which the theory derives its name. The "marginal physical product" is the addition to the total output of the firm which is obtained by employing one additional worker (more rigorously, an additional unit of labour). All other elements in the production process are assumed to be held constant. The value of the marginal product is the value of this additional output.

Assuming that the employer behaves in such a manner as to obtain maximum profits—an assumption which underlies all analyses of this type—then it is clear that he will continue to hire additional labour so long as the revenue produced by the addition of a worker exceeds the cost—determined by the wage rate—of hiring him. The law of diminishing returns leads to the conclusion, however, that the employer will not continue to hire more workers indefinitely.

Though each additional worker increases the total product, the increase in output becomes smaller, as more and more workers are added. The law of diminishing returns predicts. in other words, that the marginal physical product, and therefore the value of the marginal product, decreases as the number of workers increases. Hence eventually the cost of hiring an additional worker will exceed the revenue gained by doing so.

It must be emphasized that the marginal productivity theory, as applied to the firm, does not yield the wage the typical employer will pay, but rather the amount of labour he will hire at a given wage. The higher the wage, the less labour he will employ. A decline in wage rates will produce an increase in the amount of labour hired (and in output); an increase in wage rates will have an opposite effect.

In order to generalize on this conclusion to embrace the entire economy, it is necessary to make several simplifying assumptions in addition to the ones already made: that no firm, by its own decisions, can affect the price of the commodities it sells or of the labour it hires. It must also be assumed that labour is completely mobile and that employers and employees have knowledge on which to judge their best interests. These assumptions are bracketed together under the term "perfect competition." Under such conditions it is possible to develop a logical theory to explain the wage rates that will prevail in the economy as a whole.

The total demand for any given type of labour will be the aggregate demand of employers and will be related to the wage rate. At the same time, the number of workers available will vary directly with the wage rate. Supply and demand, in other words, each depend on the wage rate—the one rising, the other falling as the wage rate rises. At a certain wage the supply of labour offered exactly matches the amount of labour hired. In the absence of barriers to the free operation of competitive forces, this rate will actually obtain.

Under conditions of perfect competition, the equilibrium wage structure has two essential properties. First it "clears the market" in the sense that there is no unemployment or underemployment (employment at a rate below that obtained by other individuals possessing the same skills). Furthermore, it is associated with an allocation of labour which is the most efficient possible—given the existing income distribution and schedule of consumer wants. It must be emphasized that no moral or ethical properties are ascribed to this rate—the wage rate is simply part of the total price structure in the economy and has in the last analysis no more ethical content than the system of consumer demand underlying the entire edifice.

It has never been maintained, even by the most fervid devotees of this economic doctrine, that the rigid assumptions of perfect competition are actually fulfilled in any existing economy. However, some economists have made two claims. First, the theory is said to yield results that approximate reality with fair accuracy. Wage rates, it is claimed, do not deviate far in most instances from those which the theory would predict. Second, it is asserted that in instances where wages above competitive levels have been established by union pressure, law or other means, a misallocation of labour has resulted.

The original marginal productivity analysis was modified and enriched by the development in the early 1930s of techniques for analyzing certain cases in which the conditions of perfect competition do not prevail. The theory of imperfect or monopolistic competition was evolved almost simultaneously by Joan Robinson in England and Edward H. Chamberlin in the United States. It furnished insight into two situations—referred to in technical writings as monopsony and oligopoly—in nhich wages may be increased—all other things remaining equal—without an attendant decline in employment.

Monopsony occurs when a single employer (or a group of employers acting in formal or informal collusion) exercises control over the labour market sufficient to influence wage rates by his own policies. Roughly speaking, such control reduces the effect of employer competition for labour as an upward pressure on wages. Monopsony might be present, for example, where one employer hires the major portion of the labour force in a community and where movement of workers from the area is difficult.

Oligopoly exists where a few large firms produce the entire output of a commodity. Under such circumstances each firm must expect that its decisions as to output and price will cause a reaction on the part of its competitors. In consequence, the relationship between the wage rate and the volume of employment ceases to be well defined.

Criticisms of the Marginal Productivity Theory.—Like the wages fund doctrine, the marginal productivity theory admits the possibility that steady increases in real wages may occur as a result of increasing productivity. On the other hand, it offers little satisfaction to those who seek to raise the general level of wages above that which would result from the operation of competitive forces at any particular time. For it asserts that the payment of wages above the competitive level to any part of the labour force must carry with it the certainty of unemployment, misallocation of labour or both.

Ever since the theory emerged, there has been considerable interest in wage raising via minimum-wage legislation and union organization. To accept the marginal productivity theory without reservations is in effect to renounce the aspiration to alter wage rates through either of these channels. It is not, therefore, surprising that there have been vociferous criticisms of the theory. These generally take three forms.

First, the assumptions of the theory are sometimes challenged. It is asserted, for example, that not all business conduct can be interpreted in terms of profit maximization. It is also asserted that the marginal product is technically difficult if not impossible to determine in substantial sectors of the economy. Moreover, it is pointed out that business decisions are not predicated on present prices but on estimates of the future.

Second, some critics of the theory believe that wage rates not only are affected by productivity but that they affect it in ways not incorporated in the marginal productivity theory. Increased wages may make employees more efficient, for example. They may, moreover, make employers more efficient. A wage increase which occurs because of government regulation or union intervention may "shock" an employer into introducing improved techniques of production rather than reducing his labour force. This is particularly true where competitive forces are not very strong.

Third, the applicability of the theory in a dynamic economy is questioned by a number of critics. It is maintained that in such an economy market forces are subject to rapid change. Other things may not remain the same, and consequences predicted by the theory may fail to materialize.

Bargaining Theory of Wages.—The labour market, in marginal productivity analysis, is regarded as the market for a factor of production and as amenable to the general techniques appropriate to the study of such markets. According to the bargaining theory of wages, on the contrary, the labour market can be understood only by a careful consideration of those elements which distinguish wage determination from the determination of other prices in the economy.

Traces of the bargaining theory—like most others—are discernible in Adam Smith. Thornton, too, in attacking the wages fund doctrine asserted that the power of employers to combine easily and the inability of most workers to postpone accepting employment even at unfavourable terms are factors acting to depress wages. In 1898 John Davidson developed at some length a theory that wages are the result of bargaining between employers and employees and that no simple principle of economic analysis is capable of explaining this process adequately.

Exponents of the bargaining theory believe that there can at best be described upper and lower limits between which the rate for a given type of labour must lie. Within this range, the precise wage paid is said to depend on the relative bargaining power of labour and employers. The greatest weakness of the bargaining theory of wages lies in its failure to define the limits precisely or to estimate the range between them. The upper limit becomes simply that rate above which the employer will refuse to hire a certain group of workers, the lower limit the rate below which workers refuse to work. Supply and demand analysis appears thus to enter by the back door, so to speak, in the formulation of the limits. Because, however, the theory supposes a range between the limits, a range created essentially by the various impediments to perfect competition, there is room for workers to raise wages or for employers to lower them, depending on which has superior bargaining power.

The bargaining theory offers a powerful theoretical justification for union organization. For the theory admits the possibility that wages may be increased without untoward effects on employment, and it suggests that such an increase may actually be possible if labour is able to augment its bargaining strength. Moreover, the theory embraces the possibility of achieving desirable results through minimum-wage legislation.

Purchasing Power Theory.—The purchasing power theory of wages is one not of wage determination but rather of the relation of wages to the level of economic activity. That wages affect consumer demand for goods is easy to perceive. The lower an individual's income. the greater tends to be the proportion of it that goes toward consumption. Thus, higher wages received by lower income groups will tend to increase consumer demand. This fact was long used by unions as an argument for high wages.

The argument, however, that low wages might lead to depression did not achieve professional status until the British economist John Maynard Keynes developed his general theory of the business cycle during the 1930s. Keynes attributed the business cycle to an unbalance between three quantities: consumption, savings and investment.

Certain followers of the Keynesian analysis, by highlighting consumption, gave additional substance to the purchasing power theory. Even so, the theory did not gain universal acceptance. Debate continued to prevail, for example, as to whether a suitable wage policy during depression would be to raise wages in order to increase buying and stimulate employment or to lower them in order to decrease costs and stimulate employment.

Most economists agreed, however, that although the wage level may affect economic activity it is only one among several factors which do so. Also it is recognized that in the presence of strong unions, wage reduction might not be a feasible political expedient even if clearly justified on economic grounds.

TRENDS IN WAGE LEVELS IN THE UNITED STATES

The history of the United States has been characterized by an enormous expansion in productivity and a rising level of real wages. The increase in real wages has not been steady, however. During the period from the Revolutionary War to around 1820 price increases appear to have offset increases in money wages to keep real wages at about a stationary level.

Between 1820 and 1850, on the other hand, there was an overall increase in real wages of around 40%. Further advances occurred from 1860 to 1890, so that by 1890 real wages stood at more than twice the 1820 level.

Paul H. Douglas, in his monumental study of real wages, estimated that real hourly earnings for industry as a whole increased about 40% between 1890 and 1926—an increase in excess of 1% per year. Here again, however, the increases did not occur uniformly. Real wages were almost constant between 1890 and World War I, and most of the increase in real hourly earnings occurred after 1917. The years from 1890 to 1926 witnessed a substantial shortening in the length of the work week, the average standard week in industry as a whole declining from 58.4 hours to 49.8. It is therefore not surprising that the rise in average weekly earnings was less than that in hourly wages.

For the period from 1914 to 1955, average real hourly earnings in manufacturing increased about 215%. Real weekly earnings in the same period rose by 160%. Real weekly earnings more than doubled between 1933 and 1955. They advanced rapidly during the latter years of the 1930s, during World War II and again during the years around 1950. In only a few years—mainly during the early 1930s and immediately following World War II—did they fail to rise.

It is interesting to compare figures in wage trends with closely related data on productivity. Using 1850 as a base, output per man-hour, measured in constant prices, had more than doubled by 1900 and had increased by more than five times by 1950 Over this century, the total annual production of goods and services multiplied twenty-fivefold. At the same time, the aggregate of man-hours worked in 1950 was less than five times as great as that of 1850.

These figures suggest one conclusion of great significance. So long as productivity continues to increase, this trend in itself permits and justifies a steady increase in real wages. It must be recalled, however, that the figures cited deal with total productivity and represent contributions to total output of all factors of production together.

The total amount of wages paid in an economy depends not only on the size of the total product but on the proportion of the product which goes to labour. Over the years, this proportion displayed only small variation. It increased a little in depression years, but on the whole the annual wage income remained around two-thirds of the total national income.

The substantial increase in real wages resulted from an increase in the total product rather than in labour's proportionate share of the product.

Wage Differentials.—Wages in a modern industrial economy differ from person to person and from one locality and region to another, both within the same occupational level and among occupations. Wage differentials. that is. differences in remuneration received by the various wage earners, are of many kinds and stem from a number of causes.

Some differentials in wages would be expected to occur under assumptions of perfect competition. Of this character are differentials resulting from subjective worker preferences as to types of employment. Jobs differ markedly in their characteristics. Some involve dirt, noise, high temperature, monotony, hard physical labour, irregular employment, low social prestige or other undesirable features. For such work, a higher wage rate may be necessary to attract labour from more desirable jobs requiring similar skills. Wages, in other words, are only one element of a job, and some wage differentials have the effect of equalizing the desirability of various types of work requiring the same type of labour. Moreover, wage earners are not all identical in talents, skills and efficiency. Thus the supply of labour to various occupations is not the same. This fact is sufficient to explain why high wages tend to go to those possessing talents which are valued highly by society but are relatively rare. Even within the same occupational classification variations in individual efficiency give rise to differences in remuneration.

Both the foregoing types of wage differentials would be expected to occur and persist under the conditions of perfect competition. In a perfectly competitive economy, furthermore, some temporary differentials might occur because economic adjustments do not take place instantaneously. A wage differential between two jobs with identical characteristics, for example, might exist by virtue of a transition reflecting a change in production methods or consumer demand. though in the long run the differential would be expected to be eliminated through the interaction of market forces.

In contrast, it appears that some wage differentials can be interpreted only by taking into account deviations from competitive conditions. Lack of labour mobility is a paramount factor in many such instances. A few examples are sufficient to suggest the effects of barriers to mobility. Regional differences in wage rates may be traced in part to the reluctance or inability of individuals in low-wage communities to leave their homes and seek work elsewhere or to their lack of knowledge regarding the existence of better job opportunities. Wages in specialized skills and professions may be maintained at levels above competitive rates by restrictions on the number of individuals admitted to training for such occupations. The traditionally low wage level of women has undoubtedly been partly the result of restrictions on the type of work open to them.

It is an interesting fact that, by mid-20th century, the upward trend in real wages in the United States had been accompanied by some shifts in differentials. Though all groups had shared in the advances in real income, the relative position of workers in various sections of the economy had not remained constant.

Differentials between skilled and unskilled labour declined during the first half of the 20th century. According to one estimate, the wage rates of skilled factory workers averaged about twice as much as the rates for unskilled labour in 1907. By 1947 the ratio had declined to one and a half. Tending also to narrow the spread in average wage rates has been the increase in assembly-line production, which has increased the number of semiskilled workers and decreased the relative significance of the highly skilled and unskilled.

In average earnings for various industries for the period from 1929 to 1950, some tendency toward a narrowing of industrial differentials is observable. A number of low-wage industries made unusually large gains, while remuneration in some high-wage industries advanced at less than the average rate.

Notable gains in average annual earnings were made, for example, in water transportation and highway freight transportation, both of which had been low-wage industries prior to World War II; the percentage gains in air transportation, with comparatively high prewar earnings, were considerably less. With some exceptions, wages in typical white-collar industries tended to advance less rapidly than did those for manufacturing and manual labour. On the other hand, most manufacturing industries exhibited relatively uniform gains over this period.

Changes in the relative wage positions of industries are difficult to interpret. In some cases technological advances alter the composition of the labour force in such a way as to account for a wage trend which fails to conform to the national average. The economic status of the industry also may be an important factor.

During the 20th century, wages of agricultural labour remained characteristically low as compared with those of urban employees, even when allowance is made for the difference between rural and urban living costs. In 1920, a peak year for farm earnings in the early decades of the century, average weekly farm wages were less than half the full-time weekly wages of factory workers. In 1929 hourly earnings of farm labourers averaged 42% of earnings in manufacturing. The depression period of the 1930s saw a decline in this ratio—between 1933 and 1940 hourly earnings of employees in agriculture were approximately one-fourth of those in manufacturing. By 1946, however, hourly wages on farms had risen enough to average 46% of factory workers' earnings. These figures can be explained in part by the fact that migration from farm to city tends to decline when unemployment is high, creating a greater supply of rural labour which tends to depress wages. The depressed level of prices of agricultural commodities which persisted until World War II is also a relevant factor.

Regional differentials have formed a noticeable feature of the wage structure of the United States. Average wages in the south have lagged behind those of other sections, while in the far west a high-wage tendency has existed.

Data accumulated in the late 1940s indicated that although the relation between wages in the south and those of other sections had varied considerably over the period 1907 to 1946, the relative position of southern workers at the end of this period was approximately the same as at the beginning. A widening of the differential associated with the depression of the 1930s had been offset by an opposite trend in later years. There are great variations within regions, however. and comparisons for specific localities or specific occupations show that the average north-south differential does not prevail consistently throughout the various segments of the economy.

A correlation exists between the earnings of individuals and such personal characteristics as age. sex and race. Earnings tend to be lowest in the earliest and latest years of a worker's productive life. Earnings of women average lower than those of men, and of Negroes lower than of white workers. In large part, however, these facts represent not differentials in pay for identical jobs, but differences in employment opportunities and in regularity of employment.

Modern Wage Structures.— In describing wage structures of modern firms a distinction is usually made between primary or basic wage rates and supplementary wages. Basic wage rates are those paid for work performed during normal working periods. The majority of basic wage rates are defined in terms of a time unit—hour, day, week, month or, less frequently, year. Often the term salary is used to denote earnings computed on the basis of a weekly or longer time unit. For a substantial number of wage earners compensation is defined in terms not of time units but of output, under various types of incentive systems.

Supplementary wage payments are premium payments, over and above applicable basic rates, for work performed during hours outside a normal working day or week. Such payments are commonly made for work done on Saturday, Sunday or holidays, for night work or for a work day in excess of 8 hours or a work week in excess of 40 hours.

From the standpoint of the individual employee, premium wage payments for undesirable schedules compensate for the discomfort or inconvenience of such schedules. When an enterprise operates on a multiple-shift or seven-day week basis, supplementary wage payments equalize the position of the variously scheduled employees. When labour is scarce, these payments are inducements for workers to offer their services on night shifts, holidays and week ends.

From the standpoint of the employer, premium payments increase production costs. They have the effect, therefore, of discouraging production outside the normal work day and work week.

Wage payments in goods, as food, use of employer-owned housing or the like, are sometimes found. They are probably of greatest significance in agriculture, although even there they are not, on the average, a large fraction of total wages.

Pension and insurance benefits of various types, payments for holidays and vacation periods not worked and dismissal wages are part of the total compensation received by many mage earners. The prevalence and importance of these so-called "fringe benefits" greatly increased during and following World War II. Like wages, payments of this type represent labour costs to employers.

Time Wage Rates.—Time wage rate structures, in which wage payments are based on time intervals, are the commonest form of basic wage structure. All companies have at least some employees paid on a time rate basis, and in many enterprises this is the sole method of compensation.

There are three major types of time wage systems: personal wage rate structures; job title rate structures; and job evaluation systems.

Under personal wage rate structures, wage rates apply to persons rather than to jobs. In the personnel records of companies using such systems, wage rates are established according to named employees. Such informal and individualized wage structures are particularly prevalent in small firms. They are appropriate in enterprises where management can be familiar with the requirements of each job and the capabilities of each worker.

Job title rate structures assign wage rates by referring to names of jobs—machinist, carpenter, janitor, for example. Frequently there are refinements within each classification for different levels of proficiency and experience. In firms using this type of wage rate structure, job titles are characteristically those that have evolved by usage in the plant or in the labour market.

In contrast, where job evaluation wage rate systems prevail jobs are analyzed and defined in terms of basic attributes and requirements. Scientific job analysis is thus the essence of job evaluation. It assumed increasing importance in the United States after the 1920s.

There are a variety of possible systems. of varying complexity, for developing evaluated wage rate structures. Most of them, however, have a number of common features. A set of evaluation factors is the basis for the job analyses. The factors depend on the types of work covered by the system. Among those typically used are: mental development; accuracy; dexterity; responsibility for equipment; responsibility for the work of others; physical effort; visual effort; physical discomfort; and accident hazard. In establishing a job evaluation system, evaluation factors are subdivided into degrees, and weights are attached to the various degrees of each factor. Each job to be evaluated is then analyzed on the basis of these factors. The analysis of the requirements and content of the job, taken in conjunction with the weights assigned to the factors, furnishes a means of grouping jobs in labour grades. The wage rate for a given job depends on the labour grade associated with it.

Job evaluation is a method not for setting the general wage level for a firm, but for evolving a rational wage structure within a given general wage level. The choice of a general wage level depends, among other things, on the financial position of the firm. its present and potential position within the industry, the number and qualities of employees desired, the anticipated bargaining reactions of union representatives (if the concern is unionized), the type of competition characteristic of the local labour market and, most important, the actual wage rate levels existing in competitor plants and in the labour market as a whole.

After the general wage level has been selected, the job evaluation system is brought to conform with this policy by assigning wage rates to a few key jobs occurring at various points in the job range. These rates are assigned in reference to the firm's general wage policy and the going rates in the labour market. The remaining jobs are then assigned wage rates in conformance with the rates for key jobs.

A particular labour grade may be assigned a single rate or a rate range. In the latter case, an employee's wage lies somewhere within the range for his job classification. Some companies provide for automatic progression within this range; others for increases within the range based on merit.

Incentive Wage Rates.—The essential characteristic of an incentive wage rate structure is that payment depends on output rather than work time. Such wage structures have been introduced into the production phases of a variety of manufacturing industries and have been used in some extractive industries.

Taking into account all forms of incentive mage payments—piecework, bonus and commission—it was estimated in 1952 that about a fourth of all employees in the United States received wages in this form. Commonly the incentive wage is based on the individual worker's output. although occasionally group incentives are used. In general, there appears to be a tendency for incentive workers to receive higher earnings than those on time rates in the same occupations.

If incentive wages are to be successfully employed in manufacturing, certain conditions must exist. First, the process of production must be substantially standardized, uniform and repetitive. Raw materials and productive equipment must be uniform and must be maintained at adequate levels. Under these circumstances, variation in output can be assumed to be primarily attributable to variations in worker effort. Second, output must be measurable and homogenous. Third, the production cycle must be relatively brief. Finally, incentives must be applied with caution where costly raw materials or delicate machinery create the possibility that more will be lost through spoilage and waste than will be gained through increased speed of production.

Modern incentive plans commonly provide for a guaranteed minimum hourly rate which constitutes a "floor" below which hourly earnings cannot fall. Compensation increases above the minimum in direct proportion to increase in output. Production standard3 used in arriving at the guarantee and the incentive rates are usually based on motion and time analysis of the job. The normal time for the production of a unit of output is determined, in other words, by analyzing the various operations necessary to produce the unit. However. production standards determined in this way are based on concepts of "the average worker," "normal work speed and effort" and "normal working conditions." Hence the determination of standard production time inevitably involves human judgment and cannot be purely objective.

Effect of Labour Organization **on** Wage Rates.—In the absence of labour organization, wages are determined unilaterally by employers on the basis of considerations noted in the preceding section. In unionized firms (or where a group of firms act as a unit in dealing with a union) wages are arrived at through collective bargaining negotiations between representatives of labour and management. Collective bargaining may involve proposals which are made solely for strategic purposes. However, the real positions — as opposed to possible strategic positions — of employer and union are formulated at least in part with reference to conditions of supply and demand. The employer is willing to pay at least enough to attract labour of suitable kinds and amounts. The wage demanded by the union is ordinarily not so high as to produce the danger of substantial unemployment in the firm.

The determination of the wage in the range between these positions depends in part on the skill of the negotiators. Moreover, since wages are only one issue in collective bargaining, the agreement may be influenced by settlements on nonwage issues. Most important are the varied factors — public opinion, government action. financial reserves of each party and the like — which determine the relative strength of labour and management in the event of a strike. For although the overwhelming majority of labour-management agreements are reached without a work stoppage, the possibility that failure to agree may lead to a strike is the driving force that impels the bargainers to seek agreement.

In addition to bargaining within the range between the employer offer and the union demand, labour may attempt to influence conditions of supply and demand to change the bargaining range.

As to supply. effective avenues of influence are limited. The demand for immigration restriction, which was one of the major political planks of the American Federation of Labor prior to the 1920s, was unquestionably related to a desire to restrict labour supply. Similarly certain licensing laws have the effect of limiting supply in some occupations. It is doubtful, however, whether conditions of labour supply can be appreciably affected in the short run except through legislation.

Some unions have endeavoured to increase the demand for union-made goods by advertising campaigns, boycotts imposed on competing nonunion products and similar techniques. A different method of increasing the demand for labour has also been used — that of imposing limitations on output of individual workers through some form of union-set productive standards. For the most part. however, these and other techniques of influencing demand are adopted not primarily as a means of achieving wage gains but to make more jobs available at times when employment declines.

Efforts to evaluate the actual impact of unions on wage rates are hampered by the difficulty of separating the effects of various factors. Statistical data can give information as to relative levels of union and nonunion wages, but they give no satisfactory evidence as to whether or not the differentials occurring are attributable to union activity.

Douglas found that during the 1890s and the early years of the 20th century union wages were considerably above those of the labour force as a whole. Since unionism was concentrated primarily in skilled trades at that time, however. the significance of his findings is difficult to assess. From around 1914 through the 1920s union wages in manufacturing rose no more rapidly than did nonunion wages. Only in the highly organized building trades did unionists make gains appreciably above the general average. Douglas concluded that the effect of a union is to raise wages at the time organization becomes effective, after which time advances tend to be at approximately the general rate.

Studies in the late 1940s showed that in partially unionized industries wages in nonunion plants tended to lag behind those in union plants, although within each industry differentials for various occupations were not consistent.

Detailed analyses of the studies, however, show that it is difficult to isolate the effect of unionization because regional and other differences enter. The general advance in real wages from 1939 to 1948, for example. showed no close correlation between the wage rise by industries and the extent of unionization. Increases above average were obtained in bituminous coal mining, which is highly organized, but also by unorganized domestic and agricultural workers.

Some economists have considered collective bargaining as a factor tending to increase wage rigidity in periods of rapid price adjustments. They base this view on the fact that collective wage bargains run for a prescribed period of time. However, wages tend generally to be "sticky" over the business cycle, in the sense that turns in their movement lag behind alterations in employment and price levels.

The total effect of unions on wages cannot be estimated entirely by studying contrasts between union and nonunion workers, since the presence of widespread unionization may affect the position of labour as a whole. For example. employers of nonunion labour may follow union wage patterns in an effort to avoid organization. On the other hand, if union-achieved rates are so high as to curtail employment in some occupations, a larger supply of labour to other occupations may depress wages there.

Finally, a discussion of the impact of unions on wages is incomplete without reference to political questions. Contemporary unions exert political pressures not only to win desired legislation on wages and collective bargaining but to influence national economic policy as well. Thus union espousal of a price stabilization program during World War II and the Korean war undoubtedly influenced the trend of real wages. In short, the economic position of labour as a whole may be affected not only by the direct wage-determining activities of unions but by their effect on national economic policy as well.

Wage Regulations. — The earliest wage regulations in the United States were maximum wage laws, enacted during the colonial period by town and colonial governments in an effort to prevent labour shortages from pushing wages upward. In their purpose these laws resembled enactments which were in effect in England in the same period.

Indeed, wage-fixing laws of this character came into being in England in the 14th century, when the Black Death had decimated the labour force, and persisted until the beginning of the 19th century. The early wage laws in the United States had little effect, and they disappeared. as did those of England, with the Industrial Revolution and the ascendancy of the principles of *laissez faire*.

Late in the 19th century there began a movement for a different type of wage legislation, the setting of minimum standards to prevent wages from sinking below the subsistence level. This movement, which led to government action at about the same time in England, Australia and New Zealand, was essentially social and humanitarian in character. Its spokesmen emphasized such costs of poverty as illness: crime and social disorganization.

The first minimum-wage law in the United States was enacted by Massachusetts in 1912. In the course of the next decade 14 states took similar action. All the laws applied solely to women or to women and children. This may be attributed partly to the fact that the wages of women tended to be lower than those paid to men, and partly also to the view that the health and well-being of women and children are of especial importance to society. On the latter ground it was believed that the regulation of the wages of women would be upheld by the courts as a proper exercise of the constitutional powers of the states.

In 1923, however, the supreme court declared minimum-wage laws to be unconstitutional. Not until 1937 was this decision reversed. By 1956 minimum-wage laws were in effect in 30 states as well as in Alaska, the District of Columbia, Hawaii and Puerto Rico. The laws of most jurisdictions applied only to women or to women and minors. although in a few instances their coverage extended to men as well.

State minimum-wage laws have displayed much variation, not only as to coverage and effectiveness of administration but also as to the way in which the minimum wage is determined. In some states, the law establishes a flat minimum, applicable to all covered workers, with exceptions permitted only for those whose inexperience or physical disability justify special lower rates. In the majority of states, however, the rate for each covered industry is set separately by a commission or wage board. The wage levels established by the various states have also been far from uniform. The trend during the early 1950s was toward a minimum of 75 cents an hour, but many states had minima far below this figure for some or all covered occupations.

Federal regulation of wages was embodied in the Fair Labor Standards act of 1938, sometimes called the Wages and Hours law. This act, which dealt with wages, hours and child labour, covered most employment in interstate commerce and in the production of goods for interstate commerce. Employees in agriculture and in certain other specified industries were excluded, however. Originally the act's wage provisions were aimed at the establishment of a 40-cent an hour minimum wage.

By subsequent amendments to the act, the minimum wage was increased to 75 cents an hour in 1949 and to $1 in 1956. Wages below the statutory minimum might be authorized for learners or apprentices and also for certain handicapped individuals. Except during periods of emergency, as during World War II and the Korean war, direct governmental regulation of general wage levels was not adopted in the United States.

States also commonly regulated methods of wage payment and similar matters. Typical instances were measures forbidding the payment of wages in scrip, requiring that wages be paid at least every two weeks or specifying in some manner the place of payment. Related in purpose to such legislation were mechanics lien provisions, which reinforced the common-law doctrine that workmen have a prior claim on an employer's property for wages due. Prevalent also were laws concerning the garnishment of wages. These usually restricted the percentage of future wages which might be assigned to creditors. Compensation for work on public contracts has also been subject to government regulation.

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TRENDS IN THE UNITED KINGDOM

The distinction between a wage and a salary was, by the middle of the 20th century, being less sharply drawn than it once had been. The board of trade at successive censuses of industrial production asked firms to classify employees as "operatives" or as "administrative, technical and clerical employees." Administrative, technical and clerical staff includes: directors, managers, superintendents and works foremen; research, experimental, development, technical and design employees (other than operatives); draftsmen and tracers; and travellers and office (including works office) employees. Operatives include all other classes of employees, and these are the wage earners in industry. Outside industry, the official statisticians tried to apply a comparable classification. whence the description "wage" is given to the earnings of operative workers in transport such as drivers and conductors and to those of storemen. warehousemen, porters, messengers, postmen, waiters, cooks and domestic servants; moreover, in 1953 shop assistants, who had been classified as receiving a salary, were reclassified as wage earners on the ground that their work was not administrative, technical or clerical. The classification therefore depends not on the frequency of payment or on the size of income, but on occupation.

Formerly a salaried worker in contrast with a wage earner tended to receive his or her pay irrespective of the number of hours worked, being paid in periods of holiday or absence through sickness but receiving no additional pay for extra effort or for working overtime. Hence salaries fluctuated less than wages. Presumably this was why the commissioners of inland revenue used to obtain half-yearly information from firms about the earnings of any manual workers within the income-tax ranges, whereas the earnings of the salaried workers were assessed annually. That distinction, however, disappeared in 1944 with the introduction of pay-as-you-earn income tax.

Furthermore, under the pre-1948 insurance schemes against unemployment, sickness and old age, manual workers had to contribute no matter what their incomes were, but salaried workers earning more than a specified amount (£250 a year up to 1940 and £420 a year subsequently) did not contribute anything or become entitled to benefits. After the introduction of the national insurance scheme with universal insurance, that distinction too disappeared. Thus as a result of changes in the 1940s the inland revenue and the national insurance authorities ceased to make any distinction between wages and salaries or to issue any statistics from which any such distinction could be derived.

Sources and Scope of Statistics.—The principle source of statistics about wages in the United Kingdom is the ministry of labour and, for the period before the establishment of the ministry of labour in 1917, the board of trade, which from 1893 had maintained a labour department. So far as the number of wage earners is concerned, complete information is primarily provided by the occupational records of the censuses of population taken in 1951, in 1931 and at ten-year intervals before that; however, for the manufacturing and other industries covered by the census of production more frequent information is available. Early information about wages can best be extracted from A. L. Bowley's Wages and Income in the C'nited Kingdom Since 1860 (1937).

Official statistics are of two types, the one relating to recognized rates of pay, the other to money receipts by wage earners (before deduction of national insurance contributions and income tax); the former are called wage rates and the latter earnings.

The information about recognized rates of pay applies almost entirely to minimum and standard rates which have been the subject of collective agreements, arbitration awards or legislation. Such rates are a good guide, but in times of active trade many wage earners can earn substantially more than the agreed rates: for example. in the spring of 1956 adult males in the coal-mining industry were averaging £14 15*s.* a week when the quoted rate—the national minimum weekly wage inclusive of the value of certain allowances in kind—was £9 0*s.* 6d. a week for underground workers aged 21 years and over; and in the engineering industry. where the agreed rates were about £8 8s. a week for skilled workers and £7 2s. a week for labourers (though varying somewhat according to area), the average earnings for adult males were £12 12*s.* a week.

The agreed rates of pay are recorded in a volume called Time Rates of *Wages* and *Hours of* Labour, published annually after 1946 but infrequently before then and including only two editions between 1915 and 1946 (those of 1920 and 1929). Details of changes in such rates are recorded monthly in the Ministry of *Labour Gazette*. It is from such information that the official index number of wage rates is derived.

The information about earnings is obtained as a result of special inquiries undertaken by the ministry of labour every six months after 1941. Before 1941 such surveys were only made at irregular intervals, including July 1940 and Oct. 1938 (which serves as a base for measuring increases after the outbreak of World War II). Surveys were also made in 1886, 1906, 1924, 1928, 1931 and 1935, the results normally showing average earnings in the week of inquiry in the industry covered and distinguishing males and females always and adults and young workers in 1935 and subsequently. After 1938 the figures for individual industries were combined to give averages for groups of industries and for all industry by weighting according to the estimated number of wage earners in each individual industry (the results are summarized in Tables V and VI).

The average for all industry is therefore variable with the distribution of personnel among the several industries and might conceivably increase without any change in rates in any of the industries if workers were transferred from low-paid to higher-paid industries. These returns also indicate the average number of hours worked in the week.

The statistics are incomplete. They are collected on a voluntary basis in the industries covered and do not cover all industries. For some of the industries excluded (*e.g.,* coal mining, the dock service, agriculture and the railways) information is available elsewhere; but for most of the service industries, including distribution, catering establishments, entertainments and sport, there is a dearth of statistics.

Variation of Earnings.— *In* general the only information has been about average weekly earnings and we have very little knowledge of the variation in earnings within industries. The wage census for *1938* recorded individual earnings, and hence some information about the spread of earnings in that year is available.

The average earnings for men in *1938* were *69s.* a week; one-quarter of the number of men earned less than *55s. 9d.;* and one-quarter more than *80s. 6d.* This indicated that a spread of about *24s. 9d.* a week (or 36% of the average) covered half of the number of male wage earners. For women workers the spread of earnings about the average of *32s. 6d.* a week was relatively greater, one-quarter of their number earning less than *25s.* and one-quarter more than *38s. 7d.*, so that a range of *13s. 7d.* (or 42% of the average) covered half the number of women workers.

The variation between workers in *1938* was relatively less than it had been in 1906 when ranges of *45%* of the average for men and 49% for women covered half the total of workers. There is some evidence that the relative variations in *1886* were smaller than in 1906.

During the first half of the 20th century the proportion of wage earners on piecework increased for men and decreased for women as follows: for men, the number on piecework was 18% of the total of male wage earners in 1906, still 18% in *1938* but 24% in 1947; for women, the corresponding figures were 59%, then 46%, then 39%. The decrease for women was apparently partly associated with the rapid growth of employment of women in industries other than textiles. *(See* R. B. Xnsworth, article in the *Statistical Society Journal,* 1949.)

The Period 1795–1914.—The earliest general investigation into wages in the United Kingdom was the inquiry of *1886,* and the study of movements before that date depends on scattered accounts, which can only be pieced together with great difficulty and some uncertainty (at least till *1850,* after which date records are more numerous). Table I exhibits the wages in some of the occupations for which records can be traced back to an early date, together with some more recent figures for comparison. With the great rise of prices during the Napoleonic wars wage rates increased by more than 50%, reaching a maximum in *1815;* during the next 15 or 20 years there was an irregular fall, and then wages were nearly stationary till about 1850, at a height about one-third above that of 1790–95. If the movements of money wages are compared with those of prices, it becomes evident that a considerable advance was made in real wages between *1815* and 1850.

TABLE *I.— Weekly Wages, 1795–1956*

Year	London rates*				Average earnings	
	Brick-layer	*Brick-layer's labourer*	Com-positor	Fitter	*Cotton-mill spinner*†	Agri-cultural *labourer*
1795	18s. od.	12s. od.	30s.	...	.	10s. 6d.
1805	25s. od.	18s. od.	33s.	...	25s. 10d.	15s. 6d.
1815	30s. od.	205. od.	36s.	...	265. od.	15s. 6d.
1825	33s. od.	21s. od.	33s.	...	25s. 8d.	11s. 6d.
1835	27s. od.	18s. od.	33s.	...	24s. 4d.	11s. 6d.
1845	30s. Cd.	20s. od.	33s.	...	23s. 5d.	11s. 6d.
1855	33s. od.	20s. od.	33s.	34s.	22s. od.	14s. 6d.
1865	35s. 4d.	20s. od.	33s.	35s.	28s. 6d.	14s. od.
1875	39s. 4d.	25s. 2d.	36s.	36s.	33s. 6d.	18s. od.
1885	39s. 4d.	26s. 3d.	36s.	38s.	31s. 1d.	14s. od.
1895	395 7d.	27s. 1d.	38s.	38s.	36s. od.	15s. 6d.
1905	43s. 9d.	29s. 2d.	39s.	39s.	41s. 5d.	17s. od.
1914	47s. 11d.	33s. 4d.	39s.	40s.	41s. 5d.	19s. od.
1920	102s. 8d.	91s. 8d.	95s.	68s.	...	49s. od.
1928	77s. od.	58s. 8d.	89s.	61s..	...	32s. 6d.
1946	115s. 6d.	92s. 7d.	115s.	107s.	...	.
1952	154s. od.	133s. 10d.	176s.	134s.	...	133s. od.
1956	194s. 4d.	170s. 6d	222s.	173s.	...	174s. 6d.

**Trade-union or other agreed rates* †As *estimated* by G. H. *Wood in the Statistical Journal,* p. 135 (1910) with *some adjustment of dates.*

Prices began to rise soon after 1850, culminated after some fluctuations in 1873 and then fell rapidly till in *1880* they were near the level of *1850* again. During these *30* years it is computed that wage rates in specific occupations rose about 30%, but because of the relative increase of numbers in the better-paid occupations the average wages of all men rose more than 40% and reached about *24s.* weekly.

It is probable that prices moved faster than money wages till *1860* and that wages gained on prices till *1870,* and in the next decade real wages made rapid progress (at the cost of some unemployment) as prices fell. Prices continued to fall irregularly till about *1895* and then rose with some interruptions till, at the outbreak of war in 1914, the level of *1880* and of *1850* was again approximately reached.

Money wages rose from *1886* to 1890, from *1896* to 1900 and, after a slight fall, from 1911 to 1914. Throughout the period of falling prices real wages rose considerably. but from 1900 to 1914, or even from *1895* to 1914, it is doubtful whether money wages rose as fast as prices. Some statisticians, indeed, have computed that real wages fell perceptibly in the *1j* or 20 years before World War *I;* but in this connection the figures given in Table II may be borne in mind.

TABLE *11.—Average Weekly Wages of Fully Employed Men in Great Britain, 1795–1914*

Item	1795	1850	*1880*	1902	1914
Actual wage . . .	13s. 6d.	17s.	24s.	*29s.*	32s.
Real wage (1914 prices)	8s. 6	17s.	24s.	32s.	32s.

The Period After 1914.—Table II indicates that prices in 1914 approximated to prices both in *18jo* and in *1880* so that from *1850* to 1914 money wages were a tolerable measure of real wages. After 1914 price increases associated with two major wars were not balanced by corresponding decreases and the problem of allowing for the decreased value of money became important. Prices rose rapidly from 1914 to 1920, then fell rapidly throughout *1921* and *1922* until they were at a level about 75% higher than they had been in 1914. They rose rapidly again from 1939 and continued to rise until in *1952* they were about 120% higher than they had been in *1938.* Yet from the viewpoint of the United Kingdom in 1953 one is impressed by the stability of money wages in the period *between* the wars.

Index numbers of wage rates recorded the same value in 1937 that they had recorded in 1924 after having been about 7% lower in 1933. Table III, based on A. L. Bowley's index of wage rates and on the ministry of labour's official cost-of-living index. illustrates the course of wages from 1914 to *1938.* Some typical rates are given in Table IV. which is derived mainly from the 22nd *Abstract* of *Labour Statistics* (1937).

TABLE *111.—Index Numbers, 1914–38*

Year	*Wages*	*Cost of living*	Real wages
1914	50	64	78
1924	96	112	86
1933	90	90	100
1938	100	100	100

TABLE IV.—*Rate of Pay for Recognized Working Week, 1914–36*

Year	*Agri-culture*	*Engineering*		*Building*		Railways (goods porters)	Cost-of-living index*
		Fitters	La-bourers	Brick-layers	La-bourers		
July 1914 . .	18s.	39s.	23s.	41s.	27s.	22s.	100
Dec. 1918 . .	30s.	77s.	58s.	70s.	56s.	55s.	220
1920 . .	47s.	90s.	71s.	101s.	88s.	71s.	269
1922 . .	28s.	56s.	40s.	71s.	53s.	51s.	183
1924 . .	28s.	56s.	40s.	73s.	55s.	49s.	175
1926 . .	32s.	56s.	40s.	74s.	56s.	49s.	172
1928 . .	32s.	59s.	42s.	72s.	54s.	47s.	166
1930 . .	32s.	59s.	42s.	71s.	53s.	47s.	158
1932 . .	31s.	59s.	42s.	67s.	50s.	43s.	144
1934 . .	31s.	59s.	42s.	66s.	49s.	43s.	141
1936 . .	32s.	64s.	47s.	69s.	52s.	43s.	147

**For December in 1918 and in 1920 (when prices were changing substantially) and for the average month in the subsequent years.*

The economy settled down after World War I with real wages about 10% higher in 1924 than they had been in 1914. It was after 1924 that it was common to speak of the rigidity of the wage structure, meaning that wage rates moved too slowly to reflect the needs of an economy in which prices were falling and in which, after 1929, unemployment rose to more than 20% of the insured population in the years from 1931 to 1933 inclusive. This period did not represent all loss to the wage earners, for throughout the period prices were falling more rapidly than wage rates. so that the real wages of those who remained employed rose rapidly. In 1933 real wages were about 15% better than they had been in 1924.

The striking improvement in real wages between 1924 and 1933 is what one expects in an economy with rigid wage rates and falling prices. What perhaps was equally striking was that the improvement was not lost in the subsequent period of rising prices following 1933, a period of recovery from depression and increased employment. Wage rates increased every year from 1934 to 1938 about as fast as the cost of living rose.

The United Kingdom therefore entered World War II with a wage structure that had increased real wages by about 25% or 30% in the 25 years from 1914. This improvement was not entirely due to increased productivity: it was greatly helped partly by the ability to buy the requisite imports with a smaller volume of exports and partly by the income from overseas investments that had been made during the 20 years preceding 1914, which years however had themselves by contrast seen little if any improvement in real wages.

TABLE V.—*Average Weekly Earnings and Hours Worked in Industry, 1938–56*
(Excluding coal-mining, railways and agriculture, which are not covered by the wage censuses)

Year'	Earnings		Hours worked	
	Men*	Women†	Men*	Women†
Oct. 1938	69s. 0d.	32s. 6d.	47.7	43.5
July 1940	89s. 0d.	38s. 11d.	...	...
July 1941	99s. 5d.	43s. 11d.	...	...
July 1942	111s. 5d.	54s. 2d.	...	...
July 1943	121s. 3d.	66s. 2d.	52.9	45.9
July 1944	124s. 4d.	64s. 3d.	51.2	44.6
July 1945	121s. 4d.	63s. 2d.	49.7	43.3
Oct 1946	120s. 9d.	65s. 3d.	47.6	42.6
Oct. 1947	128s. 1d.	69s. 7d.	46.6	41.5
Oct. 1948	137s. 11d.	74s. 6d.	46.7	41.6
Oct. 1949	142s. 8d.	78s. 9d.	46.8	41.7
April 1950	145s. 9d.	80s. 6d.	47.0	41.9
Oct. 1950	150s. 5d.	82s. 7d.	47.6	42.0
April 1951	160s. 2d.	87s. 4d.	47.9	42.0
Oct. 1951	166s. 0d.	90s. 1d.	47.8	41.5
April 1952	173s. 7d.	92s. 2d.	47.3	40.9
Oct. 1952	178s. 6d.	96s. 4d.	47.7	41.8
April 1953	185s. 11d.	100s. 3d.	47.8	42.0
Oct. 1953	189s. 2d.	102s. 5d.	47.9	42.0
April 1954	197s. 8d.	105s. 3d.	48.3	42.0
Oct. 1954	204s. 5d.	108s. 2d.	48.5	41.9
April 1955	217s. 5d.	112s. 5d.	48.9	41.9
Oct. 1955	222s. 11d.	115s. 5d.	48.9	41.8
April 1956	235s. 4d.	119s. 9d.	48.6	41.5

*Aged 21 years and over. †Aged 18 and over

For the period from 1939 to 1947 the official cost-of-living index is an unsatisfactory measure of price increases. This index was based on working-class standards as they had been before World War I and was calculated. especially for food. on a small number of commodities, the prices of which served to indicate the general level of prices. So long as prices were uncontrolled and not subsidized, prices in the index had tended to move in a way not greatly dissimilar from that of other prices. Rut when, in World War II, commodities in the official index were subsidized and other commodities taxed, the cost-of-living index was lower than the cost of maintaining the standard to which wage earners had become accustomed. In this article, therefore, to evaluate real wages from 1938 until the introduction of the new and satisfactory index of retail prices in 1947, the index calculated by R. G. D. Allen and published in the London and Cambridge Economic service's bulletin has been used.

Early in World War II wage rates lagged behind prices, but by the end of the war that lag had ended. Wage rates, however, were by now an inadequate indication of wages. With full employment, the withdrawal of wage earners into the armed forces and the need to attract workers into new types of employment, the opportunities for exceeding the minimum or recognized rates of pay increased. Earnings rose more rapidly than either wage rates or prices and became a more realistic measure of wages than were wage rates. One must remember, however, that greater effort and longer hours were often required to obtain these greater earnings. In July 1944 weekly earnings of adult males reached a peak that they were not again to reach until mid-1947. This pause in the increase of earnings of men was associated with a decrease in the intensity of work and a spurt in wage rates, especially in 1946, the year following the end of the war. Increases granted in that year are officially estimated to have increased the national wage bill by £3,000,000 a week. It looked for a while as if the position were going to resemble that of the period immediately after World War I, when in 1919 wage increases put up the weekly wage bill by £2,500,000. (See Tables V and VI.)

In fact the pattern of wage rates in 1919 and later was not followed after 1946. For each of the four years 1947 to 1950 the increase in the weekly wage bill was about £1,000,000 or £2,000,000 a week compared with an increase of £5,000,000 in 1920, a decrease of £6,000,000 in 1921 and of £4,000,000 in 1922. After World War II the United Kingdom avoided a rapid inflation and subsequent deflation such as had followed World War I. Nevertheless, whereas after World War I a period of near stability in wage rates had been achieved in five years, that is by 1923, after World War II the inflation became chronic and was continuing unabated after ten years. There were record increases in wage rates of £6,500,000 a week in 1951 and of £6,600,000 in 1956 with increases in the intervening years averaging £4 000,000 a week. Stability was still not in sight and annual demands for wage increases by trade unions were recognized parts of the industrial pattern.

The substantial increases in wage rates in 1946 were followed by reductions in the number of hours nhich constituted the normal working week. These reductions typically reduced hours from 47 or 48 to about 44 a week and were the first substantial changes made since 1919 (likewise a date shortly after the end of war), when hours were reduced from about 53 to 48 a week. The reduction, however, in the number of hours to make up a recognized week's work was not associated with a corresponding reduction in the number of hours actually worked. That had already fallen from a wartime peak of 53 to between 47 and 48 by Jan. 1946, that is, before the reduction in normal hours and it remained between 46 and 49 for the whole of the period up to 1956. The reduction proved to be a way, not of giving wage earners more leisure, but of giving them more money income by counting some of the hours customarily being worked as overtime, attracting additional rates of pay. It is typical to reckon the first two hours overtime in any day as if it aere two and a half hours, and further hours as if each were one and a half hours.

Table VII shows that real

TABLE VI.—*Average Weekly Earnings in Specified Industries, 1935–56*

Industry	Oct. 1935	Oct. 1938	July 1941	July 1944	April 1947	[illegible]	April 1952	[illegible]	April 1956
Men (aged 21 and over):									
Chemicals	63s.	69s.	98s.	120s.	122s.	147½s.	174s.	201½s.	236s.
Metal manufacture						166s.	197s.	221s.	265s.
Engineering	68s.	75s.	112s.	139s.	134s.	151s.	185s.	210½s.	252s.
Vehicles						163s.	190s.	219s.	256s.
Textiles	56s.	57s.	81s.	102s.	113s.	142s.	156½s.	188s.	210s.
Clothing	64s.	64s.	84s.	105s.	117s.	141s.	154s.	177s.	208s.
Food, drink and tobacco	64s.	65s.	87s.	106s.	117s.	134s.	158s.	179s.	211s.
Wood	65s.	66s.	86s.	107s.	121s.	143s.	168s.	187s.	215s.
Paper and printing	84s.	84s.	97s.	121s.	135s.	164s.	191s.	218s.	258s.
Building	61s.	66s.	97s.	108s.	112s.	140s.	171s.	193s.	234s.
Public utilities	58s.	63s.	77s.	94s.	109s.	137s.	161s.	180s.	220s.
Transport (excluding railways)	69s.	70s.	92s.	114s.	122s.	137s.	162s.	183½s.	223s.
Women (aged 18 and over):									
Chemicals	29s.	33s.	45s.	65s.	66s.	78½s.	94s.	103s.	120s.
Metal manufacture						82s.	99s.	113s.	129s.
Engineering	31s.	33s.	48s.	71s.	72s.	83s.	100s.	114s.	131s.
Vehicles						91s.	107s.	123s.	137s.
Textiles	30s.	32s.	42s.	56s.	66s.	83s.	90s.	108s.	118s.
Clothing	33s.	33s.	41s.	53s.	65s.	82s.	88s.	101s.	116s.
Food, drink and tobacco'	32s.	33s.	40s.	54s.	63s.	75s.	88s.	98s.	114s.
Paper and printing	33s.	34s.	39s.	54s.	66s.	79s.	96s.	107s.	124s.
Transport	32s.	35s.	59s.	79s.	84s.	102s.	121s.	140s.	163s.

Note: There was a reclassification of industries in 1948. Earnings of 1935 can be considered typical of those of the period of stability in money earnings between World Wars I and II.

TABLE IX.—*Wages and the Cost of Production, 1950 and 1955*

Industry	1950			1955		
	Total cost	Proportion of total		Total cost	Proportion of total	
	£000,000	Wages	Salaries	£000,000	Wages	Salaries
Agriculture	680	35%	3%	765	36%	4%
Mining and quarrying	412	79%	5%	573	81%	6%
Manufacturing	4,371	45%	15%	6,471	47%	16%
Building	681	68%	10%	1,015	68%	10%
Gas, electricity, water	251	36%	17%	398	34%	17%
Transport and communications	922	46%	18%	1,275	45%	19%
Other industries	4,639	24%	29%	6,374	24%	29%
All*	11,959	38½%	19½%	16,871	40%	20%

*Gross domestic product and stock appreciation.
Source: *National Income Blue Hook, 1956.*

earnings early in 1956 were markedly higher than before the war, the apparent improvement having taken place in two stages, the first during the war; then after a period of relative stability there was further marked improvement after 1952.

The changes in wage rates were achieved with little industrial strife and negligible unemployment. After World War I industrial disputes caused an annual loss of 50,000,000 working days in the three years 1919 to 1921, 162,000,000 in 1926 (the year of the coal stoppage and general strike) and an annual loss of 7,000,000 in the three years 1929 to 1931. In contrast, the annual loss in the ten years from 1946 averaged less than 2,000,000 working days, which is about the same as in the best years between the wars.

For two reasons the picture of earnings and wage rates so far

TABLE VII.—*Index Numbers, 1938–56*

Year	Retail prices	Wage rates	Earnings men	Real wage rates	Real earnings
1938	100	100	100	100	100
1940	117	112	129	96	110
1942	137	131	161	96	117
1944	145	144	181	99	125
1946	154	163	175	106	114
1948	175	177	197	101	113
1950	185	186	215	100	
1952	221	218	2j6	99	
1954	232	238	292	103	126
1956	254	274	343	108	135

Retail prices from the *Bulletin* of the London and Cambridge Economic service; wage rates from the ministry of labour, covering men and women and including workers in agriculture, coal mining and on the railways; earnings of adult males covered by the ministry of labour's half-yearly inquiry; real wage rates and earnings obtained by division with the index of retail prices.

presented needs modifying: during World War II wage earners became for the first time substantial payers of income tax; and there were some important changes in relative positions not indicated by measures of average change.

When indirect taxation is changed, prices change as well and the calculated index of real wages automatically allows for the change. There is no such automatic correction when income tax is changed and, therefore, an allowance might specifically be made as soon as wage earners become substantial payers. At average earnings of 1938 a single man paid about 2% of his income in tax and a married man paid nothing. At average earnings of 1944 or 1945 a single man paid 22% of his income as tax, a married man without children 14%, with one child 9% and with two children 3%; allowing for these substantially modifies the picture of a wartime increase in real earnings, especially for single men. By 1950 the burdens of income tax for men had fallen: at the average earnings level, to about 10 % of income for the single man, 5% for the married man without children and 2% for the married man with one child, the man with two dependent children not paying anything, and since 19jo the burden as a proportion of the average man's wage has remained substantially unchanged. Table VIII attempts to make allowances for changes in income tax.

TABLE VIII.—*Index Numbers of Real Earnings, 1938–56*

Year	Not allowing for income tax	Allowing for income tax			
		Single man	Married, no child	Married, 1 child	Married, 2 children
1938	100*	100	100	100	100
1944	125*	100	107	114	121
1950	116*	106	110	114	116
1952	116*	107	111	115	116
1954	126*	115	118	123	
1956	135*	120	128	131	

*As given in Table VII (last column). The 1956 figures are provisional.

It is to be noticed that the increases in income tax during the war years took away much of the apparent improvement in real earnings, especially for single men and married men without dependent children, but reductions in income tax which took place between 1946 and 1950 were for all groups studied except those with two children, sufficient to remove the deterioration otherwise apparent between 1944 and 1950. After 1950 changes in the level of income tax had little further influence on earnings at the average level. Persons with incomes above the average received by wage earners suffered proportionately more from the wartime increases in income tax and generally benefited proportionately more from the subsequent reductions.

The other reason for modifying the situation already presented is a tendency for agricultural workers and coal miners to gain relatively to workers in other industries and, within industries, for the unskilled to gain relatively to craftsmen. Earnings per-man-shift worked at coal mines (including allowances in kind), which had averaged 11*s.* 8*d.* in 1938, averaged 52*s.* 10*d.* in 1955. Similarly, whereas in 1938 the average of minimum rates for agricultural workers was 34s. 6d. a week during Jan.–Aug. 1956, the national minimum of 135*s.* was raised in Sept. 1956 to 141*s.*

The tendency for unskilled workers in industry to gain relatively to the skilled was the result of flat-rate increases being given to all workers to compensate for rises in the cost of living, and though there had been sporadic attempts by skilled workers since the war to obtain increased differentials, the movement had not gone far by the late 1950s. In 1929 engineers in London received 39% more than their labourers; in March 1956 they received only 18% more. Likewise in 1929 builders in large towns had 32% more than their labourers; in 1956 only 13% more. Further examples could be given to show that the increase in wage rates after the outbreak of World War II was such that craftsmen benefited less than labourers and might in some cases be worse off in real terms than they had been.

Wages as a Cost of Production.— Wages, primarily considered as a major source of most individual incomes are also part of the cost of production of almost all goods and services. Table IX attempts to show wages in relation to the total cost of production. It shows that in 1955 wages represented 40% of all costs of production and including salaries 60%. In addition many other costs are in fact analogous to wages, as for example much of the income of self-employed persons. The reason for the low proportion that wages represent of the cost of agricultural production is that there are many working farmers whose income is not called a wage because they are self-employed and much the same applies to the income of many small shopkeepers. If one adds to this the fact that total cost is recorded before allowing for depreciation of durable equipment, the large extent to which general wage increases must produce almost proportionate increases in prices and therefore have little influence in real terms will be realized.

Table IS shows that in 1955 wages and salaries represented a slightly higher proportion of national income than in 1950, and there is some evidence that this is part of a process continued from 1938 However! the change certainly has been slow and if allowance had been made for the costs of maintaining the increased volume of capital equipment, it would be less than Table IX indicates.

Summary.— There was a striking improvement in real wages in the quarter-century before World War II. During the war there was further improvement in earnings, largely associated with increased intensity of work and mostly taken away by increased taxation. After the war real wages continued to improve, rather slowly at first but with gathering momentum in the period from 1952 to 1956. The rapid improvement before 1939 was helped by the reduction in foreign lending compared with the period before 1914, by the improvement in the terms of trade and by the income from investments made in previous periods, but it was hindered by a less than full employment of the United Kingdom's economic resources. After the war there was a full utilization of economic resources. full employment and marked increases in industrial production, but much of the increased production was absorbed in compensating for the reduction in real income from overseas investments and the deterioration in the terms of trade. The wage earner had the benefit of full employment, and where she desired it his wife was able to obtain work also. But by 1956 the experience of the worker was that from 1938 or from 1945 increases in money earnings of the order of 6% or 7% a year meant what seemed to them modest increases in real income. They were, therefore. demanding annual increases automatically, making restoration of monetary stability difficult. It seemed, in 1956, that they looked upon an annual increase in the same way that in the period of nage rigidity between World Wars I and II they looked upon unchanged incomes—as something that could only be sacrificed at risk to real standards. And. with full employment, they obtained these annual increases. (H. S. BR.)

WAGES BOARDS: see INDUSTRIAL RELATIONS.

WAGGA WAGGA: see RIVERINA.

WAGNER, COSIMA (1837–1930), was born in Bellagio, Italy, on Dec. 25, 1837. She was the illegitimate daughter of Franz Liszt (*q.v.*) and the Countess Marie d'Agoult. In 1857 she married Hans Von Bulow (*q.v.*), one of the outstanding conductors of his time and a favourite pupil of Liszt, but though she encouraged him in his work and remained devoted to him throughout her life, their marriage proved far less than she had hoped for. She bore him two daughters whom she called Daniela and Blandina. The two daughters subsequently born to Cosima—Isolde (1865) and Eva (1867) were Richard Wagner's children. In 1868, Cosima with her four daughters left Bülow and went to live with Wagner in Triebschen where she came to know Friedrich Nietzsche on whom she made a lasting impression. Wagner and Cosima were finally married in 1870. In that year, too, on the occasion of the first anniversary of the birth of their son Siegfried (1869–1930), Wagner composed the Siegfried *Idylle* as a surprise for Cosima. With the passing of Wagner (1883), she took upon herself the management of the Bayreuth festivals, of which she was art director until 1908 when her son took over. To this self-imposed task, she applied her characteristic energies and her continued devotion to the works of Wagner's genius. She was the moving force behind the festival plays both in commercial and social matters, influencing the selection of repertoire, artists and style of presentation. She died in Bayreuth, in total blindness, on April 1, 1930. Cosima was not only the wife of Wagner, his close coworker, but a woman of great gifts and enormous energies. Part of her published diaries and letters convey a vivid impression of her strong and fascinating personality. That she was sometimes unhappy with Wagner was no doubt true. But their marriage was one of singular mutual enrichment and for Cosima the realization of perfect womanhood.

WAGNER, HONUS (JOHN PETER WAGNER) (1874–1955), U.S. baseball player, one of the first five men elected to the Baseball Hall of Fame at Cooperstown, N.Y., and generally considered the greatest shortstop in U.S. baseball history. The "Flying Dutchman," as he was called, led the Iiational league in batting eight times and established records for the greatest number of doubles and triples.

Born Feb. 24, 1874, at Mansfield (now Carnegie), Pa., Wagner, who stood 6 ft. tall and weighed 200 lb., joined Louisville (then in the National league) in 1897 and went to the Pittsburgh Pirates in 1900. He was past 40 when he retired in 1917. Wagner, who appeared in two world series, had a batting average of .329 for 21 seasons and stole a total of 720 bases.

Honus Wagner died in Carnegie, Pa., on Dec. 6, 1955.

(J. D. McC.)

WAGNER, (WILHELM) RICHARD (1813–1883), German dramatic composer and theorist, was born at Leipzig on May 22, 1813. That year his father, a minor civil servant, died and his mother married Ludwig Geyer, a painter and a singer-actor. The artistic and theatrical background of Wagner's early years (several elder sisters became opera singers or actresses) was a main formative influence. Impulsive and self-willed, he was a negligent scholar at the Kreuzschule, Dresden, and the Nicolaischule, Leipzig; but under the inspiration of Beethoven, Mozart, Weber, Shakespeare, Goethe and Schiller, he taught himself the piano and composition and wrote a five-act verse-trageay. At 17 he had a crude overture performed at the Leipzig theatre.

A Hoffmannesque romantic youth, he was attracted by the glamour of German student life. Not having matriculated. he enrolled at Leipzig university as a second-class student and, although he lived wildly, he applied himself earnestly to composition. Owing to his impatience with all academic techniques, he spent a mere six months acquiring a groundwork with Theodore Weinlig, cantor of the Thomasschule, but his real schooling was a close personal study of the scores of the masters, notably the quartets and symphonies of Beethoven. His own Symphony in C was performed at the Leipzig Gewandhaus concerts in 1833. On leaving the university that year, he spent the summer as operatic coach at Wurzburg, where he composed his first opera. Die Feen (The Fairies). As with all his subsequent works, the libretto, after a fantastic tale by Carlo Gozzi, was his own. The opera being refused at Leipzig. he sought employment and became conductor to a provincial theatrical troupe from Magdeburg. impelled by having fallen in love at first sight with one of the actresses, Wilhelmine (Minna) Planer (1809–66).

The next six years he spent struggling as a provincial conductor of third-rate opera companies in Magdeburg, Konigsberg and Riga, striving idealistically to raise standards and incurring enormous debts owing to his poor pay and careless expenditure. In 1836, at Konigsberg, he directed a single disastrous performance of his second opera, Das Liebesverbot ("The Ban on Love," after Shakespeare's Measure for Measure). Later in the same year and in the same city he married Minna Planer. In 1839, fleeing from his creditors in Riga, he assayed his long-cherished plan to conquer Paris. German opera composers were without honour in their native country, which preferred French and Italian models; and Wagner, precociously convinced of his coming greatness, thought a dazzling success in Paris would win him recognition at home.

His three years in Paris were disastrous. Despite Meyerbeer's recommendation, he could not break into the closed circle at the Opéra. Living with the colony of poor German artists, he staved off starvation by means of musical journalism and hack work. Nevertheless in 1840 he completed Rienzi (after Bulwer-Lytton's novel) ; and in 1841. his technique having profited from his hearing of the music of Berlioz, he composed his first representative opera. Der *fliegende Holländer* (The Flying Dutchman), based on the old legend. He offered Rienzi to Dresden, where it was accepted.

In 1842. aged 29, he gladly returned to Dresden, where Rienzi was triumphantly performed on Oct. 20. Next year The Flying *Dutchman* (produced at Dresden, Jan. 2, 1843) was less successful, owing to its innovatory style and method. But he was appointed *Hofkapellmeister* at the court opera, a post that he held until 1849. On Oct. 19, 1845, *Tannhäuser* (based. like all his future works, on Germanic legends) was coolly received but soon proved a steady attraction; after this, each new work achieved popularity with the public, despite persistent hostility from many critics. For the next 20 years, however, Wagner was not to present any further new works. He completed Lohengrin in 1848 but his projected administrative and artistic reforms alienated the court opera authorities; and, his mind having turned to ideas of social regeneration, he became embroiled in the Gerinan revolution. He wrote inflammatory articles and took an active part in the Dresden uprising of 1849. When this failed he fled from Germany with a price on his head, unable to attend the first performance of Lohengrin at Weimar, given by his friend Liszt on Aug. 28, 1850.

Until 1858 Wagner lived in Zurich. composing, writing treatises and conducting (he directed the London Philharmonic concerts in 1855 with great success). Having already studied the Siegfried legend and the Norse myths as a possible basis for an opera. and having written an operatic "poem." *Siegfrieds Tod,* in which Siegfried was conceived as the new type of man who would emerge after the successful revolution he had hoped for. Wagner now cogitated intensely concerning revolution, social and artistic. From 1849 to 1852. he wrote his basic prose works: *Die Kunst und die Revolution (Art and Revolution), Das Kunstwerk der Zukunft (The Art Work of the Future). Eine Mitteilung an meine Freunde (A Communication to My Friends)* and *Oper und Drama (Opera and Drama).* The latter adumbrated a new. revolutionary type of musical stage work—the vast work. in fact, on which he was engaged. By 1852 he had added to the poem of *Siegfrieds Tod* three others to precede it, the whole being called *Der Ring des Nibelungen (The Ring of the Nibelung)* and providing the basis for a tetralogy of musical dramas: *Das Rheingold (The Rhinegold); Die Walküre (The Valkyrie); Der junge Siegfried (Young Siegfried),*later called simply *Siegfried;* and *Siegfrieds Tod (Siegfried's Death),*later called *Götterdämmerung (The Twilight of the Gods).*

By 1857 Wagner's style had been enriched by the stimulus of Liszt's discoveries and he had composed *The Rhinegold, The Valkyrie* and two acts of *Siegfried.* But he now suspended work on *The Ring:* the impossibility of mounting this colossus within any foreseeable future was enforcing a stalemate on his career and led him to project a "normal" work capable of immediate production. Also his optimistic social philosophy had yielded to a metaphysical, world-renouncing pessimism. nurtured by his discovery of Schopenhauer's philosophy. The outcome was *Tristan und Isolde* (1857–59). of which the crystallizing agent was his hopeless love for Mathilde Wesendonk (the wife of a rich friend and patron). which led to separation from his wife Minna.

Life in Zurich had become too embarrassing, and Wagner completed *Tristan* in Venice and Lucerne. In 1860 he went to Paris. where the following year sumptuous productions of a revised version of *Tannhäuser* were a fiasco. owing to scandalous riots by a powerful clique. But in 1861 an amnesty allowed him to return to Germany: from there he went to Vienna, where he heard *Lohengrin* for the first time. He remained in Vienna three years, enjoying enthusiastic recognition. traveling widely as conductor and awaiting a projected production of *Tristan.* As this failed to materialize, owing to the artists' bewilderment over its revolutionary style, Wagner began a second "normal" work, the comedy-opera *Die Meistersinger von Nürnberg (The Mastersingers of Nürnberg).* But by 1864 his lavish expenditure and inveterate habits of borrowing and living on others had brought him to financial disaster: he had to flee from Vienna to avoid imprisonment for debt. *The Ring* was still incomplete and *Tristun* apparently unperformable. He had powerful enemies. largely because of his own bad dealing. which arose from blind artistic self-centredness and a sense of persecution. He was without a penny; and he arrived in Stuttgart, a man of 51 without a future. almost at the end of his tether.

Something like a miracle saved him. He had always made loyal friends, owing to his fascinating personality, his towering genius and his artistic integrity. Now a new friend, of the highest influence. came to his rescue. In 1863 Louis II (*q.v.*), a youth of 18, ascended the throne of Bavaria. He was a fanatical admirer of Wagner's art and. having read the poem of *The Ring* (published the year before with a plea for financial support), he invited Wagner to Munich to complete the work there.

The king set him up in a villa. and during the next six years there mere successful Munich productions of all of Wagner's representative works to date, including the first performances of *Tsistan* (1865), *The Mastersingers* (1868), *The Rhinegold* (1869) and *The Valkyrie* (1870,—all directed by the first great Wagner conductor. Hans von Bülow. At first a new theatre at Munich was projected for this purpose. with a music school attached. but this came to nothing because Wagner raised a storm by his way of living. Not only did he constantly run into debt despite his princely salary but he also attempted to interfere in the government of the kingdom. In addition. he entered into relations with von Bulow's wife, Cosima (the daughter of Liszt; 1837–1930). She bore him three children. Isolde (1865–1921), Eva (1867–1942) and Siegfried (1869–1930), before her divorce in 1870 and her marriage to Wagner in the same year, his first wife Minna having died in 1866. For all these reasons. Wagner ceased to live in Munich as early as 1865. But he never forfeited the friendship of the king, nho set him up at Triebschen on the Lake of Lucerne whence he paid lengthy visits to Munich to supervise the productions of his works The year 1870 saw the appearance of his profound essay *Beethoven.*

In 1869 Wagner had resumed work on *The Ring,* which, in keeping with his later views, he now brought to its world-renouncing conclusion. It had been agreed with the king that the tetralogy should be first performed in its entirety at Munich. but Wagner broke the agreement, convinced that a new type of theatre must be built for the purpose. Having discovered a suitable site at Bayreuth he toured Germany, conducting concerts to raise funds and encouraging the formation of societies to support the plan. In 1872 the foundation stone was laid In 1874 Wagner moved into a house at Bayreuth that he called Wahnfried (Peace from Madness), and that year he completed *The Ring.* The whole vast project was eventually realized, in spite of enormous difficulties, artistic. administrative and financial. The king. who had provided Wahnfried for Wagner, made him a gift of 100 000 talers. and mortgages were raised that were later paid off by the royalties on Wagner's works. *The Rzng* received its triumphant first performance in the new Festspielhaus at Bayreuth on Aug. 13. 14, 16 and 17. 1876. (*See* also BAYREUTH.)

Wagner spent the rest of his life at Wahnfried, making several visits to Italy. and one to London in 1877 to give a successful series of concerts. During these years he composed his last work. the sacred festival drama. *Parsifal*, begun in 1877 and completed and produced at Bayreuth in 1882; and he dictated to his wife his autobiography. *Mein Leben* (My *Life*) He died of heart failure. at the height of his fame. in Venice on Feb 13. 1883 aged 69. He was buried in the grounds of Wahnfried in the tomb he had himself prepared; a few days later. King Louis rode to Bayreuth alone at dead of night to pay his personal tribute. Since then. the Festspielhaus has staged yearly festivals of Wagner's works except during World War II; it is worth mentioning that he himself intended it also to present the works of any outstanding German composers nho might follow him.

These are merely the main events of Wagner's life. which cannot be adequately summarized since it was crammed with intense and variegated activity. His inexhaustible energy went not only into his work but also into innumerable friendships, enmities and love affairs. into various far-reaching projects that he abandoned and into sporadic political activity; and most of the countless separate happenings of his life were surrounded by tortuous intrigue.

Development.—Wagner's development. achievement and influence can only be understood by accepting his own view that he was not simply a composer but a musical dramatist. Music never interested him for its own formal sake but only as emotional and psychological expression It is significant that he first taught himself composition to provide music for his boyhood verse-tragedy, and that the conception that eventually materialized as *The Rzng* originally presented itself as an alternative between a poetic drama concerned with Fredrick I Barbarossa and a musical drama on the Siegfried legend. Apart from certain jejune youthful efforts, he composed no purely formal instrumental works; his whole significant *oeuvre* is musicodramatic. Nevertheless, his search for the utmost depth. subtlety and precision in the musicodramatic expression of feeling resulted in a radical revolution of compositional technique that crucially affected the development of music as an art in itself.

Wagner's slow and erratic development, from the crudest tyro to a supremely original master creator is unique. beginning with the poorest technical equipment, he achieved greatness by sheer persistent force of artistic imagination and hard-won experience. However his early incapacity should not be exaggerated. he made a considerable step forward from the gauche Symphony in C of his 20th year to the opera *Dze Feen* of his 21st The latter is a really professional work; and in using the fantastic-legendary atmosphere and style of the new romantic German opera so newly founded by Weber and continued by Marschner, Wagner was already following his ordained path, since his primary achievement was to bring this tradition to a magnificent climax and thus to set Germany on the operatic map once and for all. The crucial deficiency of *Die Feen* is its lack of any personal musical style. On the other hand, an additional section for an aria in Marschner's *Der Vampyr,* written the same year, reveals Wagner's individuality clearly, since it develops a vivid thematic complex that later became a main element in *The Ring.*

His two subsequent operas were not an advance but a diversion along a false path. Acutely aware of the provincialism of German opera (and with one eye on Paris), he wrote *Das Liebesverbot,* a clumsy plagiarism of Bellini and Donizetti, and *Rienzi,* a grandiose attempt at opera in the manner of Meyerbeer and Gasparo Spontini. The former was so much wasted energy, but in the latter he learned something about constructing a musical stage work on the vast scale he was to adopt later. But it was in his comparatively compact next opera that his personality was first defined. Homesick in Paris and disillusioned with his false gods, he composed *The Flying Dutchman,* in which his mature romantic German style clearly emerged. If the subsidiary parts of. the work followed conventional models, the main dramatic situations showed a Wagner who had hitherto appeared only in the music added to the *Vampyr* aria. The essence of this new style was the symphonic expression of aspects of the unconscious linked with the characters portrayed symbolically on the stage.

In *Tannhäuser* and *Lohengrin* Wagner developed this style on the large scale he had broached in *Rienzi.* The sheer scope of these works—the building of rnusicodramatic climax on climax—is masterly. Nevertheless, as before, Wagner was only his true self in the symphonic handling of the main situations. In the subsidiary parts he was now worse off than before: having abandoned conventional models, he handled the supporting action in an amateurish, four-square, semirecitative style that he himself was later to smile at. And even at the great climaxes he sometimes used vulgar material, which is recognizable early Wagner but bears little relation to his definitive style. The trouble was that he wanted to reject as mere artifice all conventional methods of operatic construction and to extend dramatic and pyschological development over a whole work by means of a continuous symphonic web; but he had not yet discovered a way to do this. The three early operas contain much deadwood of his own or others' devising.

It was during his period of cogitation over social theory that he found the way at last. Theoretically, in *The Art Work of the Future,* and autobiographically, in *A Communication to nay Friends,* he projected a revolutionary type of musical stage work that he specified in full in *Opera and Drama.* This treatise analyzed intellectually the art form toward which he was moving creatively in building *The Ring.* Basing himself on the romantic-socialistic doctrine of the "natural man," and looking forward to the imminent creation of a socialist state in which this concept would flourish, he prophesied the disappearance of opera as artificial entertainment for an elite and the emergence of a new kind of musical stage work for the people, expressing the self-realization of free humanity. This new type of work was later to be called "music drama," though Wagner never used this term but preferred simply "drama." It was intended as a return to the Greek drama as Wagner understood it—the public expression of national and human aspirations in symbolic form by enacting racial myths and using music for the full expression of the dramatic action.

Wagner's emphasis on opera as drama merely resumed and developed the ideas of Monteverdi and Gluck; but in propounding the revolutionary conception he had been striving for in his three previous works he went much further. He envisaged the disappearance of the old operatic type, with its libretto provided by a hack versifier as an opportunity for the composer to make a "set-piece" opera out of purely musical forms separated by recitative. Briefly put, the new art form would be created by a single artist, who would write a poetic drama that should find full expression as a musical drama when it was set to a continuous vocal-symphonic texture. This texture would be woven from basic thematic ideas. called *Leitmotive* (singular, *Leitmotiv)* or "leading motives": these would arise naturally as expressive vocal phrases sung by characters at crucial emotional points of the drama and would then be developed by the orchestra as "reminiscences" in accordance with the expressive need of the dramatic and psychological development of the action. *(See* also LEITMOTIV.)

This conception found full embodiment in The *Ring,* except that the leading motives did not always arise as vocal utterances but were often introduced by the orchestra to portray characters, emotions or events in the drama. With his use of this method, he rose immediately to his amazing full stature: his style became unified and deepened immeasurably, and he was able now to fill his works from end to end with intensely characteristic music. Except for moments in *The Rhinegold,* the old weaknesses, formal and stylistic, vanished altogether and with them disappeared the last vestiges of the old "opera." Wagner's works now fulfilled his new conception literally, except in two respects. First, whereas in *The Rhinegold* and *The Valkyrie* the symphonic development of the motives was largely explanatory of the drama, Wagner used it with much greater subtlety from *Tristan* onward. The impact of Schopenhauer's theory of the supremacy of music among the arts (brilliantly developed in Wagner's own essay *Beethoven)* led him to tilt the expressive balance of musical drama more toward music: the motives ceased to remain neatly identifiable with their dramatic source but worked with greater psychological complexity, in the manner of free association. Secondly, for the comedy of *The Mastersingers* Wagner incorporated into his new conception certain of the old "operatic" elements (aria, quintet, etc.)

Achievement.—Wagner's creation of his own type of musical drama was a fantastic singlehanded achievement, considering the scale and scope of his art. His method was to condense the confused mass of material at his disposal—the innumerable conflicting versions of the legend chosen as a basis—into a taut dramatic scheme; and in this scheme. as in his model, the *Oresteia* of Aeschylus, the stage events are few but crucial. the main part of the action being devoted to the working out of the characters' psychological motivation?. The "poem"—the verbal drama—he laid out with musical structure in mind so that it formed a natural basis for large-scale musical forms comprising detailed musical-emotional development.

In setting the poem he used his mastery of construction on the largest scale. which he had learned from studying Beethoven, to keep the broad outlines clear while he consistently developed the leading motives to mirror every shifting nuance of the psychological situation. Criticism of these motives as arbitrary, factual labels shows a complete misunderstanding of Wagner: he called them "carriers of the feeling" and, owing to their essentially emotional character, their pliability and Wagner's resource in alternating, transforming, combining and intermingling them, they do function as the subtle expression of the changing feelings, conscious or unconscious, behind the dramatic symbols.

The result of these methods was a new art form, of which the distinguishing feature was a profound and complex symbolism working on three indivisible planes—dramatic, verbal and musical. The vital significance of this symbolism is being more and more realized, though its involution of layer beneath layer of meaning has hardly begun to be explored. Through all the various stages of Wagner criticism—the opposition to him as a "modernist" in his lifetime, the heavy-handed exegesis of his philosophy during the high Wagnerian period (1880–1914) and the ill-informed abuse of his art when reaction set in between World Wars I and 11—Wagner's complex interrelation of dramatic. verbal and musical symbolism has not been approached with anything like the thoroughness it deserves.

Wagner's symbolic art was a fundamental contribution to the stream of thought and feeling passing from Paul Feuerbach, through Schopenhauer and Nietzsche, to modern depth psychology. The common theme of all his mature works. except *The Mastersingers,* is the romantic concept of "redemption through love"; but this element, used rather naïvely in the three early operas. became, in the later musical dramas, a mere catalyst for much deeper complexes of ideas on various levels. In *The Ring* there are at least five interwoven strands of overt meaning concerned with German nationalism, international socialism, the philosophy of Schopenhauer. Buddhism and Christianity. (Wagner sketched a dramatic scheme for a Buddhist musical drama, *Die Sieger* [*The Victors*], and for a Jesus von *Nazareth*, neither of which he completed.) On another level, there is a prophetic treatment of some of the dominant themes of depth psychology: power complex arising from sexual inhibition, incest, mother-fixation and Oedipus complex. (*See* also PSYCHOANALYSIS.)

Tristnn stands in a line of symbolism extending from the themes of "night" and "death" explored by such German romantic poets as Novalis, through the Schopenhauerian indictment of life as an evil illusion and the renunciation of the will to live, to the modern psychological insight into the relationship between eroticism and the death wish. *The Mastersingers* stands apart as a work in which certain familiar themes are treated on a purely conscious plane with mellow wisdom and humour: the impulsiveness of youth and the resignation of age, the ecstasy of youthful love. the value of music itself as an art. But in Wagner's last work, *Parsijal*, the symbolism returns on a deeper level than before He has been much criticized for this strongly personal treatment of a religious subject, which mingles the concepts of sacred and profane love; but in the light of modern knowledge. his insight into the relationship between religious and sexual experience can only seem much in advance of his time. The themes of innocence and purity, sexual indulgence and suffering, remorse and sexual renunciation are treated with a peculiar subtle intensity and depth of compassion that explore deeply into the unconscious and make *Parsifal* in some ways the most visionary of all Wagner's works.

Influence.—Wagner's influence, as a musical dramatist and a composer. was a powerful one. Later operatic composers mere greatly indebted to him—not only the many who adopted his methods more or less implicitly. like Richard Strauss or the few who turned them to entirely personal account. like Debussy, but even those who rejected his conception and continued the older type of "set-piece" opera. Although few have been able to follow him in providing their own verbal basis. all significant opera composers have profited from his reform in the matter of giving dramatic depth. continuity and cohesion to their works. "Music drama" is dead but musical drama is still fully alive.

In the purely musical field. Wagner's influence was even more far-reaching. He de eloped such a wide expressive range thst he was able to make each of his works inhabit a unique emotional world of its own; and. in doing so. he raised the melodic and harmonic style of German music to its highest emotional and sensuous intensity. It was this intensity that caused him to bestride the late 19th century like a Colossus: the subsequent history of music, apart from the nationalist schools and the development of the traditional symphony by composers like Sibelius and Shostakovich, stems entirely from him, either by extension of his discoveries or reaction against them. There was. of course his immediate effect on late romantics like Richard Strauss in Germany and like Bruckner and Mahler both of whom exploited his gains in the field of the gigantic Austrian symphony; but his influence was far more widespread than this. The sensuous and symbolic content of his works profoundly affected artists of all kinds in France and impelled Debussy, partly by subtilization and partly by rejection, to evolve his own elusive sensuous, symbolic and epoch-making art Moreover, Wagner's persistent modulation without perfect cadences and his intensive development of German chromaticism, notably in *Tristan*, was later carried further by Schoenberg to the point where it led to the crucial breakthrough into atonality (see HARMONY) And on the negative aide, the psychological intensity of his music caused a violent reaction that resulted in the fierce abstract intellectualism of the theory and practice of the neoclassic school headed by Stravinsky. Wagner was the great turning point of western music, representing at once the final romantic culmination of the old tonal system and the source of the new music of our time.

See also references under "Wagner, (Wilhelm) Richard" in the Index volume.

BIBLIOGRAPHY.—For a realistic but sympathetic analysis of Wagner's phenomenally complex character, the reader should consult Ernest Newman, *The Life of Richard Wagner,* 4 vol. (1933–47), which unravels the tangled skein meticulously. Against this work should be checkrd all the preceding, unreliabie accounts of Wagner's life and personality, including Wagner's own in *Mein Leben*. 2 vol. (1911), and the official German and English biographies by C. F. Glasenapp, *Das Leben Richard Wagners*, 6 vol. (1894–1911), and W. A. Ellis, *Life of Richard Wagner*, 6 vol. (1900–08). Even Newman is not absolutely final in every last detail. since certain sources (notably the letters of Wagner published as the Burrell collection, 1951) were not available to him.

Wagner's own prose works were translated into English by W. A. Ellis, 8 vol. (1892–99). The best analytical introduction to Wagner's stage works, with exhaustive accounts of which they are based. is Ernest Newman's *Wagner Operas* (1949, republished with the title *Wagner Nights,* 1950). A penetrating and detailed study of Wagner's development as a musical dramatist, in close connection with his changing theories, is Jack Stein's *Richard Wagner and the Synthesis of the Arts* (1960). A. O. Lorenz, in *Das Geheimnis der Form bei Richard Wagner,* 4 vol. (1924–1933), provided a schematic bar-by-bar analysis of the musical construction of *The Ring, Tristan. The Mastersingers* and *Parsifal*. There is no book on Wagner's influence, operatic or purely musical; and the studies that attempt to interpret the symbolism of Wagner's works should all be approached with caution.

(D. V. C.)

WAGNER-JAUREGG, JULIUS (1857–1940). Austrian psychiatrist. was born at Wels in Upper Austria on March 7. 1857. He was awarded the 1927 Nobel prize in medicine and physiology for his introduction of malaria treatment for general paralysis. After graduating doctor of medicine at the University of Vienna in 1880 he worked first in the department of experimental pathology and internal medicine and then in the psychiatric clinic. In 1859 he was appointed professor of psychiatry and neurology at the University of Graz, and in 1893 was called to the corresponding chair at Vienna and to the directorship of the university hospital for nervous and mental diseases. He held these posts for 35 years, acquiring an international reputation as a psychiatrist, and retired in 1928.

Cases in which sufferers from nervous or mental disease had shown considerable improvement after contracting a febrile infection had been recorded from early times, but these empirical observations had never been followed up systematically. As early as 1587 Wagner-Jauregg proposed that nature's experiment should be imitated by deliberately producing an infectious disease. and he stressrd the advantages uf malaria as a disease that could be interrupted at will by means of quinine. In 1890 he attempted to induce fever by the injection of tuberculin and other foreign proteins, and it was not until 1917 that he actually inoculated cases of progressive paralysis with tertian malaria. The result was a striking improvement in the prognosis of a disease which had hitherto been regarded as incurable.

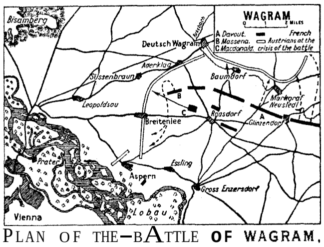
Although the treatment of general paralysis was later greatly modified by the introduction of chemotherapeutic and antibiotic agents. Wagner-Jauregg's work remained of importance. Earlier in his career he had made contributions to other branches of medicine, especially concerning cretinism and other thyroid diseases. He died in Vienna on Sept. 27. 1930. (W. J. BP.)

WAGON or WAGGON, a large four-wheeled vehicle for the carriage of heavy loads, drawn by two or more horses. This is the general English use of the term, where it is more particularly confined to large vehicles used in the carrying of agricultural produce. It is also used of uncovered heavy rolling stock for freight on railways. (*See* RAILWAY.) In the U.S. the term is applied also to lighter vehicles, such as are used for express delivery, police work. etc.. and to various forms of four-wheeled vehicles used for driving, to which the English term "cart" would be given.

WAGRAM or DEUTSCH WAGRAM, a village of Austria in the plain of the Marchfeld, $11\frac{1}{2}$ mi. N.E. of Vienna. Pop. (19.51) 3.996. It gives its name to the battle of July 5 and 6. 1809, in which the French army under Napoleon defeated the Austrians under the archduke Charles.

On the failure of his previous attempt to pass his army across the Danube at Aspern (*see* ASPERN-ESSLING, BATTLE OF; NAPOLEONIC CAMPAIGNS), Napoleon set himself to concentrate around Vienna and the island of Lobau not only his own field forces but also every man, horse and gun available from Italy and south Germany for a final efiort. Every detachment was drawn in within 48 hours' call, his rearward communications being practically denuded of their covering troops. The island of Lobau itself was converted practically into a fortress, and more than 100 guns were mounted on its banks to command the Austrian side of the stream. Giving up. in face of this artillery. the direct defense of the riverside, the Austrians formed in a great arc of about 6-mi. radius extending from the Bisamberg, overlooking the Danube, in the west, to Markgrafneusiedl on the east. From this point to the Danube below Lobau a gap was left for the deployment of the archduke Johann's army from Pressburg 35 mi. distant. This army. however, arrived too late. The total front, therefore, was about 12 mi, for 120,000 men, which could be reduced to about 6 mi. by a forward march of a couple of hours.

Meanwhile Napoleon replaced the temporary bridges over the main stream by means of two solid structures, protecting them by palisades of piles and floating booms, and organized an armed flotilla to command the waterway. On the island itself preparations were made to throw three bridges across the Lobau arm of the stream opposite Aspern and Essling. and seven more on the right, facing east between Gross Enzersdorf and the main river. For several days previous to the great battle the French had sent across small detachments; hence when, on the afternoon of July 4, an advanced guard was put over near Gross Enzersdorf, the attention of the Austrians was not particularly attracted and they did not interfere. Under cover of this detachment Napoleon's pontoniers made the seven bridges. Long before daylight on July 5 the troops began to stream across, and about 9 A.M. the three corps destined for the first line (Davout. Oudinot and Masséna) had completed their deployment on a front of about 6.000 yd. and were moving forward to make way for the second line (Eugène and Bernadotte) and the third line (Marmont, Bessikres's cavalry and the guard). About noon the general advance began, the French opening outward like a fan to obtain space for manoeuvre.



PLAN OF THE BATTLE OF WAGRAM, JULY 5–6, 1809

The Austrians held a strong position along the line of the Russbach from Wagram to Markgrafneusiedl with their left, while their right was held ready for a counterattack intended to roll up the French attack from left to right when the proper moment should come. The movements of the great French masses in the confined space were slow, and although the French left under Masséna pushed the Austrians back beyond Leopoldsau and Süssenbrunn, the main attack on the line of the Russbach did not declare itself till 8 P.M.; the corps did not attack simultaneously, and failed altogether to make any serious impression on the Austrian position. But, hearing of the success of his left wing on the Russbach, the archduke determined to anticipate the French next morning on that side, and four corps were directed upon Masséna, who had bivouacked his troops overnight on the line Leopoldsau-Sussenbrunn-Aderklaa. the latter, a strongly built village. forming, as it were, a bridgehead to the passages of the Russbach at Wagram. Another corps with a strong cavalry force was also directed to pivot round Markgrafneusiedl and to attack Davout on his right; on this flank also the arrival of the archduke Johann was expected later in the day.

The Austrian movements were somewhat ill connected; nevertheless, by 11 A.M. Masséna's detached left division had been driven back almost to Aspern, and hi's right. though aided by Bernadotte, had failed to recapture Aderklaa, from which the Austrians had driven his advanced posts early in the morning. The situation for the French looked serious, for their troops were not fighting with the dash and spirit of former years. But Napoleon was a master in the psychology of the battlefield. and he knew that on the other side things were much the same. He therefore sent orders for a great counterstroke. Davout on the right was to press his attack on Markgrafneusiedl and roll up the Austrian left flank, Oudinot, next him. mas simply to engage the enemy on the heights with artillery fire for the time being. The capture of Markgrafneusiedl was to be the signal for the main blow against the Austrian centre by Eugene's two corps (under Macdonald and Grenier), which were then moving up. Meanwhile Masséna was to move laterally across the front to aid his isolated division in guarding the threatened left flank. The gap thus left was covered by a line of guns, soon raised to a total of 104, which prepared the advance of the 5th corps (Macdonald) through the gap on Sussenbrunn, followed by the guard and reserve cavalry.

Macdonald formed his 30.000 men in a gigantic hollow square —two lines, each of four deployed battalions. closed up so that the whole was six ranks deep, while the remainder of the infantry marched behind in column on either flank, and cavalry closed the rear. The Austrian round shot cut swaths through this dense square, whose trail appeared one mass of dead and dying, creating a terrible impression on all who saw it. It had shrunk so much from losses. and still more from stragglers. that it came to a halt in a sandpit a mile short of Siissenbrunn. When reinforced, both directly and by divisions launched to attack Aderklaa and Breitenlee on its flanks, Macdonald resumed his advance and reached his objective. At the same time Napoleon had ordered forward Oudinot to cross the Russbach between Baumdorf and Wagram and to strike the joint of the Austrian line at Wagram. The Austrian left centre had been weakened by reinforcements sent to the left, hard pressed by Davout, and by stretching to cover the gap on the other side. This weakening enabled Oudinot to gain Wagram, while Davout had also made headway. With the penetration near Wagram, the Austrian army mas split. and learning that the archduke Johann could not arrive until evening the archduke Charles at about 2:30 P.M. ordered a general retreat, the main part westward and the left wing northward.

The French had seen more of the slaughter than their adversaries, and except for the emperor and Davout all seem to have been completely shaken. Even in Davout's command: always the steadiest in danger, the limit of endurance had been passed, for when, at about 5 P.M., the advanced patrols of the archduke Johann's force appeared on their flank, panic on a scale previously unknown in the *grande armée* seized the right wing, and Napoleon had to confess that no further advance was possible for several days.

Berndt (*Zahl im Kriege*) gives the following figures: French 181,700 (including 29,000 cavalry) and 450 guns engaged, of whom 23,000 men were killed and wounded, 7,000 missing; Austrians. 128.600 (including 4,600 cavalryj and 410 guns engaged. losses 19.110 killed and wounded and 6,740 missing.

WAGTAIL, the popular name for birds of the subfamily Motacillinae, which, together with the Anthinae (see PIPIT), form the passerine family Motacillidae.

The pied wagtail is almost confined as a breeding species to the British Isles. It constitutes a good example of a species owing its origin to isolation. It is represented on the continent by the white wagtail (*M. alba*), of which it is a subspecies. Three other species occur in England, but the subfamily with several genera and many species ranges over the old world, except Australia and Polynesia, while Asiatic species reach northwest America.

Wagtails are long-tailed, generally particoloured birds. frequenting streams and stagnant water and feeding on seeds, insects, worms, small molluscs and crustaceans. The nests are made of moss, grass and roots. with a lining of hair and feathers; four to six eggs are laid, bluish-white or brown, with yellow marks.

WAHHABI, the name of a puritan movement within Islam. Wahhabis or *Ikhwan* (brothers) purport to follow in detail the practice of the Prophet, and regard as infidels all who do otherwise. Their enemies are the enemies of the true faith and their every campaign is therefore a jihad (holy war), death in which is a sure passport to paradise. Another feature of these communities is the complete elimination of all tribal distinctions. The old pastime of tribal raid and counterraid is discountenanced. The blood feud is no more. In the matter of doctrine the Wahhabis (*Ikhwan*) differ from their fellow Moslems in rejecting a large mass of tradition which they regard as unauthentic. Like all Moslems they regard the Koran as the word of God and therefore the foundation of their social code, but there is admittedly much in the Koran and much not in it which from the earliest days of Islam required explanation or consideration. Such matters were freely dealt with by the Prophet in conversation or in his practice, the records of which were collected in the form of traditions of the Prophet, which, being generally handed down by word of mouth, with time grew in volume. *See* ARABIA: *History*.

WAHOO *(Euonymus atropurpureus)*, a small North American tree of the staff tree family (Celastraceae), known also as burning bush, found from New York to Montana and southward and sometimes planted for ornament. The handsome fruit, ripening in October and persisting until midwinter, is a deeply lobed capsule with smooth purple valves which split apart at maturity, disclosing large seeds covered with a scarlet aril. *See* CLIMEING BITTERSWEET; SPINDLE TREE.

WAINEWRIGHT, THOMAS GRIFFITHS (1794–1852), English journalist and subject painter, was born at Chiswick in Oct. 1794. He contributed to various magazines and painted pictures some of which were exhibited at the Academy. Because of his extravagant habits, Wainewright's affairs became deeply involved. In 1830 he insured the life of his sister-in-law in various offices for a sum of £18,000, and uhen she died, in December of the same year, payment was refused by the companies on the ground of misrepresentation. Wainewright retired to France, where he was seized by the authorities as a suspected person and imprisoned for six months. He had in his possession a quantity of strychnine, and it was afterward found that he had poisoned not only his sister-in-law but also his uncle, his mother-in-law and a friend. He returned to London in 1837 but was arrested on a charge of forging, 13 years before, a transfer of stock, and was sentenced to exile for life. He died in Tasmania in 1852.

The *Essays and Criticisms* of Wainewright were published in 1880, with an account of his life, by W. Carew Hazlitt; and the history of his crimes suggested to Dickens his story of *Hunted Down* and to Bulwer-Lytton his novel of *Lucretia*.

WAINWRIGHT, JONATHAN MAYHEW IV (1883–1953), U.S. army officer, achieved fame as the hero of Bataan and Corregidor in the defense of the Philippines early in World War II (*q.v.*). Born on Aug 23, 1883, at Walla Walla, Wash., Wainwright grew up on army posts along the western frontier where his father had served in the wars against the Indians. Like his father he attended the U.S. Military academy, West Point, N.Y., and on his graduation in 1906 was commissioned a second lieutenant of cavalry. His career thereafter followed the usual pattern — service with troops, attendance at army schools and slow promotions. During World War I, when he rose to the temporary rank of lieutenant colonel, he served as adjutant of the training camp at Plattsburg, N.Y., and later saw action in France during the St. Mihiel and Meuse-Argonne offensives. He remained in Germany with the army of occupation until Oct. 1920. Promoted to major in 1920, he reached the rank of brigadier general 8 years later when he became commander of the 1st cavalry brigade. In Sept. 1940 he was promoted to major general and sailed for Manila to assume command of the Philippine division. There, on March 11, 1942, when Gen. Douglas MacArthur departed for Australia, Wainwright took over command of all U.S. forces in the Philippines, in a situation that was already hopeless. At Corregidor on May 6 he was forced to surrender to the Japanese. From that time until Aug. 1945 General Wainwright was a prisoner of war in Formosa and Manchuria. Rescued in time to participate in the surrender ceremony aboard the U.S. battleship "Missouri," he returned to the United States in September to be greeted with a hero's welcome and to receive the medal of honour. His book, *General Wainwright's Story* (1946), was edited by R. Considine. Wainwright retired from the army Aug. 31, 1947, and died Sept. 2. 1953.

See Louis Morton, *The Fall of the Philippines, "U.S. Army in World War II Series"* (1953). (L. MN.)

WAITE, MORRISON REMICK (1816–1888), seventh chief justice of the Gnited States, was born in Lyme, Conn.. on Nov. 29, 1816. He graduated from Yale college in 1837 and studied law in the office of his father, Henry M. Waite, a justice of the supreme court of Connecticut. In 1838 he moved to Maumee City, O., where he was subsequently admitted to the bar and began the practice of law. In 1850 he moved to Toledo, where he developed a substantial practice in railroad and other corporate matters. Although he was a Whig and later a Republican, he was not so active in politics as many of his predecessors and successors on the supreme court. Waite first achieved national prominence in 1871 in the "Alabama" arbitration (*q.v.*) at Geneva, Switz., where he served as one of the U.S. counsel with William M. Evarts and Caleb Cushing. He was serving as chairman of the Ohio constitutional convention in Jan. 1874 when Pres. U. S. Grant appointed him to the supreme court. He served as chief justice until his death, which occurred on March 23, 1888.

In general it may be said that the Waite court represented a reaction against the extreme nationalist movement which followed the close of the Civil War, and the significant contribution of his court was the tendency to uphold state powers against claims that the 14th amendment or the commerce clause had invalidated the state action. The extent of the economic and social problems which came before the court in this period is illustrated by the fact that before the beginning of Waite's term only 30 cases involving the commerce clause of the constitution had reached the court (five in the era of the Marshall court), and at the close of Waite's tenure the number had increased to 158. In Waite's term he gave the opinion of the court in more than 1,000 cases.

Waite in many cases held that the privileges and immunities of citizens of the United States mere not increased by the 14th amendment, and that the amendment did not give congress extensive power to protect civil rights (*see* CIVIL LIBERTIES). While Waite represented a movement to uphold the power of the states, statements by him, first in *Munn* v. *Illinois*, 94 U.S. 113 (1877), later in *Stone* v. *Farmer's Loan and Trust Co.*, 116 U.S. 307 (1886), that a state cannot "do that which . . . amounts to taking of private property for public use . . . without due process of law" were used by subsequent supreme courts as the basis of asserted power of the supreme court to invalidate state police power (*q.v.*) regulations of private property. In one of the few cases in which Waite invalidated a state act, *Hall* v. *De Cuir*, 95 U.S. 485 (1878), a Louisiana reconstruction statute which required all carriers to give equal accommodation without discrimination on account of race or colour was involved. This statute was held unconstitutional as a "direct burden" upon interstate commerce and therefore a matter for national regulation. In 1945 this case served to invalidate a Virginia statute requiring interstate carriers to separate races (*Morgan* v. *Virginia*, 328 U.S. 373 [1945]).

Waite's most famous case was *Munn* v. *Illinois*, one of a group of six cases known as the Granger cases, involving legislation growing out of the Populist movement in Illinois and other states, principally in the midwest, to fix maximum rates to be charged by grain elevators and railroads. The suits instituted to test the validity of these laws charged that state laws providing for rate fixing constituted deprivation of private property "without due process of law" under the 14th amendment. Waite borrowed a phrase from Lord Chief Justice Sir Matthew Hale in 17th-century England (Hale, *De Portibus maris*) to hold that when a business or private property was "affected aith a public interest" it was subject to regulation. The chief justice said that where business was subject to regulation, then "for protection against abuses by legislatures, the people must resort to the polls, not to the courts." Without doubt the basic significance of this case was the establishment of the idea, foreign to much of the economic thinking of the time, that private property was subject to legislative regulation. Waite's loose use of the phrase borrowed from Lord Hale was in later cases turned to a contrary purpose so that no regulation was permitted unless the business was in the nature of a public utility. It was not until 1934 (in *Nebbia* v. *New York*, 291 U.S. 502 [1934]—New York milk cases) that the supreme court returned to Waite's own idea of the legislative power — private property could be regulated whenever the court could find that the legislature sought to fulfill a public interest.

Another of Waite's decisions, *Reynolds* v. *United States*, 98 U.S. 145 (1878), which attracted notoriety at the time and was considered with renewed interest in the second half of the 20th century, concerned religious freedom. The question was whether the religious belief of a Mormon must be accepted as a justification for a criminal act (polygamy) because the 1st amendment forbids congress to pass a law which shall prohibit free exercise of religion. Subsequent interest in the case stemmed from its extended discussion of the meaning of the constitutionally protected religious freedom. Waite held that congress could make polygamy by a Mormon a criminal act, for he drew a distinction between freedom to believe, which was protected, and freedom to practise certain acts which were not protected by the constitution against legislative acts.

The 14 years of Waite's chief justiceship are sometimes a forgotten period in constitutional history or are treated as a time in which the chief justice is described as a weak or insignificant leader. Yet Waite and his court established or confirmed many of the accepted principles of U.S. constitutional jurisprudence. Waite also attempted to establish a conception of the office of chief justice which would take it out of politics. He stopped consideration of his name for the presidency because he thought such consideration would detract from the prestige of the court, and he refused for similar reasons to serve on the electoral commission (*q.v.*) in the Hayes-Tilden controversy.

See Bruce Raymond Trimble, *Chief Justice Waite, Defender of the Public Interest (1938)*; Felix Frankfurter, *The Commerce Clause Under Marshall, Taney and Waite* (1937). (A. DM.)

WAITS, the itinerant musicians who paraded the streets at night at Christmas time (A.S. *wacan,* to "wake" or "watch"). The waits of the 14th and 15th centuries were watchmen who sounded horns or even played a tune to mark the hours. The book of household expenses of Edward IV (1478) provides for "a wayte. that nyghtely from Mychelmas to Shreve Thorsdaye pipe the watch within this courte fowere tymes; in the somere nightes three tymes."

Besides "piping the watch" and guarding the palace against thieves and fire, this wait had to attend at the installation of knights of the Bath. London and all the chief boroughs had their corporation waits from the early 16th century. In 1582 Dudley, earl of Leicester, wrote to the corporation of London asking that a servant of his should be admitted to the city waits. The London waits played before the mayor during his annual progress through the streets and at city dinners.

In the 18th and early 19th century the ordinary street watchman serenaded householders at Christmas time, calling round on Boxing day to receive a gratuity for their tunefulness. When in 1829 their place as guardians of the city's safety was taken by police, private individuals kept up the custom.

WAKATSUKI, REIJIRO (1866–1949), Japanese statesman, graduated in law at the Imperial university of Tokyo in 1892, when he also entered the civil service. He was nominated crown member of the house of peers in 1911, and was minister of finance in 1912 and in 1914–15, and also minister of home affairs in 1924–26. He succeeded Viscount Kato as prime minister and leader of the Kensei-kwai party in 1926. He desired to broaden the basis of his cabinet by including members of the Seiyuhonto party, but failed, and was compelled to reconstitute his ministry (June 1926). exclusively with members of the Kensei-kwai party. Later on, he succeeded in obtaining the support of the Seiyuhonto party, thus securing a majority in the chamber. During the autumn of 1926 proceedings against students accused of communism caused considerable unrest. But the real cause of his fall on April 16, 1927, was the failure of the Suzuki firm. Later, the Kensei-kwai and Seiyuhonto united to establish a new party, Minseito, on June 1, 1927. Wakatsuki transferred the leadership to Hamaguchi, co-operating with Tokonami, the leader of Seiyuhonto. A few years later, on April 14, 1931, he again was selected to head a cabinet, but his tenure lasted only a few months, until Dec. 12. He died near Ito, Japan, Nov. 21, 1949.

WAKE, "waking" or watching round a corpse before burial (A.S. *wacan,* to "wake" or "watch"); in the wider sense, a vigil kept to commemorate the dedication of the parish church. This religious wake consisted in an all-night service of prayer and meditation in the church. These services, termed *Vigiliae* by the church, appear to have existed from the earliest days of Anglo-Saxon Christianity. Each parish kept the morrow of its vigil as a holiday. Wakes soon degenerated into fairs; people from neighbouring parishes came to join in the merrymaking, and the revelry and drunkenness became a scandal. In 1445 Henry VI tried to suppress markets and fairs on Sundays and holy days.

Side by side with these church wakes there existed the custom of "waking" a corpse. The custom, as far as England was concerned, seems to have been older than Christianity, and to have been at first essentially Celtic. Doubtless it had a superstitious origin, the fear of evil spirits hurting or even removing the body. The Anglo-Saxons called the custom lich-wake or like-wake (A.S. *lic,* "a corpse"). With the introduction of Christianity the offering of prayer was added to the vigil. As a rule the corpse, with a plate of salt on its breast, was placed under the table, on which was liquor for the watchers. These private wakes soon tended to become drinking orgies. With the Reformation and the consequent disuse of prayers for the dead the custom of waking became obsolete in England, but survived in Ireland.

WAKEFIELD, EDWARD GIBBON (1796–1862), British statesman, prime mover in colonizing New Zealand, was born in London on March 20, 1796. Wakefield was for a short time at Westminster school. He eloped at 20 with Eliza Susan Pattle, the orphan daughter of a merchant in the far east trade. Her relatives became reconciled to the match and procured Wakefield a secretary's appointment in the British legation at Turin. He resigned this post in 1820, upon the death of his wife and then spent some years in Paris. In 1826 he decoyed Ellen Turner, the daughter of a wealthy manufacturer, from school by means of a forged letter and induced her to believe that she could only save her father from ruin by marrying him. She accordingly accompanied him to Gretna Green. where they went through a ceremony of marriage. His wife's relatives pursued them to France and persuaded her to leave him. He was tried with his confederates at Lancaster assizes (March–May 1827), convicted and sentenced to three years' imprisonment in Newgate. The marriage, which had not been consummated, was dissolved by parliament.

Wakefield turned his attention while in prison to colonial affairs and acutely detected the main causes of the slow progress of the Australian colonies in the enormous size of the landed estates and the reckless methods of allocation of land. He proposed the sale of land in small quantities at a sufficient price, and the employment of the proceeds as a fund for promoting immigration. These views were expressed with extraordinary vigour in his *Letter From Sydney* (1829), published while he was still in prison, but composed with such graphic power that it has been continually quoted as if written in Australia. After his release, Wakefield produced a tract on the *Facts Relating to the Punishment of Death in the Metropolis,* with a vivid picture of the condemned felons in Newgate and another on incendiarism in the rural districts, with an equally powerful exhibition of the degraded condition of the agricultural labourer.

He soon, however, became entirely engrossed with colonial affairs and having impressed John Stuart Mill, Col. Robert Torrens and other leading economists with the value of his ideas. became the motive force behind the South Australian company, by which the colony of South Australia was ultimately founded. In 1833 he published anonymously *England and America,* a work primarily intended to develop his own colonial theory outlined in the appendix entitled "The Art of Colonization." The body of the work is fruitful in seminal ideas, though some statements may be rash.

In 1837 the New Zealand association was established, as a result of Wakefield's efforts. Scarcely, however, was this great undertaking fairly begun when he accepted a post on Lord Durham's staff on the latter's appointment as lord high commissioner in Canada (*see* DURHAM, JOHN GEORGE LAMBTON, 1ST EARL OF). The "Public Lands and Emigration" section of the Durham report embodied Wakefield's ideas and he is said to have been the means by which the report mas given prematurely to the public through *The Times,* to prevent its being tampered with by the government. He certainly acted in this spirit a few months later, when in May 1839, understanding that the authorities intended to prevent the dispatch of emigrants to New Zealand, he hurried them off on his own responsibility, thus compelling the government to annex the country just in time to anticipate a similar step on the part of France (*see* NEW ZEALAND: *History*). In 1846 Wakefield. exhausted by work, was struck down by apoplexy and spent more than a year in complete retirement, writing during his gradual recovery his *Art of Colonization.*

The management of the company had meanwhile passed into the hands of others, whose sole object was to settle accounts with the government and wind up the undertaking. Wakefield seceded, and joined Lord Lyttelton and John Robert Godley in establishing the Canterbury settlement as a Church of England colony. A portion of his correspondence on this subject was published by his son as *The Founders of Canterbury* (Christchurch, 1868). In 1854 he appeared in the first New Zealand parliament as extra-official adviser of the acting governor, a position which excited great jealousy, and as the mover of a resolution demanding the appointment of a responsible ministry. In that year Wakefield's health broke down. He spent the rest of his life in retirement, dying at Wellington on May 16. 1862.

Wakefield was a man of large views and lofty aims and in private life displayed the warmth of heart which commonly accompanies these qualities. But he hesitated at nothing necessary to accomplish an object and the conviction of his untrustworthiness gradually alienated his associates and left him politically powerless. Excluded from parliament by the fatal error of his youth, he was compelled to resort to indirect means of working out his plans by influencing public men. But for a tendency to paradox, his intellectual powers were of the highest order.

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WAKEFIELD, a city and a municipal, county and parliamentary borough in the West Riding of Yorkshire, Eng. Pop. (1951) 60,371. Area 8.3 sq.mi. Lying on the Calder river at the eastern edge of the Pennines, it became the meeting place of the lowlanders with the people of the dales and thus developed as a market. It is still an agricultural centre and is also a focus of rail and road routes from all parts of Yorkshire and the headquarters of the county council of the West Riding. Textiles and coal account for about hali the local employment, and there are chemical and engineering industries, brewing and a considerable traffic in grain. The Aire and Calder Navigation canal connects it with the Humber ports.

The name (Wacafeld in Domesday) probably denotes the site of the annual festivals or woke plays, and the town became noted for its miracle plays and, more recently, for its music festival. Wakefield was the chief place in a large estate belonging to Edward the Confessor and was still a royal manor in 1086. Shortly afterward it became a baronial liberty, extending into Lancashire and Cheshire. In 1204 the lord of the manor received a grant of a three days' fair at Wakefield, and as early as 1231 the town seems to have had some form of burghal organization. By 1308 it had a wool market; about 1470, foreign cloth weavers, chiefly Flemings, began to settle there; and by 1500 Wakefield was the centre of the district. During the 18th century it became noted for the manufacture of woolen stuffs. In 1342 rights of toll were granted to repair the bridge over the Calder, and a chantry chapel was built alongside it; the chapel was drastically restored in 1847, its ancient façade now being at Kettlethorpe hall; and a modern bridge was built beside the old one in 1933. The town was attacked and taken by Lord Fairfax in 1643 but Sandal castle, south of the river, was not taken until 1644; it was dismantled in 1648.

Down to 1832 Wakefield was under the superintendence of a constable appointed by the steward of the lord of the manor, but in that year the town was enfranchised and now the borough returns one member. In 1848 a charter of incorporation was granted; in 1888 the town was created a city; and in 1915 it became a county borough.

In 1888 the bishopric of Wakefield was formed, almost entirely from that of Ripon. The diocese includes about one-seventh of the parishes of Yorkshire and covers a small portion of Lancashire. The cathedral is the ancient parish church of All Saints, rebuilt in 1329, whose crocketed spire (247 ft.) is the highest in Yorkshire. The Queen Elizabeth Grammar school was founded in 1591, and among its scholars was John Radcliffe (1650–1714), iounder of the Radcliffe observatory and library at Oxford. George Gissing was also a native of Wakefield. The city has a museum and an art gallery.

The battle of Wakefield (1460) was fought near Sandal castle, a monument marking the spot where Richard Plantagenet fell.

WAKEFIELD ESTATE, Westmoreland county, Va., the site of George Washington's birthplace, was purchased by his father in 1718. The original house, situated between Bridges creek and Popes creek, where George Washington spent the first three or four years of his childhood, was accidentally burned during the Revolutionary War, and no description of it has survived. The memorial mansion, built in 1931 by the Wakefield National Memorial association, therefore represents a Virginia plantation house of the 18th century but is not a restoration. The estate and the memorial mansion were donated to the United States in 1931 and became the George Washington Birthplace National monument. (E. M. RY.)

WAKE ISLAND, an atoll in the central Pacific ocean 2,302 mi. W. of Honolulu and 1,987 mi. S.E. of Tokyo. It consists of three low lying (altitude 21 ft.) islets, Wilkes, Peale and Wake ($2\frac{1}{2}$ sq.mi. in all), lying in a horseshoe shape on the reef, separated by narrow, shallow channels and enclosing a lagoon 44 mi. long and 2 mi. wide. It was probably seen by the Spanish explorer Mendaña in 1568 and was visited by the British Capt. William Wake in 1796; its position (latitude 19° 16' N., longitude 166° 39' E.) was fixed by the U.S. exploring expedition under Lieut. Charles Wilkes in 1841. It was formally claimed by the U.S. in 1899 to be used as a cable station and was placed under naval jurisdiction in 1934. In 1935 a commercial airline established a seaplane base and hotel there for overnight stops on transpacific flights to Guam and the Philippines.

In 1941, recognizing the strategic location of Wake, the U.S. navy began the construction of an air and submarine base which was about half completed at the time of the Pearl Harbor attack. At this time the atoll was commanded by Comdr. W. S. Cunningham, U.S.N.; the marine defense force of about 447 men was under Maj. James P. S. Devereux and there were about 1,100 civilian workers on the atoll. The Japanese first attacked Wake with 36 bombers at noon on Dec. 8, 1941 (Wake time), a few hours after the Pearl Harbor assault. A Japanese naval task force, including cruisers, destroyers and transports, appeared on Dec. 11, but was repulsed with considerable loss by the coast defense guns and aircraft, Thereafter, however, the Japanese had the atoll under almost continuous air attack, and a U.S. relief force failed to reach the area before the Japanese returned on Dec. 23 with a much more powerful force. In the predawn hours they succeeded in putting about 1,000 troops ashore and after five hours of fierce resistance the island commander surrendered when the situation had become manifestly hopeless. Altogether 1,616 Americans were captured and most of them were evacuated to China and Japan. The Japanese fortified the atoll heavily, but repeated attacks by U.S. aircraft during the remainder of the war devastated it completely. The Japanese garrison surrendered on Sept. 4, 1945, and the U.S. immediately constructed a naval air base there for the use of planes en route from Hawaii to Japan. Commercial planes began to use the atoll again on Nov. 25, 1945. Wake was the scene on Oct. 15, 1950 (Wake time), of an important conference between Pres. Harry S. Truman and Gen. Douglas MacArthur (*q.v.*) regarding the situation in Japan, Korea and the far east generally. Placed under the control of the Civil Aeronautics administration, Wake continued to serve as a stopping point for military and commercial planes flying the North Pacific. (J. H. K.)

WAKE-ROBIN, a name given to various wild flowers of the genus *Trillium* of North America and Asia, and also applied to the cuckoopint of Europe and north Africa. *See* CUCKOOPINT; TRILLIUM.

WAKSMAN, SELMAN ABRAHAM (1888–), U.S. microbiologist and biochemist; won the Nobel prize in physiology and medicine in 1952 for the discovery of streptomycin (*q.v.*). One of the world's foremost authorities on soil microbiology and on antibiotics derived from microorganisms of the soil; his most important contributions were in the characterization and classification of the *Actinomyces,* which include many antibiotic-producing organisms. Waksman and his pupils and co-workers discovered and described many new species and also characterized the antibiotics which they produce. Outstanding among them were streptomycin. first described in 1944, the first important specific agent effective in the treatment of human tuberculosis, and neomycin, reported in 1949, extensively used in treating numerous infectious diseases of man, animals and plants.

Waksman was born July 22, 1888, in Priluka, Russia. He emigrated to the United States in 1910 and became a naturalized citizen in 1916. He received his B.S. and M.S. degrees in agriculture at Rutgers university and his Ph.D. in biochemistry at the University of California. With only brief interludes, his teaching and research were all at Rutgers. There he became professor of soil microbiology in 1930, professor and head of a newly organized department of microbiology in 1940 and director of its institute of microbiology, which he established in 1949. He also organized a division of marine microbiology at Woods Hole Oceanographic institute and served as consultant and adviser to many governmental institutions and commercial organizations. In addition to scientific papers and books: he wrote an autobiography My *Life with the Microbes* (1954). (M. FD.)

WALACHIA or **WALLACHIA,** a former principality of southeastern Europe, constituting after its union with Moldavia on Nov. 9, 1859, a part of Rumania (*q.v.*).

WALAFRID STRABO (or Strabus, *i.e.*, "squint-eyed") (d. 849). German monk and theological writer, was born about 808 in Swabia. He was educated at the monastery of Reichenau, near Constance, where he had for his teachers Tatto and Wettin. Then he went on to Fulda, where he studied under Hrabanus Maurus before returning to Reichenau, of which monastery he was made abbot in 838. There is a story—based, however, on no good evidence—that Walafrid devoted himself so closely to letters as to neglect the duties of his office, and so was expelled from his house; but, from his own verses, it seems that the real cause of his flight to Spires was that he espoused the side of Lothair I (*q.v.*) on the death of Louis the Pious in 840. He was, however, restored to his monastery in 842, and died on Aug. 18, 849, on an embassy to his former pupil, Charles the Bald.

Works.—Of his theological works the most famous is the exegetical compilation which, under the name of *Glosa ordinariu* or the *Glosa,* remained for about 500 years the most widespread and important quarry of medieval biblical science, and even survived the Reformation, passing into numerous editions as late as the 17th century. The oldest known copy, in four folio volumes, is almost entirely Walafrid's work and gives us his method. In the middle of the pages is the Latin text of the Bible; in the margins are the "glosses," consisting of a very full collection of patristic excerpts in illustration and explanation of the text. An *Expositio quutuor Evangeliorum* is also ascribed to Walafrid.

Of interest also is his *De exordiis et incrementis rerum ecclesiasticarum* written between 840 and 842. It deals with ecclesiastical usages, churches, altars, prayers, bells, pictures, baptism and the Holy Communion. Walafrid shows no trace of belief in transubstantiation as taught by his famous contemporary Radbertus.

Walafrid's chief historical works are the rhymed *Vita sancti Galli* and a much shorter life of St. Othmar, abbot of St. Gall (d. 759). A critical edition of them by E. Dummler is in the *Monzimenta Germaniae hist. Poetae Latini*, ii, p. 259 ff. (1884). Walafrid's poetical works also include a short life of St. Blaithmaic, a high-born monk of Iona, murdered by the Danes in the first half of the 9th century; a life of St. Mammas; and a *Liber de visionibus Wettini*.

Many of Walafrid's other poems are, or include, short addresses to kings and queens (Lothair, Charles, Louis, Pippin, Judith, etc.) and to friends.

His most famous poem is the *Hortulus,* dedicated to Grimald. It is an account of a little garden that he used to tend with his own hands, and is largely made up of descriptions of the various herbs he grew there and their medicinal and other uses.

WALCOTT, CHARLES DOOLITTLE (1850–1927), U.S. paleontologist and geologist, noted principally for work on the Cambrian faunas of North America. He was born in New York Mills, N.Y., March 31 and became interested in fossils as a boy. After selling a collection to Harvard university he became assistant (1876) to James Hall, state geologist of New York. He studied the geology and paleontology of New York, eastern Canada, Ohio and Indiana. In 1879 he became assistant geologist on the newly organized U.S. geological survey. In 1883 he was appointed paleontologist of the U.S. survey and honorary curator of the National museum. His interest in Cambrian paleontology carried him to all parts of the west, all of the Appalachian states, eastern and western Canada and Wales. These studies and his search for Pre-Cambrian fossils continued throughout the remainder of his life in spite of continuous administrative duties.

Walcott published about 300 scientific papers and books. The most notable are on the appendages of trilobites, paleontology of the Eureka (Nev.) district, Cambrian faunas of North America, fauna of the Olenellus zone, Cambrian correlations, fossil medusae, Cambrian brachiopods, Cambrian geology and paleontology (5 vol.) and Cambrian faunas of China. Although Walcott never attended college he received 12 honorary degrees, four from European universities, and many other honours. He died in Washington, D.C., Feb. 9, 1927. (J. M. WR.)

WALD, LILLIAN D. (1867–1940), **U.S.** sociologist, nurse and social worker, who originated municipal school nursing, was born in Cincinnati, O., on March 10, 1867. She graduated (1891) from the New York hospital training school for nurses. In 1893 she founded the internationally known Henry Street settlement for social services and later expanded it into a nurses' training centre. She began the work of the school nurse in New York city in 1902 and planned the district nursing service of the American Red Cross. Vitally interested in the promotion of child welfare, Miss A'ald was active in promoting the establishment of the federal children's bureau in 1912. She served the cause of public welfare on several national and international commissions and conferences, notably in the 1919 series at Cannes, Zürich and Washington; was chairman of the American Union Against Militarism; one of the organizers of the National Women's Trade Union league; and represented the public from 1910 on the joint board of sanitary control of certain trades. Her books include *The House on Henry Street* (1915) and *Windows on Henry Street* (1934). She died on Sept. 1, 1940, in Westport, Conn.

WALDECK, a *kreis* and former state of Germany, between Westphalia and Hesse-Nassau. Once a principality and from Nov. 1918 to March 1929 a republic and constituent state of the Weimar republic, it was, on April 1, 1929, amalgamated with Prussia at the request of its people. It has an area of 420 sq.mi., covered with hills, which culminate in the Hegekopf (2,766 ft.). The centre is the plateau of Corbach. The chief rivers are the Eder and the Diemel, flowing into the Weser. Pop. (1950) 91,925.

Oats is the principal crop, but rye, potatoes and flax are also grown, and fruit cultivated. There are mines, slate and stone quarries. Manufactures are retarded by isolation from railways. The old capital was Arolsen (pop. 5,759 in 1950).

WALDECK-ROUSSEAU, PIERRE MARIE RENÉ (1846–1904), French statesman, remembered for his legalization of trade unions, for his pacification of the Dreyfus affair and for his Associations law, was born at Nantes on Dec. 2, 1846. Having studied law at Poitiers and in Paris, he practised as a barrister at Saint-Nazaire from 1870 and at Rennes from 1873 to 1879, when he was elected to represent Rennes in the chamber of deputies. A supporter of Léon Gambetta, he first distinguished himself with a report to the committee on the reform of the judiciary (1880). Re-elected deputy in 1881, he was minister of the interior in Gambetta's cabinet (Nov. 1881–Jan. 1882) and again in Jules Ferry's (Feb. 1883–March 1885). To these years belong his circular to the prefects warning them against appointing the nominees of deputies instead of those of the government to offices in the *de'partements* (1881); and the celebrated *loi Waldeck-Rousseau* of 1884, which legalized the formation of trade unions (with certain restrictions).

From 1885 to 1889 Waldeck-Rousseau sat as deputy for Ille-et-Vilaine. He did not stand for re-election to the chamber in 1889 or in 1893, but continued practising as a barrister in Paris (where he was enrolled as one in 1886); and in 1893 he defended Gustave Eiffel in the trial at the climax of the Panama scandal. In 1894, however, he became senator for the *département* of Loire. He stood as candidate for the presidency of the republic in 1895, but withdrew in order to allow Félix Faure an absolute majority.

On the fall of Charles Dupuy's ministry in June 1899, during the agitation about the proposed retrial of Alfred Dreyfus (*see* FRANCE: History), Waldeck-Rousseau was invited to form a cabinet. He assembled a coalition of "republican defense," another "union of the left," comprising at one extreme Gen. G. A. A. de Gallifet and at the other Alexandre Millerand, the first Socialist to hold office under the third republic (this appointment was the occasion of a split in the French Socialist party). When Dreyfus was again found guilty at his retrial, the government promptly advised Pres. Émile Loubet to grant him a pardon. To restore the rule of law and to put an end to the disorders provoked by the "nationalist" factions ("plebiscitary republicans" and monarchists), Waldeck-Rousseau had recourse to procedure under the law of 1875, whereby the senate could be transformed into a high court to try cases of treason: the result was the condemnation of Paul Déroulède (*q.v.*) and his supporters in Jan, 1900. Waldeck-Rousseau could thereafter maintain order without displays of force, relying on the senate and manipulating the groups in the chamber of deputies. The amnesty of Dec. 1900, against further prosecutions in the Dreyfus affair, was chiefly the result of his advocacy.

The most important measure of the later period of Waldeck-Rousseau's administration was the Associations law of July 1, 1901. This on the one hand abolished all restrictions on the right of association for licit purposes but on the other withheld this freedom from religious congregations, for which specific authorization by statute was required. In the debating preceding enactment Waldeck-Rousseau avoided extreme anticlericalism; and in 1903 he emerged from retirement to protest against the interpretation that Emile Combes was putting on the law in refusing on principle to authorize any religious associations.

The elections of April–May 1902 returned a majority favourable to the government; and surprise was felt when Waldeck-Rousseau resigned on June 3, 1902. He died on Aug. 10, 1904.

WALDEN, PAUL (1863–1957), Russian chemist who won international fame by his discovery in 1897–99 of the phenomenon known as the "Walden inversion," was born at Rosenbeck castle near Riga in the district of Livonia, on July 26 (new style; July 14, old style), 1863. He studied at the universities of Riga, Leipzig and Munich, and was successively professor of chemistry at Riga, St. Petersburg, Moscow, Rostock and, after Rostock was burned in 1942, guest professor at Tiibingen. In 1912 he was delegate to the International Congress of Applied Chemistry, New York, and in 1927–28 visiting professor at Cornell university, Ithaca, N.Y.

The Walden inversion is a chemical reaction in which a reversal of the rotatory power of an optically active compound takes place. It indicates that the mechanism of substitution does not involve the simple replacement of one group by another, but probably the loosening of all groups and atoms followed by a rearrangement. Walden's later researches were concerned mainly with the electrical properties of solutions, but his publications covered a wide range. As a noted historian of chemistry, his best-known work is *Geschichte der Chemie* (1947; 2nd ed., 1950). He died in the village of Gammertingen near Sigmaringen, Ger., Jan. 24, 1957. His "Notes From the Life of a Chemist" was translated into English by R. E. Oesper, *J. Chem. Educ.*, 28:160 (1951). (W. J. BP.)

WALDENBURG (Polish WALBRZYCH), a town in Wroclaw, Poland, in former German Silesia. Waldenburg, which became a town in 1426, lies in the centre of the productive coal district of the Waldenburger Gebirge, a branch of the Sudetic chain. Among other industrial establishments are machine, brick, wire, furniture, porcelain and earthenware factories and a china-painting establishment; there are also numerous flax-spinneries and linen factories in the neighbourhood. It was incorporated into Poland in 1945. Pop. (1960) 117,100.

WALDENSES. The Waldensian valleys lie to the southwest of Turin, in the direction of Monte Viso, being fertile and well wooded. The principal town near the valleys is Pinerolo (Pignerol). Just to its southwest there opens the chief Waldensian valley, the Val Pellice, watered by the stream of that name with the capital, Torre Pellice.

SECTS OF THE MIDDLE AGES

The name Waldenses was given to the members of an heretical Christian sect which arose in the south of France about 1170. The history of the sects of the middle ages is obscure, because the earliest accounts of them come from those who were concerned in their suppression. Later apologists of each sect reversed the process. In early times these sectaries produced little literature of their own; when they produced a literature at the beginning of the 1jth century they attempted to claim for it a much earlier origin. Hence there is confusion on every side. The polemical conception which has done much to perpetuate this confusion is that of the historical continuity of Protestantism from the earliest times. According to this view the church was pure and uncorrupt till the time of Constantine, when Pope Sylvester gained the first temporal possession for the papacy, and so began the system of a rich, powerful and worldly church, with Rome for its capital. Against this secularized church a body of witnesses silently protested; they were always persecuted but always survived, till in the 13th century a desperate attempt was made by Innocent III. to root them out from their stronghold in southern France. Persecution gave new vitality to their doctrines, which passed on to Wycliffe and Huss, and through these leaders produced the Reformation in Germany and England.

But, so far as can now be discovered the heretical sects of the middle ages rested upon a system resembling Manichaeism which was imported into Europe from the East. (*See* MANICHAEISM.) The Manichaean system of dualism, with its severe asceticism, and its individualism, which early passed into antinomianism, was attractive to many minds in the awakening of the 11th century. Its presence in Europe can be traced in Bulgaria soon after its conversion in 862, where the struggle between the Eastern and Western churches for the new converts opened a way for the more hardy speculations of a system which had never entirely disappeared, and found a home amongst the Paulicians (*q.v.*) in Armenia. The name of Cathari (*q.v.*), taken by the adherents of this new teaching, sufficiently shows the Oriental origin of their opinions, which spread from Bulgaria amongst the Slavs, and followed the routes of commerce into central Europe. The earliest record of their presence there is the condemnation of ten canons of Orleans as Manichees in 1022, and soon after this we find complaints of the prevalence of heresy in northern Italy and in Germany. The strongholds of these heretical opinions were the great towns, the centres of civilization, because there the growing sentiment of municipal independence, and the rise of a burgher class through commerce, created a spirit of criticism directed against the worldly lives of the clergy.

The system of Catharism recognized two classes of adherents, *credentes* and *perfecti*. The *perfecti* only were admitted to its esoteric doctrines and to its superstitious practices. To the ordinary men it seemed to be a reforming agency, insisting on a high moral standard, and upholding the words of Scripture against the traditions of an overgrown and worldly church. It may be said generally that Catharism formed the abiding background of mediaeval heresy. Prevailing discontent, in conflict with authority generally ended by borrowing something from Catharism. The result was that in the beginning of the 13th century there was a tendency to class all bodies of heretics together.

WALDENSIAN SECT

Most of these sects were stamped out before the period of the middle ages came to a close. The Waldenses, under their more modern name of the Vaudois, survived into the 19th century in the valleys of Piedmont, and have been regarded as at once the most ancient and the most evangelical of the mediaeval sects. It is, however, by no means easy to determine their original tenets, as in the 13th and 14th centuries they were a body of obscure and unlettered peasants, hiding themselves in a comer, while in the 16th century they were merged in the Reformation.

Already in the 9th century there were many protests against the rigidity and want of spirituality of a purely sacerdotal church. Thus Berengar of Tours (999–1088) upheld the symbolic character of the Eucharist and the superiority of the Bible over tradition. The Paterines in Milan (1045) raised a protest against simony and other abuses of the clergy, and Pope Gregory VII. did not hesitate to enlist their Puritanism on the side of the papacy and make them his allies in imposing clerical celibacy. In France, at Embrun, Peter de Bruys founded a sect known as Petrobrusians, who denied infant baptism, the need of consecrated churches, transubstantiation, and masses for the dead. A follower of his, a monk, Henry, gave the name to another body known as Henricians, who centred in Tours. The teachers of these new opinions were men of high character and holy lives, who in spite of persecution wandered from place to place, and made many converts from those who were dissatisfied at the want of clerical discipline which followed upon the struggle for temporal supremacy into which the reforming projects of Gregory VII. had carried the church.

It was at this time (1170) that a rich merchant of Lyons, Peter Waldo, sold his goods and gave them to the poor; then he went forth as a preacher of voluntary poverty. His followers, the Waldenses, or poor men of Lyons, were moved by a religious feeling which could find no satisfaction within the actual system of the church, as they saw it before them. Like St. Francis, Waldo adopted a life of poverty that he might be free to preach. He had a translation of the New Testament made into Provencal, and his preachers explained the Scriptures. Pope Alexander III., who had approved of the poverty of the Waldensians, prohibited them from preaching without the permission of the bishops (1179). Waldo answered that he must obey God rather than man. He was excommunicated by Lucius III. in 1184.

DIVISIONS OF WALDENSIAN BELIEF

The earliest definite account given of Waldensian beliefs is that of the inquisitor Sacconi about 1250. (D'Argentré, *Collectio judiciorum de novis erroribus,* i. 50, etc.) He divides them into two classes; those north of the Alps and those of Lombardy. The first class hold (1) that oaths are forbidden by the gospel, (2) that capital punishment is not allowed to the civil power, (3) that any layman may consecrate the sacrament of the altar, and (4) that the Roman Church is not the Church of Christ. The Lombard sect went farther in (3) and (4), holding that no one in mortal sin could consecrate the sacrament, and that the Roman Church was the scarlet woman of the Apocalypse, whose precepts ought not to be obeyed, especially those appointing fast-days. This account sufficiently shows the difference of the Waldenses from the Cathari: they were opposed to asceticism and had no official priesthood; at the same time their objection to oaths and to capital punishment are closely related to the principles of the Cathari.

These opinions were subversive of the system of the mediaeval church, and were viewed with disfavour by its officials. The earliest known document proceeding from the Waldensians is an account of a conference held at Bergamo in 1218 between the ultramontane and the Lombard divisions, in which the Lombards showed a greater opposition to the recognized priesthood than did their northern brethren. (Preger, *Beiträge zur Geschichte der Waldensier*)

ATTEMPTS AT SUPPRESSION

The spread of these heretical sects led to resolute attempts at their suppression. The crusade against the Albigensians could destroy prosperous cities and hand over lands from a heedless lord to one who was obedient to the church; but it could not get rid of heresy. The revival of preaching, which was the work of the order of St. Dominic, did more to combat heresy, especially where its persuasions were enforced by law. The work of inquisition into cases of heresy proceeded slowly in the hands of the bishops, who were too busy with other matters to find much time for sitting in judgment on theological points about which they were imperfectly informed. The greatest blow struck against heresy was the transference of the duty of inquiry into heresy from the bishops to Dominican inquisitors. The secular power, which shared in the proceeds of the confiscation of those who were found guilty of heresy, was ready to help in carrying out the judgments of the spiritual courts. Everywhere, and especially in the district round Toulouse, heretics were keenly prosecuted, and before the continued zeal of persecution the Waldenses slowly disappeared from the chief centres of population and took refuge in the retired valleys of the Alps. There, in the recesses of Piedmont, where the streams of the Pellice, the Angrogne, the Clusone and others cleave the sides of the Alps into valleys which converge at Susa, a settlement of the Waldensians was made who gave their name to these valleys of the Vaudois. In the more accessible regions north and south heresy was exposed to a steady process of persecution, and tended to assume shifting forms. Among the valleys it was less easily reached, and retained its old organization and its old contents. Little settlements of heretics dispersed throughout Italy and Provence looked to the valleys as a place of refuge, and tacitly regarded them as the centre of their faith. At times attempts were made to suppress the sect of the Vaudois, but the nature of the country which they inhabited, their obscurity and their isolation made the difficulties of their suppression greater than the advantages to be gained from it. However, in 1487 Innocent VIII. issued a bull for their extermination, and Alberto de' Capitanei, archdeacon of Cremona, put himself at the head of a crusade against them. Attacked in Dauphine and Piedmont at the same time, the Vaudois were hard pressed; but luckily their enemies were encircled by a fog when marching upon their chief refuge in the valley of the Angrogne, and were repulsed with great loss. After this Charles II., duke of Piedmont, interfered to save his territories from further confusion, and promised the Vaudois peace. They were, however, sorely reduced by the onslaught. Scattered bodies of Waldenses in Germany influenced, and afterwards joined, the Hussites and the Bohemian Brethren.

The last step in the development of the Waldensian body was taken in 1530, when two deputies of the Vaudois in Dauphin6 and Provence, Georges Morel and Pierre Masson, were sent to confer with the German and Swiss Reformers. A letter addressed to Oecolampadius gives an account of their practices and beliefs at that time, and shows us a simple and unlettered community, which was the survival of an attempt to form an esoteric religious society within the mediaeval church. It would appear that its members received the sacraments of baptism and the holy communion from the regular priesthood, at all events sometimes, but maintained a discipline of their own and held services for their own edification, largely dependent on the work of itinerant preachers. After giving an account of themselves they asked for information about several points in a way which showed the exigencies of a rude and isolated society, and finally they said that they had been much disturbed by the Lutheran teaching about freewill and predestination, for they had held that men did good works through natural virtue stimulated by God's grace, and they thought of predestination in no other way than as a part of God's foreknowledge. Oecolampadius gave them further instruction, especially emphasizing the wrongfulness of their outward submission to the ordinances of the church: "God," he said, "is a jealous God, and does not permit His elect to put themselves under the yoke of Antichrist." The result of this intercourse was an alliance between the Vaudois and the Swiss and German Reformers. A synod was held in 1532 at Chanforans in the valley of the Angrogne, where a new confession of faith was adopted, which recognized the doctrine of election, assimilated the practices of the Vaudois to those of the Swiss congregations, renounced for the future all recognition of the Roman communion, and established their own worship no longer as secret meetings of a faithful few but as public assemblies for the glory of God.

THE VAUDOIS AND PROTESTANTISM

Thus the Vaudois ceased to be relics of the past, and became absorbed in the general movement of Protestantism. This was not, however, a source of quiet or security. In France and Italy alike they were marked out as special objects of persecution, and the Vaudois church has many records of martyrdom. The most severe trial to which the Vaudois of Piedmont were subjected occurred in 1655. The Congregation de Propaganda *Fide* established, in 1650, a local council in Turin, which exercised a powerful influence on Duke Charles Emmanuel II., who ordered that the Vaudois should be reduced within the limits of their ancient territory. Fanaticism took advantage of this order; and an army. composed partly of French troops of Louis XIV., partly of Irish soldiers who had fled before Cromwell, entered the Vaudois valleys and spread destruction on every side. They treated the people with horrible barbarity, so that the conscience of Europe was aroused, and England under Cromwell called on the Protestant powers to join in remonstrance to the duke of Savoy and the French king. The pen of Milton was employed for this purpose, and his famous sonnet is but the condensation of his state papers. Sir Samuel Morland was sent on a special mission to Turin, and to him were confided by the Vaudois leaders copies of their religious books, which he brought back to England, and ultimately gave to the university library at Cambridge. Large sums of money were contributed in England and elsewhere, and were sent to the suffering Vaudois.

By this demonstration of opinion peace was made for a time between the Vaudois and their Persecutors; but it was a treacherous peace, and left the Vaudois with a hostile garrison established among them. Their worship was prohibited, and their chief pastor, Leger, was obliged to flee, and in his exile at Leyden wrote his *Histoire générale* des *églises vaudoises* (1684). The revocation of the edict of Nantes in 1685 began a new period of persecution, which aimed at entire extermination. This was found so difficult that the remnant of the Vaudois, to the number of 2,600, were at last allowed to withdraw to Geneva. But the love of their native valleys was strong among the exiles, and in 1689 one of their pastors, Henri Arnaud, led a band of 800 men to the reconquest of their country. His first attempts against the French were successful; and the rupture between Victor Amadeus, duke of Savoy, and Louis XIV. brought a sudden change of fortune to the Vaudois. They were recognized once more as citizens of Savoy, and in the war against France which broke out in 1696 the Vaudois regiment did good service for its duke. The peace of Utrecht saw the greater part of the French territory occupied by the Vaudois annexed to Savoy, and, though there were frequent threatenings of persecution, the idea of toleration slowly prevailed in the policy of the house of Savoy. The Vaudois, who had undergone all these vicissitudes, were naturally reduced to poverty, and their ministers were partially maintained by a subsidy from England, which was granted by Queen Anne. The 18th century, however, was a time of religious decadence even among the Alpine valleys, and the outbreak of the French revolution saw the Vaudois made subjects of France. This led to a loss of the English subsidy, and they applied to Napoleon for an equivalent. It was granted, and their church was organized by the state. On the restoration of the house of Savoy in 1816 English influence was used on behalf of the Vaudois, who received a limited toleration. From that time onwards the Vaudois became the objects of much interest in Protestant countries. Large sums of money were collected to build hospitals and churches among their valleys, and they were looked upon as the possible centre of a Protestant church in Italy. Especially from England did they receive sympathy and help. An English clergyman, Dr. Gilly, visited the valleys in 1823, and by his writings on the Vaudois church attracted considerable attention, so that he was enabled to build a college at La Torre. Moreover, Dr. Gilly's book *(A* Visit to the Valleys of Piedmont), chancing to fall into the hands of an officer who had lost his leg at Waterloo, Colonel Beckwith, suggested an object for the energies of one who was loth at the age of twenty-six to sink into enforced idleness. Beckwith visited the valleys, and was painfully struck by the squalor and ignorance of a people who had so glorious a past. He settled among them, and for thirty-five years devoted himself to promoting their welfare. During this period he established no fewer than 120 schools; moreover he brought back the Italian language which had been displaced by the French in the services of the Vaudois church, and in 1849 built a church for them in Turin. He lived in La Torre till his death in 1862, and the name of the English benefactor is still revered by the simple folk of the valleys

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WALDERSEE, ALFRED, COUNT (1832–1904), Prussian field marshal, first campaigned in 1866 as aide-de-camp to General of Artillery Prince Charles of Prussia, being present at Königgrätz. In the Franco-German War he was at Metz and joined the staff of the grand duke of Mecklenburg-Schwerin against Chanzy's army on the Loir. In 1881 Waldersee became Moltke's principal assistant at Berlin He succeeded Moltke as chief of the general staff in 1888; during the Boxer insurrection in China in 1900 he commanded the joint forces, but arrived too late for the fighting before Peking. He died on March 5, 1904.

WALDO, SAMUEL LOVETT (1783–1861), U.S. painter, who was extremely prolific in his production of competent but unexceptional portraits, was born in Windham, Conn., April 6, 1783. After working in Hartford, Conn., and Charleston, S C., he went in 1806 to London. In 1809 he returned to New York and was a conspicuous figure in the city's art life until his death there on Feb. 16, 1861. He became an associate of the National Academy of Design in 1847.

Among Waldo's many works, which are exhibited in a number of U S. galleries, are a series of portraits of the early mayors of New York, now in the New York city hall; a portrait of Peter Remsen. in possession of the New York Historical society; and a portrait of Andrew Jackson and a self-portrait, in the Metropolitan Museum of Art.

In 1820 Waldo began a collaboration with his student William Jewett (1792–1874). For nearly 40 years they jointly produced and signed a vast number of portraits.

WALDSTEIN, FERDINAND, COUNT (1762–1823), youngest son of Graf Waldstein und Wartemburg von Lux, was born on March 24, 1762. At Bonn, Beethoven received encouragement from Waldstein, to whom he dedicated his opus 53, known as the "Waldstein" sonata. A theme of Count Waldstein's also served for a set of 12 variations for piano duet, written by Beethoven in 1791 or 1792. Waldstein died on Aug. 29, 1823.

WALENSEE, also called the Lake of WALLENSTADT, a Swiss lake. It is formed by the Seez river, which now enters the lake at its eastern end. Near its western end the Linth has been diverted through the Escher canal (completed in 1811) into the lake, from which it soon again issues in order, by means of the Linth canal (completed in 1816), to flow into Lake Zürich. The Walensee has an area of 9.3 sq.mi. It is 492 ft. deep, and its surface is 1,375 ft. above sea level. On the northern shore rises the seven-peaked range of the Churfirsten (7,566 ft.). On the south side are the crags of Mürtschenstock (8,008 ft).

WALES. The principality of Wales (Cymru, Gwalia, Cambria) in Great Britain has an area of 7,476 sq.mi. and had in 1961 a population of 2,196,943.

Its maximum length from north to south is 136 mi., while its breadth varies between 92 mi from St. David's head to the English border near Crickhowell and 37 mi. in central Wales between Aberystwyth and the Shropshire boundary.

Structure and Physical **Features.**—Wales is a hill country composed almost entirely of Palaeozoic rocks much dissected by deep valleys. The highland mass culminates in the Snowdon massif in the northwest, where Snowdon itself (3,561 ft.) is the highest mountain in England and Wales. Carnedd Dafydd (3,427 ft.) and Carnedd Llewelyn (3,485 ft.) are also specially marked. The whole of this country is mountainous, with bare slopes deeply worn by ice action above 2.000 it. The mountain line tapers out southwestward to the peninsula of Lleyn which has some spectacular peaks of crystalline rock and ends in the Isle of Bardsey (Ynys Enlli)—the isle of the saints. The Snowdon country is interspersed with lakes. Those in the valley bottoms—long and deep—show evidence of glacial as well as of structural origin. They contrast markedly with the rounder, darker lakes in the mountain cirques. To the northwest of the Snowdon country is the island of Anglesey (Ynys Mon), a remnant of a very ancient land mass.

It is now a worn-down peneplain showing in its drainage pattern a well-marked Caledonian trend. Some of the northeast to southwest valleys have been drowned in recent geological times to form the picturesque Menai strait separating the island from the mainland. To the south and east of the Snowdon massif the country is still highland approximately at about 2,000 ft., but it is less mountainous in character in the Harlech dome, the Arenig moorlands, the Berwyn mountains and the Wiraethog moorlands. Sometimes, however, as in southern Merioneth, peaks like Cader Idris (2,927 ft.) represent once more true mountain scenery.

Still farther to the eastward and southward there stretches a vast plateau of crumpled grits and shales in an endless succession of rounded hills from Denbighshire around to north Pembrokeshire. Plynlymon (2,468 ft.) is among the higher points of this central moorland. The region is covered to a great extent by boulder clay, giving a cold, wet subsoil with many bogs and consequently able to support only a small population.

This crescentic plateau of pre-Carboniferous rocks is followed to the southeastward by the country of the Old Red Sandstone and the coal measures. This region is more varied in relief with outstanding hills of sandstone like Radnor forest (2,163 ft.) or the steep scarp of the Brecknock (Brecon) Beacons (2,907 ft.), the Black mountains or the volcanic rocks of the Breidden. The coal-measure country has become very distinct from the rest of Wales in many respects, whether we consider the belt on the English border in Flint and Denbigh or the great coal field of south Wales. The latter is oval in form, becoming narrower at its western end in Pembrokeshire. Geologically it is a syncline within which the hard bands of Pennant grit stand out above the deeply incised valleyways. Numerous streams flow across the southern coal field in long, narrow steep-sided valleys that limit possibilities of settlement and communication. Many of the resulting problems, both industrial and social, have been very difficult. *(See* RHONDDA.) To the south of the coal field is the lower plateau country known as the vale of Glamorgan. This has Triassic and Liassic rocks with much fertile soil.

The south coastal plain of Wales is broken by the sea, giving Carmarthen and Swansea bays. The north Wales coast line is low westward from the Dee estuary, but Great Ormes head, a peninsula of Carboniferous limestone, stands out, as does the igneous rock of Penmaenmawr farther west. The coasts of Lleyn are rocky as many of the mountain lines die away to the sea. In Cardigan bay especially, former low ridges between the valleys run out to sea as partly submerged causeways. They are known locally as *sarnau.*

Southwest Wales sends out hard, resistant bands of old rock to form numerous headlands, the softer rock between being worn away to form small bays in the coast of north Pembrokeshire. In south Pembrokeshire is a coast with the great submerged valley or ria of hlilford Haven. There are evidences of subsidence along the south Wales coast in the west; submerged forests are uncovered at Amroth.

The rivers of Wales may be said to fan out to sea from the interior highland mass. In the north are the Clwyd and the Conway; on the west the Dwyryd, Mawddach, Dovey (Dyfi), Rheidol, Ystwyth and Teifi; and on the south the eastern and western Cleddau, the Taf, Towy, Loughor, Nedd (Neath), Taff and Wysg (Usk). It is these radiating valleys, or, rather, those of them which are most shut off from English influences working from the eastward along the coastal plains, that are the special homes of the Welsh heritage. The interior highland mass is drained also by rivers which fall to the lowlands of the English border—the Dee, Severn and Wye—and these valleys have offered opportunities for contacts between the English and Welsh ways of life for generations. (E. G. Bow.)

Flora and Fauna.—The flora is a somewhat impoverished version of the British flora in general: thus 1,100 flowering plants are recorded as native to Wales as against about 1,600 for Great Britain as a whole. The following species are confined in Britain to Wales: lesser whitebeam (*Sorbus minima*), rock cinquefoil (*Potentilla rupestris*), yellow whitlow grass (*Draba aizoides*), cotoneaster (*Cotoneaster integerrima*), mountain spiderwort (*Lloydia serotina*) and the grass *Mibora minima.*

The vegetation reflects the mountainous nature of the country and its westerly climate and consequent prevalence of leached soils, and the range of natural or seminatural vegetation types is very wide. Moisture-loving species such as ferns and bryophytes are found almost throughout in greater abundance than in England.

The proportion of grassland is relatively high, nearly two-thirds, as compared with less than 40% in England. Monmouthshire, with nearly 13% of woodland, was relatively well afforested even before World War I; since that time, and in consequence of the rise of state forestry, artificial plantations have increased very considerably in most parts of Wales, and the landscape in certain districts is becoming increasingly dominated by coniferous trees. (H. A. He.)

The remoter parts of Wales shelter some mammals and birds extinct or rare elsewhere in Britain. Thus the polecat is fairly common in central Wales though hardly known elsewhere, and the pine marten occurs in a few places; among birds, a few pairs of kites represent the sole British survivors, and the rare chough breeds inland as well as at some coastal sites.

The vole of the Pembrokeshire island of Skomer is differentiated as a subspecies from the mainland bank vole. Grassholm, off Pembrokeshire, is the home of one of the largest gannet colonies in Europe, and other sea and shore birds occur in the numbers that might be expected in a country with about 600 mi. of varied coast line. There are bird observatories on Skokholm and Bardsey Islands. Large beds of cockles on parts of the south Wales coast support a flourishing cockle fishery. Fresh-water fishes peculiar to Wales are the gwyniad of Bala lake and the Llanberis char. Among insects, the beautiful beetle *Chrysolina cerealis,* confined to one small area of Snowdon, and the moths Ashworth's rustic and Weaver's wave. also known in Britain only from the hilly regions of north Wales, may be regarded as faunal relicts. (C. Mn.)

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HISTORY

The earliest traces of man in Wales are known from the caves at Paviland in Gower, Coygon in Carmarthenshire and Pontrewydd in Flintshire. The earliest signs of occupation refer to a time when man became a cave dweller. 4s pine forests spread with the return of a somewhat milder climate after the Glacial period. Wales was inhospitable to early man, especially as the only flint available was that derived from the debris of the ice sheets on the shores of the Irish sea. People appear to have drifted to Wales, finding forest-free spots on the windswept tops of the lower moorland and along the shore where in several places occur flint chipping floors with implements of early type but unknown date. Among the early immigrants in Wales were people of Old Stone Age stock whose descendants still live in remote moorland areas such as Plynlymon and the Black mountain region of Carmarthenshire. These people have dark hair and eyes, long, high-ridged heads, big eyebrows and rather prominent mouths. A very much larger element in the Welsh population are the little dark people with dark hair and eyes and rather long heads and slender build. These represent early drifts from southwest Europe by land and sea, presumably in Neolithic times. Wales, with its volcanic rocks in the northwest and the southwest, was more attractive to people who had learned the art of polishing stone, and the principality has yielded many beautiful examples of polished stone axes. A proportion of the population on coastal patches in southern Glamorganshire, northwestern Pembrokeshire, Ardudwy and elsewhere belong to a type with broad heads, strong jams, very dark hair and often a strong, tall build. Similar people occur on many of the coastal patches of southwestern and western Europe and represent emigrants or traders of the early ages of metal. In several, though not in all, cases this type occurs in regions with megalithic monuments, and these are important in the projecting peninsulas of northwest and southwest Wales.

The stone circle seems to have been of special significance in west Wales and the stones of the inner circle and horseshoe at Stonehenge (*q.v.*) were taken from the Prescelly mountains. (See H. H. Thomas, "The Source of the Stones of Stonehenge," *Antiquaries Jour.*, vol. iii, p. 239, 1923.) The arrival of large numbers of Beaker folk at the dawn of the age of metal in Yorkshire and East Anglia does not seem to have influenced Wales to any great extent, although there are evidences of their culture along the south Wales coastal plain and in the north. Central Merioneth has yielded many examples of the broad-headed, fair, tall type with arched skull and deep-set eyes that is associated with Beaker burials in England and on the continent. The movement of Bronze swordsmen through western Europe to Britain and Ireland in the later Bronze Age is thought by some to be responsible for the spread of the Gaelic languages now surviving in Ireland, the Isle of Man and northwest Scotland. This movement apparently had relatively little influence in Wales. The expansion of the La Tène culture from the continent to Britain in the last centuries B.C. is usually associated with the spread of Brythonic Celtic speech, the foundation of the Welsh language. The western aspect of this culture—Iron Age B as it is known in Britain—entered Wales just before or during Roman times and was closely associated mith the western sea routes. The newcomers appear to have strengthened the Nordic, or tall, fair, long-headed elements in the population, and it is to this period that we can ascribe many hilltop fortresses that guard the lower slopes of the Welsh moorlands. It is thought that the builders of these hilltop camps maintained fairly peaceful relations with the Romans, and in Cardiganshire their influence was strong where the traces of Roman work are weak.

Roman Wales.—Wales was won for the Roman empire by S. Iulius Frontinus and Gnaeus Iulius Agricola. The former was legate in Britain from A.D. 74 to 78, during which time he crushed the Silures, the warlike tribesmen of southeastern Wales. Farther west were the Demetae, of the country round Carmarthen; they were probably subdued at the same time. Agricola's first act, upon his arrival in 78, was to conquer the Ordovices of mid-Wales; in the same campaign, he attacked the tribes of the northwest, crossed the Menai strait and completed the conquest of Anglesey, from which C. Suetonius Paulinus had been recalled 18 years earlier. The island had been the stronghold of the druids and throughout its history has held an exceptional position as an area of great fertility (hence known as *Mon mam* Cymru, "Mona, the mother of Wales"), defended from attack by a rampart of mountains. Wales was effectively held throughout the period of the Roman occupation of Britain, but always as a part of the imperial frontier and by purely military measures. Two of the three legions quartered in the island after 120 held the portals. The 20th was stationed at Deva, the modern Chester, known to the Welsh ever since as Caerlleon, the 2nd Augustan at Isca, also known to later times as Caerllion and Caerleon. From the two legionary stations roads ran west to smaller forts such as Segontium (Caernarvon), Canovium (Caerhun), Cardiff and Gelligaer; roads and forts of the same type were built in the interior. Some of these forts, perhaps, served only a temporary purpose, but it is clear from the absence in Wales (save around Cardiff and Newport) of Roman towns and country houses that the region had no settled civil life of the type found in eastern Britain. Excavations, notably at Dinorben near Abergele, have shown that the natives, while not uninfluenced by Roman culture, lived for the most part an independent and semibarbarous life and still occupied the rude stone and earthen hill forts of their ancestors. The survival of Welsh, a Celtic language akin to Gaulish, supports this conclusion and that it should contain a large number of Latin loan words is natural. (See BRITAIN: Roman Britain.)

Irish and Saxon.—In the age following the abandonment of Britain by the Roman empire, the two outstanding features are the conflict between the Brythonic and the Goidelic elements and the rapid conversion of the country to the Christian faith. It is beyond doubt that, in the 5th century, western Wales was occupied by an Irish-speaking people; the traditions on the subject have been confirmed by the discovery of Ogham inscriptions, especially in Pembrokeshire and Carmarthenshire. Whether these Goidels were aboriginal or invaders from Ireland is still an open question; in either case, they were overborne by Brythonic conquerors from the east and their language became extinct. Tradition ascribed the Brythonic triumph in Gwynedd (northwest Wales) to a leader from north Britain named Cunedda, whose posterity became kings of various districts from Cardigan to Denbigh. As to the coming of Christianity, there is nothing to associate it with Roman rule in Wales. Yet, in the middle of the 6th century, it is to be gathered from the De *Excidio* of Gildas (the one British work of this epoch which has survived) that the British princes who had risen to power on the ruins of the old order were Christians and, if lawless and licentious, yet amenable to the influence of the church. He mentions especially Maglocunus, the Maelgwn Gwynedd of Welsh tradition, lord of Anglesey and Snowdonia and great grandson of Cunedda, as having at one time forsworn his realm and become a monk. Monasticism, in fact, was the movement which wrought the transformation; Wales was converted by the monks, the "sancti" of Gildas, to which company belonged Dewi, who became in Norman times the patron saint of Wales, St. David.

While these events were taking place, the eastern side of Britain was being occupied by English settlers. Wales was not, at first, greatly affected, for the flight of the defeated Britons into the mountains of the west is legend and not history. But at the beginning of the 7th century a new problem arose, which resulted directly from the Saxon conquests. When hugustine, after the conversion of Kent, strove to establish relations with the British clergy, he met with unexpected opposition and failed in his purpose. The differences were merely the result of the long separation between the Celtic and the continental churches; they did not affect doctrine, but .concerned such practical questions as the true date of Easter. Nevertheless, they were sufficient to bring about a schism, which was still violent in the time of Bede; the Welsh Church did not accept the Roman Easter until 768, when it finally gave way at the instance of Elfodd, who was bishop in north Wales. By this time, secular life in Wales had also come to feel the full force of the English impact. The victories of Wessex, notably that of Deorham in 577, had parted the Welsh of Gwent and Glamorgan from their brethren in Somerset, Devon and Cornwall; in the north, the efforts of Cadwallon of Gwynedd, who fell in 633/634 in battle with Oswald of Northumbria, did not avail to maintain British ascendancy in that region, with the result that, in the 8th century, having lost Chester, Shrewsbury and Hereford to the Mercians, the Welsh were confined to the mountainous tract in the west which has ever since been their home. It was Offa (757–796) who definitely marked the boundary by the dike which bears his name, a "travelling" earthwork connecting the mouth of the Clwyd with the Wye above Hereford and shown by place names to have been for centuries the actual frontier between the two races.

Wales bore the full brunt of the attacks of the Northmen. Its monasteries, distributed along the coast and often set, as was the manner of the Celts, on lonely islands, suffered grievously. St. David's was often in peril, but contrived to keep up a tradition of learning, of which the leading representative in the 9th century was Asser, the friend and biographer of Alfred of Wessex. It does not appear, however, that the pirates made any substantial settlement on Welsh soil; they were held at bay by the gallant Rhodri the Great (844–877). founder of the princely houses of Gwynedd and Deheubarth (south Wales) and ruler of all Wales save Dyfed (the land of the Demetae), Brecon, Gwenr and Glamorgan. Many Scandinavian place names are still found on the coastal patches, especially in south Pembrokeshire and south Glamorganshire. Through all the confusion of the next 150 years, a time of conflict with the Northmen and with the Mercians, as well as of internal strife, the line of Rhodri maintained itself in its two branches in north and in south \Vales. It produced one remarkable man in Howel the Good (910–950), a scion of the southern line, who married the heiress of Dyfed, journeyed to Rome in 928 and is styled "king of all the Welsh." His position enabled him to undertake a reform of Welsh law, for which posterity gratefully remembered him; the representative gathering which met at Whitland (Y Ty Gwyn ar Daf) to receive the new code is without a parallel in the early annals of Wales, and "the law of Howel," amplified and re-edited by generation after generation of Welsh legists. became the standard of tribal and personal relations throughout the country. In its precision and subtlety, it has been held to be the greatest intellectual achievement of mediaeval Wales.

The Norman Conquest.—On the eve of the Norman Conquest, there was a striking outburst of activity under one of the ablest of Welsh princes. Gruffydd ap Llewelyn (1039–63) was not of the ruling dynasty, yet he succeeded in making himself master of the whole of Wales—a position never reached by any Welsh chieftain in later times. He owed his power to his success against the Mercians, whom he drove out of their villages in the neighbourhood of Prestatyn, Mold, Wrexham. Oswestry, Montgomery, Knighton and Radnor. Later, he formed an alliance with Aelfgar and Mercia against the Normans whom Edward the Confessor had posted at Hereford (1055); on Aelfgar's death. he was exposed to the hostility of Harold Godwinson and by him was overthrown. His meteoric career made a great impression in England and led to the question of Wales being envisaged there as one of national defense. When William I had completed the subjugation of the English he attacked this problem with his usual insight and, as a first measure. set up the three earldoms of Chester, Shrewsbury and Hereford to protect the realm from the ravages of the Welsh. Further, he encouraged his followers to win land for themselves in north Wales. and to such good purpose that in 1098 the earls of Chester and Shrewsbury had almost conquered Anglesey. In that year, however, the Normans discovered their weakness in sea power. without which the island could not be held; the attempt to subjugate Gwynedd was abandoned. Progress in south Wales had been slower; the Conqueror had there recognized the claims of Rhys ap Tewdwr (1078–93), who had stepped into the dominant position in the south through the signal victory of Mynydd Carn (1081), won in comradeship with Gruffydd ap Cynan of Gwynedd. On the death of Rhys, however, the floodgates were opened and Korman adventures swept irresistibly over the southern area.

During the reign of Henry I the Welsh problem appeared to have been settled. The Norman hold upon south Wales was complete, extending even to the bishopric of St, David's, and the line of Rhys ap Tewdwr was almost forgotten. Powys, the region between Chester and Machynlleth, kept its independence under the posterity of Bleddyn ap Cynfyn (d. 1075), but it was much enfeebled by the quarrels of the reigning house. The weak spot in the Korman system was Gwynedd; there, behind the shelter of the Snowdonian range, Gruffydd ap Cynan (1081–1137) was able to rebuild from humble beginnings the edifice overthronn by William I and William II. No sooner was the king's hand removed by death than a revolt broke out against the foreign power, in which the leaders were Gruffydd's sons, Owain and Cadwaladr, backed by the renewed strength of Gwynedd. The reign of Stephen marks a general revival of energy among the Welsh, who profited to the full by the English civil war; Gwynedd, Powys and Deheubarth became strong principalities under the respective leadership of Owain Gwynedd (1137–70), Madog ap Maredudd (1132–60) and Rhys ap Gruffydd (1135–97). It was thus a hard task which Henry II had before him when he strove in Wales, as elsewhere, to re-establish the conditions of his grandfather's rule; temporary success against Owain in 1157 and against Rhys in 1163 was followed by virtual defeat in 116j, when storms drove him back from the Berwyn moorlands before he had encountered the united forces of the Welsh. The Becket quarrel and his Irish schemes induced him to reconsider his policy; he now resolved upon an alliance nith Rhys ap Gruffydd, whom events had made not only master of most of south Wales, but also beyond question the leading Welsh prince. The pact between Henry and Rhys, concluded in Sept. 1171, was observed until the king's death and bore fruit in the assistance given by the Welsh to the crown in the rebellion of 1173–74. Bard and chronicler alike sound the praises of "the Lord Rhys," who is also well known from the writings of his relative, Gerald of Barry (Giraldus Cambrensis). The authentic history of the eisteddfod begins with the festival he held in Cardigan in 1176; he was also the liberal patron of the Cistercian movement, and supported Archbishop Baldwin, when in 1188 he made a tour of Wales to preach the crusade.

The Power of **Gwynedd.**—After Rhys's death, the primacy of Wales reverted to Gwynedd. A grandson of Owain. Llewelyn ap Iorwerth (1194–1240), ousted his rivals in that district and proved his quality by the capture of Mold from the English (1199). He had two external opponents to fear, the ruler of southern Powys and the English king. From Gwenwynwyn (1195–1216) he wrested his dominions and, with northern Powys in vassalage, he remained arbiter of north Wales until his death. John was. at first, friendly, but the inevitable struggle came in 1211 and, having survived this ordeal, Llewelyn was able to cooperate, first with the pope and then with the insurgent barons, in the humiliation of the king. His services were recognized in the Great Charter and he profited by the situation to carry his arms into south Wales, where he became overlord of the descendants of the Lord Rhys and aided them in the destruction of Norman castles. Under Henry III he was one of the magnates of the English realm, wedded to a half-sister of the king, an ally of the feudal party, attacked in vain by Hubert de Burgh in 1228.

Llewelyn's son, David (1240–46), struggled to retain his father's position, but died before the issue was finally determined. He left no heir, and Gwynedd passed to his young nephews, against whom Henry III had no difficulty in asserting the royal power. In 1255, however, Llewelyn ap Gruffydd defeated his brothers at Bryn Derwin and prepared to repeat the triumphs of his grandfather. Seizing the opportunity afforded by the baronial revolt, he found himself lord in a few years of as wide a territory as his great namesake; even the fall of his ally, Earl Simon, did not check his progress, and by the treaty of Montgomery (1267) he was recognized as prince of Wales (the first official appearance of the title) and suzerain of the other Welsh chieftains. When Edward I succeeded, he was at the height of his power, but, misjudging the situation, he soon lost all; resistance in 1277 led to the forfeiture of everything save western Gwynedd and his title; a second rebellion in 1282 resulted in total overthrow and death in a chance encounter not far from Builth (Dec. 11).

The English Conquest.—In both his wars with Llewelyn the Last. Edward had won his victory by the use of sea power against Gwynedd. He had realized that it was only thus that Wales could be crippled. namely by a final blow at the vulnerable danger spot. The dynasty was disposed of by the execution of David, Llewelyn's brother, in 1283. But it was in a quite limited sense that Wales was conquered at this time. Llewelyn's dominions were brought by the statute of Rhuddlan (1284) under the direct rule of the crown; they were divided into counties, furnished with crown officials and protected by new castles and boroughs at Caernarvon, Conway, Beaumaris, Criccieth and Harlech. But the old marcher lordships, baronial preserves where the lords ruled as little kings and royal writs did not run, mere not interfered with; indeed, their number was increased and new franchises arose around Denbigh, Ruthin, Wrexham and Chirk. Even the loyalist princes of Powys and the vale of Towy were left undisturbed and among the smaller Welsh landowners the changes were far fewer than might have been supposed. Indeed, in many respects the new Wales differed little from the old. It was still a land of small, independent states. each governed by its own customs and inhabited by a Welsh-speaking population, among whom the old Welsh culture flourished. Edward was no friend to marcher privileges, in 1291 he brought the lords of Brecon and Glamorgan to book for exercising the right of private war, and in 1301 he revived the principality of Wales in the person of his son, seemingly in order to create a Welsh authority which could bridle the barons. But tradition was more potent than the royal will; under the weak rule of Edward II Wales became the battleground of baronial factions and, when Edward III in 1343 again created a prince of Wales, it was with a less ambitious purpose; the Black Prince was hardly more than the chief Welsh landlord, the master of Welsh archers and lancemen who fought mith distinction under him at Crécy and Poitiers.

There had been revolts of the Welsh under Rhys ap Maredudd of Dryslwyn (1287), Madog ap Llewelyn of Meirionydd (1294) and Llewelyn Bren of Senghenydd (1316). But, in the course of the 14th century, resistance died down; even Anglesey, that ancient focus of liberty. produced defenders of the crown such as the Penmynydd family, ancestors of the Tudors, and Sir Howel of the Horseshoes. men who never forgave the murderers of Edward II. The country was growing more prosperous and a thriving trade sprang up at ports like Rhuddlan, Beaumaris, Haverfordwest and Carmarthen. It is therefore startling to find, at the opening of the 15th century, Wales convulsed by a new revolt, more widespread than any of its predecessors.

Owen Glendower (*q.v.*) was the direct male representative of the line of northern Pomys, with claims through his mother to the lands of the Lord Rhys, At the accession of Henry IV he held a portion of this inheritance on the banks of the Dee and of the Teify. When in 1400 he broke into rebellion, it was mainly to vindicate personal wrongs. But Henry underestimated both his hereditary prestige and his high abilities, with the result that Owen's power grew from year to year and he was ere long emboldened to proclaim himself independent prince of Wales. The capture of his enemy Reginald Grey gave him financial resources: that of Edmund Mortimer a valuable ally. He concluded a treaty with Charles VI of France, won the castles of Harlech and Aberystwyth, held parliaments of his subjects and exercised in a large part of Wales the powers of a ruling prince. The downfall of his friends, the Percys, at Shrewsbury (1403) was not fatal to the movement; more serious was the failure of the French at Woodbury Hill (1405) and the loss of the two castles (1408–09). As the difficulties of Henry IV gradually disappeared, Owen's cause became hopeless and he died in hiding c. 1416. He has never ceased to be the darling hero of Welsh popular tradition.

The Glendower movement left Welsh society in ruins and during the rest of the century recovery was but slow. Disorder returned with the Wars of the Roses, in which Welshmen such as Owen Tudor (d. 1461) and William Herbert, earl of Pembroke (d. 1469), were deeply involved. It was a Tudor who at last brought peace alike to England and Wales on the field of Bosworth (148j), with a large Welsh following who reckoned that they had avenged in this victory the wrongs of foreign rule.

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Union With England,— Under Henry VII and during the first 25 years of the next reign. Wales, whether old principality or feudal marches, was administered by a prerogative council; the Court of the lord president in the marches of \Vales, an amalgam (of pre-1485 Yorkist origin) of the prince of Wales' council with the council of the earls of March; its seat was usually at Ludlow, the *caput* of the great Mortimer territories. But later a group of acts of parliament (those of 1j36 and 1542 being the most important), loosely known today as the Acts of Union, replaced this dominion status by an incorporation of all Wales in the realm of England. The hitherto unshired march ground was now divided into five new shires (including Monmouth, which, however, was left awkwardly suspended between Wales and England, through inconsistencies in the wording of the acts); the 13 shires and their boroughs were between them to return 27 members to parliament. March jurisdiction disappeared (though not the manorial courts); henceforth the common law of England alone was to be valid in Wales. But, for convenience, 12 of the shires (excluding Monmouth, this time) were grouped into four circuits, whose business was to be taken by special judges not drawn from the Westminster bench. There were also to be special chancery and exchequer courts for Wales. This mechanism, the king's great sessions in Wales, lasted till 1830. The shires were to have justices of the peace and quarter and petty sessions. The council at Ludlow was not only continued, but was even recognized by statute (1542) and further given appellate and first-instance jurisdiction. As no line of demarcation was drawn between its executive functions and those of the magistracy, or between its judicial functions and those of the great sessions, each could during the next century be played off against the other. However. the council was shorn of many of its powers in 1641 and, though revived in 1660, was finally abolished in 1689. The fixed pattern then emerges: great, quarter and petty sessions as the judicial mechanism, quarter sessions as the main administrative organ. The justices of the peace governed Wales in local matters, right down to the Local Government acts of 1888.

The New **Squirearchy.**—With the extension of English law to Wales, the old Welsh law of land inheritance (already obsolete in many parts of Wales) disappears, except for local vestiges (disguised as copyhold tenures) which could be found even in 1918. Primogeniture and entail together fostered the growth of a landlord class, which indeed had begun to arise in Wales as far back as the age of the princes but nas now reinforced by the advent of "new men" nho fished successfully in the troubled waters of the times. The landlords would naturally furnish justices of the peace and members of parliament. Moreover, though really large estates (by English standards) were not numerous in Wales, estates in general would now devolve en bloc, in many cases enhanced by grants and purchases of monastic lands and of crown lands alienated by royal necessities.

It is true that, even before the disasters of the Commonwealth period, the effort to emulate the material standards of their English compeers tended to involve the Welsh squires in difficulties which neither speculation nor screwing up rents nor marrying English heiresses availed to remove. Yet, for all that, the squirearchy ruled the roost. The smaller freeholders (then numerous) were indeed economically independent within their own limits, but the rise of the squires depressed them in the social scale. Of old, they had been the social and cultural equals even of the greater gentry, for they too had bonedd, "gentle blood," as the old Welsh way of life regarded it. But now the increasing disparity of material conditions and the monopoly of public officeby the squires opened a gulf between the two. Disinherited younger sons of squires either sought their fortunes in England or abroad or were given by the head of their house a meed of freehold land (or a family living). with which they dropped into the freeholder class, or took a tenant farm on the family estate. Most of the tenantry, burdened with rising rents and infringed leases, sank into poverty — though not into pauperism, for the Elizabethan poor law was to be a dead letter in most parts of Wales until the 18th century. There was as yet hardly any middle class. Professional men clung to the skirts of the great. Towns were few and small. most of them mere pawns in the rivalry of the gentry for the control of parliamentary representation.

The Welsh Language After the **Union.**—By the act of 1536 (not modified in this particular till the Welsh Courts act, 1942), English became the official language of the court and of public business. The consequences, though indirect and long term, were important. It was not that the gentry then, or even before a long time, ceased (or could afford to cease) to be Welsh speaking; even late in the 18th century a magnate here and there took pride in his native language and in its literature. But the act led to an early stratification of the gentry and ultimately to a cleavage between the gentry as a whole and their social inferiors. The largest landowners, whose official duties and social aspirations assimilated them with their fellows in England, were Anglicized at a fairly early date. The lesser squires (with whom we may group the upper beneficed clergy) moved more slowly — monoglot Welshmen indeed even they could hardly remain. with their grammar-school and university or inns-of-court education. Even the freeholders were affected. The 17th- and early 18th-century dissenting ministers (mostly freeholders), though ministering in Welsh, corresponded and kept their church records in English (not to speak of eking out their stipends by keeping little schools in which English was taught), and so did the 18th-century leaders of Welsh Methodism, nearly all of them clergymen. The masses were only sporadically literate even in Welsh, though literacy reached a lower social stratum than it did in contemporary England. They kept up a fairly vigorous folk literature in Welsh, though the classical poetry which had of old depended upon the patronage of the gentry declined as these drifted from the ancient moorings. Any extensive Anglicization of the masses was hardly possible before the English-speaking immigrations of the 19th century and the compulsion of the Education act of 1870. Even so, Welsh, until the great dislocations that followed World War I, remained the language most familiar to more than 40% of a population that had quadrupled between 1801 and 1911.

The Protestant Reformation.—The official discouragement of Welsh was countermined by the government's own action. For a Protestant government had to provide its Welsh-speaking subjects with a Welsh prayer book (1567, rev. 1621) and a Welsh Bible (1588, rev. 1620). The work of the Welsh Bible in preserving the literary language from extinction and the spoken language from crumbling into a congeries of patois cannot be exaggerated, though it should be remembered that, until literacy became much more widespread, the stately biblical diction and style could be propagated, even after the pocket Bible of 1630 appeared, for the most part only through the people's hearing Bible and prayer book read in church. Protestaptism was also promoted among the reading classes by books in Welsh written or translated by clergymen or laymen of the upper class who still clung to the old literary tradition. On the other hand, learned and patriotic Roman Catholics in exile strove to provide counterpropaganda in Welsh, in the teeth of government censorship.

The rate of the genuine acceptance of the Reformation by the Welsh people cannot be measured, with our insufficient data. In a sense, the masses must still have largely hankered after the old faith, even at the end of Elizabeth's reign, but they were not vocal, and outward conformity seems by 1603 to have been pretty complete. The ruling classes as a whole had found it desirable to support the new religion. Quite apart from the profit which the dissolution of the religious houses had brought them, loyalism was ingrained in them. Further, the menace to the long Welsh coast line from Spain, either directly or through Ireland (a country not loved in Wales), was always at hand to stiffen them. Their tenantry, schooled by agelong tribal tradition, would make little demur. There was, of course. always a declared minority of Roman Catholic recusants to be found in all classes; Jesuit and other missions were active; there were Welsh Roman Catholic martyrs both in Elizabethan times and in the time of Titus Oates; and there were whole pockets (chiefly in the northeastern and southeastern corners) of Roman Catholicism sheltered by gentry of the old faith. Indeed. there was a marked increase of recusancy in Wales under James I.

Nonetheless, the story is one of decline—slow at first, much more rapid after 1679—until Irish immigration in the 19th century brought substantial numerical increase. And it is certain that by the middle of the 17th century the Anglican Church was deeply ensconced in the hearts of the people. whose countryside poets stoutly championed it against papist and puritan alike.

Puritanism, indeed, in the sense of inconformity, was for a long time far rarer in Wales than was recusancy, although, if we judge by their writings, the Elizabethan propagators of Protestantism in Wales were rather "leftist" in their views (always of course within the Anglican order) and although the earl of Essex's conspiracy of 1601 was supported not only by the men of his own lands in southern Pembrokeshire but also by men in eastern Denbighshire. Indeed, these two latter regions (together with eastern Monmouthshire) were precisely the parts of Wales in which the later inconformity showed its head. It should be noted that they were mostly of English speech and influenced by Cheshire or Shropshire. or by the City of London either directly or through Bristol. The first dissenting congregation in Wales was at Llanfaches (1639), on the Monmouthshire border. In the hinterland, apart from the Bristol channel ports, only an occasional freeholder or squireen was attracted by puritanism. With the Civil War came deliberate puritan propaganda. first by itinerant preachers, then (1650) under an Act for the Propagation of the Gospel in Wales, whose commissioners strove to purge Wales of inactive or "malignant" clergymen, to replace these by "godly" ministers, and to redistribute the endowments of the church, setting up also a system of puritan grammar schools. The plan naturally collapsed in 1660, to the great joy of most Welshmen. But one important and permanent result of the act is often overlooked: it had spread dissent, however thinly, over all the Welsh-speaking parts of Wales. and the penal laws of Charles II failed to stamp it out. Dissent had by 1688 set up county organizations, and these by 1715 had crystallized into more than 70 local congregations. Even though dissent in 1715 accounted for barely more than 5% of the population, it was there, organized for further advance.

Politics After the Union.—Politics in the modern sense hardly affected the homekeeping Welshman before the 19th century. The ruling class (about 100 families), from which members of parliament were drawn, had indeed its internal rivalries, but contested elections were infrequent. Only on occasion would a recalcitrant group of squires challenge those in possession; what was at stake was prestige and power within the shire rather than any larger issue. Once elected, the Welsh members, down to 1642, mostly acted as a body, a "Welsh interest," often as an official Welsh committee of the house on matters affecting Wales. In general politics they were stoutly loyalist, but very far from being uncritical of authority. Under Charles I they strongly expressed their dissatisfaction with excessive taxation, arbitrary uses of prerogative and mishandling of foreign affairs, but they vented their disapproval upon the king's favourites and advisers, not upon the king's own head, and when it became clear that the left wing of the Long parliament was bent on wholesale encroachments upon the king's authority, the Welshmen pulled out. Only 7 out of the 27 took the parliamentary side in 1642, and only in southern Pembrokeshire, eastern Denbighshire and eastern Montgomeryshire did parliament find much armed support. In Wales outside these areas there was indeed no real civil war but only, at first, a parliamentary attempt to contain Wales (the king's recruiting ground) and then a parliamentary invasion of Wales. Despite the shocking mishandling of loyalist Wales by royalist commanders, Wales, harried by parliamentary committee after committee and then by majors general, welcomed the Restoration well-nigh unanimously.

But the Restoration could not wholly restore. Welsh members no longer acted as a body, and a few of them are found in the ranks of the later Country party. Further. a certain amount of sequestration and a greater amount of forced sales of land to meet fines had crippled many landowners. The greatest (especially the most prudent during the troubles) could weather the storm with some prospect of recovery, but the smaller, clinging in spite of their losses to "gentle" standards of life, gradually sank with diminished lands into the freeholder class or sold out and turned to the law or to commerce. The county families (with estates enlarged by buying out their less fortunate fellows) became a caste of about 50 families. More and more, as the 18th century wore on, these monopolized the parliamentary seats. A striking example is that of the Williams-Wynn family, which held Montgomeryshire till 1880—far down in a newer era—and lost its Denbighshire seat only in 1886. The politics of these men, whose dependents were still tribally docile, concerned Wales hardly at all. The atavistic spurt of Jacobitism among some of them was of no practical importance.

Popular Education and the Methodist Movement.—A great impulse in the field of popular education (not that Wales had ever been totally devoid of this) was given by the charity-school movement of the Society for the Promotion of Christian Knowledge (1699), continuing the experiment of Thomas Gouge's Welsh trust (c. 1672–81). The S.P.C.K. not only printed a considerable number of Welsh Bibles, prayer books and other religious literature in Welsh but also founded about 95 schools all over Wales. But the movement was completely transformed in the hands of Griffith

Jones (1683–1761), rector of Llanddomror in Carmarthenshire, and of his coadjutor and successor Bridget Bevan (*née* Vaughan, 1698–1779). Their work. begun about 1737. took the form of establishing circulating schools with itinerant teachers who camped for three or six months in a locality and then moved on to fresh ground. During Jones's lifetime, more than 158,000 learners of all ages passed through his schools—possibly one-third of the population. The effect was a mass production of literacy in Welsh. intended by him solely to promote Bible reading. But obviously the spread of literacy was bound to have wider effects in the future.

The Welsh Methodist movement, initiated independently in 1735 by Howel Harris (1714–73) and by Daniel Rowland (1713–90), was not. as is too often assumed, a revolt against abuses in the established church. It is true that, crippled as it had been at the Reformation by wholesale alienation of monastic tithes and hampered after 1714 (and for that matter till 1870) by the practice of appointing English bishops (often absentees) to the Welsh dioceses, the church was not, in the 18th century. at the peak of its efficiency. But the root of Methodism was "enthusiasm," a thing suspect in the eyes of the educated, whether lay or clerical and whether Anglican or dissenting. Eloquent preaching spread the movement primarily among the masses. A network of small religious groups (societies), organized in a quasi-Presbyterian framework. consolidated it; and the Bible reading made possible by the schools of Griffith Jones (no Methodist) helped to transform the mass of small tenantry, rural labourers and the increasingly numerous industrial workers into a literate, articulate and potentially critical public.

For a long time there was no thought (except in a few instances) of cecession from the established church; indeed, though the evangelical wing of Welsh dissent had at first co-operated with the Methodist leaders. they were on not too good terms after 1742 or so. Secession. when it did at last come, came through the force of circumstances. Authority in the established church had increasingly hardened toward the new movement; clerical recruits to it became fewer and fewer; the parish clergy frequently refused communion to hlethodists; and many Methodists would no longer communicate in their parishes. preferring to await a Methodist clergyman's visits. After the death of the older clerical leaders. such as Daniel Rowland and the hymnist William Williams (1717–91), this became a grave difficulty. On the other hand. the greater lay preachers, men not only of eloquence but also of ability and force of character, could not see why the sacramental office should be denied them. Thomas Charles (1735–1814), a clergyman who was now the acknowledged leader and organizer of the movement. for some time resisted the seceding tendency but was finally convinced. In 1811 Methodism began to ordain its ministers. At one stroke the Calvinistic Methodist "connection" within the church became a dissenting denomination. Dissent (the older dissent itself had grown slowly down to 1775 but had since acquired considerable momentum) now greatly outnumbered Anglicanism in Wales. though it was not till after 1843 that Methodist dissent swung over to political Radicalism.

The 19th and 20th Centuries.— The 19th century was to witness the political sequel of the Methodist secession, of the cleavage (linguistic. religious and economic) between the landlords and their tenantry (a tenantry now literate and beginning to be provided with journalism in Welsh) and of the new rivalry between landed and industrial interests. Successive Reform acts extended the franchise, and by 1886 the parliamentary representation of Wales had been almost monopolized by the Liberal-Radical party and a "Welsh interest," indeed an officially styled Welsh party, had reappeared in the commons. Its program was in general that of English Radicalism, but differences of emphasis and of priority in application led the Welsh party to pursue a course which can quite fairly be labelled nationalist. Welsh agrarian grievances (manifested. for example, in 1839–44 in a sort of *Jacquerie* known as the Rebecca riots and again in the "tithe war" of 1886–91) tended to be elbowed out of priority by the antiestablishment urgency of Welsh dissent. One form of this was the demand for popular education of all grades freed from Anglican association—primary schools (especially after 1870), then secondary schools (1889) and finally the federation of university colleges (the first of which dated from 1872) into a national university (1893). A national museum and a national library came in 1907. Piecemeal attacks upon the ascendancy of the established church culminated in 1919 in the disestablishment and disendowment of the Anglican Church in Wales; as a corollary that church, now known as the Church in Wales, became an autonomous province. But all these were achievements of a new middle class which had developed in Wales during the 19th century and was now providing Wales with members of parliament in lieu of the old squire members. It was a class which had recoiled from Chartism and from the infant trade-union movement. In the end, therefore, Welsh Radicalism ceased to attract that working-class vote which had enabled it to realize so much of its program; the workers, at first in south Wales and afterward in north Wales too, went over to political Labour; and by the 1950s Welsh Liberalism had suffered almost total parliamentary eclipse. One of its unrealized aspirations (1886), home rule for Wales, became the watchword of a new Welsh Nationalist party (1924) which, however, had not made much headway at the polls by the middle of the 20th century.

World War I and. much more. World War II led to considerable upheaval in Wales. For example, large-scale English immigration and Welsh emigration seriously imperilled the Welsh language, which in the 1950s was not spoken by much more than 20% of the people. Yet the awareness of nationhood (whether Welsh-speaking or not) was, if anything, sharpened. In April 1949 the Labour government established the advisory council for Wales; in Oct. 1951 the Conservative government included a minister for Welsh affairs in the cabinet (the home secretary); from Jan. 1957 the position of minister for Welsh affairs was held by the minister of housing and local government, and in December of that year a minister of state for Welsh affairs was appointed.

The cry for home rule was not confined to the Nationalist party proper. Strenuous efforts. moreover. were made to check the disuse of Welsh. Quite apart from the sympathy of the ministry of education toward the use and teaching of Welsh in the schools, these efforts were strongly supported by Urdd Gobaith Cymru (the League of Welsh Youth), by Undeb Cymru Fydd (the New Wales union) and by the council (1937) of the Eisteddfod (*q.v.*), all three nonparty and undenominational.

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POPULATION

In 1961 the total population of Wales and Monmouthshire was 2,640,632. The sparse numbers of inhabitants in the rural areas and the intensive crowding of the southern coal field made the distribution of population very uneven. All the towns with the highest population figures (1961) are in the south Wales coal field: Cardiff (256,270). Swansea (166.740): Rhondda (100.314). Merthyr Tydfil (59.008) and Port Talbot (50.223). Other large towns are (1951 population) Pontypool (42,703). Barry (40,990). Aberdare (40.932). Pontypridd (38.633). Gelligaer (36,169), Caerphilly (35,189), Llanelly (34,476) and Neath (32.254).

Since the 16th century Monmouthshire, although geographically in Wales, has been regarded as part of England. It is still largely peopled by Celts many of its place names are Welsh and for legislative and administrative purposes it is usually linked with Wales, while the bishopric of Monmouth is within the Church in Wales. For administration of justice, honever, Monmouthshire is part of the Oxford assize circuit.

TABLE I —*Area and Population of Wales*

County	Area (sq mi.)	Population			
		1871	1901	1951	1961
Anglesey (Ynys Mon)	276.2	51,040	50,606	50,637	51,700
Breconshire (Brycheiniog)	733.5	59,901	54,213	56,484	55,544
Caernarvonshire (Arfon)	569.1	106,121	125,649	124,074	121,194
Cardiganshire (Ceredigion)	692.7	73,441	61,078	53,267	53,564
Carmarthenshire (Caerfyrddin)	919.8	116,710	135,328	171,742	167,736
Denbighshire (Dinbvch)	668.9	105,102	131,582	170,699	173,843
Flintshire (Flint)	255.8	76,312	81,485	145,108	149,888
Glamorgan (Morgannwg)	817.8	397,859	859,931	1,201,989	1,227,828
Merioneth (Meirionvdd)	660.2	46,598	48,852	41,456	39,007
Montgomeryshire (Trefaldwyn)	797.3	67,623	54,901	45,989	44,228
Pembrokeshire (Penfro)	614.3	91,998	87,894	90,896	93,980
Radnorshire (Maesyfed)	470.7	25,430	23,281	19,998	18,431
Total	7,476.3	1,218,135	1,714,800	2,172,339	2,196,943

Religion.— Classical references to religious cults in pre-Roman Britain have been the pretext for much conjecture as to the nature of the pre-Christian religions of Wales. All that can be said is that the island of Anglesey seems to have had a tradition of special sanctity. The post-Roman centuries were characterized by a revival of prehistoric conditions in the west and although Christianity reached there very early the salient feature is its close associations with the previously existing traditions. The church of Yspytty Cynfyn in north Cardiganshire is built within what was once a stone circle and observers have recorded many circular churchyards in Wales. The spread of the Celtic saints or preachers of Christianity from Ireland to Wales, Cornwall, Brittany and many parts of the continent helped to make St. David's important. It stands at the convergence of a number of routes from little landing places on a storm-washed peninsula. The itinerant Celtic saints established many small cells or churches in Wales, many of which still bear the founder's name in their dedication. From the 7th century onward the power of the Roman Church grew and the older Welsh traditions were brought nominally under its sway. The attempts of Giraldus Cambrensis in the 12th century to gain ecclesiastical independence for Wales are an echo of the marked individuality of the Celtic traditions.

Among pilgrim routes to Santiago de Compostela (*q.v.*) the maritime one from Ireland via Wales. Cornwall and Brittany was important, and it seems to have been also a survival or revival of a prehistoric route of trade. By the Renaissance the Roman Church had gathered into itself and assimilated all the earlier ritual, and the Anglican Church did not replace it completely in rural Wales. The strongholds of Anglicanism were in the small castle-towns of the coastal plains. The mass of the population of moorland Wales long retained its mediaeval ideas. Early Puritanism appeared in those regions that had the closest associations with the English plains and particularly in those regions that had specialized in weaving. Such districts attracted refugees from the continent.

Radnorshire became an early centre of the Quakers and Baptists, Montgomeryshire of the Independents, while in the weaving centres of the south Wales coastal plains early Puritanism was developed especially by the Independents and the Baptists, who seem to have been specially selected for persecution and whose early chapels are in several cases in remote spots. They seem to have entered regions in southwest Wales (*e.g.*, northwest Pembrokeshire) that were sparsely populated in the middle ages, a movement that seems to have been associated with the introduction of root crops. The Methodist revival of the 18th century, mainly through the influence of the Welsh language, affected chiefly the moorland regions of Wales. Henceforth the country was predominantly Nonconformist.

An honourable exception to the absentee or indifferent English prelates of this period is to be found in Thomas Burgess. bishop of St. David's, whose exertions were the chief cause of the foundation in 1822 of St. David's college at Lampeter, an institution erected to provide a better and cheaper education for intending young Welsh clergymen. It was not until 1870 that, by Gladstone's appointment of Joshua Hughes to the see of St. Asaph, the special needs and claims of the Welsh Church were officially recognized. Thus between 1811 (the year of the Methodist secession) and 1832 (the date of the Reform bill), the number of dissenting chapels had risen from 945 to 1.428. In 1870, the dissenting bodies were supporting two quarterly, six monthly and ten weekly papers. all published in the vernacular. A result was the Sunday Closing act of 1881 and the Welsh Intermediate Education act of 1889. In 1893 Lord Rosebery's cabinet appointed the Welsh Land Tenure commission, whose report, published in 1896, did much to exonerate the squirearchy from charges of extortion and sectarian oppression.

In 1914 the Bill for the Disestablishment and Disendowment of the Church of England in Wales was passed. It provided that the secularized portion of the endowment of the church should be applied to specified national purposes, mainly educational. and a financial amendment in the direction of compensation to the church was passed in 1919.

Cnder a new constitution (1922) the supreme authority of the Church in Wales was vested in a governing body, representative of the clergy and laity. The area that came under the jurisdiction of this body became known as the province of Wales. with an archbishopric established for the time being at St Asaph. The province is practically coterminous with Wales and Monmouthshire. with the exception of a few border parishes which under the Welsh Church act voted themselves out of the Church in Wales. Six dioceses are comprised within the ecclesiastical province of Wales: Bangor in the northwest, St. Asaph in the northeast, St. David's in the southwest. while the populous area of the southeast is shared between Llandaff, Monmouth and Swansea and Brecon (including the almost entirely rural counties of Brecon and Radnor).

Roman Catholicism is still strong here and there in the border counties, especially Flintshire. In most cases it survives in' conjunction with mediaeval landed families. After the last half of the 19th century it flourished exceedingly in the south Wales industrial regions. especially among the immigrants of Irish descent. In 1898 a bishop with the title of Menevia (Latin form of St. David's) was appointed for the Roman Catholic community in all Wales except the counties of Glamorgan and Monmouth; these latter (and Herefordshire) were included in the archbishopric of Cardiff, which was founded in 1916. After the expulsion of the religious orders from France in 1903 several communities of French monks and nuns took up their abode in the principality.

The majority of the followers of the Methodist revival movement of the 18th century in Wales form the Calvinistic Methodist Church of Wales, known also as the Presbyterian Church of Wales by virtue of an act of parliament passed in 1927. While its churches are strongholds of the Welsh language, many use English in the services. It is organized under the *Cymanfa Gyfredinol* (general assembly), which meets annually and elects a moderator. There are two *Cymdeithasfa* (synods), representing respectively the north and south of the country. The individual churches are grouped into a *Cwrdd Dosbarth* (district meeting), and the latter into a large unit, the *Cwrdd Misol* (presbytery). In addition to the presbyteries in Wales, there are three of the Welsh body in England: in London, Manchester and Liverpool.

Other followers of the Methodist revival are members of the Methodist Church in Wales (formerly the Wesleyan Methodist Church), an integral part of the Methodist Church in England; Welsh candidates for this branch of the ministry are trained in English Methodist theological colleges.

The Independents and Baptists each have an Undeb (union) for Wales; the former is part of the Congregational Cnion of England and Wales, and the latter is within the Baptist Union of

Great Britain. (E. G. Bow.; X.)

University.—The Cniversity College of Wales was founded at Aberystmyth in 1872; that of South Wales and Monmouthshire at Cardiff in 1883; and that of North Wales at Bangor in 1884. On Nov. 30, 1893. the constituent colleges were incorporated by royal charter as the University of Wales. nith Lord Aberdare (d 1895) as its first chancellor. The university was reorganized nith a supplemental charter in 1920 when the fourth constituent college was founded at Sn ansea.

There are 2j8 members of the governing body. appointed representatives of county and county borough councils in Wales and Monmouthshire being in a majority of one over the other representatives which include those chosen by the lord president of the council. 12 each appointed by the colleges and the Welsh National School of Medicine. the Guild of Graduates. the national museum and the national library The local authorities contribute financially by the levy of special rates for the purpose. All the main branches of cultural and scientific education are catered for and special attention is given to Celtic studies agriculture metallurgy and engineering The national school of medicine is at Cardiff

Extramural studies have been vigorously developed throughout Wales. In addition to the regular financial support received froin local authorities there were liberal private benefactions during the earlier part of the 20th century. The total number of students grew from a few hundred in 1872 to more than 5,000 in 1953.

ECONOMIC AND INDUSTRIAL CONDITIONS

Wales and Monmouthshire form approximately one-seventh of England and Wales. Half of the land reaches an altitude of 600 ft. above sea level, while half of this exceeds 1,000 ft. This enabled the inhabitants to maintain a distinct political existence for centuries after the English lowlands had become subject to one authority. It was not until the 19th century that the traditional isolation of Wales began to be profoundly affected by the development of railways. World competition became operative. to the embarrassment of local industries previously protected by the isolation of the local market.

Agriculture.—Largely because of its climate Wales is primarily a dairy-farming country. Essentially it is also a country of small farms. the great majority of the total holdings being less than 150 ac Even so. the farming industry plays a more important part in the economy of the country as a whole than it does in England.

During the period of World War II Welsh agriculture undernent a virtual revolution. increasing production to such effect that it contrived to feed Wales to a greater extent than ever before and at the same time to supply parts of England.

One of the outstanding achievements of the Welsh livestock industry was to increase its milk production on a substantial scale so that by 19j2 there nere more than 315,000 cows and heifers in milk. an advance of 14% on the 1939 total. In the same period temporary grass acreage had risen by 81%. The output of milk continued to increase during the mid-1950s.

Other striking advancec up to 1952 nere the doubling of the tillage acreage, the increase in cattle. pigs and poultry by 10% and the making good of the severe losses caused by the disastrous 1946–47 winter. Substantial increases were maintained in sheep, pigs and cattle during 1956–57.

Much is attributable to a big increase in use of machines. Whereas in 1939 only one farmer in 1j in Wales had a tractor by 1953 the average was one tractor per farm and there was a further increase in tractors of about 30% during 1953–56.

In the early 1950s advance in production appeared to have been halted. but by mid-1953 Welsh agriculture was forging ahead again. Up to Aug. 31. 1953, government grants had been paid to hill farmers to cover 1 458 improvement schemes costing £465,805. The total number of cattle and calves in 1953 was the highest since records were first kept in 1867, each subsequent year showing a slight increase.

Many of the large farms in the Welsh lowlands employ paid labourers but in the uplands the work is done for the most part by family labour. The total of those engaged in agriculture and horticulture in Wales in 1957 was 41.800. Agriculture in Wales made marked progress after the application of scientific methods to all branches of farming, in nhich the Lniversity colleges at Bangor and Aberystwyth. with the support of the ministry of agriculture. rendered invaluable service Agricultural co-operative societies first established in Wales in 1901, multiplied rapidly after World War I. and in 1922 a Welsh agricultural organization society was founded Small mixed holdings of the average size of 47 ac are characteristic of Wales, and the small farmers were quick to grasp the advantages provided by the co-operative purchasing of foodstuffs. etc. The independent Welsh Farmers' union, founded in 1918, was later merged in the National Farmers' union.

The total forestland in Wales increased from 106,909 ac. in 1939 to 189.116 ac in 19j6 h noteworthy change after 1939 nas the big proportion of derelict woodland acquired for replanting by the Forestry coinmission. which was 50% of the total in 1953 compared with only 10% in 1939. During 1939–56 total workers increased from 800 to 3,290.

The Industrial Revolution in Wales.—In 1801 Wales and Monmouthshire had a population of 587,245, fairly evenly distributed over the land. since the vast majority of the people were engaged in agriculture or in related occupations. As the Industrial Revolution developed. and particularly after 1841. the rural exodus. accompanied by the decay of many industries nhich had supplemented the earnings of agriculture. led to an enormous concentration of population in the iron- and coal-producing valleys of southeast Wales. According to the 1951 census. 62 6% (1 627,-696) of the population of Wales and Monmouthshire (2,598,67j) uas concentrated in the two counties of Glamorgan (1,202,581) and Monmouth (425 11j).

Trade unionism has long been a potent force in south Wales. The first important organization of miners and ironworkers was the Cnion club and after its suppression in 1831 there came into existence a secret society. the Scotch Cattle. whose symbol was a bull's head and horns.

In the 1860s the Amalgamated Association of Miners, a rival to the National Miners' union gained much support in Wales nhere. from 187j there was constant agitation against the sliding scale payment of wages. Following a strike in 1898 the sliding scale was abolished and the South Wales Miners' federation was organized This body, later affiliated nith the Miners' Federation of Great Britain, latterly the National Cnion of Mineworkers, continued to be proinineint in the trade-union movement. (*See* Ness Ednards' *History of the South Wales Miners' Federation,* 1938.)

South **Wales.**—*Coal.*—Because of the high quality of the coal and its proximity to tidal waters. from 1881 the south Wales coal field was the chief coal-exporting region of the norld However the narrow mining valleys present unusual difficulties. for the level ground is occupied by surface norks and the hillsides are used as waste tips The same causes which gave Welsh coals their superiority also made mining in this area more costly and dangerous than in any other part of Britain. Welsh coal is dry and fiery, and the fine coal dust is a constant source of danger. Loose-jointed coal and loose or rotten roof. more frequent in south Wales mines than elsewhere. are responsible for nu- accidents accompanied loss of life. The incidenre of dust disease by the 1930s and 1940s had vere in any British coal field. but scientific dust suppression and

TABLE II.—*Welsh Agricultural Production*

Item	1939	1952	1956	Item	1939	1952	1956
Tillage (ac.)	292,400	568800		Potatoes (ac.)	[illegible]	[illegible]	27,800
Temporary grass (ac.)		443,100	402,300	Vegetables (ac.)	4,500	6,700	10,800
Permanent a (ac.)	2,159,100	1,560,500	1,714,700	Cattle	858,600	958,400	1,055,000
Wheat (ac.)	245,300	33,100	23,100	Pigs	207,800	231,200	256,700
Barley (ac.)	159,100	34,800	25,800	Poultry (000)	4,406.7	5,399.5	5,150.1
Oats (ac.)	12,900	215,700	166,300	Horses	[illegible]	45,000	27,900
Mixed corn (ac.)	160,300	101,900	57,300	Sheep (000)		4,235.1	4,492.6
Fodder crops a	[illegible]	122,500	1	Milk (000 gal. d	88,510	179,900	219,980

Sources: *Digest of* **Welsh** *Agricultural Statistics*, 1952 (Ministry *of* Agriculture and Fisheries, Welsh Department, Aberystwyth, 1953); *Digest* d *Welsh Statistics* (H.M.S.O., London, 1957).

combative measures later caused considerable improvement. For these reasons, the output per man is less than the average for the rest of Britain

After World War I the demand for Welsh coal decreased greatly, both at home and abroad. Although the population and the industrial power equipment increased substantially, economies in the utilization of coal lessened consumption in the United Kingdom. The Welsh coal export trade fell off because of the development of coal resources abroad and the increased use of fuel oils, coupled with heavy import duties, drastic quotas and the subsidizing of industries. In 1938 there were 136,000 miners employed in the south Wales coal field, as compared with 168,000 in 1928 and nearly 250,000 in 1913. There were 119,600 persons employed in the coal mining industry in 1956. The output of coal in 1928 was 43,300,000 tons, but by 1938 the figure had fallen to 35,300,000 tons. South Wales continued, however. then to be the premier coal exporting area in the United Kingdom. Coal exports fell still further after World War II and drastic reorganization was called for when the industry became nationalized in 1947. The total output of salable coal from south Wales pits in the first year of nationalization was 22,288,000 tons and by 1952 this had risen to 23,730,000 tons, an average production maintained annually since. Opencast production in south Wales in 1947 yielded 842,600 tons and by 19j6 the total was 1,640,000 tons. In the north Wales coal field the average production of salable coal rose to 2,300,000 tons between 1948 and 1956.

The National Coal board's plans for south Wales provided for a capital expenditure of about £100,000,000 in the period 1950 to 1965. There were seven administrative areas in the coal field in 1953, each of which had a major project in hand or planned where horizon mining methods would be concentrated on for improved haulage, ventilation and output. Most of the remaining 140 pits would also be modernized.

Industries — Prior to 1870 the leading place in the economic development of south Wales was held by the iron industry. Along the northern edge of the coal field plentiful and readily accessible supplies of coal, iron ore and limestone occurred in close proximity. Consequently, in the first half of the 19th century a narrow upland tract, extending for about 20 mi. from Pontypool and Blaenavon to Hirwaun, nith its chief centre at Merthyr-Dowlais, became the greatest iron-producing region in the world. The invention of processes for the large-scale manufacture of steel and the resulting demand for richer and purer iron ores than those found in the coal field caused many of those works to be closed or to be transferred to the seaboard, where imported iron ore could be treated.

At one period \Vales enjoyed a virtual world monopoly in the manufacture of tin plate. Of 77 such works in Britain in 1875

TABLE III.—*South Wales Industry, 1956–57*

Electricity generated (kw.hr.)	6,993,000,000
Crude petroleum imported and refined at National Oil Refineries, Ltd., at Llandarcy (tons)	2,310,000
Crude steel production (tons)	5,830,400
Sheet steel production (tons)	1,950,200
Fisheries, met fish landed (cat.)	426,801
Inward and outward cargoes handled at' Cardiff, Swansea, Newport, Barry, Port Talbot, Penarth and Briton Ferry (tons)	20,342,000

Sources: *Digest of Welsh Statistics* (H.M.S.O., London, 1957); Wales and *Monmouthshire*, Cmd. 319 (H.M.S.O., London, 1957).

there were 57 situated in south Wales. The industry was hard hit by the U.S. McKinley tariff in 1890 but recovered through the willingness of both employers and workers to make sacrifices and by the capturing of new markets in eastern Europe. The manufacture of heavy steel products (such as rails, sleepers [ties]. ship plates and girders) is carried on at Port Talbot, Cardiff and Ebbw Vale. The works at Cardiff, completed in 1936. were then the most modern of their type in Great Britain, and those at Ebbw Vale replaced the old steelworks, closed after World War I.

During World War II most of the old-type tin-plate works ceased production and were used for storing war material; and their workers were dispersed in munition factories all over the country. It became clear after the war that the Welsh tin-plate industry would have to be thoroughly modernized if it was to hold its own in the world markets. Accordingly four leading companies pooled plans and resources and formed the Steel Company of Wales which in four years laid down a steel strip plant at Margam, Port Talbot, the most up-to-date of its kind in Europe, which. when in full production, would employ 8,400 men and attain a weekly output of 3,500 tons of rails and 22,800 tons of steel strip and plate.

To complete the modernization scheme an extensive cold reduction plant capable of converting 7,000 tons a week of Port Talbot strip was built at Llanelly and started production in 1952, while in 1956 a similar modern plant was completed at Velindre, near Swansea. This enterprise, involving capital outlay of about £100,000,000, was expected to restore the supremacy of Welsh tin plates in the intensified battle for world trade.

Although by the mid-1950s there was some decrease in home demand for certain steel products. Welsh steel output continued to rise gradually. In west Wales the long-foreseen closure of the old tin-plate handmills caused unemployment. Major developments were being carried out at several major steelworks during the mid-1950s.

Copper ores were shipped from all parts of the world to Swansea for smelting and refining in the 19th century, but because of the lessened copper content of ores and the increasing cost of freights, smelting came to be conducted in close proximity to the copper mines. and the industry disappeared in Wales. However, a copper manufacturing industry still remained. In the years following World War I many works were closed down, but though export trade was affected by economic, financial and political conditions in foreign countries, the industry was continued at Landore, Llanelly and Port Talbot.

Copper sulphate, a by-product of copper manufacturing, was exported mainly to France and Italy for the purpose of spraying in vineyards. Copper-nickel sulphide ores smelted in Canada to a kind of Bessemer matte are shipped to Swansea for refining. The principal by-products of the nickel-manufacturing process, copper sulphate, nickel sulphate and nickel ammonium sulphate, are put to a variety of uses.

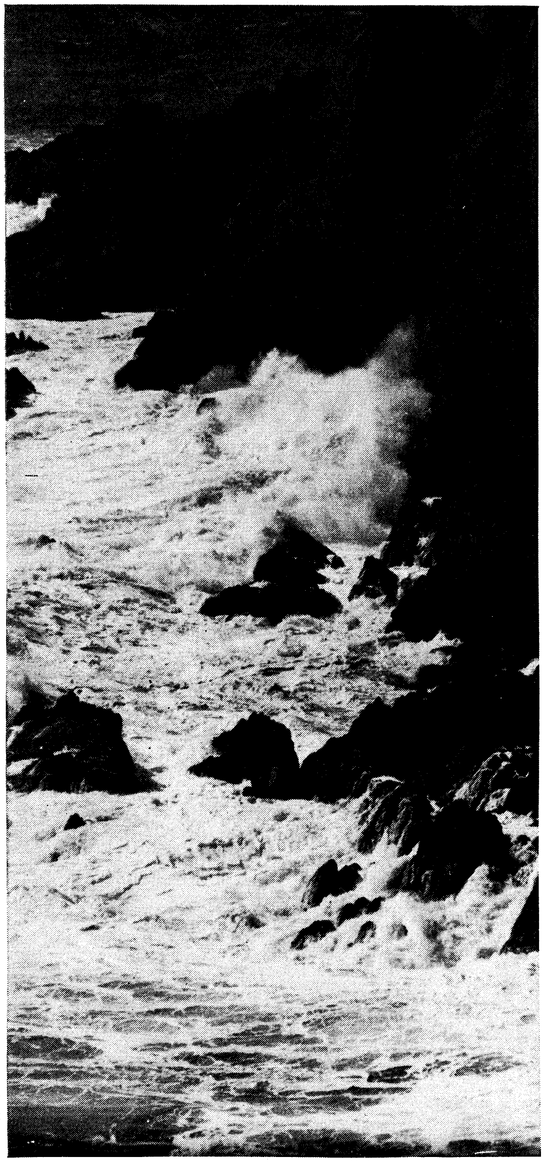
Spelter (zinc) is produced in Swansea from sulphide ores imported mainly from Australia and used chiefly in the making of alloys. brass and bronze and in the manufacture of galvanized iron. General engineering industries in Wales include iron and brass founding. the manufacture of railway material and patternmaking; wire, wire netting and wire rope are also made. In 1922 an oil refinery was built at Llandarcy, between Neath and Swansea, for treating crude petroleum imported through Swansea by the Anglo-Iranian Oil company.

A new industrial revolution occurred in Wales after World War II with the government-stimulated settlement of new industries in areas that had been severely hit. especially in south Wales, by the trade slump in the interwar period.

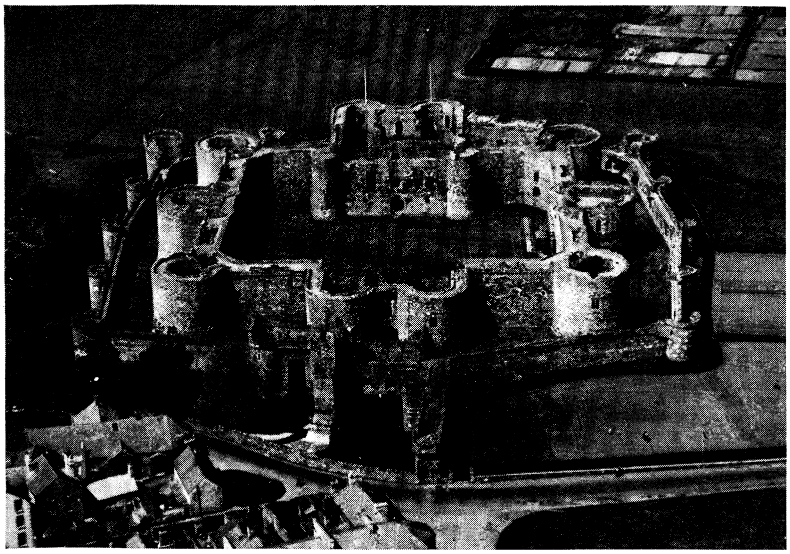
By the end of June 1953 new factories and extensions of existing factories had provided 137,000 new jobs of which 109,000 had been created after the end of the war in 194j. A total of 453 factory projects were completed. An example of the expansion of new industries was the progress of the toymaking trade with 3j firms regularly employing 3,000 workers in Wales and exporting their products to all parts of the world in competition with traditional toymakers on the continent. Despite restrictions on capital investment several extensions of government-financed factories were carried out in the mid-1950s.

While a number of small manufacturing firms on trading estates closed under the economic stress of 19jj–56, the general trend in Wales was toward further expansion. The Suez canal crisis focused attention on the deepwater anchorages of Milford Haven where oil interests were planning harbourage for enlarged tankers to berth and for crude oil to be pumped through a pipeline to the refinery at Llandarcy (Glamorgan). By 1957 plans were prepared for extending Milford docks and an iron ore terminal was also envisaged. The main south Wales ports combined their efforts to try and gain new general cargo traffic to offset the loss of coal trade.

North **Wales.**—*Coal.*—North Wales is more closely related in



Rocky coast at St. Anne's Head, Pembrokeshire



Beaumaris castle, Anglesey, built by Edward I in 1295–1323

"Plas Newydd," a manor house at Llangollen, Denbighshire, operated by the National trust

Mountains of North Wales: a view from Snowdon (3,561 ft.), highest mountain in England and Wales

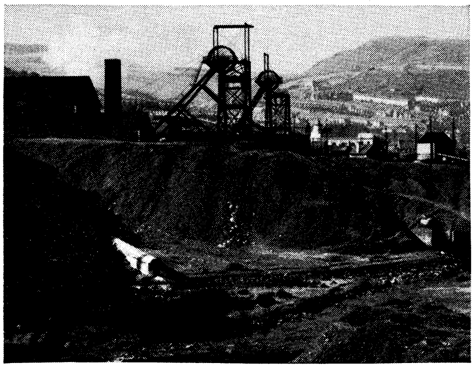
PHYSICAL FEATURES AND BUILDINGS OF WALES

PHOTOGRAPHS (TOP LEFT. BOTTOM) A. W. KERR, (TOP RIGHT) AEROFILMS. LTD., FROM EWING GALLOWAY, (CENTRE RIGHT) MUSTOGRAPH

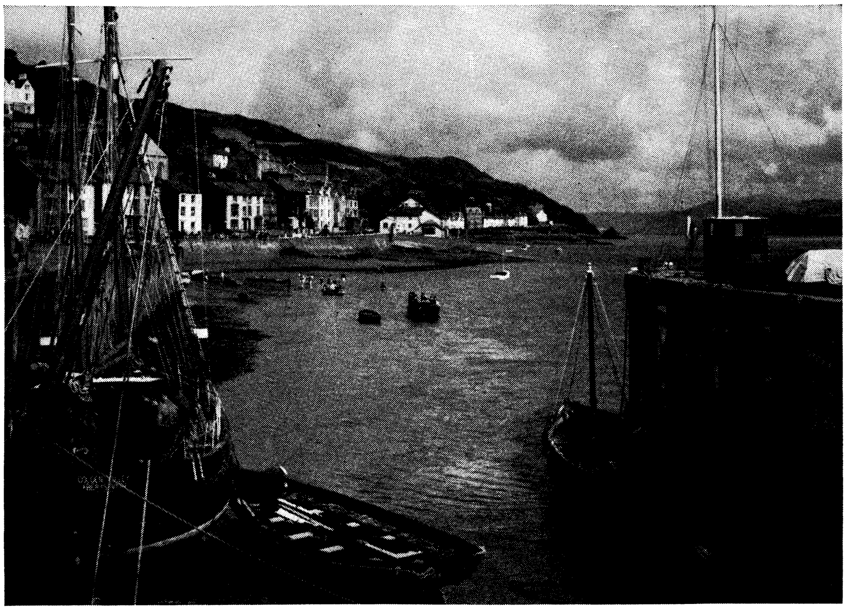
WALES

Cottages at Harlech, Merionethshire. In the background is the famous 13th century castle

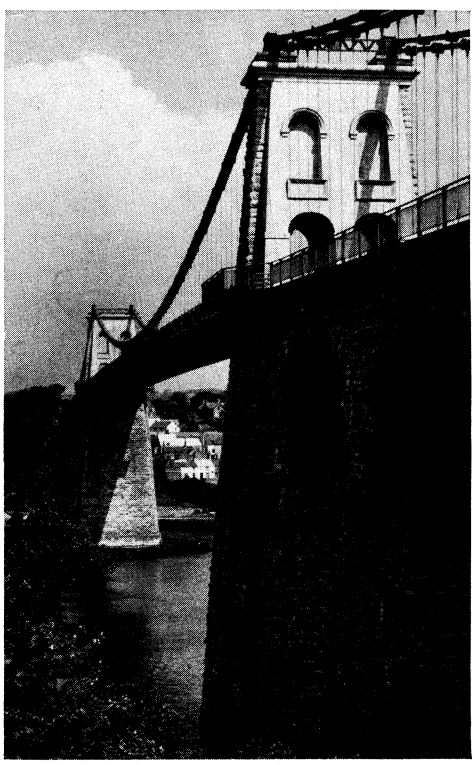
Llandudno, Caernarvonshire. a seaside town on a peninsula in the Irish sea



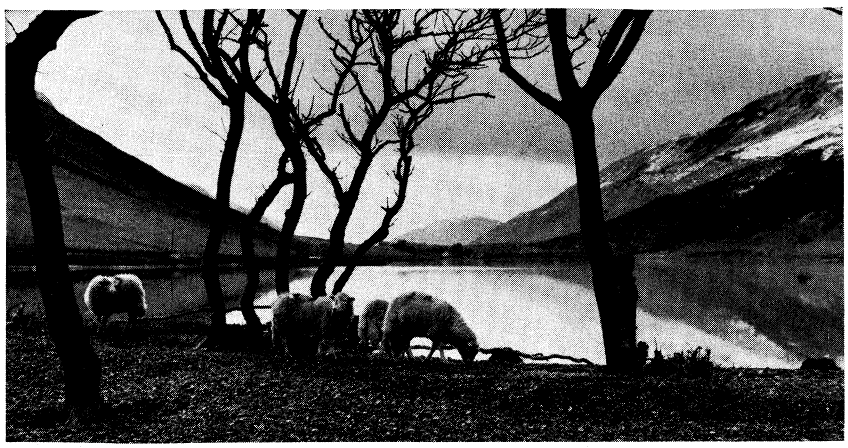
Colliery in the Rhondda valley, Glamorganshire, an important Welsh mining centre



Aberdovey, a small resort town on the Dovey estuary, Merionethshire; formerly a fishing centre



Menai Strait bridge, built by Thomas Telford 1819–26. The strait is a channel of the Irish sea dividing Anglesey and Caernarvon



Sheep grazing near the shore of Lake **Tal-y-llyn,** Merionethshire, near **Dolgelley**

SCENES IN WALES

PHOTOGRAPHS (TOP LEFT, CENTRE LEFT, BOTTOM LEFT. BOTTOM RIGHT) E. W. TATTERSALL, (TOP RIGHT, CENTRE RIGHT) MUSTOGRAPH its economic life to Lancashire and the Midlands than to south Wales, for east-to-west routes are far more practicable than north-to-south in Wales. The north Wales coal field lies in the counties of Flint and Denbigh and extends for about 40 mi. from south to north along the Dee valley. Although extensive, it is far less rich and varied in its output than the south Wales field. The coal obtained is used chiefly for domestic purposes and for gas manufacture, the cannel coal of Flintshire (around Leeswood, Hope and hlold) being specially reputed for its gas-producing qualities. Fire clay, which is mined along with the coal, is used in the brick and tile industries at Ruahon. Cefn, Rhosllanerchrugog and near Mold. Production figures for north Wales after nationalization were: from the mines in 1947, 2,038,446 tons, opencast. 83,909 tons; in 1952, 2,226,100 tons and 215,222 tons respectively.

Industries.—The first ironworks in Wales n-as established at Bersham. near Wrexham. in 1701, but the ore mined from the coal measures of North Wales became almost exhausted before the close of the 19th century. However. as in south Wales, the manufacture of steel from imported ores became a considerable industry. and galvanized iron and tin plates are made at several places. Extensive developments took place from 1948 onward at the Shotton steelworks, putting them in line with the latest production methods.

The chief centre of the fine chemical industry in Wales is at Ruahon. and around Holywell and Flint are important paper and artificial silk industries. Although the mining of lead and zinc declined, it was still being carried on at Halkyn during World War II. Holywell is the centre of the woollen industry of north Wales, fine imported wools being employed in preference to the coarser local product. Wales produces the best slates in the world, but the industry has been struggling following the end of World War II.

Chief centres of the slate-quarrying industry are Bethesda, Llanberis, Nantlle and Festiniog in the counties of Caernarvon and Merioneth, all districts faced with economic eclipse in the 1950s.

Efforts were continuing in the mid-1950s to attract new industries to depressed areas in north Wales, in Anglesey and Caernarvonshire.

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WALEWSKI, ALEXANDRE FLORIAN JOSEPH COLONNA, Comte (1810–1868), French politician and diplomatist, was born at Walewice near Warsaw on May 4, 1810, the son of Napoleon I and his mistress Marie, Countess Walewski. At the age of 14 Walewski refused to enter the Russian army, escaping to London and thence to Paris. where the French government refused his extradition to the Russian authorities. Louis Philippe sent him to Poland in 1830, and he was then entrusted by the leaders of the Polish revolution with a mission to London. After the fall of Warsaw he took out letters of naturalization in France and entered the French army, seeing some service in Algeria. In 1837 he resigned his commission and began to write for the stage and for the press.

The accession of Louis Napoleon to power ill France guaranteed his career. He was sent as envoy extraordinary to Florence. to Naples and then as ambassador to London. where he announced the coup d'état to Palmerston (*q.v.*). In 1855 Walewski became minister of foreign affairs, and acted as French plenipotentiary at the congress of Paris next year. When he left the foreign office in 1860 it was to become minister of state. an office which he held until 1863. Senator from 1855 to 1865, he entered the *corps législatif* in 1865 and was installed, by the emperor's interest. as president of the chamber. A revolt against his authority two years later sent him back to the senate. Walewski died on Oct. 27, 1868.

WALKER, FRANCIS AMASA (1840–1897), U.S. economist and statistician. a leader in modernizing and broadening the character and scope of economics in the Anglo-U.S. world, was born at Boston, Mass., on July 2, 1840. His father, Amasa Walker (1799–1875), also a distinguished economist. was the author of The *Science* of *Wealth,* a widely popular textbook. As superintendent of the United States censuses of 1870 and 1880, Francis Amasa Walker expanded the coverage of the census so that it would mirror the nation's development. He exerted his influence as a teacher first at Yale college (1873–81) and then. while president of the Massachusetts Institute of Technology. Cambridge. He was the author of outstanding treatises. notably *The Wages* Question (1876), *Money* (1878) and Political *Economy* (1883). He was president of the American Statistical association (1883–97) and of the American Economic association (1885–92). He died Jan. 5, 1897.

Walker was a decisive influence in discrediting the previously generally accepted wages-fund doctrine. He also effectively stressed the importance of the entrepreneur (as distinct from the capitalist) as the organizer of industry. His controversial studies on immigration invigorated the analysis of population trends.

See James P. Munroe, *A Life of Francis Amasa Walker* (1923). (J. Dn.)

WALKER, FREDERICK (1840–1875), English painter and illustrator, was born in Marylebone, London, May 26, 1840. He studied at Leigh's academy, the British museum and the Royal academy schools, and in 1858 apprenticed himself to J. W. Whymper, the wood engraver. His mature work (particularly illustration which, however, he practically gave up after about 1866) was influenced by his friend J. E. Millais, and especially by the latter's Tennyson drawings of 1857. For another close friend, W. M. Thackeray, he illustrated *The Adventures of Philip* (1861–62) and *Denis Duval* (1860–63) in the *Cornhill* magazine. His first oil, "The Lost Path," was shown at the Royal Academy in 1863, but "Bathers" (Royal Academy. 1867) began the series of his most popular pictures in which, like A. Legros at this time, he turned to a socially-minded realism ("The Plough," 1870; "At the Bar," 1871), sometimes painting like J. F. Millet ("Mushroom Gatherers," *c.* 1868). Walker was elected associate of the Royal Academy in 1871. He died at St. Fillans, Perthshire, June 5, 1875.

WALKER, GEORGE (1618?–1690), hero of the siege of Londonderry, son of George Walker, rector of Kilmore and chancellor of Armagh (d. 1677). In the Irish war of 1688. Walker, though in Holy Orders and advanced in years. raised a regiment for the defense of Dungannon. However, Robert Lundy, the acting governor of Londonderry, ordered the abandonment of the place on March 14, 1689.

On the approach of the enemy (April 13) Walker hurried to Londonderry to inform Lundy, but mas unable to convince him of his danger. He returned to his men at Lifford, where, on the 14th, he took part in a brush with the enemy, afterward following the retreat of the army to Londonderry. The town was in great confusion. and Walker found the gates shut against him and his regiment. He was forced to pass the night outside, and only entered the next day "with much difficulty and some violence upon the Centry." Immediately on his arrival he urged Lundy to take the field and refused the demand to disband his own soldiers. On April 17 Lundy determined to give up the town to James, and called a council from which Walker and others were excluded. But the next day the king and his troops, who had advanced to receive the surrender, were fired upon from the walls contrary to Lundy's orders, and the arrival of Capt. Adam Murray with a troop of horse saved the situation. Lundy was deprived, and allowed to escape in disguise. On April 19 Walker and Maj. Henry Baker were chosen joint governors. Walker commanded 15 companies (900 men) and to him also was entrusted the supervision of the commissariat. He showed great energy, courage and resource throughout the siege, and led several successful sallies. At the close of the siege, which lasted 150 days, the town was at the last extremity; but on July 30 Walker preached the last of the sermons by which he had helped to inspire its defense. An hour later ships were seen approaching, and the town was relieved.

Walker was received by William and Mary at Hampton court on Aug. 9. 1689. He was nominated to the bishopric of Londonderry, but was shot at the Boyne, July 1. 1690.

WALKER, HENRY OLIVER (1843–1929), U.S. painter, known mainly for his murals, was born at Boston, Mass., on May 14, 1843. He was a pupil of Léon Bonnat in Paris. Walker at first painted the figure and occasional portraits, but later he devoted himself almost exclusively to mural decoration.

His paintings, symbolizing lyric poetry. for the Library of Congress. Washington. D.C., and his decorations for the appellate courthouse in New York city, the enlarged statehouse at Boston. the Essex county courthouse at Newark. N.J.. and the capitol at St. Paul. Minn., are among his most important works. He died in Belmont. Mass.. on Jan. 14, 1929.

WALKER, HORATIO (1858–1938), U.S.-Canadian painter. whose subjects were most often taken from Canadian peasant life. was born at Listowel. Ont., on May 12. 1858. \t7hen he was a child his family settled at Rochester, N.Y. Although entirely self-taught, he became a distinguished painter of animals. the figure and landscape. His pictures show the influence of Troyon and Millet. mainly in their feeling for largeness of composition, in solidity of painting and in the choice of themes. Walker was a member of the National Academy of Design, New York city, and of the American Water Color society. Among the several U.S. galleries that exhibit his works are the City Art museum. St. Louis. Mo. ("Milking, Evening" and "Woodcutters"), and the Albright gallery. Buffalo, N.Y. ("Prodigal Son").

WALKER, OBADIAH (1 616-1699), master of University college, Oxford, was born at Darfield, near Barnsley, Yorkshire, and was educated at University college. Oxford, becoming a fellow and tutor. In 1638 he was deprived of his academic appointments. but he returned to Oxford at the restoration of 1660. In June 1676 he was elected to the headship of University college. Xfter the accession of James II Walker declared himself a Catholic, being partly responsible for the tactless conduct of James in forcing a quarrel with the fellows of Magdalen college. Mass was said in his residehce, and later a chapel was opened in the college for Roman Catholic worship. He died on Jan. 21, 1699.

WALKER, ROBERT (fl. 1641–1660?), English portrait painter, much employed by the parliamentarians. His portraits of Oliver Cromwell (National Portrait gallery, London. and elsewhere), "Henry Ireton" and "John Lambert" (National Portrait gallery!, "Colonel Hutchinson" and "Mrs. Hutchinson" (Milton park, Northants), and "The Marquess of Hertford" (1656, Syon house, Middlesex) show a slavish dependence on Van Dyck (a plagiarism with which he was reproached by his contemporaries), an impersonal use of paint and no sense of colour. There is. however, a dour sincerity in the heads, and such portraits on a smaller scale as his self-portraits (at Belvoir: Ashmolean museum. Oxford; and Hampton court) or the "John Evelyn" (1648; Evelyn collection. Christ Church, Oxford) are native portraits of some character. He painted copies of some of the Titians in the collection of Charles I. He appears in the records of the Painter Stainers company between 1641 and 1652 and he may have survived until after the Restoration.

See E. Waterhouse, *Painting in Britain, 1530 to 1790* (1953). (O. M.)

WALKER, ROBERT JOHN (1801–1869), U.S. senator, secretary of the treasury and governor of the Kansas territory, was born on July 19, 1801 at Northumberland, Pa. He was graduated from the University of Pennsylvania in 1819 at the head of his class, and was soon thereafter admitted to the bar. He early associated himself with the Republican-Democratic party and played a prominent part in organizing a Jacksonian movement in the state. In 1825 he married Mary Bache, great granddaughter of Benjamin Franklin, and the next year moved to Natchez, bliss., to join his brother in the practice of law. Speculation in public lands, however; soon absorbed his attention, and by assisting squatters and small bidders to secure plots at low prices he gained a popularity that opened the nay to a public office.

In 1835 Walker won a seat in the U.S. senate, where he quickly gained a reputation as a ready speaker and an ardent supporter of Democratic party measures. He was particularly active in moves to secure land legislation favourable to the actual settler and to the nevi-er states. He opposed Whig efforts to increase the tariff and to distribute proceeds from the sale of public lands to the states. He kept a firm hold on his own state by supporting the moves to repudiate the huge debt contracted by extravagant internal improvements and excessive bank loans. He was re-elected to the senate in 1841.

Always a promoter and expansionist in temper, Walker early became interested in Texas. He sponsored the senate bill of 1837 for the recognition of Texas independence, and worked closely with Pres. John Tyler for annexation. In Jan. 1844 he wrote a long letter to friends in Kentucky setting forth the great benefits to be derived from annexation and the grave dangers of permitting Texas to fall into British hands. Widely circulated throughout the United States. this letter played an important part in forcing the Texas question into the presidental campaign of that year and in giving James K. Polk the presidency. For Walker's services Polk named him secretary of the treasury.

In his first annual report as secretary, Walker advocated a reduction of the tariff to a revenue basis, and then framed the administration bill for that purpose. The report was hailed as a "classic of free-trade literature," and the passage of the "Walker tariff" played an important part in preparing British public opinion for acceptance of a compromise settlement of the Oregon boundary. Walker also won acclaim by establishing a warehouse system for handling imports and for his part in the creation of the department of the interior.

Out of office in 1849, Walker remained in Washington practising law and promoting land and railroad schemes. Pres. Franklin Pierce offered him the mission to China but a misunderstanding occurred and he resigned immediately after acceptance. He had again resumed his business activities when Pres. James Buchanan implored him to accept the governorship of the Kansas territory. It was a difficult assignment but, given assurance that the administration would back him in permitting the people of the territory to decide the slavery issue for themselves. Walker accepted. In Kansas he attempted to secure the co-operation of the free-soil forces by promises of fair elections and assurance that "climate not politics" would decide the issue. The inference that climate forbid slavery antagonized the south and frightened the administration. Walker's rejection of fraudulent votes in Kansas elections and his refusal to accept the Lecompton constitution brought his recall and his break with the Democratic party.

During the Civil War Walker served the treasury department abroad, selling federal bonds and undermining Confederate credit by linking Jefferson Davis with Mississippi repudiation—a thing which he himself had supported and which Davis had opposed. Xfter the war he continued his law practice and played some part in pushing the Alaska purchase bill through congress.

See for the best study of Walker, H. D. Jordan, "A Politician of Expansion," *Miss. Valley Hist. Rev.*, xix, 362–381 (Dec. 1932); W. E. Dodd, "Robert J. Walker, Imperialist,!' Chicago Literary Club *Papers* (1914). (Ay. Cn.)

WALKER, WALTON HARRIS (1889–1950), U.S. army officer, who commanded United Nations and Republic of Korea ground troops during the Korean war, was born in Belton, Tex., on Dec. 3, 1889, and graduated from the U.S. Military academy in 1912. He served with Funston's Veracruz expedition in 1914 and commanded a machine-gun battalion in France during World War I. During World War II Walker commanded the 4th armoured corps (later redesignated the 20th corps), and organized the vast desert training centre in California. With Gen. George S. Patton's 3rd army in Europe, he achieved outstanding offensive success by aggressive employment of co-ordinated infantry and armoured units. His 20th corps, the "ghost corps," liberated Chartres and Verdun, fought at Metz, helped reduce the Saar-Palatinate pocket and captured Erfurt and Weimar.

Walker was commanding the 8th army in Japan when the North Koreans invaded South Korea in 1950, and he was promptly appointed ground commander in Korea. His skillful defense of the Pusan perimeter prevented the expulsion of UN forces and made it possible for Gen. Douglas MacArthur to outflank and rout the North Koreans by the amphibious landing at Inchon. Walker's 8th army pushed to the Manchurian border, but entry into the conflict of Chinese Communist forces necessitated withdrawal. He died in an automobile accident near Seoul, Dec. 23, 1950, and was posthumously promoted to full general. (&!IN. BN.)

WALKER, WILLIAM (1824–1860), U.S. adventurer, was born in Nashville. Tenn., on May 8, 1824. He graduated at the University of Nashville in 1838, and in 1843 received his M.D. from the University of Pennsylvania. Later he studied law and was admitted to the bar in New Orleans. On Oct. 15, 1853, he sailed from San Francisco with a filibustering force for the conquest of Mexican territory. He landed in lower California, and on Jan. 18, 1854, proclaimed this and the neighbouring state of Sonora an independent republic. Starvation and Mexican attacks led to the abandonment of this enterprise, and Walker resumed his journalistic work in California. On May 4, 1855, with 56 followers, Walker sailed for Nicaragua, having been invited by one of the belligerent factions to come to its aid. In October Walker seized a steamer on Lake Nicaragua belonging to the Accessory Transit company, a U.S. corporation engaged in transporting freight and passengers across the Isthmus, and was thus enabled to surprise and capture Granada and make himself 'master of Nicaragua. Peace was then made; Patricio Rivas, who had been neutral, was made provisional president, and Walker secured the real power as commander of the troops. At this time two officials of the Accessory Transit company determined to use Walker as their tool to get control of that corporation, then dominated by Cornelius Vanderbilt. They advanced him funds and transported his recruits from the United States free of charge. In return Walker seized the property of the company, on the pretext of a violation of its charter, and turned over its equipment to the men who had befriended him.

On May 20, 1856, the new government was formally recognized at Washington by Pres. Franklin Pierce. Walker managed to maintain himself against a coalition of Central American states, led by Costa Rica, which was aided and abetted by agents of Cornelius Vanderbilt, until May 1, 1857, when, to avoid capture by the natives, he surrendered to Commander Charles Henry Davis, of the U.S. navy, and returned to the United States In Nov. 1857 he sailed from Mobile with another expedition, but soon after landing at Punta Arenas he was arrested by Commander Hiram Paulding of the U.S. navy, and had to return to the United States as a prisoner on parole. On his arrival he was released by order of Pres. James Buchanan.

After several unsuccessful attempts to return to Central America, Walker finally sailed from Mobile in Aug. 1860 and landed in Honduras. There he was taken prisoner by Capt. Salmon, of the British navy, and was surrendered to the Honduran authorities. He was executed Sept. 12, 1860.

See Walker's own narrative, accurate as to details, *The War in Nicaragua* (1860) ; also W. V. Wells, *Walker's Expedition to Nicaragua* (1856) ; C. W. Doubleday, *Reminiscences of the "Filibuster" War in Nicaragua* (1886) ; J. J. Roche, *The Story of the Filibusters* (1891), revised and reprinted as *Byways of War* (1901); and W. O. Scroggs, *Filibusters and Financiers* (1916) (W. O S)

WALKER, WILLIAM HULTZ (1869–1934). U.S. chemical engineer who made important contributions to the development of methods for manufacturing acetate rayon and for waterproofing fabrics, was born in Pittsburgh, Pa., April 7, 1869. After receiving a B.S. degree from Pennsylvania State college in 1890 and M.A. and Ph.D. degrees from Gottingen, Ger., in 1892, he taught chemistry for two years at Pennsylvania State college and then in 1894 became a professor at Massachusetts Institute of Technology. He organized the institute's department of chemical engineering in 1905, the research laboratory of applied chemistry in 1907 and the school of chemical engineering practice in 1916. He remained on the institute's staff until 1921.

From 1900 through 1905, Walker and A. D. Little operated a partnership as consulting chemists. Walker's work resulted in many discoveries and inventions. including the methods for producing rayon and waterproofing fabrics. *(See* SYNTHETIC FIBRES: *History.)* During World War I, Walker did important work on poison gases and the production of helium while in charge of the chemical service section of the U.S. army and the Edgeworth arsenal. Walker was associate editor of the *Journal of Industrial and Engineering Chemistry* and received many professional, academic, military and civilian honours. He died July 9, 1934, near Seabrook, N.H. (W. E. HD.)

WALKING, as a recreational activity distinct from competitive sport, is a pleasant method of promoting physical fitness, especially among those whose occupations are sedentary. It combines a natural means of exercise with the advantage of economy, for it requires no special equipment. Since the walker can adjust the length and duration of his exercise to suit his wishes, it does not impose physical strain except perhaps on those who undertake walking among hills or mountains.

Many persons choose walking, mainly on weekends or holidays, as a solitary form of relaxation, but youth clubs and other groups arrange rambles or hikes. The normal length of the walk undertaken is from 7 to 12 mi. for a half-day or from 12 to 20 mi. for a full day. These organized rambles, in which the desire for exercise is combined with a love of the countryside, are held in the country districts surrounding large towns and follow a route previously decided upon by the leader or a specially chosen route published in a newspaper or magazine.

For those who follow the pastime regularly and intensively, there are associations established in some countries, such as the Ramblers' association in Great Britain and the Wilderness society in the United States. These encourage walking and protect the interests of their members by making representations to preserve footpaths, bridle paths and rights of way in parkland, common land and recognized open spaces in areas of natural beauty against the encroachment of builders, local authorities and national undertakings. They also help walkers to obtain hostel accommodation, and by exchange of information and services enable those of one country to pursue their activities in others. The Appalachian Trail conference, with the aid of its member organizations in 14 states, maintains campsites and a trail more than 2.000 mi. long from Mt. Katahdin in Maine to Mt Oglethorpe in Georgia; it publishes information on conditions of the camps and trail. (J. C. G. C.)

Walking Races. — These races are tests of speed and endurance in walking, either over a measured distance or in a set period of time Walking is often called the "heel and toe" sport because the early method of judging the fairness of competitors laid emphasis on these as points of contact with the ground.

As a healthful form of recreation walking races have no superior, for the contestant derives all the benefits of complete and prolonged muscular exercise accompanied by stimulation of the heart and lungs. A competitive span of 20 years is quite normal among devotees, while some have won world honours in their mid-40s.

Walking is used as a test of fitness, notably in England, where it is embraced in the duke of Edinburgh's scheme for boys, in Sweden and in the Netherlands. In Sweden it was made a national fitness test in the early 1930s and by 1960 about 3,000,000 Swedish men. women and boys possessed the time qualification badge. The Nijmegen marches in the Netherlands, organized by the Dutch League of Physical Culture, are open to the world in both civilian and military categories. The test comprises four separate days' consecutive walking over distances up to 35 mi. each day, with about 12,000 persons taking part.

There have been some remarkable results in both speed and endurance: V. Hardmo of Sweden covered 2 mi. in 12 min. 45 sec. and D. J. Thompson of England covered the 53 mi. from London to Brighton in 7 hr. 35 min. 12 sec. The study of walking mechanics has made its contribution to these results, especially the part played by the hips in extending the length of stride while keeping the rate of energy used very low. This allows the average race walker to stride $\frac{4}{7}$ of his standing height without the necessity of lifting his body weight.

Thk shortest racing distance in common usage is that of 1 mi., popular in the United States for indoor meets but in other countries mainly used for junior competitions. The longest annual event is from Paris to Strasbourg, a distance of 312 mi.; this nonstop race is usually won in a time around 70 hr.

The popularity of nalking as a sport dates from the latter part of the 19th century, although chronicles of single walking feats go back many decades. Between 1850 and 1870 it was mainly professional and many a record was made as the result of a staked wager. Sometimes it was man versus horse, with the man invariably winning if the duration was great enough. Notable walkers of those days mere C. Westhall, W. Perkins, H. Thatcher, J. H. Hocking and J. W. Raby. In England, organized control of walking came when the Amateur Athletic club introduced a 7-mi. event into their championships of 1866, won in the time of 59 min. 32 sec. by J. G. Chambers. His name is perpetuated on the vase named for him and still awarded to the winner of that event.

In the 1870s and 1880s a number of U.S. handicap and distance events were held, a feature of that era being a six-day (144-hr.) go-as-you-please race in the Gilmore gardens in New York city. The men walked rapidly as long as they could, rested or napped, then returned to walk again; the competitor who covered the longest distance at the end of the week was the winner.

Walking races were first part of the Olympic games in 1908 when the British walkers G. E. Larner and E. J. Webb finished first and second in both 3.500-m. and 10-mi. events. Only once after that was a short-distance walk included—in 1920 when one of 3.000 m. mas tried. No walk was included in 1928 because of judging difficulties, but in 1932 a longer distance of 50.000 m. was won by T. W. Green of Great Britain. This distance remained, but the 10.000 m reintroduced in 1948 was superseded by one of 20,000 m. on a closed road circuit. Italy, Sweden and the U.S.S R. in turn dominated these walking races. For complete record of Olympic walking races, see OLYMPIC GAMES.

The United States developed outstanding performers in W. Milhalo, W. Chisholm and Henry Laskau, but these set up no recognized amateur records. However, Milhalo turned professional in 1952 and in four years established 59 world professional records, nearly all of which were better than the comparable amateur standards. Among them was the feat of walking 140 mi, in 24 hr. (H. H. W.)

WALKING FERN (Camptosorus *rhizophyllus*), a small fern notable for its curious method of producing new plantlets at the tips of the leaves or fronds that touch ground. It is native to, but not common in, the eastern United States, where it is found mostly on limestone outcroppings. The bluish-green, spear-shaped fronds are 4 to 12 in. long and are, unlike the popular conception of fern leaves, undivided; they arise from a short, erect or ascending rootstock Colonies of these ferns are sometimes seen growing on mossy boulders.

WALKLEY, ARTHUR BINGHAM (1855–1926), English dramatic critic, son of Arthur Hickman Walkley, was born at Bristol on Dec 17, 1855. He was educated at Warminster school, Balliol and Corpus Christi colleges, Oxford. In 1877 he entered the post office in a junior capacity, rising to become assistant secretary in 1911. He was dramatic critic to the Star, the Speaker and the Tinzes.

His criticism was none the less serious for being shrewd and witty, and was given greater value by his determination "that his work was the creative art of letters not the writing of news." Two volumes have been published of his collected Times articles. He died at Brightlingsea, on Oct. 7, 1926.

WALL, RICHARD (1694–1778), diplomat and minister in the Spanish service, belonged to a family settled in Waterford. Debarred from public service at home as a Roman Catholic, he served in an Irish regiment—probably—of the Spanish army during the expedition to Sicily in 1718. Appointed secretary to the duke of Liria, his knowledge of languages, his adaptability, his Irish wit and self-confidence made him a favourite not only with the duke of Liria, but with other Spanish authorities. He became known to Jose Patiño, minister to Philip V, and was sent by him on a mission to Spanish America. In 1747 he was employed in the peace negotiations at Aix-la-Chapelle, and in 1748 was named minister in London, where he was popular. A partisan of an English alliance, his views recommended him to the favour of Ferdinand VI (1746–59), whose policy was resolutely peaceful. From 1752–64 he was minister of foreign affairs at Madrid. Charles III (1759–88) continued Wall in office, but the king's close relations with the French branch of the House of Bourbon made Wall's position very trying: as a foreigner he was suspected of favour to the English. Charles, however, detested changing his ministers and Wall only extorted leave in 1764 by feigning a disease of the eyes. He was given a handsome allowance and a grant for life of the crown land near Granada, which afterward became Godoy's and finally, the duke of Wellington's.

See Coxe, *Memoirs of the Kings of Spain of the House of Bourbon* (1815) ; *Documentos inéditos para la historia de España,* **vol. xciii.** (1842 *et seq*).

WALLABY (BRUSH KANGAROO) : see KANGAROO.

WALLACE, ALFRED RUSSEL (1823–1913), British naturalist famous for his joint communication with Charles Darwin on the origin of species by natural selection, was born at Usk, Monmouthshire, on Jan. 8, 1823. After leaving school he worked as a land surveyor and architect. About 1840 he began to take an interest in botany, and began the formation of a herbarium. In 1844–45, while an English master in the Collegiate school at Leicester, he met Henry W. Bates (*q.v.*), through whose influence he became interested in beetles, and with whom he went in 1848 on an expedition to the Amazon. In March 1850 the two naturalists separated, and each wrote an account of his travels and observations. Wallace's Narrative of Travels on the Amazon *and* Rio Negro was published in 1853. On his voyage home the ship was burned and his collections lost, except those which he had dispatched beforehand. In 1854–62 he made a tour in the Malay archipelago. His *The* Malay Archipelago appeared in 1869. The chief parts of his vast insect collections eventually passed into the Hope collection of the University of Oxford and the British museum. Wallace divided the Malay archipelago into a western group of islands, which in their zoological affinities are oriental. and an eastern, which are Australian. The oriental Borneo and Bali are respectively divided from Celebes and Lombok by a narrow belt known as "Wallace's Line," on the opposite sides of which the indigenous Mammalia are as widely divergent as in any two parts of the world. Wallace originated his theory of natural selection during these travels.

Origin **of** Species.—In Feb. 1855, staying at Sarawak in Borneo, he wrote an essay "On the Law Which Has Regulated the Introdpction of New Species" (*Ann.* and *Mag. Nat. Hist.*, 1855. p. 184). He states the law as follows: "Every species has come into existence coincident both in time and space with a pre-existing closely-allied species." For three years, so he tells us, "the question of how changes of species could have been brought about nas rarely out of my mind." Finally, in Feb. 1858, during a severe attack of intermittent fever at Ternate. in the Moluccas, he began to think of Thomas R. Malthus' Essay on *Population* (see MALTHUS, THOMAS ROBERT), and, to use his own words, "there suddenly flashed upon me the idea of the survival of the fittest." The theory was thought out during the rest of the ague fit, drafted the same evening, written out in full in the two succeeding evenings and sent to Darwin by the next post. Darwin in England at once recognized his own theory in the manuscript essay sent by the young and almost unknown naturalist in the tropics, then a stranger to him. "I never saw a more striking coincidence." he wrote to Sir Charles Lyell (*q.v.*), on the very day, June 18, when he received the paper: "if Wallace had my manuscript sketch written out in 1842, he could not have made a better short abstract! Even his terms now stand as heads of my chapters."

Under the advice of Lyell and Sir Joseph Hooker (*q.v.*), the essay was read, together with an abstract of Darwin's own views, as a joint paper at the Linnean society on July 1, 1858. The title of Wallace's section was "On the Tendency of Varieties to Depart Indefinitely From the Original Type." The "struggle for existence," the rate of multiplication of animals, and the dependence of their average numbers upon food supply are very clearly demonstrated, and the following conclusion nas reached: "Those that prolong their existence can only be the most perfect in health and vigour; . . . the weakest and least perfectly organized must always succumb."

The difference between Lamarck's theory (see LAMARCKISM) and natural selection is very clearly pointed out. "The powerful retractile talons of the falcon and the cat tribes have not been produced or increased by the volition of those animals; but among the different varieties which occurred in the earlier and less highly organized forms of these groups, *those always survived longest which had the greatest facilities for seizing their prey.* Neither did the giraffe acquire its long neck by desiring to reach the foliage of more lofty shrubs, and constantly stretching its neck for the purpose, but because any varieties which occurred among its antetypes with a longer neck than usual *at once secured a fresh range of pasture over the same ground as their shorter-necked companions, and on the first scarcity of food were thereby enabled to outlive them."* Wallace also alluded to the resemblance of animals, and more especially of insects, to their surroundings, and pointed out that "those races having colours best adapted to concealment from their enemies would inevitably survive the longest."

Natural Selection.—In 1870 Wallace's two essays, written at Sarawak and Ternate, were published with others as a volume, *Contributions to the Theory of Natural Selection.* In the additional essays, the new theory was applied to the interpretation of certain classes of facts. In this and other works, Wallace differed from Darwin on certain points. Thus the two concluding essays contend that man has not, like the other animals, been produced by the unaided operation of natural selection, but that other forces have also been in operation. Here may be seen the influence of Wallace's convictions on the subject of spiritualism. He expressed his dissatisfaction with the hypothesis of "sexual selection" by which Darwin sought to explain the conspicuous characters which are displayed during the courtship of animals. The expression of his opinion on both these points of divergence from Darwin will be found in *Darwinism* (1889).

Darwin died before the controversy upon the possibility of the hereditary transmission of acquired characters arose over the writings of August Weismann (*q.v.*), but Wallace freely accepted the general results of the German zoologist's teaching, and in *Darwinism* presented a complete theory of the causes of evolution unmixed with any trace of Lamarck's use or disuse of inheritance, or the comte de Buffon's hereditary effect of the direct influence of surroundings. *Tropical Nature and Other Essays* appeared in 1878, and was later republished combined with the 1871 *Essays.* His *Geographical Distribution of Animals* appeared in 1876 and *island Lzfe,* a supplement to it, in 1880.

Miscellaneous **Works.**—Wallace published *Miracles and Modern Spiritualism* in 1875 (new ed., 1896), in which he gives the experimental reasons for his beliefs. which were in no way connected with revealed religion. In 1882 he published *Land Nationalization,* in which he argued the necessity of state ownership of land, a principle which he had originated long before the appearance of Henry George's work. In *Forty-five Years of Registration Statistics* (1885) he maintained that vaccination is useless and dangerous. Wallace also published an account of what he held to be the greatest discoveries as well as the failures of the 19th century, *The Wonderful Century* (1898; new ed., 1903). His later works include *Studies, Scientific and Social* (1900), *Man's Place in the Universe* (1903), *The World and Life* (1910) and *Social Environment and Moral Progress* (1912). He published his autobiography, *My Life,* in 1905 (new ed., 1908). Possessed of a bold and original mind, his activities radiated in many directions, apparently rather attracted than repelled by the unpopularity of a subject. A nontheological Athanasius, he had the truest missionary spirit.

Wallace was married in 1866 to the eldest daughter of the botanist William Mitten, of Hurstpierpoint, Sussex. In 1910 he received the Order of Merit. Wallace died at Broadstone, Dorset, on Nov. 7, 1913.

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WALLACE, SIR DONALD MACKENZIE (1841–1919), British author and journalist, was born on Nov. 11, 1841. He was educated at the universities of Glasgow, Edinburgh, Berlin and Heidelberg and at the École de Droit. Paris. When 28 years of age he was invited by a friend to visit Russia, and became so much interested that he remained there six years. His *Russia* (1877) had a great success, and was at once recognized as a classic. Mackenzie Wallace acted as correspondent of the *Times* (London) in St. Petersburg (Leningrad), Berlin and Constantinople, and after the battle of Tell-el-Kebir (1882) in Egypt. From 1884 to 1889 he was in India as private secretary to the viceroy, Lord Dufferin, and to his successor, Lord Lansdowne. From 1891 to 1899 he was director of the foreign department of the *Times.* In 1899 he undertook the editorship of the new volumes (issued in 1902 as the 10th edition) of the *Encyclopedia Britannica.* Wallace died at Lymington, Hampshire, on Jan. 10, 1919.

WALLACE, HENRY AGARD (1888–), 33rd vice-president of the United States, was born in Adair county, Ia., Oct. 7, 1888. After graduating from Iowa State college, Ames, in 1910, he joined the staff of *Wallace's Farmer.* This magazine had been founded by his grandfather and was later edited by his father, who served as secretary of agriculture under President Harding and President Coolidge. Wallace studied farm prices, produced the first corn–hog ratio charts and forecast the farm price collapse of 1920. His experiments with higher yielding corn strains resulted in major advances in plant genetics.

Wallace, formerly a Republican, shifted to the Democratic party in 1928, and edited *Wallace's Farmer and Iowa Homestead* from 1929 to 1933. As secretary of agriculture under Pres. Franklin D. Roosevelt from 1933 to 1940, he helped formulate and administer the Agricultural Adjustment acts to conserve the soil, store reserves, control production and raise farm prices.

He was President Roosevelt's choice for vice-president in 1940. As vice-president, Wallace became Roosevelt's good-will ambassador in Latin America and also traveled in the far east. During World War II he assumed many emergency duties in addition to the vice-presidency. After being passed over for renomination as vice-president in 1944, Wallace became secretary of commerce in 1945 and continued in that position under Pres. Harry S. Truman. But his plans for revitalizing the department were overshadowed by his criticisms of the Truman administration's "get tough" policy with the Soviet Union and his warnings against getting into an atom bomb race with the Russians.

Wallace left the Truman cabinet in 1946 and became editor of the *New Republic.* He resigned this position late in 1947 to become the Progressive party candidate for president. He campaigned for closer co-operation with the U.S.S.R.; urged that the United Nations administer all foreign aid; favoured reduction of armaments; and opposed universal military training. He got more than one million popular votes but no electoral votes. Later he broke with the Progressive party and returned to private life.

Wallace was a prolific writer. His best known works are *Sixty Million Jobs* (1945), which called for governmental action to supplement private enterprise; *The Century of the Common Man* (1943); and *America Must Choose* (1934).

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WALLACE, LEWIS (Lew) (1827–1905), U.S. army officer and author, was born at Brookville, Ind.. April 10, 1827. He abandoned law in Indianapolis to recruit volunteers for the Mexican War, and served in 1846–47. In the Civil War he served with the Union forces and attained the rank of major general of volunteers. He served as president of the courts of inquiry that investigated the conduct of Gen. D. C. Buell and condemned Henry Wirz, commander of the Confederate prison at Andersonville, Ga. He was also a member of the court that tried the persons charged with conspiracy against Pres. Abraham Lincoln. He resigned from the army in 1865 and resumed the practice of law. He was governor of New Mexico territory (1878–81) and minister to Turkey (1881–85). He died at Crawfordsville, Ind., Feb. 15, 1905. His literary reputation rests upon three historical romances: *The Fair God* (1873), a story of the conquest of Mexico; *Prince of India* (1893), dealing with the Wandering Jew and the Byzantine empire; and his greatest popular success. *Ben Hur* (1880), a tale of the coming of Christ, which was translated into several languages and made into a play and a motion picture. *Lew Wallace: An Autobiography* was published in 1906.

WALLACE, SIR RICHARD (1818–1890), English art collector and philanthropist whose name is perpetuated by the famous collection at Hertford house, Manchester square, London, was born in London on June 21, 1818. A natural son of Viscount Beauchamp, later the 4th marquess of Hertford, and Agnes Jackson, née Wallace, he was educated in Paris and, after the 3rd marquess' death in 1842, acted as confidential secretary to the 4th marquess, assisting him in the formation of his magnificent art collections. In 1870 Lord Hertford died, leaving Wallace heir to the bulk of his large fortune, his unentailed property and his entire art collections. The part of these collections that eventually went to form the celebrated museum at Hertford house owes its character to both men. Lord Hertford assembled most of the superb French 17th- and 18th-century furniture and minor arts, the old masters and the modern French paintings, to which Wallace added the armour and the medieval and Renaissance objects of art. In 1871 he was created a baronet for his services to the English community during the siege of Paris. He was a British commissioner at the Paris exhibition of 1878 and also a trustee of the National gallery, the National Portrait gallery and a governor of the National Gallery of Ireland. He sat in parliament for Lisburn, Ire., from 1873 to 1885, when he retired to Paris, where he died on July 20, 1890. His wife, who died in 1897, bequeathed to the British nation those sections of the art collections, then housed on the ground and first floors of Hertford house, which form the Wallace collection.

See General Guide to the Wallace Collection (1958). (F. J. B. W.)

WALLACE, SIR WILLIAM (*c.* 1270–1305), the popular national hero of Scotland, is believed to have been the second son of Sir Malcolm Wallace of Elderslie and Auchinbothie, in Renfrewshire. The only authority for the events of his early life is the metrical history of Blind Harry, who lived about two centuries later than Wallace, during which a considerable body of legend had probably gathered round the name. At the same time he professes to follow as his "autour" an account that had been written in Latin by John Blair, the personal friend and chaplain of Wallace himself. Blair's account has perished.

In his boyhood, according to the usual accounts, he resided for some time at Dunipace, in Stirlingshire, with an uncle, who is styled "parson" of the place. His education was continued at Dundee, where he made the acquaintance of John Blair. On account of an incident that happened at Dundee—his slaughter of a young Englishman named Selby, for an insult offered to him—he is said to have been outlawed, and so driven into rebellion against the English. He gradually gathered round him a body of desperate men whom he led in various attacks upon the English. Several of the more patriotic nobles—including the steward of Scotland, Sir Andrew Moray, Sir John de Graham, Douglas the Hardy, Wishart, bishop of Glasgow, and others—joined him. An attack was made upon the English justiciar, Ormsby, who was holding his court at Scone. The justiciar himself escaped, but many of his followers were captured or slain. The burning of the Barns of Ayr, the quarters of English soldiers, in revenge for the treacherous slaughter of his uncle, Sir Ronald Crawford, and other Scottish noblemen, followed.

The success of these exploits induced the English king to send an army, under the command of Sir Henry Percy and Sir Robert Clifford, against the insurgents. The English came up with Wallace at Irvine, when all Wallace's titled friends left him and made submission to Edward, except the ever faithful Sir Andrew Moray. The treaty of Irvine by which these Scottish nobles made submission, is printed in Rymer's *Foedera.* It is dated July 9, 1297, and is the first public document in which the name of Sir William Wallace occurs. Wallace retired to the north, and although deserted by the barons was soon at the head of a large army. In a short time he recovered almost all the fortresses held by the English to the north of the Forth. He had begun the siege of Dundee when he heard that an English army, led by the earl of Surrey and Cressingham the treasurer, was on its march northward.

Battle of Stirling.—Leaving the citizens of Dundee to continue the siege of the castle, he made a rapid march to Stirling. Encamping in the neighbourhood of the Abbey Craig—on which now stands the national monument to his memory—he watched the passage of the Forth. After an unsuccessful attempt to bring Wallace to terms, the English commander, on the morning of Sept. 11, 1297, began to cross the bridge. When about one half of his army had crossed, and while they were still in disorder, they were attacked with such fury by Wallace, that almost all—Cressingham among the number—were slain, or driven into the river and drowned. Those on the south side of the river were seized with panic and fled tumultuously, having first set fire to the bridge. The Scots, however, crossed by a ford, and continued the pursuit as far as Berwick. Sir Andrew Moray was killed.

Its results were important. The English were everywhere driven from Scotland. To increase the alarm of the English, as well as to relieve the famine which then prevailed, Wallace organized a great raid into the north of England, in the course of which he devastated the country to the gates of Newcastle. On his return he was elected guardian of the kingdom. In this office he set himself to reorganize the army and to regulate the affairs of the country. His measures were marked by much wisdom and vigour, and for a short time succeeded in securing order, even in the face of the jealousy and opposition of the nobles.

Battle of Falkirk.—Edward was in Flanders when the news of this successful revolt reached him. He hastened home, and at the head of a great army entered Scotland in July 1298. Wallace slowly retired before the English monarch, driving off all supplies and wasting the country. The nobles as usual for the most part deserted his standard. Edward, compelled by famine, had already given orders for a retreat when he received information of Wallace's position and intentions. The army, then at Kirkliston, was immediately set in motion, and next morning (July 22, 1298) Wallace was brought to battle in the vicinity of Falkirk. After an obstinate fight the Scots were overpowered and defeated with great loss. Among the slain was Sir John de Graham, the bosom friend of Wallace, whose death, as Blind Harry tells, threw the hero into a frenzy of rage and grief. The account of his distress is one of the finest and most touching passages in the poem. With the remains of his army Wallace found refuge for the night in the Torwood—known to him from his boyish life at Dunipace. He then retreated to the north, burning the town and castle of Stirling on his way. He resigned the office of guardian, and betook himself again to predatory warfare against the English.

Betrayal.—At this point his history again becomes obscure. He is known to have paid a visit to France, with the purpose of obtaining aid for his country from the French king. This visit is narrated with many untrustworthy details by Blind Harry; but the fact is established by other and indisputable evidence. When in the winter of 1303–1304 Edward received the submission of the Scottish nobles, Wallace was expressly excepted from all terms. A price was set upon his head, and the English governors and captains in Scotland had orders to use every means for his capture. On Aug. 5, 1305 he was taken—as is generally alleged, through treachery—at Robroyston, near Glasgow, by Sir John Menteith, carried to the castle of Dumbarton, and thence conveyed in fetters and strongly guarded to London. He reached London on the 22nd of August, and next day was taken to Westminster Hall, where he was impeached as a traitor by Sir Peter Mallorie, the king's justice. To the accusation Wallace made the simple reply that he could not be a traitor to the king of England, for he never was his subject, and never swore fealty to him. He was found guilty and condemned to death. The sentence was executed the same day with circumstances of unusual cruelty.

For bibliography *see* the article in the *Dict. Nat. Biog. The* principal modern lives are James Moir's (1886), and A. F Murison's (1898). (A. F. Hu.; X.)

WALLACE, WILLIAM VINCENT (1812–1865), Irish composer, was born at Waterford, Ireland, on Mar. 11, 1812. He led a roving and adventurous career in Australia, the South Seas, India, and S. America. In 1845 he settled in London and in November of that year his opera *Maritana* was played at Drury Lane theatre with great success. This was followed by *Matilda of Hungary* (1847). *Lurline* (1860), *The Amber Witch* (1861), *Love's Triumph* (1862), and *The Desert Flower* (1863). He also composed for the piano He died on Oct 12. 1865.

WALLACH, OTTO (1847–1931), German organic chemist awarded the Nobel prize in chemistry in 1910 for his pioneer uork on the structure of asoxy and alicyclic compounds. was born at Konigsberg, March 27, 1847. An early student of literature and art, he was attracted to chemistry by Friedrich Wöhler at Göttingen and August Wilhelm von Hofmann at Berlin. He was an assistant to Hermann Wichelhaus in Berlin and Friedrich August Kekulé at Bonn. In 1889 he was appointed director of the Chemical institute at Gottingen where he remained until his retirement in 191j. At Bonn, where Wallach taught pharmacy. he became interested in the structure of ethereal oils such as camphene. citrene, carvene, eucalyptene and related terpenes with the empirical formula $C_{10}H_{16}$. There were many of these oils which were thought at that time to be different since they occurred in a variety of plants. Utilizing common reagents such as hydrogen chloride and hydrogen bromide, Wallach by 1895 had laid the foundations for the carbon skeleton of the terpenes and characterized the differences between the structure of similar compounds. JVallach was not so much a theorist as an analyst who proved that many terpenes thought to be different were the same. By 1901, 100 papers by Wallach reported the painstaking work which formed the basis of subsequent research to determine the structure of complex naturally occurring organic substances. He wrote *Terpene und Kampfer* (1909; 2d ed.. 1914). His accuracy as an analyst was proved by synthesis of the molecules whose structure he had determined. He died Feb. 26, 1931, at Gottingen. (V. Bw.)

WALLACK, a famous family of British-U.S. actors and theatre managers. William Wallack, the founder of the family. was a leading player at Astley's amphitheatre in London. Henry John Wallack (1790–1870), his son, was born in London and appeared at Astley's at an early age. In 1819 he made his U.S. debut in Baltimore. then returned to England and played the Covent Garden theatre for several years, returning to the U.S. in 1837 to manage the first Wallack's theatre. He died in New York in 1870.

James William Wallack (1795–1864), second son of William and brother of Henry. was born in London. Aug. 24. 1795. Beginning his acting career in 180; at the age of 12, he spent the next decade chiefly at the Drury Lane theatre in London. Between 1818 and 1852 he crossed and recrossed the Atlantic. playing alternate engagements in London and New York. He became manager of the National theatre in New York in 1837 and remained there until the theatre burned two years later. For a time he managed Niblo's Gardens, and in 183'2 took over Brougham's Lyceum. renaming it Wallack's. In 1861 he built another theatre at 13th and Broadway. He died on Dec. 25, 1864.

James William Wallack II (1818–1873) was born in London on Feb. 24, 1818, the son of Henry John and nephew of James William. He played at the Covent Garden theatre under his father, and in 1837 he joined his uncle's company at the National theatre in New York. He was outstanding in tragedy and melodrama. His best roles were Fagin, Macbeth. Richard III and Iago. In 1865 he became a member of Wallack's Stock company, under his cousin Lester. He died near Aiken. S.C., on May 24. 1873.

Lester Wallack (1820–1888), christened John Johnstone Wallack, an outstanding actor, playwright and manager of the 19th century. was born in New Tork city on Jan. 1. 1820, the son of James William Wallack I. He made his first New Tork stage appearance in 1847 in Dion Boucicault's *Used Up*, and after several years of apprenticeship became an actor in his father's company. In 1861 he succeeded to the management of Wallack's theatre. His play *Rosedale; or, The Rifle Ball* was a considerable success in 1863. In 1882 he opened the New Wallack's theatre and until his retirement in 1887 managed both theatres. His productions were noted for their polish. A spectacular benefit was held in his honour in 1888, when Edwin Booth, Lawrence Barrett, Joseph Jefferson. Helena Modjeska and other stars performed *Hamlet*. Wallack died on Sept. 6, 1888, at his home near Stamford. Conn. His memoirs, *Memories of Fifty Years*, were published in 1889. (S. W. H.)

WALLASEY, a municipal, county and parliamentary borough. Cheshire. Eng., 20 mi. N.W. of Chester by road. Pop. (1951) 101,369. Area 9.2 sq.mi. It covers the northeast tip of the Wirral peninsula, at the mouth of the Mersey river. A system of ferries connects it with Liverpool, for many of whose workers it is a dormitory suburb.

The borough includes the seaside resort of New Brighton, and the whole of its water frontage (7 mi.) is skirted by a promenade. Except in the south, where the borough adjoins Birkenhead docks, there is little industry, the area being almost entirely residential. The church of St. Hilary, a foundation of the 10th century, was rebuilt in 1759 and again in 1858 after a fire. Wallasey was incorporated in 1910, became a county borough in 1913 and a parliamentary borough in 1918.

WALLA WALLA, a city of southeastern Washington, U.S., 120 mi. S.W. of Spokane; the seat of Walla Walla county. The name was the Indian place name and means "place of many waters." Marcus Whitman, a Congregational missionary, established a mission in the locality in 1836 which became a way station on the Oregon trail until Nov. 29. 1847, when Whitman, his wife and several other members of the mission were massacred. In the succeeding Indian wars the site became a base of military operations and Ft. Walla Walla was begun in 1856. A settlement developed around the fort and in 1862 the town was laid out and incorporated. During the 1870s and early 1880s it was the largest city in the territory; bypassed by transcontinental railroads, it lost first place to Seattle by 1883 and fell behind Spokane by 1890. Stock raising. grain growing and pea canning (established by 1932) are leading industries. Branch-line railroads, good highways and excellent airport facilities make up for lack of mainline railroad service. Improvements on the nearby Columbia and Snake rivers have expanded hydroelectric power and provided slack water for barge transport. Educational facilities include Whitman college. a private college established in 183'9. and Walla Walla college, a Seventh-day Adventist institution founded in 1892 at College Place, a suburb. There is also a civic orchestra and a little theatre group. For comparative population figures *see* table in Washington: *Population.* (H. J. De.)

WALL CREEPER (*Tichodroma muraria*), a small, nonmigratory bird of the family Certhiidae. It inhabits rocky ravines and cliff faces as well as stone structures from central Europe to southern China. The total length is about 6½ in., including the short tail and slender curved bill. Although the upper parts are mainly grayish with the throat and breast black in summer and white in winter (young are like winter adults), the rounded wings have distinctive brilliant red coverts. The wall creeper has a desultory fluttering flight, spending most of its time climbing about rock faces, boulders or stonework. searching the crevices for insects. It nests well back in crevices, usually laying four eggs. (R. S. Pr.)

WALLENSTEIN (properly Waldstein). **ALBRECHT WENZEL EUSEBIUS VON,** duke of Friedland, Sagan and Mecklenburg (1583–1634). German soldier and statesman. was born at Hermanice (Hermanitz on the Elbe) in Bohemia. on Sept. 24. 1583. After the death of his parents he was sent to the Jesuit college of nobles at Olmütz. after which he professed the Roman Catholic faith. In 1599 he went to the University of Altdorf, which he had to leave in consequence of some boyish follies. Next he studied at Bologna and Padua and visited many places in southern and western Europe. While in Padua he gave much attention to astrology. and during the rest of his life he never wavered in the conviction that he might trust to the stars for indications as to his destiny. For some time Wallenstein served in the army of the emperor Rudolph II in Hungary. which was commanded by a methodical professional soldier. George Basta. His personal gallantry at the siege of Gran won for him a company without purchase. In 1606 he returned to Bohemia. and in 1609 he married an elderly widow, Lucretia von Vičkov (née Rekesch von Landeck), whose great estates in Moravia he inherited after her death in 1614. His new wealth enabled him to offer 200 horse, splendidly equipped. to the archduke Ferdinand for his war with Venice in 1617. Wallenstein commanded them in person. and from that time he enjoyed both favour at court and popularity in the army.

In the disturbances which broke out in Bohemia in 1618 and proved to be the beginning of the Thirty Years' War. advances were made to Wallenstein by the revolutionary party; but he preferred to associate himself with the imperial cause, and he carried off the treasure chest of the Moravian estates to Vienna, part of its contents being given him for the equipment of a regiment of cuirassiers. At the head of this regiment Wallenstein won great distinction under Buquoy in the war against Mansfeld. He was not present at the battle of the White Mountain (1620), but he did brilliant service as second-in-command of the army which opposed Gabriel Bethlen in Moravia, and recovered his estates which the nationalists had seized. The battle of the White Mountain placed Bohemia at the mercy of the emperor Ferdinand, and Wallenstein turned the prevailing confusion to his own advantage. He secured the great estates belonging to his mother's family, and the emperor sold him on easy terms vast tracts of confiscated lands. He was allowed to form his possessions into a territory called Friedland, and he was raised in 1622 to the rank of an imperial count palatine, in 1623 to that of a prince. In 1623 he made another wealthy marriage, with Isabella Katharina Harrach. In 1624 he was made duke of Friedland. Meantime he fought with skill and success against Gabriel Bethlen, and so enhanced his reputation at the dark moment when Vienna was in peril and the emperor's general Buquoy dead on the field of battle. He was not only the detached visionary with vast ambitions, but also the model ruler of his principality. He placed the administration of justice on a firm basis, founded schools and developed agriculture, mining and manufactures.

When the war against the Bohemians had become a widespread conflagration. Ferdinand found he had no forces to oppose the Danes and the northern Protestants other than the army of the Catholic league, which was controlled not by him but by Maximilian of Bavaria. Wallenstein saw his opportunity and early in 1626 he offered to raise not a regiment or two, but a whole army for the imperial service. After some negotiations the offer was accepted. the understanding being that the troops were to be maintained at the cost of the countries they might occupy. Wallenstein's popularity brought great numbers of recruits to his standard He soon found himself at the head of 30.000 (not long afterward of 50,000) men. For the campaigns of this army in 1625, 1626 and 1627, against Mansfeld. the northern Protestants and Gabriel Bethlen, see THIRTY YEARS' WAR.

Having established peace in Hungary. Wallenstein proceeded, in 1627, to clear Silesia of some remnants of Mansfeld's army; his outlay in the conduct of the war was to be taken into account in the conclusion of the bargain with the emperor whereby he eventually became duke of Sagan (Feb. 1628). He then joined Tilly in the struggle with Christian IV, and afterward took possession of the duchy of Mecklenburg, which was granted to him in Jan. 1628 in reward for his services, the hereditary dukes being displaced on the ground that they had helped the Danish king. He failed to capture Stralsund, which he besieged for several months in 1628. This important reverse caused him bitter disappointment, for he had hoped that by obtaining free access to the Baltic he might be able to make the emperor as supreme at sea as he seemed to be on land. It was a part of Wallenstein's scheme of German unity that he should obtain possession of the Hanseatic towns, and through them destroy or at least defy the naval power of the Scandinavian kingdom, the Netherlands and England. This plan was completely frustrated by the resistance of Stralsund. Moreover the emperor's Edict of Restitution (1629) not only rallied against him all the Protestants but brought in a great soldier and a model army, Gustavus Adolphus and the Swedes.

At the same time the victory of the principles of the league involved the fall of Wallenstein's influence. By his ambitions, his high dreams of unity and the incessant exactions of his army, he had made for himself a host of enemies. He was reported to have spoken of the arrogance of the princes, and it appeared probable that he would try to bring them, Catholics and Protestants alike. into rigid subjection to the crown. Again and again the emperor was advised to dismiss him. Ferdinand was very unwilling to part with one who had served him so well; but the demand was pressed so urgently in 1630 that he had no alternative, and in August Wallenstein was removed from his command.

Wallenstein accepted the decision calmly, gave his army to Tilly, and retired to Gitschin (Jicin), the capital of his duchy of Friedland. There, and at his palace in Prague, he lived in an atmosphere of mysterious magnificence, the rumours of which penetrated all Germany.

Gustavus Adolphus had landed in Germany, and it soon became obvious that he was formidable. Tilly was defeated at Breitenfeld and on the Lech, where he received a mortal wound, and Gustavus advanced to Munich. while Bohemia was occupied by his allies the Saxons. The emperor entreated Wallenstein to come once more to his aid. Wallenstein at first declined; he had, indeed, been secretly negotiating with Gustavus Adolphus, in the hope of destroying the league and its projects and of building his new Germany without French assistance. However, he accepted Ferdinand's offers, and in the spring of 1632 he raised a fresh army as strong as the first within a few weeks and took the field. This army was placed absolutely under his control, so that he assumed the position of an independent prince rather than of a subject. His first aim was to drive the Saxons from Bohemia—an object which he accomplished without serious difficulty. Then he advanced against Gustavus Adolphus, whom he opposed near Nuremberg and dislodged after the battle of the Alte Veste. In November came the great battle of Liitzen (*q.v.*), in which the imperialists were defeated. but Gustavus Adolphus was killed.

To the dismay of Ferdinand, Wallenstein made no use of the opportunity provided for him by the death of the Swedish king, but withdrew to winter quarters in Bohemia. In the campaign of 1633 much astonishment was caused by his apparent unwillingness to attack the enemy. He was in fact preparing to desert the emperor. In the war against the Saxons he had offeredthem as terms of peace the revocation of the edict. Religious toleration and the destruction of the separatist regime, as well as not inconsiderable aggrandizements for his own power. formed his program, so far as historians have been able to reconstruct it. and. becoming convinced from Ferdinand's obstinacy that the edict mould never be rescinded. he began to prepare to "force a just peace on the emperor in the interests of united Germany." With this object he entered into negotiations with Saxony. Brandenburg. Saeden and France. He had vast and vague schemes for the reorganization of the entire constitutional system of the empire, with himself as supreme authority.

Irritated by the distrust excited by his proposals and anxious to make his power felt, he at last assumed the offensive against the Snedes and Sasons, winning his last victory at Steinau on the Oder in October. He then resumed the negotiations. In December he retired with his army to Bohemia. fixing his headquarters at Pilsen. It had been suspected in Vienna that Wallenstein was playing a double part, and the emperor, encouraged by the Spaniards at his court. anxiously sought for means of getting rid of him. Wallenstein was well aware of the designs formed against him, but displayed little energy in his attempts to thwart them. This was due in part, no doubt, to ill-health, in part to the assurances of his astrologer, Battista Seni.

His principal officers assembled around him at a banquet on Jan. 12, 1634, when he got them to sign a declaration to the effect that they would remain true to him. On Feb. 19 a second paper was signed; but on this occasion the officers' expression of loyalty to their general was associated with an equally emphatic expression of loyalty to their emperor.

On Jan. 24 the emperor had signed a secret patent removing him from his command, and imperial agents had been labouring to undermine Wallenstein's influence. On Feb. 7 two of his officers, Octavio Piccolomini and Johann Aldringer, had intended to seize him at Pilsen, but finding the troops there loyal to their general. they had kept quiet. But a patent charging Wallenstein and two of his officers with high treason, and naming the generals who were to assume the supreme command of the army, was signed on Feb. 18 and published in Prague.

Wallenstein realized the danger and, on Feb. 23, accompanied by his most intimate friends and guarded by about 1,000 men, he went from Pilsen to Eger. hoping to meet the Swedes under Duke

Bernhard. After the arrival of the party at Eger, Col John Gordon, the commandant, and Col. Walter Butler and Maj. Walter Leslie agreed to rid the emperor of his enemy. On the evening of Feb. 25 Wallenstein's supporters Christian Ilow, Wilhelm Kinsky. Adam Trczka and his master of the horse. Heinrich Neumann, were received at a banquet by the officers and then murdered. Butler, Capt. Walter Devereux and a number of soldiers hurried to the house where Wallenstein was staying and broke into his room. He was instantly killed by a thrust of Devereux's partisan.

WALLER, EDMUND (1606–1687), English poet, was born on March 9, 1606. the eldest son of Robert Waller of Coleshill and Anne Hampden. his wife. Early in his childhood his father moved to Beaconsfield. Waller was educated at Eton and King's College, Cambridge. He left without a degree, and it is believed that in 1621 he sat as a member for Agmondesham (Amersham) in the last parliament of James I. Clarendon says that Waller was "nursed in parliaments." In that of 1624 he represented Ilchester, and in the first of Charles I. Chipping Wycombe. The first act by which Waller distinguished himself, however, was his surreptitious marriage with a wealthy ward of the Court of Aldermen, in 1631. He was brought before the Star Chamber for this offence, and heavily fined. After bearing him a son and a daughter at Beaconsfield, Mrs. Waller died in 1634. It was about this time that the poet was elected into Falkland's "Club."

It is supposed that about 1635 he met Lady Dorothy Sidney, eldest daughter of the earl of Leicester, who was then eighteen years of age. He formed a romantic passion for this girl, whom he celebrated under the name of Sacharissa. She rejected him, and married Lord Spencer in 1639. In 1640 Waller was once more M.P. for Amersham; later, in the Long Parliament, he represented St. Ives. Waller had hitherto supported the party of Pym, but he now left him for the group of Falkland and Hyde. An extraordinary and obscure conspiracy against Parliament, in favour of the king, which is known as "Waller's Plot," occupied the spring of 1643, but on May 30 he and his friends were arrested. In the terror of discovery, Waller was accused of displaying a very mean poltroonery, and of confessing "whatever he had said, heard, thought or seen, and all that he knew . . . or suspected of others." Waller was called before the bar of the House in July, and made an abject speech of recantation. His life was spared and he was committed to the Tower, whence, on paying a fine of £10,000, he was released and banished the realm in Nov. 1643. He married a second wife, Mary Bracey of Thame, and went over to Calais, afterwards taking up his residence at Rouen.

In 1645 the *Poems* of Waller were first published in London, in three editions. Many of the lyrics were already set to music by Henry Lawes. In 1646 Waller travelled with Evelyn in Switzerland and Italy. During the worst period of the exile Waller managed to "keep a table" for the Royalists in Paris, although in order to do so he was obliged to sell his wife's jewels. At the close of 1651 the House of Commons revoked Waller's sentence of banishment, and he was allowed to return to Beaconsfield, where he lived very quietly until the Restoration.

In 1655 he published *A Panegyric to my Lord Protector,* and was made a Commissioner for Trade a month or two later. He followed this up, in 1660, by a poem *To the King, upon his Majesty's Happy Return.* Being challenged by Charles II. to explain why this latter piece was inferior to the eulogy of Cromwell, the poet smartly replied, "Sir, we poets never succeed so well in writing truth as in fiction." He entered the House of Commons again in 1661, as M P. for Hastings, and Burnet has recorded that for the next quarter of a century "it was no House if Waller was not there." His sympathies were tolerant and kindly, and he constantly defended the Nonconformists. One famous speech of Waller's was: "Let us look to our Government, fleet and trade, 'tis the best advice the oldest Parliament man among you can give you, and so God bless you." After the death of his second wife, in 1677, Waller retired to his house called Hall Barn at Beaconsfield. In 1661 he had published his poem, *St. James' Park;* in 1664 he had collected his poetical works; in 1666 appeared his *Instructions to a Painter;* and in 1685 his *Divine Poems.* The final collection of his works is dated 1636, but there were posthumous additions made in 1690. He died at Hall Barn, with his children and his grandchildren about him, on Oct. 21, 1687.

Waller's lyrics were at one time admired to excess, but with the exception of "Go, lovely Rose" and one or two others, they have greatly lost their charm. His fancy was plain and trite. He made writing in the serried couplet the habit and the fashion. It was this regular heroic measure which was carried to so high a perfection by Dryden and Pope.

The only critical edition of Waller's *Poetical* Works is that edited, with a careful biography, by G. Thorn-Drury, in 1893. (E. *G.;* X.)

WALLER, SIR WILLIAM (*c.* 1597–1668), English soldier, son of Sir Thomas Waller, lieutenant of Dover, was educated at Magdalen hall, Oxford, and served in the Venetian army and in the Thirty Years' War. He was knighted in 1622 after taking part in Sir Horace Vere's expedition to the Palatinate. In 1640 he became member of parliament for Andover. He supported the parliament when the Great Rebellion broke out in 1642. As colonel he captured Portsmouth. Farnham. Winchester and other places; and in 1643 as major general he operated around Gloucester and Bristol (*see* CIVIL WAR, *ENGLISH*), winning a victory at Highnam and capturing Hereford He then opposed the advance of Sir Ralph Hopton and the royalist western army, and though defeated at Lansdown (near Bath) he shut up the enemy in Devizes. However. Hopton and a relieving force from Oxford completely defeated Waller's army at Roundway Down, many reproaching Essex, the commander in chief, for allowing the Oxford royalists to turn against Waller. The Londoners, who had called him "William the Conqueror." raised a new army, but the forces nere distinctly local. and resented long marches and hard work far from their own counties. At the first siege of Basing house they mutinied in face of the enemy, and their gallantry at critical moments, such as the surprise of Alton in Dec. 1643 and the recapture of Arundel in Jan 1644. only partially redeemed their general bad conduct. Waller himself. a general of the highest skill, "the best shifter and chooser of ground" on either side, was, like Turenne, at his best at the head of a small and highly disciplined army.

Though successful in stopping Hopton's second advance at Cheriton (March 1644), he was defeated by Charles I in the war of maneuver ahich ended with the action of Cropredy Bridge (June) ; and in the second battle of Newbury in October his tactical success at the village of Speen led to nothing His last expeditions were made into the west for the relief of Taunton, and in these he had Cromnell as his lieutenant general. By this time the confusion in all the armed forces of the parliament had reached such a height that reforms were at last taken in hand. The original suggestion of the celebrated New Model army came from Waller (July 2, 1644). Simultaneously came the Self-Denying ordinance, nhich required all members of parliament to lay down their military commands. Waller had already requested to be relieved—and his active military career came to an end. Henceforth, embittered. he was constantly engaged, as presbyterianism waned in parliament, in opposing both the Independents and the army politicians: and after the death of Charles I he supported the presbyterian-royalist opposition to the Commonwealth. He was several times imprisoned between 1648 and 1659 He promoted the final negotiations for the restoration of Charles II and sat in the Convention parliament. He died on Sept 19, 1668

See A à Wood, *Athenae Oxonienses,* ed by P Bliss, vol iii, p 812 (London, 1813–20), and two partial autobiographies, "Recollections by General Sir William Waller" (printed in *The Poetry of Anna Matilda,* London, 1788) and *Vindication of the Character,* etc. (London, 1793).

WALLINGFORD, a municipal borough in the Abingdon parliamentary division of Berkshire. Eng , on the Thames. $14\frac{1}{2}$ mi. N.W. of Reading by road. Pop. (1961) 4,829. Area 1.2 sq.mi. It is a residential town and a resort for Thames boating. From the earliest times the ford was important and there are traces of the earthworks which surrounded the town and which have been attributed to Alfred the Great (c. 878). Traces have also been found of Bronze Age occupation; there was a Romano-British settlement, and the motte of the Norman castle can still be identified. Wallingford castle. one of the last to hold out for Charles I, nas demolished during the Commonwealth. The church of St.

Leonard retains pre-Conquest and Norman work. The bridge, rebuilt in the 19th century, incorporates parts of the 13th-century bridge. Though burned by Sweyn in 1006, Wallingford was the most important borough in Berkshire at the time of the Domesday survey. The town suffered greatly from the Black Death, and its decline was accelerated by the building, in the early 1 jth century, of two bridges near Abingdon, which diverted the main road bet\\-een London and Gloucester from Wallingford. The earliest charter, given by Henry II (11 j5), was confirmed and enlarged by Henry III in 1267 and by Philip and Mary in 1557–58. The governing charter until 1835 was that given by Charles II in 1663.

WALLINGTON: *see* BEDDINGTON AND WALLINGTON.

WALLIS, JOHN (1616–1703), an English mathematician, one of the greatest of Isaac Newton's precursors, was born at Ashford, Kent, on Nov. 23, 1616. In 1632 he entered Emmanuel college, Cambridge, where he distinguished himself in many branches of learning. About eight years later he gained a fellowship at Queens' college, Cambridge. He was ordained in 1640, and shortly afterward he exhibited his skill in an entirely different direction by deciphering a number of cryptic messages from royalist partisans which had fallen into the hands of the parliamentarians. Wallis was a prominent member of that body whose interest in the new experimental science led to the formation of the Royal society in 1660. His interest in mathematics began in 164;. when a copy of William Oughtred's *Clavis Mathematicae* came into his hands. His complete mastery of this work gave unmistakable evidence of his mathematical strength. .\bout this time, despite the fact that he had incurred the lasting hostility of the parliamentarians by signing the remonstrance opposing the king's execution. Wallis was elected to the vacant Savilian professorship of geometry at Oxford in 1649. This appointment marked the beginning of a period of intense mathematical activity which lasted almost without interruption until the closing years of his life. A chance perusal of the works of E. Torricelli, in which B. Cavalieri's method of indivisibles was freely used to effect the quadrature of certain curves, stimulated his interest in the age-old problem of the quadrature of the circle, and led to the publication of his *Arithmetica Infinitorum* in 1656. In this work he extended Cavalieri's law of quadrature to embrace negative and fractional exponents, and by a long, complicated chain of reasoning he established the relation: $\frac{4}{\pi} = \frac{3.3.5.5.7.7.9.9.11.11...}{2.4.4.6.6.8.8.10.10.12...}$

This work proved a great inspiration to Newton, a fact which he readily acknowledged.

In 1657 there appeared his *Mathesis Universalis*, a somewhat elementary work whose chief value lies in its account of the development of notation. In 1657–58 Wallis was appointed *Custos Archivorum* to the Cniversity of Oxford. The appointment of a Cambridge man to this office did not meet with universal approval, and there mere many who were ready to attrihute Wallis' rapid advancement to a decided inclination to trim his sails to the prevailing political winds. His next work of importance was the *Mechanica, sive Tractatus de Motu* (3 parts, 1670–71), which refuted many of the errors regarding motion which had persisted since Archimedes and, moreover, gave a definite and permanent meaning to many of the constantly occurring terms such as force and momentum.

Though he was approaching his 70th year, Wallis published in 168j his *Treatise of Algebra,* an important contribution to the study of equations. However, the historical section is of little value since Wallis was never able to recognize the genius of the mathematicians on the continent. Against Descartes he was particularly severe. Wallis' life was embittered by a number of quarrels of which the one with Hobbes was the most profitless (*see* HOBBES, THOMAS). He died at Oxford on Oct. 28, 1703.

See J. F. Scott, *The Mathematical Work of John Wallis (1616–1703)* (1938). (J. F. ST.)

WALLON, HENRI ALEXANDRE (1812–1904), French historian and statesman, was born at Valenciennes on Dec. 23, 1812. Wallon succeeded Guizot as professor at the Sorbonne in 1846. Returning to politics in 1871 he immortalized himself by carrying his proposition for the establishment of the republic with a president elected for seven years, and then eligible for re-election, which, after violent debates, was adopted by the assembly on Jan. 30, 1875. "My proposition," he declared, "does not proclaim the republic; it creates it." Upon the establishment of the republic, Wallon became minister of public instruction, and effected many reforms, but his views were too conservative for the majority of the assembly, and he retired in May 1876. He had been chosen a life senator in Dec. 1875. Returning to his historical studies, Wallon produced four works of great importance, though less from his part in them as author than from the documents which accompanied them: *La Terreur* (in *Correspondant,* 1880–73; in book form, 1873); *Histoire du tribunal révolutionnaire de Paris avec le journal de ses acts* (6 vol., 1880–82); *La Révolution du 31 mai et le fédéralisme en 1793* (2 vol., 1886); *Les Réprésentants du peuple en mission et la justice révolutionnaire dans les départements* (5 vol., 1888–90). He also published a number of articles in the *Journal des savants;* for many years he wrote the history of the Académie des Inscriptions (of which he became perpetual secretary in 1873) in the collection of *Memoirs* of this academy. He died at Paris on Nov. 13, 1904.

WALLOON LITERATURE. Walloon is a Romance dialect, belonging to the same group as the Picard, Lorrain and Francian, of which the latter, under the name of French, has had such a notable development. The several varieties of Walloon are spoken in the southern part of Belgium, in that region generally called "Wallonie" (from a word coined about 1858), of which Likge is the chief centre of dialectal literature.

This literature has its historical monuments. To the northeast belong the cantilena of *Eulalie,* one of the oldest Romance texts (11th century), *Li Ver del Juïse* (the Last Trial), the *Dialogues du Pape Grégoire* (the Dialogues of Pope Gregory), commentaries on *Job, Lent Sermons* and the *Poème Moral.* There are also the delightful song fable of *Aucassin and Nicolette,* one of the masterpieces of the middle ages, and the copious, but somewhat fastidious chronicles of Jean le Bel, Jacques de Hemricourt, Jean d'Outremeuse and Jean de Stavelot. Lastly, the edition by J. Cohen, in 1920, of the *Mystères et Moralités du XIV^e S.,* has enriched the ancient literary patrimony of the Walloon country.

The two Nativities to be found in Cohen's edition are undoubtedly the ancestors of *Noels Wallons* (ed. by Doutrepont in 1909), which are still alive in the popular minds. It may be objected that those works were not written in the dialect spoken by the people at that time, but in a literary language of Picard rather than of French character. However, their dialectal features reveal the anonymous origin of the texts.

We must wait till the beginning of the 17th century before we can find works written in dialect. The three oldest texts written in the dialect of Likge are an *Ode,* dated 1620, a *Sonnet,* dated 1622, and a *Morality,* dated 1623. They were published in 1921 by Jean Haust. A pasquinade on *Women and Marriage* (ed. Jean Haust, 1925) is, unfortunately, undated, but might be assigned to about 1600. Of the 17th and 18th centuries we possess, in all, some 50 lyrical pieces; complaints of peasants about the devastations caused by foreign soldiers, speeches on the topics of the time, satires against the affectations of women, pamphlets about political troubles or religious controversies, humorous compliments on the occasion of a clerical promotion, et~. Their literary value is, on the whole, rather mediocre. An exception must be made, however, for the lyrical satire. *Les Ewes di Tongue* (the Waters of Tongres, 1700), by Lambert Rickmann, perhaps the best Walloon satire in existence, of astonishing verve, rich in somewhat gross but striking images.

In the middle of the 18th century, four comic operas mere composed. They constitute the so-called *Théâtre Liégeois* (ed. Bailleux, 1854). A literary circle used to meet at Chevalier S. de Harlez's; its members (canons, deans, lords and rich bourgeois) amused themselves by writing burlesques, and a composer of great talent, Jean Noel Hamal, provided a lively and picturesque music to the libretti written by his friends. The performance achieved a tremendous success. The four plays in question are entitled *Li Voyedje di Tchaudfontaine* (the Journey to Chaudfontaine), a delightful farce (edit. Haust, 1924); *Li Ljîdjwes Egadî* (the Enlisted Liégeois), a touching picture of local customs; *Li Fiesse di Houte-s'i-Ploût* (the Festival of H.), a village idyll with a somewhat weak plot; and above all, the most original piece of the collection, *Les Hypocondes* (the Hypochondriacs), a diverting picture of the whims and torments of imaginary invalids who go to Spa to drink the waters. A farce in two acts entitled *Li Mâlignant* (the Malevolent) closes this first series, which, although really remarkable for its local colour and veracity, is naturally deprived of high moral feeling.

The revolution of 1789 and the troubles it brought inspired numerous patriots of Liége with popular and satirical songs. Albin Body edited more than 250 of these, but they are now forgotten, with the exception of a song against *The Prussians,* written by the lawyer, J. J. Velez (1817), the popularity of which was revived by World War I.

Few names deserve notice in the first half of the 19th century. Among these may be mentioned *Li Copareye* (1822) by Ch. N. Simonon, which celebrates the ancient clock-tower of the Cathedral of Saint-Lambert and the glorious deeds of the history of Liége; *Li Ktapé Manedje* (the Disordered Household), 1830, by H. J. Forir, a lively satire of the confusion produced in the commonwealth by carelessness and improvidence; *Li Pantalon Trawé* (the Torn Trousers) 1839, by Ch. Du Vivier, an epos, in a few stanzas, of the fighter of 1830, the humble soldier who served under different régimes without any personal profit; *Li Bourgoyne* (1846) by Jos. Lamage, a bacchic song which still enjoys popularity among the Walloon population.

A touching elegy *Leyiz-m'plorer* (Let Me Cry), 1854, and a graceful idyll *L'avez-v'-veyou passer?* (Did you see her pass?) 1856, revealed in Nicolas Defrecheux a true poet. The Walloon people were delighted to hear their patois express such sincerity so delicately. In 1856 the *Société Liégeoise de Littérature Wallonne* was founded. It grouped intellectuals, scholars, writers and folklorists into a kind of small provincial academy, held yearly competitions and published "Bulletins" and "Annuaires."

In 1857 it awarded a prize to *Li Galant dil Servante,* a play written by André Delchef, which opens the revival of the Walloon stage. In 1884, the Société awarded a prize to *Tîtâ l' Periquî,* by Edouard Remouchamps, a play which, because of its caustic vein and the admirable manner in which it was acted, led to a prodigious development of Walloon literature.

But everqwhere the spoken dialect is losing ground to French; the dialect is considered as vulgar, especially in the Hainaut district, along the French frontier. However, the written dialect is used more than ever before. In nearly all villages, dramatic societies perform Walloon plays. In more important centres, writers are grouped in societies which award prizes and publish papers and periodicals: at Tournai, the *Théâtre* of Arthur Hespel, and the *Cabaret Wallon;* at Mons, the *Ropïeur* and its circle; at La Louvière, the *Mouchon d'Aunias;* at Charleroi, the *Association Littéraire;* at Namur, the society *Les Rèlis* and its organ *Le Guetteur Wallon;* in Liége, the *Société de Littérature Wallonne,* the *Caveau Liégeois,* the *Auteurs Wallons,* the *Wallonne* and many others; and so at Verviers, at Malmedy, etc. Liége hss two theatres which, every night, perform Walloon plays before a fairly large audience; humour and wit is their chief feature, except when such writers as Henri Hurard or Louis Lekeu, helped by excellent native actors, offer important plays. Poetry includes joyful songs, satirical pasquinades, sentimental ballads, and descriptive or narrative poems. Such works as *Li Panèd Bon Diu* (the Bread of God) by Henri Simon, the somewhat nostalgic poems of Joseph Yriendts, the love elegies of Emile Wiket, the lyrics of Martin Lejeune, Louis Lagauche, Marcel Launay, Jean Wisimus and many others, combine a real respect for style and prosody with true poetic feeling. Fiction has produced interesting works, such as the *Houlot* (1888) by D. D. Salme. *La Famille Tassin* (1900) by Ad. Tilkin, and the delicate *Solia d'Amour* (1928) by Joseph Laubain. Let us also mention *Cadet* by Jean Lejeune, who, with wonderful realism, relates incidents in the life of a rabbit, *Li Brak'nî* (the Poacher) by Joseph Calozet, a masterpiece that reminds the reader of the rustic stories of George Sand, and the tales *Pou Dire à l'Eschrienne* (Hearth Tales), to mention only a few. Walloon literature to-day is most vivid, and it is to be hoped that, like Gaelic literature, it will remain popular in its inspiration.

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(J. Hau.)

WALLPAPER. Wallpaper first came into general use in Europe during the last quarter of the 17th century, and the name "paper hangings" which was then given to the product is a significant indication of its real origins. In an English publication issued by John Houghton, fellow of the Royal society, in 1699, it is stated that in Surrey at that time paper hangings were sometimes known as "Paper Tapistry." and this description aptly fitted what was, in fact, a practical and cheap substitute for the more costly decorative hangings favoured by the wealthy. It is interesting to note that even at this early date paper hangings were being sold in rolls, for Houghton refers to this as follows: "but there are some other done by Rolls in long sheets of a thick Paper made for the Purpose whose sheets are pasted together to be so long as the Height of a Room. . ."

It is often assumed that the Chinese were the inventors of wallpaper, but there is no evidence that wallpaper, as such, was in general use in the far east earlier than the time of its introduction to Europe. From the very beginning wallpaper was regarded as a cheap substitute for tapestry hangings, painted cloths, leather and wood paneling, and because it so closely imitated these and other forms of mural decoration its use was quickly established and its development assured.

In discussing origins it should be borne in mind that wallpaper, so-called, was used on occasion soon after the introduction of papermaking to Europe during the latter part of the 15th century. It is known, for example, that the early letterpress printers were responsible for some of the decorated sheets found *in situ* and dating from the early part of the 16th century. The remains of one decorated sheet printed in the black printers' ink of the period was found in 1911 on the ceiling of the master's lodge at Christ's college, Cambridge. This proved to be the work of a printer, Hugo Goes of Beverley and York, who had used the back of a proclamation of Henry VIII for the purpose. Another paper, of heraldic design, found adhering to the wattle and daub of a room at Besford court, Worcester, is known to have been printed about 1550. Similar discoveries of the kind, all pointing to a capricious use of the printing press and to a tendency to widen its scope, are noted in a paper by Hilary Jenkinson in the *Antiquaries' Journal,* vol. 5, no. 3 (July 1925). These decorated sheets. printed by nood blocks, were readily acceptable as linings for boxes, chests and cupboards, and the use of such papers as hangings for walls was simply the outcome of expediency and human ingenuity.

The distinction between the 16th- and 17th-century lining papers and the true wallpapers of the same period is an important one. The characteristic most typical of the latter is that the design should be capable of "repeat" when sheets were pasted in juxtaposition on the wall. The principle of repeating patterns mas understood by textile printers as early as the 14th century. and the idea is probably of much earlier origin. Throughout its long history wallpaper has been closely linked with textiles whether printed, painted, woven or embroidered. The Christ's college, Cambridge, example (*see* above) is distinguished by a woodcut motif (a pomegranate) similar in character to those found in medieval velvet hangings of Italian origin; other papers belonging to the Tudor period are printed with designs imitating the "black-work" embroidery to be seen in garments worn by persons of quality in the time of Elizabeth I. Contemporary with these are the lining papers and the wallpapers containing some kind of heraldic ornamentation.

It is difficult to establish which ivas the first European country to invent and use ivallpaper. The claims of France. Germany and England each have some validity, and each is based on indisputable grounds according to the nationality of the historian concerned. It can be said with reasonable certainty, however, that the English and continental letterpress printers of the 16th century played an important part in developing an idea which had already been anticipated in the production of the painted cloths and painted papers of a still earlier period.

The sort of paper hangings available when their manufacture was in its infancy are enumerated in an advertisement published by Edward Butling, stationer of Southwark, London, about 1690 (Bagford collection, British museum). Here it is stated that Edward Butling "maketh and selleth all sorts of Hangings for Rooms in Lengths or in Sheets, Frosted or Plain: also a sort of Paper in Imitation of Irish Stich and several other sorts, viz: Flock-work [*see* below] Wainscot, Marble, Damask. . ." It concludes by announcing that the business sells "all sorts of Stationary wares." It is understandable that the stationers should be associated with the beginnings of wallpaper, but a link of even greater significance is to be found in the London paper-hanging makers of the late 17th century whose predecessors were leather gilders (makers, among other items, of decorated leather hangings for rooms) who turned over to the production of the cheaper hangings made of paper as soon as the latter commodity was available in sufficiently reliable quantity and quality.

Flock Papers.—Pre-eminent among the earliest wallpapers were the flock papers which reproduced the rich texture of the medieval silk and velvet hangings. Flock papers were being made in England and France during the 17th century, and the Painters Stainers' company in London claimed "flock-work" (*cf.* Butling advertisement, above) among their monopolies as early as 1626. The art of flocking on cloth was practised in the middle ages to make coarse cloth look finer than it was in fact, but its application to paper was not widely adopted until the latter part of the 17th century because the roughly made paper was not always tough enough to withstand the weight of the flock material. It is possible that Samuel Pepys was referring to a flock paper when he used the term "counterfeit damask" to describe the hangings in his wife's closet. The flock used in making these papers originally consisted of powdered wool, which was scattered over paper on which the design had previously been drawn, or printed in a slow-drying adhesive or varnish. (Most 18th-century encyclopaedias describe this process in detail, and a full description is also found in R. Dossie's *Handmaid to the Arts* [1758] and J. Beckmann's *A History of Inventions and Discoveries,* trans. by W. Johnston, 4 vol. [1797].) Flock was sometimes used to enrich the already liberally decorated leather hangings, which were popular in Germany and the Netherlands throughout the first half of the 18th century. Flock papers formed a prominent part of the stbck in trade of some of the earliest wallpaper makers and dealers in London, and have been a deservedly popular form of paper-hanging ever since. At one time they were known on the continent as *papiers d'Angleterre,* but toward the end of the 18th century the French surpassed the English in quality and design and the latter did not regain supremacy till the early part of the 19th century. Many important mansions in various parts of the world contain rooms hung with flock wallpaper, and manufacturers today, besides producing by improved processes flock papers for modern use, can at short notice meet demands for the replacement of originals that have been damaged or destroyed.

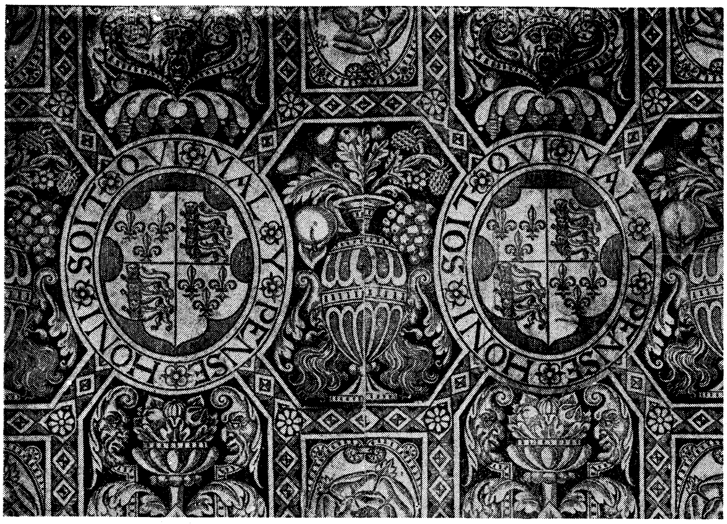
Chinese Papers.—Contemporary with the flock papers were the painted Chinese papers which first began to arrive in Europe toward the end of the 17th century. They were generally described as "India" papers, the name "India" being applied to various goods and *objets d'art* originating in the far east which were brought over in ships of the Dutch, French and English East India companies. Most of these papers were produced specially for the European market and were often made up in sets of 25 rolls, each 12 ft. long by 4 ft. wide. The absence of repeat and the studied dissimilarity of detail as between one length and another gave them a unique quality which was much prized by those who possessed a room decorated and furnished in the fashionable oriental style. Because of their beauty and costliness a far larger number of original Chinese papers have survived the years than might be expected. They may be seen in museums and also in many of the larger houses throughout the world. In England particularly fine examples may be seen at Temple Newsam, Leeds; Nostell priory, Yorkshire; and Woburn abbey, Bedfordshire. The importation of Chinese papers, as already mentioned, commenced during the late 17th century, and European wallpaper makers were quick to imitate them, though indifferently well for the most part. Many of the finest *chinoiserie* papers were produced by etched plates or wood blocks, the colour being introduced by hand or stencil.

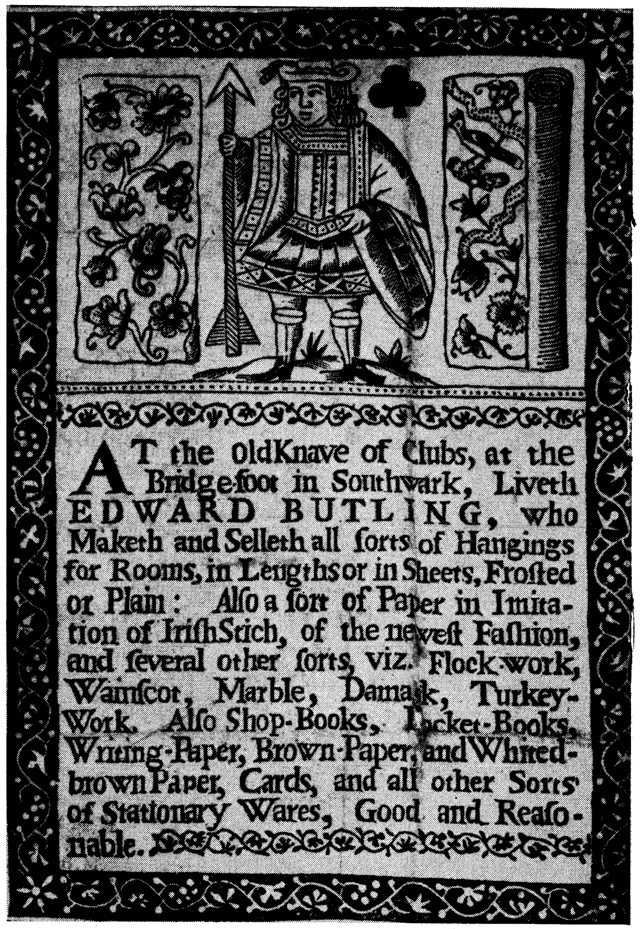
The 18th century saw the development of wallpaper manufacture far beyond the expectations of the early makers. It is true that the first wallpapers justified themselves on the score of novelty and cheapness and also because they so cleverly reproduced the appearance of more costly hangings; more significant is the fact that they made an irresistible appeal to the wealthy and fashionable sections of society both in England and on the continent. The early 18th-century makers, already experts in their craft, were in touch with persons of taste, and these valuable contacts provided a necessary stimulus to the development of style and design. The use of wallpaper by Horace Walpole at Strawberry Hill, Twickenham, and Madame de Pompadour's interest in Chinese and English wallpapers are cases in point. Wallpaper's suitability proclaimed itself by its adaptability, its novelty and its delightful appearance, and the varied types that were obtainable—embossed papers, chintz patterns, flocks, satin grounds, stripes and verditer papers to mention but a few varieties—added still further to its popularity.

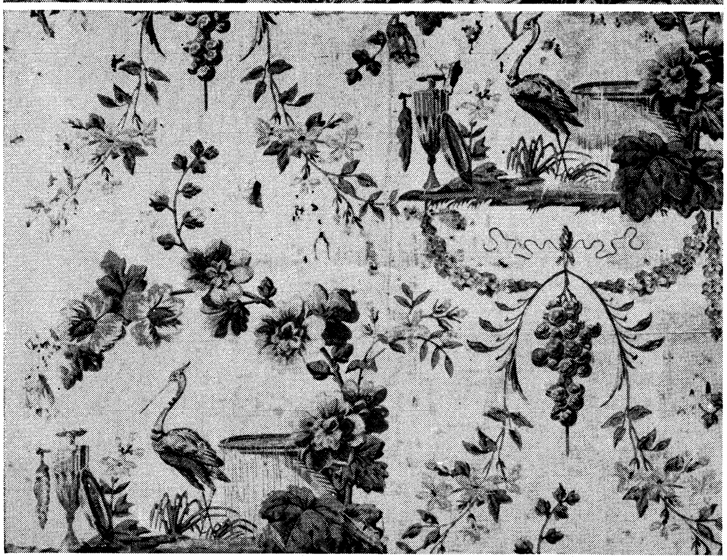
Papier-Mâché and "Long" Paper.—The 18th-century wallpaper maker. in England particularly, was a specialist in hanging his products to the best advantage, and many elaborate schemes of wallpaper decoration were devised and carried out by him. It is not generally known that he was also noted for his skill in making papier-mâché. Thomas Mortimer states in *The Universal Director* (1763): "Most if not all [the paper-hanging makers] are also manufacturers of Papier Maché ornaments for Looking Glass and Picture Frames." The papier-mâché side of the English wallpaper makers' business was of considerable importance, including elaborate ornaments for ceilings, cornices and moldings, all very necessary for the decoration of rooms. Count Friedrich von Kielmansegge, in his *Diary of a Journey to England in the Years 1761–1762* (1902), writes, "To the ceilings papier maché has been added uhich looks like stucco. This material is said to be in general use in London and I should never have taken it for what it really is." An act was passed in 1712 which imposed a duty of one penny (increased two years later to $1\frac{1}{2}d.$) on every square yard of paper "printed, painted or stained"—a very inconvenient measure for the paper stainer, entailing the presence in the works of the excise officer who had to stamp each sheet with an appropriate cipher. The tax persisted with little alteration until 1836.

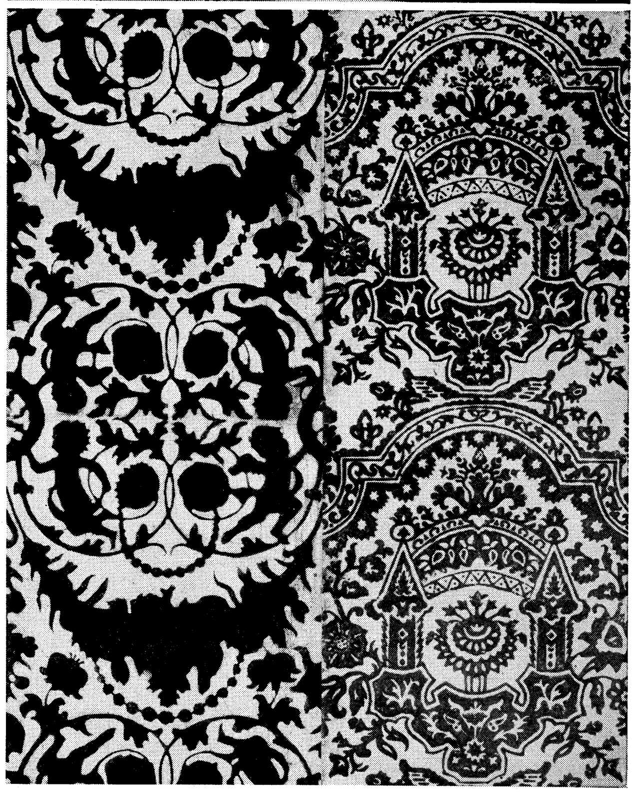
The manufacture of wallpaper in America began about 1750, and it is likely that it was introduced there by English craftsmen. At this time England was not only meeting domestic demand but exporting consignments to America and other parts of the world.

From the middle of the 18th century onward great efforts were made to satisfy the growing demand for wallpaper, and all kinds of experiments were instituted to increase the volume of production. Thomas Fryer of London obtained a patent in 1764 for a new method of printing with engraved cylinders, and a London stationer, Jacob Bunnett, in 1786 claimed to have perfected a machine capable of printing "ten times as many pieces [of wallpaper] in as short a time as one piece is now printed by the common method." William Palmer, also of London, in 1829 patented a hand-operated mechanical block-printing device, etc. But inventive progress was hampered by the lack of a "continuous" sheet of paper, which was not produced by papermakers until 1801–07, when the Fourdrinier papermaking machine was perfected at Two Waters mill, Hertfordshire, by Henry and Sealy Fourdrinier. With "long" paper in plentiful supply and the principle of calico printing in mind, success was achieved at last by a Darwen, Lancaster, firm of calico printers, C. H. and E. Potter, who commenced the manufacture of machine-printed wallpaper in 1840. English machine-



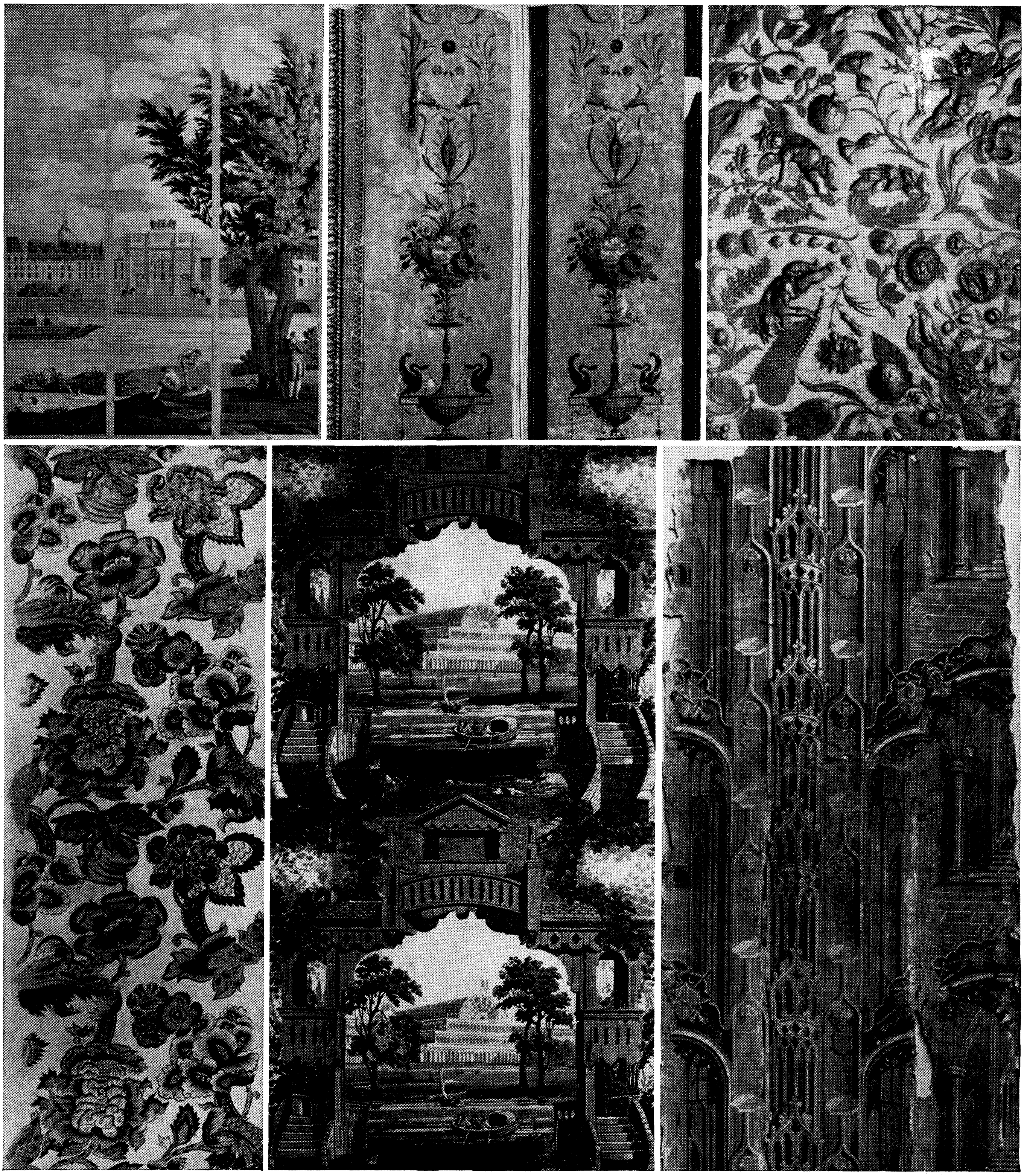






EARLY WALLPAPER DESIGNS

Top left: Elizabethan lining paper, Besford court, Worcs., 1550–75
Top right: Edward Butling's trade card, about 1690
Centre left: Early English wallpaper from Overton-on-Dee, about 1680
Bottom left: Wallpaper, block-printed, about 1790–1800. Probably of French manufacture
Bottom *right:* English flock paper and alternating embossed leather hanging, Ivy house, Worcester, about 1700



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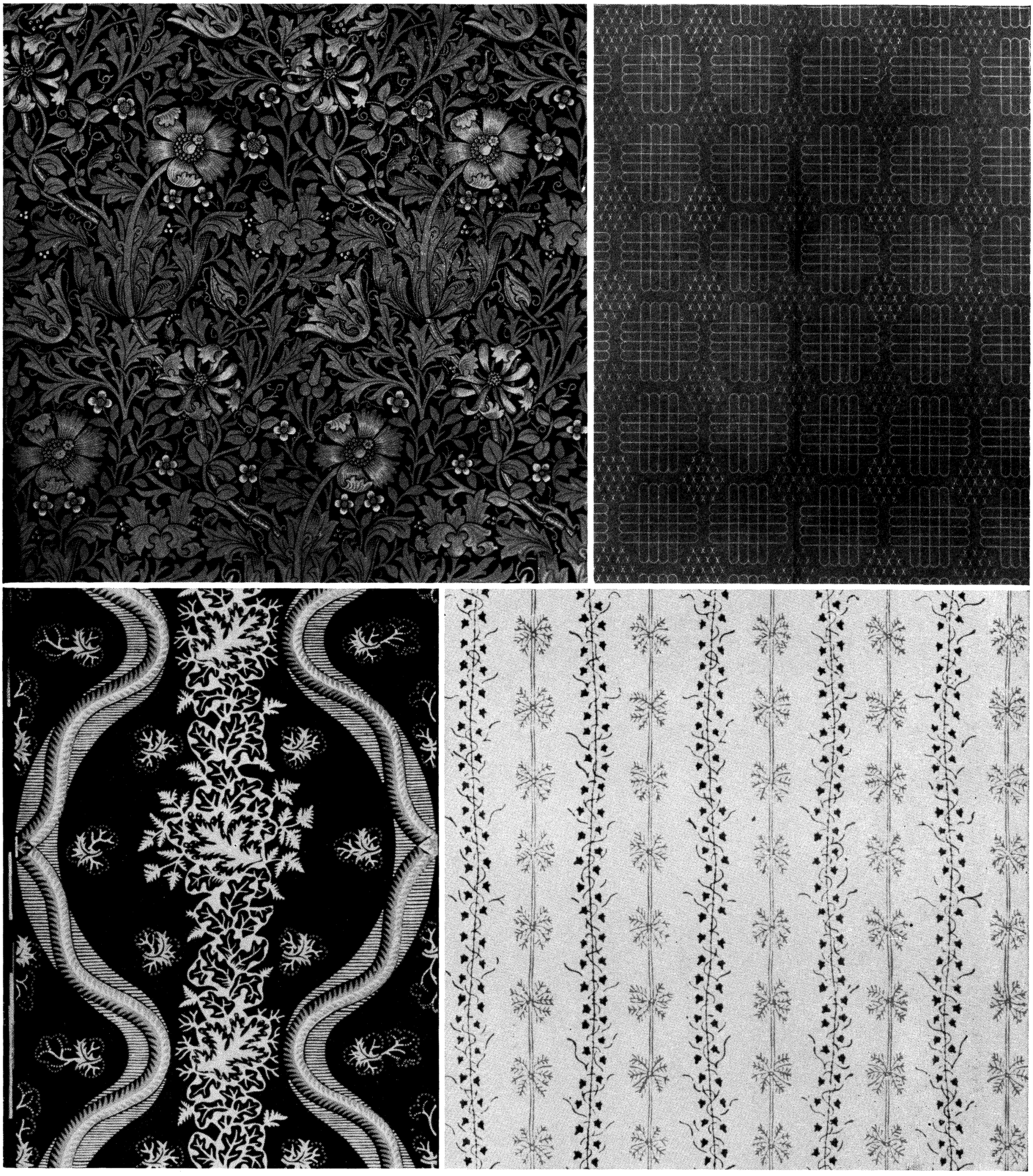
WALLPAPERS AND HANGINGS OF THE 18th and EARLY 19th CENTURIES

Top left: Example of a French "panoramic" paper of about 1830
Top centre: **Réveillon** hand-printed paper, about 1780–90
Top right: Dutch leather hanging of the 18th century

Bottom left: Paper hanging attributed to the Eckhardt brothers, about **1790**
Bottom centre: English machine printed wallpaper of 1851
Bottom right: Gothic wallpaper, hand printed, English, about 1830



BY COURTESY OF (TOP LEFT, TOP RIGHT) VICTORIA AND ALBERT MUSEUM, CROWN COPYRIGHT RESERVED, (BOTTOM RIGHT) THE WALL PAPER MANUFACTURERS LTD., (BOTTOM LEFT) COLE & SON (WALLPAPERS) LTD.

LATE 19th- AND 20th-CENTURY WALLPAPERS

Top left: "Compton," designed by William Morris, 1895
Top right: Design by Edward Bawden about 1939
Bottom left: Block printed wallpaper, "Royal Oak," by John Aldridge, A.R.A., about 1938
Bottom right: Machine-printed wallpaper designed by Roger Nicholson in the 1950s

printed papers were made in ever-increasing quantities from that date, but the production of hand-printed papers was never discontinued: in fact, the latter form an important range of present-day collections.

Design.—Such is the broad outline of wallpaper's history and origins; now a word about design. Because of its ephemerality and its acceptance as a substitute for more expensive hangings, wallpaper cannot have attracted the finest designers in the early stages of its appearance in Europe. But the middle of the 18th century saw the rise of a number of artists and craftsmen of international repute in this field of industrial art: Jean Papillon (1661–1723), wood engraver and paper stainer of Paris; John Baptist Jackson, printer in chiaroscuro of Battersea; John Sherringham of Chelsea (the Wedgwood of paper stainers); the Eckhardt brothers. Francis Frederick and George, of Chelsea, makers of hand-painted silk hangings and etched wallpapers, whose business enjoyed royal patronage; and Jean Baptiste Réveillon of Paris, whose designs were superbly drawn and produced. Many wallpapers of this period, all made by hand. have survived, and many have a dignity and authority characteristic of this golden age of design But French supremacy of design and execution reached its zenith at the turn of the century and during the early part of the 19th century, at mhich period the flock papers and distemper-coloured papers of Réveillon and the panoramic decorations of Joseph Dufour and other Parisian makers were unique. By this time wallpaper was developing rather less commendable complications of design than the French panoramic or *paysage* types, and the moldings, columns, capitals and similar architectural themes which it now imitated even called for special experience in hanging, especially in relation to the direction in which the light penetrated into the room. A large variety of hand-printed borders was available, and all kinds of finishes were used, such as embossing, varnishing or spangling with mica dust or metallic powders.

The early 19th century saw the first experiments to perfect a reliable nashable paper which involved the use of varnish or japan gold size and turpentine and most likely detracted from the general appearance of the product.

Overembellishment was a feature of those wallpapers which were to have a wide popular appeal, a factor which unfortunately persisted up to comparatively recent times. The Gothic revival in England nas responsible for some of the worst forms of wallpaper design which A. W. N. Pugin resolutely excluded from his papers used in certain rooms in the new houses of parliament. Owen Jones, author of *The* Grammar of Ornament (1856), favoured a flat formality of design, and many of his wallpapers are severely conventional in character. William Morris' wallpaper designs, printed by Jeffrey and Co., Islington, made their first appearance in 1862. The importance of this artist-craftsman in the history of paper hangings lies in his insistence on, and rediscovery of, good design and colour. His work and that of Walter Crane and their followers, both in England and elsewhere. brought a new appreciation of the possibilities of wallpaper. It was in the branches of machine production that a fresh stimulus was most needed, however, and here the Morris traditions were neglected until the end of the century when they were revived on the European continent through the *Jugend* style and art *nouveau.*

It has been said that nothing remarkable in mallpaper design was achieved after William Morris. but this, like most generalizations, is not entirely true Many competent artists contributed to the variety and versatility of nallpaper during the 20th century, and in England men such as Walter Crane, C. F. A. Voysey and Heywood Sumner were still actively at work for the industry in its opening decade. The first half of the 20th century was notable for violent economic and social changes—World Wars I and II not only interrupted nallpaper production but forcibly introduced people to the meaning of austerity; hence those years were comparatively less eventful in the matter of wallpaper design than those of the preceding half-century. Yet during the period Edward Bawden, John Aldridge and Graham Sutherland were among those artists of international standing whose designs were put into production. Others came into prommence at the time of the British Wallpaper exhibition held in London in 1945. Perhaps the most remarkable and, from the design standpoint, regrettable feature about wallpaper is that manufacturers have always tried to produce something for everybody's taste instead of adopting smaller, more selective ranges of design. With the stimulus of the Festival of Britain in 1951 and other similar exhibitions to give new incentives, wallpaper design of the 1950s, like that of many articles in common use, became influenced by the so-called contemporary trend mhich at least encouraged a more imaginative feeling for colour and pattern. This new appreciation of the value of colour and pattern became noticeable in many departments of interior decoration, and the simplicity of line characterizing the furniture perhaps led to the use of good pattern and colour in the background against which this furniture was to appear. In the mid-1950s there were signs that manufacturers were anxious to stimulate a new perception of colour and to provide opportunities for the consideration of scale and proportion. The wallpaper collections included large-scale patterns suitable for schoolrooms, lecture halls, hotels and even places of entertainment. Some of these wallpapers, too large in repeat to be printed by machine, were being produced by screen printing, and these augmented wallpapers which had already been so•widely used for exhibition and general display purposes.

Outstanding among modern wallpaper designers have been Ben Rose, Marion Dorn, Donald K. Soderlund, John R. Denst and Irving Sherman in the United States; Elsbeth Kupferoth and Margret Hildebrand in Germany; Bent Karlby in Denmark; Stig Lindberg in Sweden; Robert and Roger Nicholson, Lucienne Day, etc., in England.

Wallpaper, along with many other commodities, came, during the 1950s, within the popular "do-it-yourself" movement which swept the western world on both sides of the Atlantic and gave new zest to the instinct for homemaking which the high cost of skilled labour was checking. With the issue of detailed instructions, demonstrations and films, manufacturers of wallpaper banished most of the drudgery associated with home decorating.

Apart from the use and development of screen printing, the production of both hand- and machine-printed goods has undergone little material change for many years. Research in all branches of manufacture is rigorously pursued, however, one result being the discovery of new finishes to enhance appearance and durability. In England the larger manufacturers' productions comply with standards laid down by the British Standards institution (B.S. 1248/1954).

See also INTERIOR DECORATION.

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WALLQVIST, OLAF (1755–1800), Swedish statesman and ecclesiastic, was ordained in 1776, became doctor of philosophy in 1779, court preacher to Queen Louise Ulrica in 1780 and bishop of Växjö in 1787. His preaching had attracted the attention of Gustavus III, who placed him at the head of the newly appointed commission for reforming the ecclesiastical administration.

His political career began during the mutinous riksdag of 1786, when he came forward as one of the royalist leaders. At the stormy riksdag of 1789 it was very largely because of his co-operation that the king was able to carry through the Act of Union and Security (see SWEDEN: History). During the brief riksdag of 1792, as a member of the secret committee, Wallqvist rendered the king essential services. Indeed Gustavus III during his last six years mainly depended upon Wallqvist and his colleague Carl Gustaf Nordin, who subordinated their private enmity to the royal service.

During the G. A. Reuterholm (*q.v.*) administration, Wallqvist was kept remote from court. In 1800 he was recalled to the political arena, but he died on April 30. (R. N. B.)

WALLSEND, a municipal (1901) and parliamentary (1913) borough of Northumberland, Eng., 4 mi. E.N.E. of Newcastle on the north bank of the Tyne about 5 mi. from the North sea. Pop.

(1951) 48,678. Area 5.3 sq.mi. On the site of the Roman military camp *Segedunum* at the eastern end of Hadrian's wall (from which comes its name), it was an agricultural village until the 16th century. when glassmaking and saltmaking were begun. By the end of the 18th century these had been superseded by shipbuilding (from 1759), coal mining and marine engineering. particularly steam turbines. which from 1894 were developed in Wallsend. The chemical trade grew up between 1854 and 1898 when the coal pits were flooded. and other industries include the making of gangways, ropes, mining equipment, plywood and plastics. Though forming with Newcastle (west) and Tynemouth (east) 12 mi. of unbroken industrial building along Tyneside. Wallsend possesses six parks and open spaces and a village green.

WALL STREET, a street in the lower part of New York city on which or near which are concentrated the chief financial institutions of the United States. It corresponds to the London financial district in Threadneedle. Throgmorton and Lombard streets, and is rivalled only by that centre in its importance as an international money market. The street itself is narrow and short, extending only about seven blocks from Broadway to the East river, and the financial houses occupy only the upper or western half of the street. The Wall street financial district. however. extends several blocks north and south of the street and also includes an area west of Broadway. Even before the Civil War the street was recognized as the financial capital of the country, and most of the major banking houses have sought to maintain headquarters there, amidst the offices of insurance companies. railway corporations, steamship, iron, coal and copper companies and several hundred other large industrial corporations. Companies with securities listed on the New York Stock exchange maintain at least a transfer office conveniently near. Besides the New York Stock exchange there are in the neighbourhood the American Stock exchange. Cotton exchange. Coffee exchange. Metal exchange. Produce exchange and lesser exchanges. The district is the headquarters of most brokerage firms. Private hankers are also established in the street, the famous house of J. P. Morgan and Co. occupying its own building at the corner of Wall and Broad streets.

Wall street owes its name to Peter Stuyvesant, who in 1652, as governor of the little Dutch settlement of New Amsterdam, ordered a palisade built on the site to protect the town from feared invasions of the English. The last of the wall was removed in 1699, and both sides of the street were quickly built up. The street was famous in the political life of the country after the Revolution when for a brief period the governmental offices of the city, state and nation were all located there. At the old Federal building, on the site of the present Subtreasury building, George Washington in 1789 was first inaugurated president. and there the first United States congress met.

See F. T. Hill. *The Story of a Street* (1908), for history, and S. S. Pratt, *The Works of Wall Street,* 3rd ed. (New York, 1921), for an anaylsis of the financial activities.

WALMER, a watering place of Rent. Eng. Pop. (1931) 5,324. It was transferred to the borough of Deal in 1935. Lower Walmer. the portion most frequented by visitors. extends northward along the coast so as to be contiguous with Deal. Upper Walmer is a short distance inland, and below it Walmer castle lies close to the sea. This was a blockhouse built for coast defense by Henry VIII. but it became the official residence of the lords warden of the Cinque Ports. It ceased to be the official residence in 1905, when the prince of Wales (afterward George V) was appointed lord warden, and the public was given access to those rooms which possess historical associations with former holders of the office. such as the duke of Il'ellington, who died there in 1852, William Pitt and others. Walmer is a member of the Cinque Port of Sandwich.

WALMISLEY, THOMAS ATTWOOD (1814–1856), English musician. was born in London on Jan. 21, 1814. He was the eldest son of Thomas Forbes Walmisley (1783–1866), a well-known organist and composer of church music and glees. Thomas Attwood, his godfather, taught him composition. He became organist at Trinity and St. John's colleges. Cambridge. in 1833, and in 1836 was made professor of music in the University. He died at Hastings on Jan. 17, 18j6. His Cathedral *Music* was edited aiter his death by his father, and published in 1857. Some fine examples of his work are to be found in the D minor and B flat evening services. He was one of the first Englishmen to recognize the greatness of Bach's *Mass in B Minor*.

See the article by A. D. Coleridge in *Grove's Dictionary of Music and Musicians,* 5th ed. (London, New York, 1955) ; Edmund Fellowes, *English Cathedral Music* (London, Toronto, 1941).

WALNUT, the common name for the genus *Juglans*, which is widely known throughout the world because of the nuts and timber it produces. About 17 species are recognized, although some are distinguished only by their fruits, and in some cases there are intermediate forms hard to classify. Walnut plants, among the noblest of all hardwoods. may live for several centuries and become huge trees from 100 to 150 ft. tall with proportionate spread of crown and with trunk diameters of 4 to 6 ft. Sometimes growth is in bush or shrub form. but this is believed attributable more to environmental factors than to species limitation. All walnuts furnish food for many forms of wildlife; some produce nutritious. wholesome and palatable food for man. The product of one, the Persian walnut. is of greater importance as a food crop than that of any other nut tree outside the tropics. It and the eastern black walnut together furnish two of the world's most valuable and popular woods, used in making furniture and gunstocks and in interior decoration.

Persian Walnut.—The Persian (English) walnut, *Juglans regia,* is a large-growing tree, attaining heights of more than 100 ft. and trunk diameters of j or 6 ft. The bark is light to whitish in colour and very smooth while young. but it becomes gray and fissured with advanced age. The leaves are glossy and yellowish-green; there are from j to 0 leallets as a rule hut sometimes as many as 11 or 13. The surface is glossy and the margins are entire. The nut hulls are also smooth and glossy and about † in. in thickness. The nuts are of straw colour and the shells of varying thickness. sometimes being thick. hard and bony; in the case of nuts grown for market. the shells are thin enough to break easily with a light stroke of a hammer.

This walnut has been under cultivation for so many centuries and in so many countries that there is much uncertainty as to its exact place of origin and dates of introduction. One opinion is that the original home was in the mountains of western and northern China. Another view is that it was native throughout much of southeastern Europe, east to the Himalayas, and that it was carried from there to China. where it is cultivated to a wide extent and sometimes is naturalized to altitudes in excess of 8,000 it. It is little cultivated in Japan, although it has Iong been grown there to some extent.

Some authorities are uncertain that this walnut was in England before 1562, which appears to be the earliest date at which its presence there is definitely recorded. Others contend that it must have been taken there during the Roman occupation. A.D. 43 to 410. During modern times, production in that country has been of slight importance. Following World War I, increased planting in England and Wales was advocated. This was supported by the East Malling Research station, which then instituted a general investigation to determine the best varieties, rootstocks and methods of culture.

There is no certainty as to when this walnut was first taken to North America, although it is logically assumed to have been introduced by colonists during the 17th century. Environmental conditions in neither eastern nor southern regions of the United States are favourable for its commercial development. While there are many sites in the eastern states where the trees may grow well and bear good nuts with considerable regularity for several decades or even. in rare cases. a century or longer, the great majority of all that are planted perish before reaching bearing age. Stocks from Europe. the U.S.S.R. and China have been tried many times, only to fall short in so far as adaptability for commercial production was concerned. There are scattered trees throughout the general region between Long Island and Iiorfolk, Va., on the east and Wisconsin and Arkansas on the west.

An attempt to establish the Persian walnut in the eastern states was inaugurated in 1923 by P. C. Crath of Toronto. Ont., who as a retired Presbyterian missionary in Poland personally made selections from the hardiest and choicest trees in localities of the Carpathian mountains with which he had long been intimately familiar. Thousands of his trees were later planted in Ontario: western British Columbia and throughout the northern United States. By mid-century a fair percentage was reported to he giving promise of value for home planting in many localities where others had failed.

Cultural methods of the old world and new world differ radically. in harmony with economic necessity. In the former. where farm units are small and the primary object is to produce food for the home and a small surplus for sale to obtain money with which to purchase family necessities, trees are used in a general utility capacity. In some regions there are sizable orchards. but throughout most of Europe and Asia planting is mainly in conjunction with other crops or along farm borders, highways and about home grounds. The trees are often scattered about the fields in such manner that the landscape greatly resembles any typical pastoral view of eastern Cnited States. Prunings and dead branches serve as faggots for fuel.

The trees are headed high—18 to 20 ft.—in order to develop maximum length of trunk and also that they may interfere as little as possible with other crops to which the land is devoted. Important production is not expected in less than 20 years from the time of planting. On the whole. production is mainly from seedling trees, although there have been many grafted trees in France since probably before 1800. When for any reason these high-headed trees are cut, if fairly sound, the long trunks have value for furniture making.

It is on the Pacific coast of the United States, where the annual crops in the 1950s were about 70,000 tons for California and 7,000 for Oregon, that the industry of both producing and marketing Persian walnuts is conducted most intensively. Established in the first place (during the latter half of the 19th century) by able pioneers and later encouraged by state and federal research agencies and motivated by a strongly organized co-operative. the California Walnut Growers association, walnut growing there has long been on a plane rarely attained by any agricultural industry.

Secrets of successful walnut culture in California and the Pacific northwest call for strict use of well-chosen varieties including suitable pollinizers; trees grafted on stocks of the same walnut species: spacing the trees at not less than 60 ft. each way (12 to the acre): fertile soil; regular use of soil improvement crops; fertilization and irrigation as necessary; spraying or dusting to control pests and diseases; heading the trees low so as to provide shade for the trunks and thus lessen the danger of sunscald and also to bring about full bearing in 10 to 12 years; orchard heating in frosty areas; harvesting the nuts as soon as about 10% of the hulls have broken open; treating the nuts immediately with ethylene gas or with what is known as the "water sweat" process in order to loosen the hulls; and prompt hulling and drying (preferably by dehydration). The nuts are later graded with extreme care as to type and size. bleached so as to bring all to a common. bright. attractive colour, and each nut is stamped to show its brand designation. All that do not attain tlie required standard for sale "in-shell" are rated as "culls" and sold in the "shelled" condition; that is. as kernels. During years of overproduction. surplus nuts are also shelled.

The leading varieties are Placentia, Franquette. Payne. Eureka, Mayette and Concord.

The official estimates of the annual production of nuts, in short tons. for the five-year period 1948–52, were lor the United States 76,320 tons; Italy 22.440 tons; France 16.920 tons: Turkey 8,580 tons: Balkan countries 10,640 tons. Other important countries of production are China. India. Chile and Australia.

Other Species of Walnut.— The eastern biack walnut. J. *nigra,* is the largest groner of the genus. and heights to 150 ft. and trunk diameters to 6 it. were not unusual in tlie original virgin forests of the northeastern United States. Its native range included practically all regions where soil conditions were favourable, from lower New England, southern Ontario and southeastern Minnesota on the north to central parts of Georgia and the gulf states, westward to San Antonio. Tex. It was most abundant from the mountain valleys of western Pennsylvania, the Virginias and North Carolina. westward through the basin drained by the Ohio and Mississippi rivers to eastern Kansas and Nebraska. Outside this general region. there are many small districts where it has always grown equally well. What is believed to have been the largest walnut tree of any species ever recorded grew near Lake Erie in western New Tork. This tree was said to have been 150 ft. tall and to have had a trunk girth of 36 ft. It was 80 ft. to the first limbs and was 5 ft. through at that point. It was blown over during a gale in April 1822. The largest tree of the species known in later times overlooked Chesapeake bay, a feu. miles south of Annapolis. Md. In 1941 its girth at breast height was 19 ft. 9 in. and its estimated height 100 ft.

It is as a timber tree that this walnut is best known tliroughout the world. The value of its lumber together with its beauty and nobility -in an ornamental capacity so impressed the American colonists that it became one of the first new world introductions to be established in Europe; it is known to have been taken there during the 17th century. Its abundance. the ease with which it could be worked with carpenter's tools. its freedom from warping and checking. together with its lasting qualities when exposed to weather or in contact with soil, led to its use in countless ways. Farm residences, barns, bridges. railroad ties. canoes, boats and even ships were sometimes made of this wood. Because of the beauty of its grain. it is a great favourite in making furniture, pianos. organs, sewing machines. caskets and many other products. From early times, it has been the preferred wood for making gunstocks in the Cnited States.

Export of black walnut logs to Europe, chiefly to England and Germany. in both of which countries the lumber was iong used for both civilian and military purposes. constituted a heavy drain on the total supply. During World War I this wood served a vital end as material for making propellers for military planes, first in England and later in the United States. The extent to which it was used in making gunstocks during World War II resulted in the greatest drain on the supply that the country ever experienced. This led to the launching. late in 1943, by the American Walnut Manufacturers association of Chicago. Ill.. of a national campaign to stimulate *walnut* tree *planting* about the *entire* country. wherever soil and economic conditions might appear favourable.

Beginning with the first propagation of the Thomas variety in Pennsylvania about 1880. this species began slowly to work its way into U.S. orcharding. During the next third of a century, small numbers of grafted Thomas trees were planted in widely scattered gardens of many states. mainly to be lost sight of. Concerted interest began to show results in the way of commercial numbers of grafted trees from nurseries soon after the organization in 1910 of the Northern Nut Growers association. Inc. Other varieties were soon brought to light. largely as a result of cash prize contests conducted by that association for the best entries of seedling nuts. By the 1950s many hundreds of seedling black walnut trees had been top-worked with scions from the new selections, and there were a number or' orchard plantings ranging in size from a few trees each to 1.000 or more. These n-ere in various states. especially Pennsylvania. Michigan, Indiana, Illinois: Iowa and others south to the Carolinas and Arkansas.

Varieties which in the 1950s n-ere considered of greatest promise were: Adams. Allen. Creitz. Cresco. Edmunds. Edras. McMillen, Myers, Ohio. Sifford. Snyder. Stabler, Stambaugh. Tasterite. Ten Eyck, Thomas. Todd and Wiard.

Kernels of this walnut are a much-favoured product in making ice cream and candies and. to some extent. sweet breads. Together with kernels of the butternut, a close relative. also indigenous to the eastern Cnited States. the kernels not only add body to such food products but retain their flavour during the cooking process to a remarkable degree. The salt. oi walnut kernels in many parts of the country annually returns many thousands of dollars to rural communities. Shelling is largely by use of hand-power lever machines. although in a few instances motor-driven machines are used in small factories.

The Arizona black walnut, *J. major,* is a tree of medium size, reaching its maximum height at about 50 ft. and its greatest diameter of trunk at about 4 ft. It occurs at altitudes of 1,500 to 6,000 ft. in alluvial plains and mountain valleys of Arizona and New Mexico, southward to Durango. Mex. Its leaves are sometimes as much as a foot long and its leaflets typically 9 to 13 in number, although occasionally there are 17 or 19. The margins are distinctly serrate. The nut is edible but too small to be of value. The tree is seldom planted except in botanical gardens.

The (southern) California black walnut, J. *californica,* is a peculiar tree in that it seldom develops a trunk oi more than a few feet but puts out many branches from near the ground to form a rather bushy-appearing crown. Its maximum height is about 50 it. The nut is too small to have economic value. Stumps are reported to have been dug and sold by the pound to good advantage ior use by veneer concerns. One stump is said to have weighed joo lb. The tree is planted very little. In dry calcareous soils, this species oiten becomes a mere shrub of but a few feet in height.

The Hinds (northern California) black walnut, *J. hindsi,* is much the more valuable of the two species of *Juglans* indigenous to Caliiornia. Its usual maximum height is 50 to 60 ft. and its greatest trunk diameter about 3 ft. It is said, however, that in certain localities there are specimen trees 100 it. or more in height with diameters of 44 to 48 in. The tree is much used in roadside planting in northern Caliiornia and as an ornamental both there and in northwestern Oregon. Hinds walnuts are about equal in size to those of eastern black, and to an important extent they are shelled and the kernels sold readily to confectioners. Trees of this species formerly were, but no longer should be, used as rootstocks for propagating grafted varieties of the Persian walnut; graft union failures result.

The wood of this walnut, although the grain is somewhat coarse, takes a high polish, and to the limited extent that trees are available for cutting, the lumber is used in a manner similar to that of the eastern and Persian walnuts. There are a few clons, but these are little propagated.

The heartnut or cordate walnut, J. *sieboldiana cordiformis,* a native of Japan, is a small or medium-sized tree, rarely attaining heights of more than 50 ft. or trunk diameters greater than 2 ft. In moderately severe regions of the north temperate zone, it grows rapidly and tends to develop a broad-spreading, low crown with luxuriant foliage, considered by some as tropical in aspect. While it is normally precocious, and under favourable conditions may bear moderately for several decades, it is rarely prolific. It usually has 13 to 15 leaflets per leaf and yields its fruits in racemes of five to nine each. The nut is small, heartlike in shape, sharply pointed at the apex, flattened on the sides, and rounded at the base and grooved from the middle of the sides to the apex. When placed on a block and tapped with a hammer, either on an edge or on the end, the shell readily splits into halves along the sutures, and although this is crosswise to the kernel, it enables it to be extracted without injury. Several varieties have been made available by U.S. nurserymen ior limited use in garden planting. The best known of these are Bates, Fodermaier, Lancaster, Stranger, Walters and Wright.

The Siebold walnut, J. *sieboldiana,* a variant form of heartnut, differing irom it only in fruit, has been planted in the United States to about the same extent. As a tree, its habits and features are identical. Seedlings of either are likely to produce nuts of the other or of an intermediate type which might be classified either may. Siebold walnuts arc larger than heartnuts, being irom one to two inches long. They are roundish at the base and conical from below the middle to the apex. The shell is smooth to the hand but distinctly fissured; it is hard and difficult to crack so as to release the kernels except in particles. The kernel greatly resembles that of butternut in appearance, texture and flavour, except that it is usually milder.

It is said that in Japan both this and heartnut trees are used as sources of lumber for gunstocks and furniture. Neither has indicated special possibilities in such capacity under U.S. conditions. However, both make very satisfactory ornamentals in the northeastern states, where growth and longevity are both better than in the south. Neither has been found commercially profitable in the United States, since the nuts do not compete well with others on the market. Their most satisfactory use is as decorative trees and as producers of nuts for the home table. Both iorms hybridize readily with Persian walnut and butternut.

The Texas black walnut, *J. rupestris,* is a shrubby or small-growing tree, rarely attaining more than 30 ft. in height or a trunk diameter greater than 30 in. The leaves are 9 to 12 in. long and the leaflets 13 to 23 in number, slender and with finely serrate margins. The nuts are small, roundish, thick-walled and of little value, although sweet. The tree commonly occurs on limestone soils, especially along streams of western Texas, southwestern Oklahoma and southeastern New Mexico. Wood from the largest stumps and butt log cuts makes a beautiiul veneer and is much prized.

Miscellaneous Walnuts.— Other native walnuts of the new world which received little world attention include the Argentine black walnut, *J. australis;* the Bolivian black walnut, *J. boliviana;* the Colombian black walnut, *J. columbiensis;* the Ecuador walnut, J. *honorei;* the Cuban walnut, *J. insularis;* and the Guatemalan walnut, *J. mollis.* In the United States there are a number of hybrid forms, of which none bears evidence of promise for either nut or timber production. Both the California and Hinds walnuts hybridize freely with the eastern black; the Persian with any black or with butternut, and also with the heartnut. Some of these have been regarded as having potential value for forestry plantings, but none has been so used. The costs of procuring suitable seed in quantity and the expense of securing land suitable for walnut trees of any kind are effective barriers against growing hybrid walnut trees in quantity for timber production. The term "Claro" is applied to wood oi any hybrid walnut grown in California.

There are three walnuts in northeastern China, much alike, which are recognized as being separate species. These are the Cathay walnut, *J. cathayensis;* the Manchu walnut, *J. mandshurica;* and one which appears to have no common name, *J. stenocarpa.* None is believed to offer special inducement to practical planters, except possibly in cold regions having a maritime climate.

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WALPOLE, HORATIO or Horace (1717–1797), English politician and man of letters, 4th earl of Orford—a title to which he only succeeded at the end of his life—\\,as born in London on Sept. 24, 1717. He was the youngest of the five children of the 1st earl of Orford (Sir Robert Walpole) by Catherine Shorter, but by some scandalmongers Carr, Lord Hervey, has been called his father.

He was educated at Eton, where he formed what was known as the "Quadruple Alliance" with Thomas Gray, Richard West and Thomas Ashton, and became very intimate with Henry Seymour Conway, George Augustus Selwyn and the two Montagus; and at King's college. Cambridge.

Walpole was returned to parliament in May 1741 for the Cornish borough of Callington. He retired from parliament, probably because his success in political life had not equalled his expectations. but he continued until the end of his days to follow and to chronicle the acts and the speeches of both houses of parliament. Through his father's influence he had obtained three lucrative sinecures in the exchequer, and for many years (1745–84) he enjoyed a share, estimated at about £1,500 a year, of a second family perquisite. the collectorship of customs. He acquired in 1747 the lease and in the next year purchased the reversion of the villa of Strawberry Hill: near Twickenham, on the banks of the Thames. He established a printing press there, which he called Officina Arbuteana. where many of the first editions of his own works were printed. His nephew, the reckless 3rd earl. died on Dec. 5, 1791, and Walpole succeeded to the peerage, but he never took his place in the house of lords. All his life long he was a victim of the gout, but he lived to extreme old age and died unmarried. in Berkeley square, London, on March 2. 1797. All Walpole's printed books and manuscripts were left to Robert Berry and his two daughters, Mary and Agnes, and Mary Berry edited the five volumes of Walpole's works which were published in 1798.

The pen was ever in Horace Walpole's hands, and his entire compositions would fill many volumes. His *Castle of Otranto* (1764) is the prototype of the romantic novel. The *Mystevious Mother* (1768) is the least bad of tragedies when tragedy was at its worst. Walpole's antiquarian works merit praise. The volume of *Historic Doubts on the Life and Reign of King Richard the Third* (1760), one of the earliest attempts to rehabilitate a character previously stamped with infamy, showed acuteness and research. A work of more lasting reputation is *Anecdotes of Painting in England* (1st ed., 4 vol., 1762–71). A cognate volume, also based on the materials of Vertue, is entitled the

Catalogue of Engravers Born and Resident in England (1763), also often reprinted. As a senator himself, or as a private person following at a distance the combats of St. Stephen's, Walpole recorded in a diary the chief incidents in English politics. If he was sometimes prejudiced, he rarely distorted the acts of those whom he disliked; and his prejudices, which lie on the surface, were mainly against those whom he considered traitors to his father. These diaries extend from 1750 to 1783, and cover a period of momentous importance. The *Memoirs of the Last Ten Years of the Reign of George II.* was edited by Lord Holland (1846); its successor, *Memoirs of the Reign of King George III.*, was edited by Sir Denis Le Marchant (4 vols., 1845), and re-edited in 1854 by G. F. Russell Barker; the last volumes of the series, *Journal of the Reign of George III. from 1771 to 1783*, were edited and illustrated by John Doran (2 vols., 1859), and were edited with an introduction by A. F. Steuart (London, 1909). To these works should be added the *Reminiscences* (2 vols., 1819), which Walpole wrote in 1788 for the Misses Berry. But Walpole was above all a letter-writer. His correspondents were numerous and widespread, but the chief of them were William Cole (1714–1782), the clerical antiquary of Milton; Robert Jephson, the dramatist; William Mason, the poet; Lord Hertford during his embassy in Paris; the countess of Ossory; Lord Harcourt; George Montagu, his friend at Eton; Henry Seymour Conway (1721–1795) and Sir Horace Mann. The *Letters* were published at different dates, but the standard collection is that by Mrs. Paget Toynbee (1903–1905), and to it should be added the volumes of the letters addressed to Walpole by his old friend Madame du Deffand (4 vols., 1810). A selection has been edited by W. S. Lewis (New York and London, 1926). Walpole has been called "the best letter-writer in the English language." His political estimates are more acute than his literary ones.

Abundant information about Horace Walpole will be found in the *Memoirs* of him and of his contemporaries edited by Eliot Warburton (1851), J. H. Jesse's *George Selwyn and his Contemporaries* (4 vols., 1843–44) and the extracts from the journals and correspondence of Miss Berry (3 vols., 1866); also *Horace Walpole and his World*, by L. B. Seeley (1884) and Austin Dobson, *Horace Walpole* (1890). It would be unpardonable to omit mention of Macaulay's sketch of Walpole's life and character. *See* also P. Yvon, *Horace Walpole, 1717–97. Essai de biographie psychologique et littéraire* (1924), and *Horace Walpole as Poet* (Paris, 1924); H. B. Wheatley in *Cambridge History of English Literature*, vol. 10 (1913); D. M. Stuart, *Horace Walpole* in *English Men of Letters* (1927).

WALPOLE, SIR ROBERT: *see* ORFORD, ROBERT WALPOLE, 1ST EARL OF.

WALPURGIS (WALPURGA or WALBURGA), **SAINT** (d. *c.* 780), English missionary to Germany, was born in Sussex at the beginning of the 8th century. She mas the sister of Wunnibald, first abbot of Heidenheim. She went about 750 with some other nuns to found religious houses in Germany. Her first settlement was at Bischofsheim in the diocese of Mainz, and two years later (754) she became abbess of the Benedictine nunnery at Heidenheim in the diocese of Eichstatt. On the death of Wunnibald in 760 she succeeded him in his charge also! retaining the superintendence of both houses until her death. Her relics were translated to Eichstätt, where she was laid in a hollow rock, from which exuded a kind of bituminous oil afterward known as Walpurgis oil. and regarded as of miraculous efficacy against disease. The cave became a place of pilgrimage, and a church was built over the spot. Walpurgis is commemorated at various times, but principally on the 1st of May, her day taking the place of an earlier heathen festival marking the beginning of summer. She is regarded as the protectress against magic arts.

WALRAS, LÉON (1834–1910), French economist and author of a classical work on pure economics, was born at Évreux. son of the economist Auguste Walras. After twice failing the entrance examination to the Bcole Polytechnique in Paris for lack of adequate preparation in mathematics, he entered the Bcole des Mines in 1854. In 1858 he was convinced by his father that he should pursue economics, and he obtained the chair of political economy in the faculty of law of the Academy of Lausanne. Switz., in 1870. His outstanding work, *Éléments d'économie politique pure* (1874–77; English translation in 1954, from the edition of 1926, by William Jaffe, titled *Elements of Pure Economics)*, was a pioneering comprehensive application of mathematical analysis to the case of general economic equilibrium under a "regime of perfectly free competition"; that is, a conceptual solution of the problem of the equilibrium of prices, quantities of products and the productive factors. In his other important publications, *Théorie mathématique de la richesse sociale* (1883) and *Études d'e'conomie politique appliquée* (1898), Walras presented reforms that he conceived to be necessary for the effective functioning of the system of free enterprise, notably land nationalization and modification of the gold standard. (J. DN.)

WALRUS (MORSE) (*Odobenus rosmarus)*, a large marine mammal allied to the seals. Characterized by the prolongation, in both sexes, of the upper canine teeth into tusks, which may reach a length of 2 ft., the adult walrus measures about 10 or 11 ft. and is a heavily-built animal. The head is rounded, the eyes small, external ears absent. The short broad muzzle bears on each side a group of stiff, bristly whiskers. The tail scarcely projects beyond the skin. The fore limbs are only free from the elbow and the fore flipper is broad, flat and webbed. The hind limbs, free from the heel, are fan-shaped. The skin is covered with short, rufous hair, which becomes very scanty in old animals. There are deep folds on the shoulder.

The walrus inhabits the northern circumpolar region in small herds. It prefers the coastal portions or ice floes and feeds largely on bivalve mollusks which it digs up from the bottom of the sea with its tusks. Normally inoffensive and affectionate, when attacked the walrus can use its tusks with terrible effect and the herd usually combine against an enemy. Its principal foe, apart from man, is the polar bear, and its flesh is an important article of food to the Eskimo and Chukchi. Commercially the walrus is valuable for its oil, its hide and its ivory. The Pacific walrus, with longer and more slender tusks, has been separated as *O. r. divergens.* Like the Atlantic form, its numbers have been much reduced within recent years. Fossil walruses are known from the late Tertiary of the U.S., England, France and Belgium.

WALSALL, a municipal, county and parliamentary borough of Staffordshire, Eng., 6 mi. E. of Wolverhampton. Pop. (1961) 117,836. Area 13.7 sq.mi. The old town stands on a ridge and is dominated by the 15th-century church of St. Mafthew in the centre, On the northeast is a 90-ac. arboretum. Manufactures include leather goods, machine tools, chemicals and aircraft parts. Coal, limestone and ironstone are mined nearby. Queen Mary's school is a foundation of 1554 and there was educated John Hough (1651–1743), president of Magdalen college, Oxford, and bishop of Oxford, Lichfield and Worcester. Walsall was the scene of the charitable work of Sister Dora (Miss Pattison) who died there in 1878 and whom a statue and a stained glass window in St. ~ ~ t thew's commemorate. Walsall (Waleshale) was given in 996 to the church of Wolverhampton. It was a royal manor in the time of Edward the Confessor, but later passed to the Bassets and the Beauchamps. Henry VIII gave it (1538) to Dudley, afterward duke of Northumberland. Charters were granted by Henry II in 1159 and by Henry IV, Charles I (1627, which laid the foundations of municipal self-government) and Charles II (1674, by which the town was governed until 1835). The roll of mayors dates back to 1377 and the first mention of a town clerk is in 1660. It had a merchant guild in 1390; in the 17th century it was known for its manufacture of iron goods and nails; in the 18th century the staple industry was the making of chapes and shoe buckles. Three annual fairs are held, two were granted in 1399, and the Tuesday market was granted in 1417 to Richard Beauchamp, earl of Warwick. Walsall was not represented in parliament till 1832; it returned one member until 1955 when the borough mas divided into two.

WALSH, THOMAS JAMES (1859–1933), U.S. lawyer and senator, was born in Two Rivers, Wis., on June 12, 1859.

In 1912 he was elected U.S. senator from Montana, going to the Senate without previous experience in public office. He was re-elected in 1918 and in 1924. He was five times a delegate to the Democratic national convention previous to 1924, in which year he presided as chairman of the convention. In 1924 he was offered the vice-presidency on the ticket with John W. Davis, but he declined. He was even more seriously spoken of in 1928 as the only strong alternative candidate to Alfred E. Smith, but before the convention met he signified his desire not to be considered. In the Senate he became an outstanding figure. His speeches, replete with facts and packed with close reasoning, made him a formidable adversary in debate. As an expert lawyer he was constantly called upon for advice. He aided in drafting the Prohibition and Woman-Suffrage amendments to the Constitution, and was also author of that part of the Federal Reserve Act which requires national banks to subscribe for stock in the Federal Reserve banks. He also formulated the case against the seating of Senator Truman H. Newberry, of Michigan. He is chiefly noted, however, for the tireless tenacity with which he prosecuted the investigation of circumstances surrounding the illegal leasing of Government oil reserves during Harding's Administration. His energetic although unsuccessful struggle in 1928 to secure a Senate investigation of power companies earned him Roosevelt's first choice for Attorney General. Unfortunately his death on March 2nd closely followed the wide popular approval of the preliminary announcement of his appointment.

WALSH, WILLIAM JOHN (1841–1921), Roman Catholic divine, was born in Dublin Jan. 30, 1841. Educated in Dublin and at St. Patrick's college, Maynooth, in 1867 he was appointed professor of dogmatic and moral theology at Maynooth. In 1878 he became vice-president of the college and in 1881 succeeded Dr. Russell as president. Dr. Walsh served on several committees and commissions. He was partly responsible for the appointment of the commission to enquire into the working of the Queen's Colleges, and he became a member of the senate of the university. In 1885 he was summoned to Rome by the Pope and given the appointment of archbishop of Dublin. This office he continued to hold till his death in Dublin, on April 9, 1921. Dr. Walsh was a commissioner for education in Ireland (1891) and, a member (1908) of the Dublin statutory commission which established the Catholic National University, with himself as chancellor. In politics he was a Nationalist, but he strongly opposed compromise with the British Government, and after the rebellion of 1916 he supported the Sinn Feiners.

Dr. Walsh's published works include *A Plain Exposition of the Irish Land Act of 1881* (1881); *The Queen's Colleges and the Royal University* of *Ireland* (1883–84); *The Irish University Question* (1890).

WALSINGHAM, SIR FRANCIS (*c.* 1530–1590), English statesman, was the only son of William Walsingham, common serjeant of London (d. March 1534), by his wife Joyce, daughter of Sir Edmund Denny of Cheshunt. Francis matriculated as a fellow-commoner of King's college, Cambridge, of which Sir John Cheke was provost, in Nov. 1548; and he studied there amid strongly Protestant influences until Michaelmas 1550, when he appears to have gone abroad to complete his education. Returning in 1552 he was admitted at Gray's Inn on Jan. 28, 1553, but in 1555–56 he was at Padua, where he was admitted a "consiliarius" in the faculty of laws. Walsingham was twice married; in Jan. 1562 to Anne (d. 1564), daughter of George Barnes, lord mayor of London, and to Ursula, daughter of Henry St. Barbe and widow of Sir Richard Worsley. By his second wife Walsingham had a daughter who married firstly Sir Philip Sidney, secondly Robert Devereux, 2nd earl of Essex, and thirdly, Richard de Burgh, earl of Clanricarde.

Walsingham sat in Elizabeth's first and second parliaments for Banbury, and was attached to the party of Cecil. In 1567–70 he was supplying Cecil with information about the movements of foreign spies in London. Ridolfi, the conspirator, was committed to his custody in Oct. 1569. In the summer of 1570 he was, in spite of his protestations, designated to succeed Norris as ambassador at Paris. Walsingham was the ablest of the new men whom Cecil, having triumphed over the older aristocracy, brought to the front.

Embassy to Paris.—An essential element in the new policy was the substitution of an alliance with France for the old Burgundian friendship. The affair of San Juan de Ulua and the seizure of the Spanish treasure-ships in 1568 had been omens of the inevitable conflict with Spain; Ridolfi's plot and Philip II.'s approaches to Mary Stuart indicated the lines upon which the struggle would be fought; and it was Walsingham's business to reconcile the Huguenots with the French Government, and upon this reconciliation to base an Anglo-French alliance which might lead to a grand attack on Spain, to the liberation of the Netherlands, to the destruction of Spain's monopoly in the New World and to making Protestantism the dominant force in Europe. Walsingham threw himself heart and soul into the movement. He was the anxious fanatic of Elizabeth's advisers; he lacked the patience of Burghley and the cynical coolness of Elizabeth. He supplied the momentum which was necessary to counteract the caution of Burghley and Elizabeth; but it was probably fortunate that his headstrong counsels were generally overruled by the circumspection of his sovereign. He would have plunged England into war with Spain in 1572, when the risks would have been infinitely greater than in 1588, and when the Huguenot influence over the French Government, on which he relied for support, would probably have broken in his hands.

Walsingham, however, was an accomplished diplomatist, and he reserved these truculent opinions for the ears of his own Government, incurring frequent rebukes from Elizabeth. In his professional capacity, his attitude was correct enough; and, indeed, his anxiety for the French alliance and for the marriage between Elizabeth and Anjou led him to suggest concessions to Anjou's Catholic susceptibilities which, came strangely from so staunch a Puritan. Although a defensive alliance was concluded between England and France in April 1572, the French Government perceived that public opinion in France would not tolerate an open breach with Spain in Protestant interests. The massacre of St. Bartholomew ruined all such hopes.

He was recalled in April 1573, and eight months later he was admitted to the privy council and made joint secretary of State with Sir Thomas Smith. He held this office jointly or solely until his death; in 1577 when Smith died, Dr. Thomas Wilson was associated with Walsingham; after Wilson's death in 1581 Walsingham was sole secretary until July 1586, when Davison began his brief and ill-fated seven months' tenure of the office. After Davison's disgrace in Feb. 1587 Walsingham remained sole secretary, though Wolley assisted him as Latin secretary from 1588 to 1590. He was also returned to parliament at a by-election in 1576 as knight of the shire for Surrey in succession to Charles Howard, who had become Lord Howard of Effingham, and he was re-elected for Surrey in 1584, 1586 and 1588. He was knighted on Dec. 1, 1577, and made chancellor of the order of the Garter on April 22, 1578.

State **Secretary.**—As secretary, Walsingham could pursue no independent policy; he was rather in the position of permanent under-secretary of the combined home and foreign departments, and he had to work under the direction of the council, and particularly of Burghley and the queen. He continued to urge the necessity of more vigorous intervention on behalf of the Protestants abroad, though now his clients were the Dutch rather than the Huguenots. In June 1578 he was sent with Lord Cobham to the Netherlands, mainly to glean reliable information on the complicated situation. In Aug 1581 he was sent on a second and briefer mission to Paris. Its object was to secure a solid Anglo-French alliance against Spain without the condition upon which Henry III. insisted, namely a marriage between Elizabeth and Anjou. The French Government would not yield, and Walsingham came back, followed by Anjou, who pressed his claims in person. Walsingham's last embassy was to the court of James VI. in 1583, and here his vehement and suspicious Protestantism led him astray. Elizabeth and Burghley were inclined to try an alliance with the Scottish king, and the event justified their policy, which Walsingham did his best to frustrate, although deserted on this occasion by his chief regular supporter, Leicester.

For the rest of his life Walsingham was mainly occupied in detecting and frustrating the various plots formed against Elizabeth's life. He raised the English system of secret intelligence to a high degree of efficiency. At one time he is said to have had in his pay 53 agents at foreign courts, besides 18 persons whose functions were even more obscure. Some of them were double spies, sold to both parties, whose real sentiments are still conjectural; but Walsingham was more successful in seducing Catholic spies than his antagonists were in seducing Protestant spies, and most of his information came from Catholics who betrayed one another. The most famous of the plots frustrated by Walsingham was Anthony Babington's, the discovery of which enabled him to bring pressure to bear upon Elizabeth to ensure Mary's execution. Walsingham died deeply in debt on April 6, 1590.

See K. Stahlin, *Sir Francis Walsingham und seine Zeit* (Heidelberg, 1908, etc.) ; and C. Read, *Mr. Secrrtary Walsingham and the policy of Queen Elizabeth* (3 vols., 1925).

WALSINGHAM, THOMAS (d. c. 1422), English chronicler, was probably educated at the abbey of St. Albans and at Oxford. He became a monk at St. Albans, where he appears to have passed the whole of his monastic life except the six years between 1394 and 1400 during which he was prior of another Benedictine house at Wymondham, Norfolk. At St. Albans he was in charge of the scriptorium, or writing room, and he died about 1422. Walsingham's most important work is his *Historia Anglicans,* covering the period between 1272 and 1422. Some authorities hold that Walsingham himself only wrote the section between 1377 and 1392, but this view is controverted by James Gairdner in his *Early Chroniclers of Europe* (1879).

His most important works are *Historia Angliae brevis,* edit. by H. T. Riley (1863–64) ; *Chronicon Angliae,* edit. Sir E. M. Thompson (1874); *Gesta Abbatum Monasterii S. Albani,* edit. by T. H Riley (1867–69); *Ypodigma Neustriae,* edit. by T. H. Riley (1876).

WALTER, BRUNO (1876–1962), conductor, was born in Berlin, Ger., on Sept. 15, 1876. In 1893 he began to conduct operas at the Cologne opera house. He was chorus master, 1894–95, and conductor. 1895–96. of the opera house in Hamburg. He later held various posts, including that of conductor of the Vienna opera, 1901–12, and served as guest conductor in many of the music centres of the world. He was musical adviser to the Philharmonic-Symphony Society of New York, 1947–49. In 1938 he became a French citizen and in 1946 a United States citizen. He died on Feb. 17, 1962, in Beverly Hills, Calif.

See his autobiography, *Theme and Variations* (New York, 1946).

WALTER, HUBERT (d. 1205), chief justiciar of England and archbishop of Canterbury, was a relative of Ranulf de Glanvill, the great justiciar of Henry II., and rose under the eye of his kinsman to an important position in the Curia Regis. In 1184 and in 1185 he appears as a baron of the exchequer. He was employed, sometimes as a negotiator, sometimes as a justice, sometimes as a royal secretary. He received no clerical promotion from Henry II., but Richard I. appointed him bishop of Salisbury, and by Richard's command he went with the third crusade to the Holy Land. He gained the respect of all the crusaders, and acted as Richard's principal agent in all negotiations' with Saladin, being given a place in the first band of pilgrims that entered Jerusalem. He led the English army back to England after Richard's departure from Palestine; but in Sicily he heard of the king's captivity, and hurried to join him in Germany. In 1193 he returned to England to raise the king's ransom. Soon afterwards he was elected archbishop of Canterbury and made justiciar. He was very successful in the government of the kingdom, and after Richard's last visit he mas practically the ruler of England. He had no light task to keep pace with the king's constant demand for money. He was compelled to work the administrative machinery to its utmost, and indeed to invent new methods of extortion. To pay for Richard's ransom, he had already been compelled to tax personal property, the first instance of such taxation for secular purposes. The main feature of all his measures was the novel and extended use of representation and election in government.

His chief measures are contained in his instruction to the itinerant justices of 1194 and 1195, in his ordinance of 1195 for the conservation of the peace, and in his scheme of 1198 for the assessment of the carucage. The justices of 1194 were to order the election of four coroners by the suitors of each county court. These new officers were to "keep," *i.e.,* to register, the pleas of the crown, an important duty hitherto left to the sheriff. The juries, both for answering the questions asked by the judges and for trying cases under the grand assize, were to be chosen by a committee of four knights, also elected by the suitors of each county court for that purpose. In 1195 Hubert issued an ordinance by which four knights were to be appointed in every hundred to act as guardians of the peace, and from this humble beginning eventually was evolved the office of justice of the peace. His reliance upon the knights, or middle-class landowners, who now for the first time appear in the political foreground, is all the more interesting because it is this class who, either as members of parliament or justices of the peace, were to have the effective rule of England in their hands for so many centuries.

In 1198, to satisfy the king's demand for money, Hubert demanded a carucage or plough-tax of five shillings on every ploughland (carucate) under cultivation. This was the old tax, the Danegeld, in a new and heavier form and there was great difficulty in levying it. To make it easier, the justiciar ordered the assessment to be made by a sworn jury in every hundred, and one may reasonably conjecture that these jurors were also elected. Hubert negotiated a peace with Scotland in 1195, and in 1197 another with the Welsh. But the carucage was not a success, and the Great Council refused to equip a force of knights to serve abroad.

In 1198 Hubert, who had inherited from his predecessors in the primacy a fierce quarrel with the Canterbury monks, gave these enemies an opportunity of complaining to the pope, for in arresting the London demagogue, William Fitz Osbert, he had committed an act of sacrilege in Bow Church, which belonged to the monks. The pope asked Richard to free Hubert from all secular duties, and he did so, thus making the demand an excuse for dismissing Hubert from the justiciarship. On May 27, 1199, Hubert crowned John, making a speech in which the old theory of election by the people was enunciated for the last time. He also took the office of chancellor and cheerfully worked under Geoffrey Fitz Peter, one of his former subordinates. In 1201 he went on a diplomatic mission to Philip Augustus of France, and in 1202 he returned to England to keep the kingdom in peace while John was losing his continental possessions. In 1205 he died. Hubert was an ingenious, original and industrious public servant, but he was grasping and perhaps dishonest.

See W. Stubbs, *Constitutional History,* vol. i. (1897); Miss K. Norgate's *England under the Angevin Kings,* vol. ii. (1887) ; W. Stubbs, preface to vol. iv. of Roger of Hoveden's *Chronicle* ("Rolls" series, 1868–71).

WALTER, JOHN (1738/9–1812), founder of *The Times* newspaper, London, was born in 1738/9, probably in London, and from the death of his father, Richard Walter (about 1755/6), until 1781 was engaged in a prosperous business as a coal merchant. He played a leading part in establishing a Coal Exchange in London; but shortly after 1781, when he began to occupy himself solely as an underwriter and became a member of Lloyd's, he over-speculated and failed. In 1782 he bought from one Henry Johnson a patent for a new method of printing from "logotypes" (*i.e.,* founts of words or portions of words, instead of letters), and made some improvements in it. In 1784 he acquired an old printing office in Blackfriars, which formed the nucleus of the Printing-house Square of a later date, and established there his "Logographic Office." At first he only undertook the printing of books, but on Jan. 1, 1785 he started a small newspaper called *The Daily Universal Register,* which on reaching its 940th number on Jan. 1, 1788 was renamed *The Times.*

The printing business developed and prospered, but the newspaper at first had a somewhat chequered career. In 1789 Walter was tried for a libel in it on the duke of York, and was sentenced to a fine of £50, a year's imprisonment in Newgate, to stand in the pillory for an hour and to give surety for good behaviour for seven years; and for further libels the fine was increased by £100, and the imprisonment by a second year. On March 9, 1791, however, he was liberated and pardoned. In 1799 he was again convicted for a technical libel, this time on Lord Cowper. He had then given up the management of the business to his eldest son, William, and had (1795) retired to Teddington, where he died on Nov. 16, 1812. In 1759 he had married Frances Landen (died 1798), by whom he had six children, In 1803 William Walter transferred the sole management to his younger brother, John.

JOHN WALTER (2) (1776–1847), who really established the great newspaper of which his father had sown the seed, was born on Feb. *23,* 1776, and was educated at Merchant Taylors' school and Trinity college, Oxford. He found *The Times* one of a number of unconsidered journals whose opinions counted for little. He left it in 1847 a great organ of public opinion, deferred to and even feared throughout Europe, consulted and courted by cabinet ministers at home and in intimate relations with the best sources of independent information in every European capital. On taking over the management in *1803,* he signalized the new spirit of the direction by his opposition to Pitt, which cost him the withdrawal of government advertisements and the loss of his appointment as printer to the customs and exposed him to the not too scrupulous hostility of the official world. He let the government do its worst and held on his way. From about 1810 he delegated to others editorial supervision (first to Sir John Stoddart, then to Thomas Barnes and in *1841* to J. *T.* Delane), though never the supreme direction of policy. In *1832* Walter, who had purchased an estate called Bear Wood in Berkshire, was elected to parliament for that county, and retained his seat till 1837. In 1841 he was returned to parliament for Nottingham, but was unseated next year on petition. He died in London on July *28,* 1847.

JOHN WALTER (3) (1818–94), his eldest son, was born at Printing-house square in 1818, and was educated at Eton and Exeter college, Oxford, being called to the bar in 1847. On leaving Oxford he took part in the business management of *The Times,* and on his father's death became sole manager, though he devolved part of the work on Mowbray Morris. It was under him that the successive improvements in the printing machinery, begun by his father in *1814,* at last reached the stage of the Walter press in 1869, the pioneer of modern newspaper printing presses. In 1847 he was elected to parliament for Nottingham as a moderate Liberal, and was re-elected in 1852 and in 1857. In 1859 he was returned for Berkshire and, though defeated in 1865, was again elected in 1868 and held the seat till he retired in 1885. He died on Nov. 3, 1894, and was succeeded by Arthur Fraser Walter (1846–1910), his son. A. F. Walter remained chief proprietor of *The Times* till 1908, when it was converted into a company. He then became chairman of the board of directors, and on his death was succeeded in this position by his son John, who entered *The Times* office in 1898 and was chairman of the directors from 1910 to 1923. John Walter's son, Hubert Walter (b. 1870), joined the staff in *1894* and acted as special representative in Paris and elsewhere. (For changes in the management of *The Times* after 1908 see NEWSPAPER: *United Kingdom.)* (H. C.; X.)

WALTER, LUCY (*c.* 1630–1658), mistress of the English king Charles II and mother of the duke of Monmouth (*q.v.*), was born at Roch castle, near Haverfordwest. Her home having been captured and burned by the parliamentary forces in *1644,* Lucy Walter found shelter first in London and then at The Hague. There, in 1648, she met Charles, possibly renewing an earlier acquaintance. Their intimacy lasted with intervals till the autumn of *1651,* and Charles claimed the paternity of a child born in *1649,* whom he subsequently created duke of Monmouth.

WALTER, THOMAS USTICK (1804–1887), one of the architects of the U.S. Capitol, was important especially for the quality and influence of his designs based upon ancient Greek models. He was born in Philadelphia, Pa., on Sept. 4, 1804, and served variously as professor of architecture at the Franklin institute, Philadelphia, engineer for the harbour at La Guaira, Venez. (1843–45), and president of the American Institute of Architects (1876–87), which in 1857 he had helped to found. His style was formed in part by two brief periods of employment in the Philadelphia office of the architect William Strickland. In 1833 Walter was selected to design the main building of Girard college in Philadelphia, and the form which he finally gave to Founders' hall remains unsurpassed as an example of Greek Revival architecture. Its designer is better known, however, for the additions which he made to the U.S. Capitol in Washington, D.C., and especially for the massive cast-iron dome with which he replaced the earlier low wooden one (1855–63). Illustrative of Walter's rare use of styles other than the Greek Revival is the Gothic design of the Philadelphia county prison (Moyamensing) with its Egyptian debtors' wing *(1835).* His last years were spent in the architectural office of John McArthur, Jr., where he is assumed to have had some part in the design of the Philadelphia city hall. He died in Philadelphia on Oct. *30, 1887.*

BIBLIOGRAPHY.—Joseph Jackson, *Early Philadelphia Architects and Engineers* (1923); Talbot Hamlin, *Greek Revival Architecture in America* (1944); T. B. White (ed.), *Philadelphia Architecture in the Nineteenth Century* (1953). (G. *B.* T.)

WALTER OF COVENTRY (fl. 1290), English monk and chronicler, who is known only through the historical compilation which bears his name, the *Memoriale fratris Walteri de Coventria.* The author of the *Memoriale* lived in the reign of Edward I and mentions the homage done to Edward as overlord of Scotland (1291). Since the main narrative extends only to *1225,* the *Memoriale* is emphatically a secondhand production. Rut for the years 1201–25 it is a faithful transcript of a contemporary chronicle, the work of a Barnwell canon.

The Barnwell annalist is the most valuable authority for the Barons' War. He is less hostile to John than are Ralph of Coggeshall, Roger of Wendover and Matthew Paris. He praises the king's management of the Welsh and Scottish wars; he is critical in his attitude toward the pope and the English opposition; he regards the submission of John to Rome as a skillful stroke of policy. The constitutional agitation of *1215* does not arouse his enthusiasm; he passes curtly over the Runnymede conference, barely mentioning Magna Carta. (H. W. C. D.)

WALTHAM, a city of Massachusetts, U.S., in Middlesex county, is on the Charles river *10* mi. W. of Boston. The area was first settled in 1636, set off from Watertown (*q.v.*) and incorporated as a town in *1738,* and chartered as a city in 1884. The five-foot waterfall in the centre of town was used to grind flour in the 17th century; in *1788* a paper mill was established there. In 1813 Francis Cabot Lowell used the site for the Boston Manufacturing company's power mill, the first in the U.S. to process raw cotton into cloth under one roof. For many years the American Waltham Watch company (established in *1854)* was one of the largest in the world, and it played an important part in the city's progress. Watchmaking was largely superseded by the manufacture of electronic equipment and precision instruments. A mental hospital, a sanatorium and a school for the mentally ill are there. The first U.S. training school for nurses was started in Waltham in *1885.* The city is the site of Brandeis university (founded in 1947) and the provincial houses of two Roman Catholic orders. The town's most famous resident was Nathaniel Prentiss Banks (*q.v.*). The city, which is part of the Boston standard metropolitan statistical area: had a population of *55,413* in 1960 and 47,187 in 1950. For comparative population figures see table in MASSACHUSETTS: *Population.* (SA. S.)

WALTHAM HOLY CROSS, a market town and urban district in the Epping parliamentary division of Essex, Eng., between the Lea and Epping forest, 13 mi. N.E. of London bridge. Pop. *(1951) 8,201.* Its former name, Waltham Abbey, was derived from the abbey built by Harold in *1060.* The abbey church replaced an earlier one made to hold a miraculous cross found at Montecute in Somerset. Henry II refounded the abbey in *1177.* Henry III frequently stayed at Waltham abbey. Most of the abbey church was demolished at the dissolution, but the nave was retained and now forms the parish church. The tower was built (1556–58) from remains of the old building. Of the monastic buildings there remain only a bridge, gateway and other fragments. The district contains greenhouses, producing tomatoes, cucumbers and out-of-season fruits and flowers. The manufacture of fertilizers and plastics also provides employment. A government high-explosive factory was later devoted to research.

WALTHAMSTOW, a municipal and parliamentary borough of Essex, Eng., and a northeastern suburb of London. Pop. (1951) *121,135.* Area *6.8* sq.mi. Lying on the eastern side of the Lea valley, it has large reservoirs for London's water supply. The church of St. Mary was built in 1535. Besides other old brasses it contains effigies of Sir George Monoux (d. *1543)* and Anne, his wife. Walthamstom has several educational institutions. such as the Sir George Monoux grammar school and the South West Essex technical college and school of art. There is a local history museum and a William Morris gallery with a collection of his works. In the reign of Edward the Confessor Walthamstow belonged to Waltheof, son of Siward, earl of Northumbria, and passed in 1309 to Guy de Beauchamp, earl of Warwick. The town, incorporated in 1929, returns two members to parliament. Though the area is largely residential, there are industries, including engineering.

WALTHARIUS, a Latin poem founded on German popular tradition, relates the exploits of the west Gothic hero Walter of Aquitaine. Our knowledge of the author. Ekkehard, a monk of St. Gall, is due to a later Ekkehard (Ekkehard IV, d. 1060), who gives some account of him in the *Casus Sancti Galli* (cap. 80). The poem is said to have been by Ekkehard I (d. 973) 'in his schooldays for his master-Geraldus. If so, he must have possessed precocious powers. *Waltharius* was dedicated by Geraldus to Erchanbald, bishop of Strasbourg (*fl.* 965–991), but mss. were in circulation before that time. Ekkehard IV stated that he corrected his namesake's Germanisms. The poem was probably based on epic songs now lost.

Walter was the son of Alphere, ruler of Aquitaine, which in the 5th century was a province of the west Gothic Spanish kingdom. On Attila's invasion the western princes are represented as offering tribute and hostages. Gibich. here described as a Frankish king, gave Hagen as a hostage in place of his son Gunther; the Burgundian Heririh, his daughter Hiltegund; and Alphere, his son Walter. Hagen and Walter became brothers in arms, fighting for Attila. while Hiltegund was put over the queen's treasure. Presently Gunther succeeded his father and refused the tribute. whereupon Hagen fled from Attila's court. Walter and Hiltegund, who had been betrothed in childhood. also escaped, taking with them a great treasure. The story of their flight forms one of the most charming pictures of old German story. At Worms, however, the treasure excited the cupidity of Gunther. Taking 12 knights, among them the reluctant Hagen, he overtook them at the Wasgenstein (Vosges). Walter engaged the Nibelungs one at a time, until all were slain but Hagen, who held aloof and was only persuaded by Gunther on the second day to attack his comrade. Luring Walter from the strong position of the day before, Gunther and Hagen attacked. All three were incapacitated, but their wounds were bound up by Hiltegund.

The essence of the story is the series of single combats. The incoherences make it likely that many changes have been introduced in the legend. *Thidreks Saga* makes the story more probable by representing the pursuers as Huns. Probably Hagen was originally the father of Hiltegund, and the tale was a variant of the saga of Hild in *Skaldskaparmál*. Hild. daughter of King Hogni, was carried off by Hedinn. The fight between father and lover only ceased at sundown, to be renewed on the morrow, since each evening Hild raised the dead by her incantations. This is obviously a mediaeval variant of the ancient myth of the struggle between light and darkness.

Bibliography.—*Waltharius* was first edited by Fischer (Leipzig, 1780). Later and more critical editions are by Jacob Grimm (*Lat. Gedichte des Mittelalters*, Göttingen, 1838); R. Peiper (1873); V. Scheffel and A. Holder (Stuttgart. 1874); German translations by F. Linnig (Paderborn, 1885), and H. Althof (Leipzig, 1896). *See* also Scheffel's novel of *Ekkehard* (Stuttgart, 1887). The A.S. fragments of *Waldere* were first edited by G. Stephens (1860), afterwards by R. Wülker in *Bibl. der angel-sachs. Poesie* (Cassel, 1881); by F. Holthausen in *Göteborgs Hogskolas Årsskrift* (vol. v, 1899), with autotype reproductions of the two leaves which have been preserved. *See* also A. Ebert, *Allg. Gesch. der Lit. des Mittelalters im Abendlande* (Leipzig, 1874–87); R. Koegel, *Gesch. der deutschen Literatur bis zum Ausgange des Mittelalters* (vol. i, pt. ii, Strashourg, 1897); M. D. Larned, *The Saga of Walter oj Aquitaine* (Baltimore. 1892); B. Symons. *Deutsche Heldensage* (Strasbourg, 1905). With *Waltharius* compare the ballads "Earl Brand" and "Erlinton" (F. J. Child, *English and Scottish Popular Ballads*, i, 88 *seq.*); and *see* R. W. Chambers, *Widsith* (1912).

WALTHEOF (d. 1076), earl of Northumbria. was a son of Earl Siward of Northumbria. Too young to succeed to the northern earldom when his father died in 1055, he was afterward appointed by King Edward to an earldom in the midlands, comprising the shires of Huntingdon, Northampton, Bedford and Cambridge: He submitted at first to King William. but joined the Danes when they invaded Yorkshire and stormed York in 1069. Received again into William's favour, he was granted his father's Xorthumbrian earldom in 1072, and married to Judith, the king's niece. In 1075 he joined the conspiracy against the king arranged by the earls of Norfolk and Hereford; but soon repenting of his action he confessed his guilt to Archbishop Lanfranc, and then to William, who was in Normandy. Returning to England with William, he was arrested. As an Englishman, subject to a law which regarded treason as a capital crime, he was condemned to death and beheaded on St. Giles's hill near Winchester on May 31, 1076. Weak and unreliable in character. Waltheof, like his father, is said to have been a man of immense bodily strength. Devout and charitable, he was regarded by the English as a martyr, and miracles were said to have been worked at his tomb at Crowland. The earl left three daughters. the eldest of whom, Matilda, brought the earldom of Huntingdon to her second husband. David I, king of Scotland.

See E. A. Freeman, *The Norman Conquest*, vol. ii, iii and iv (Oxford, 1870–75); F. M. Stenton, *Anglo-Saxon England*, 2nd ed. (Oxford, 1947); R. H. Hodgkin, *A History of the Anglo-Saxons*, 2 vol., 3rd ed. (Oxford, 1953).

WALTHER VON DER VOGELWEIDE (*c.* 1170–*c.* 1230), the most celebrated of mediaeval German lyric poets. For all his fame, Walther's name is not found in contemporary records, with the exception of a solitary mention in the travelling accounts of Bishop Wolfger of Passau—"Walthero cantori de Vogelweide pro pellicio V. solidos longos"—"To Walther the singer of the Vogelweide five shillings to buy a fur coat," and the main sources of information about him are his own poems and occasional references by contemporary Minnesingers. It is clear from the title *hêr* (Herr, Sir) these give him, that he was of noble birth; but it is equally clear from his name Vogelweide (Lat. *aviarium,* a gathering place or preserve of birds) that he belonged not to the higher nobility, who took their titles from castles or villages, but to the nobility of service (*Dienstadel*), humble retainers of the great lords, who in wealth and position were little removed from non-noble free cultivators. For a long time the place of his birth was a matter of dispute, until Professor Franz Pfeiffer established beyond reasonable doubt that he was born in the Wipthal in Tirol, where, not far from the little town of Sterzing on the Eisak, a wood—called the Vorder- und Hintervogelweide—preserves at least the name of his vanished home.

Tirol was at this time the home of several noted Minnesingers; and the court of Vienna, under the enlightened duke Frederick I. of the house of Babenberg, had become a centre of poetry and art. Here it was that the young poet learned his craft under the renowned master Reinmar the Old, whose death he afterwards lamented in two of his most beautiful lyrics; and in the open-handed duke he found his first patron. This happy period of his life, during which he produced the most charming and spontaneous of his love-lyrics, came to an end with the death of Duke Frederick in 1198. Henceforward Walther was a wanderer from court to court in many Germanic countries, singing for his lodging.

For material success in this profession he was hardly calculated. His criticism of men and manners was scathing; and even when this did not touch his princely patrons, their underlings often took measures to rid themselves of so uncomfortable a censor. Thus he was forced to leave the court of the generous duke Bernhard of Carinthia (1202–1256); after an experience of the tumultuous household of the landgrave of Thuringia he warns those who have weak ears to give it a wide berth; and after three years at the court of Dietrich I. of Meissen (reigned 1195–1221) he complains that he had received for his services neither money nor praise. Walther was, in fact, a man of strong views; and it is this which gives him his main significance in history, as distinguished from his place in literature. From the moment when the death of the emperor Henry VI. (1197) opened the fateful struggle between empire and papacy, Walther threw himself ardently into the fray on the side of German independence and unity. Though his religious poems sufficiently prove the sincerity of his catholicism, he remained to the end of his days opposed to the extreme claims of the popes, whom he attacks with a bitterness which can only be justified by the strength of his patriotic feelings. His political poems begin with an appeal to Germany, written in 1198 at Vienna, against the disruptive ambitions of the princes:—

Crown Philip with the Kaiser's crown
And bid them vex thy peace no more.

He was present, on Sept. 8, at Philip's coronation at Mainz, and supported him till his victory was assured. After Philip's murder in 1209, he "said and sang" in support of Otto of Brunswick against the papal candidate Frederick of Staufen; and only when Otto's usefulness to Germany had been shattered by the battle of Bouvines (1212) did he turn to the rising star of Frederick II., now the sole representative of German majesty against pope and princes. From the new emperor his zeal for the empire at last received recognition; and a small fief in Franconia was bestowed upon him, which, though he complained that its value was little, gave him the home and the fixed position he had so long desired. That Frederick gave him an even more signal mark of his favour by making him the tutor of his son Henry VII., is more than doubtful. Walther's restless spirit did not suffer him to remain long on his new property. In 1217 we find him once more at Vienna, and again in 1219 after the return of Duke Leopold VI. from the crusade. About 1224 he seems to have settled on his fief near Wiirzburg. He was active in urging the German princes to take part in the crusade of 1228, and may have accompanied the crusading army at least as far as his native Tirol. In a beautiful and pathetic poem he paints the change that had come over the scenes of his childhood and made his life seem a thing dreamed. He died about 1230, and was buried at Wiirzburg, after leaving directions, according to the story, that the birds were to be fed at his tomb daily.

Historically interesting as Walther's political verses are, their merit has been not a little exaggerated. Of more lasting value are the beautiful lyrics, mainly dealing with love, which led his contemporaries to hail him as their master in song (*unsers* sanges meister). He is of course unequal. At his worst he does not rise above the tiresome conventionalities of his school. At his best he shows a spontaneity, a charm and a facility which his rivals sought in vain to emulate. His earlier lyrics are full of the joy of life, of feeling for nature and of the glory of love. Greatly daring, he even rescues love from the convention which had made it the prerogative of the nobly born, and puts the most beautiful of his lyrics—Unter der linden—into the mouth of a simple girl.

A certain seriousness, which is apparent under the joyousness of his earlier work, grew on him with years. Religious and didactic poems become more frequent; and his verses in praise of love turn at times to a protest against the laxer standards of an age demoralized by political unrest. Throughout his attitude is healthy and sane. He preaches the crusade; but at the same time he suggests the virtue of toleration, pointing out that in the worship of God

Christians, Jews and heathen all agree.

He fulminates against "false love"; but pours scorn on those who maintain that "love is sin." In an age of monastic ideals and loose morality there was nothing commonplace in the simple lines in which he sums up the inspiring principle of chivalry at its best:—

Swer guotes wibes liebe hbt
Der schamt sich ieder missetât.[1]

The Gedichte were edited by Karl Lachmann (1827). This edition of the great scholar was re-edited by M. Haupt (3rd ed., 1853). Walther *v.* d. Vogelweide, edited by Franz Pfeiffer, with introduction and notes (4th edition, by Karl Bartsch, Leipzig, 1873). Glossarium *zu* d. Gedichten Walther's, *nebst* e. *Reimverzeichnis,* by C. A. Hornig (Quedlinburg, 1844). There are translations into modem German by B. Obermann (1886), and into English verse Selected poems of Walter *von* der Vogelweide by W. Alison Phillips, with introduction and notes (London, 1896). The poem Unter der Linden, not included in the latter, was freely translated by T. L. Beddoes (Works, 1890), more closely by W. A. Phillips in the Nineteenth Century for July 1896 (ccxxxiii. p. 70). Songs and Sayings contains English translations of Walther's poems, by F. Belts (1917). Leben *u.* Dichten *Walther's* von der *Vogelweide,* by Wilhelm Wilmanns (Bonn, 1882), is a valuable critical study of the poet's life and works. (W. A. P.)

[1]He who has the love of a good woman
Is ashamed of every misdeed.

WALTON, ERNEST THOMAS SINTON (1903–), Irish physicist, was awarded, jointly with Sir John Douglas Cockcroft. the 1951 Nobel prize for physics for fundamental work on "the transmutation of atomic nuclei by artificially accelerated' atomic particles." Walton was born on Oct. 6, 1903, at Dungarvan. County Waterford, Ire. He was educated at the academies at Banbridge (County Down) and Cookstown (County Tyrone) and in the Methodist college. Belfast. In 1922 he entered Trinity college. Dublin, and in 1927 he went to Trinity college. Cambridge. where he worked with Cockcroft under Lord Rutherford in the Cavendish laboratory. He held in turn an 1851 Overseas Research scholarship (1927–30), a senior research award of the Department of Scientific and Industrial research (1930–34) and the Clerk Maxwell scholarship in Cambridge university (1932–34). In 1946 he was elected Erasmus Smith's professor of natural and experimental philosophy in the University of Dublin. In 1932 in collaboration with Cockcroft he disintegrated the nucleus of the lithium atom by bombarding it with protons, artificially accelerated in an electric field of high potential. The products of disintegration proved to be helium nuclei and thus there had been a transmutation of lithium into helium. In 1938 Walton was awarded the Hughes medal by the Royal society. (D. McK.)

WALTON, IZAAK (1593–1683), English writer. author of The Compleat Angler, was born at Stafford on Aug. 9, 1593; the register of his baptism gives his father's name as Jervis, and nothing more is known of his parentage. He settled in London as an ironmonger, and at first had one of the small shops, 7½ ft. by 5 ft., in the upper story of Gresham's Royal Burse or Exchange in Cornhill. In 1614 he had a shop in Fleet street, two doors west of Chancery lane. There, in the parish of St. Dunstan's, he gained the friendship of John Donne, then vicar of that church. His first wife, Rachel Floud, great-great-niece of Archbishop Cranmer, died in 1640. He married again soon after, his second wife being Anne Ken—the pastoral "Kenna" of The Angler's Wish—stepsister of Thomas Ken, afterward bishop of Bath and Wells. After the royalist defeat at Marston Moor, he retired from business. He had bought some land near his birthplace, Stafford, and he went to live there; but. according to Wood. spent most of his time "in the families of the eminent clergymen of England. of whom he was much beloved"; and in 16jo he was again living in Clerkenwell.

In 1653 came out the first edition of his famous book, *The* Compleat Angler. His second wife died in 1662, and was buried in Worcester cathedral church, where there is a monument to her memory. One of his daughters married Hawkins, a prebendary of Winchester. The last 40 years of his long life seem to have been spent in ideal leisure and occupation, the old man traveling here and there, visiting his "eminent clergymen" and other brethren of the angle, compiling the biographies of congenial spirits and collecting here a little and there a little for the enlargement of his famous treatise. After 1662 he found a home at Farnham castle with George Morley, bishop of Winchester, to whom he dedicated his Life of George Herbert and also that of Richard Hooker; and from time to time he visited Charles Cotton in his fishing house on the Dove. He died in his daughter's house at Winchester on Dec. 15, 1683, and was buried in the cathedral. It is characteristic of his kindly nature that he left his property at Shalford for the benefit of the poor of his native town.

Walton hooked a much bigger fish than he angled for when he offered his quaint treatise, The Compleat Angler, to the public. There is hardly a name in English literature, even of the first rank, whose immortality is more secure or whose personality is the subject of a more enthusiastic cult. The Compleat Angler, dedicated to his friend John Offley, was published in 16j3, but Walton continued to add to its completeness in his leisurely way for a quarter of a century. Later editions appeared during his lifetime, in 1655, 1661, 1668 and 1676. In the 1676 edition the 13 chapters of the original had grown to 21, and a second part was added by his brother angler Charles Cotton, who took up "Venator" where Walton had left him and completed his instruction in fly-fishing and the making of flies.

Walton did not profess to be an expert with the fly; the fly-fishing in his first edition was contributed by Thomas Barker, a retired cook and humorist, who produced a treatise of his own in 1659; but in the use of the live worm. the grasshopper and the frog "Piscator" himself could speak as a master. The famous passage about the frog—often misquoted about the worm—"use him as though you loved him, that is, harm him as little as you may possibly, that he may live the longer"—appears in the original edition. The additions made as the work grew were not merely to the technical part; happy quotations, new turns of phrase, songs, poems and anecdotes were introduced as if the leisurely author, who wrote it as a recreation, had kept it constantly in his mind and talked it over point by point with his numerous brethren. There were originally only two interlocutors in the opening scene, "Piscator" and "Viator"; but in the second edition, as if in answer to an objection that "Piscator" had it too much his own nay in praise of angling, he introduced the falconer, "Auceps," changed "Viator" into "Venator" and made the new companions each dilate on the joys of his favourite sport.

Although *The Compleat Angler* was not Walton's first literary work, his leisurely labours as a biographer seem to have grown out of his devotion to angling. It was probably as an angler that he made the acquaintance of Sir Henry Wotton, but it is clear that Walton had more than a love of fishing and a humorous temper to recommend him to the friendship of the accomplished ambassador. At any rate, Wotton, who had intended to write the life of John Donne and had already corresponded with Walton on the subject, left the task to him. Walton had already contributed an *Elegy* to the 1633 edition of Donne's poems, and he completed and published the life, much to the satisfaction of the most learned critics, in 1640. Sir Henry Wotton dying in 1639, Walton undertook his life also; it was finished in 1642 and published in 1651. His life of Hooker was published in 1662, that of George Herbert in 1670 and that of Bishop Sanderson in 1678.

The Lives of Dr. John Donne, Sir Henry Wotton, Mr. Richard Hooker, Mr. George Herbert, etc., was published in 1670. This, together with the life of Robert Sanderson, was edited by George Saintsbury in 1927. All these subjects were endeared to the biographer by a certain gentleness of disposition and cheerful piety; three of them at least—Donne, Wotton and Herbert—were anglers. Their lives were evidently written with loving pains, in the same leisurely fashion as his *Angler,* and like it are of value less as exact knowledge than as harmonious and complete pictures of character. Walton also rendered affectionate service to the memory of his friends Sir John Skeffington and John Chalkhill, editing with prefatory notices Skeffington's *Hero of Lorenzo* in 1652 and Chalkhill's *Thealma and Clearchus* a few months before his own death in 1683. His poems and prose fragments were collected in 1878 under the title of *Waltoniana.*

The best-known old edition of the *Angler* is J. Major's, 2nd ed. (1824, repr. 1927). A facsimile of the first edition was reprinted in 1928 by A. and C. Black. The book was edited by Andrew Lang in 1896, and various modern editions have appeared. The standard biography is that by Sir Harris Nicolas, prefixed to an edition of the *Angler* (1836). There are notices also, with additional scraps of fact, annexed to two American editions, Bethune's (1847) and Dowling's (1857). An edition of Walton's *Lives,* by G. Sampson, appeared in 1903. *See* also T. Westwood, *The Chronicle of the "Compleat Angler" of Izaak Walton and C. Cotton* (1864); S. Martin, *Izaak Walton and His Friends* (1903); E. Marston, *Thomas Ken and Izaak Walton* (1908); R. B. Marston, *Walton and Some Earlier Writers on Fish and Fishing* (1909).

WALTON AND WEYBRIDGE, an urban district (1933) in the Esher parliamentary division of Surrey, Eng., on the right bank of the Thames about 15 mi. W.S.W. of London. Pop. (1951) 38,112. Area 14.1 sq mi. The district is bounded by the Thames, Wey and Mole rivers, and rises to about 200 ft. at St. George's hill. It is mainly residential. but there is some market gardening, and large aircraft works are beside the former motor track at Brooklands, Weybridge. Electrical and dental equipment and plastics are also made. Walton church (St. Mary) has late Norman features and contains Elias Ashmole's memorial to the astrologer William Lilly, some fine brasses, and statuary by F. L. Chantrey and L. Roubiliac. The scold's bridle (1632) is one of the earliest examples in England. The Tudor manor house was occupied by John Bradshaw. president of the court that tried Charles I.

Many prehistoric implements have been dredged from the Wey and the Thames near Weybridge and on St. George's hill is a Bronze Age camp. In 1537 Henry VIII built Oatlands palace and until its demolition by Oliver Cromwell it was a residence of Elizabeth I, James I and Charles I. In 1790 the duke of York bought the estate from the duke of Newcastle and lived there until 1822.

WALTON-LE-DALE, an urban district in the Preston South parliamentary division of Lancashire, Eng., on the tongue of land betneen the Darwen and the Ribble. 2 mi. S.E. of Preston. Pop. (1951) 14,709. Area 7.4 sq.mi. The church of St Leonard was originally built in the 11th century Roman remains have been found. The manor of Walton was granted by Henry de Lacy about 1130 to Robert Banastre. It afterward passed to the Langtons and about 1592 to the Hoghtons of Hoghton. Walton was the principal scene of the battle of Preston (1648) where the royalists lost the Ribble bridge to the parliamentarians. Cotton spinning and weaving are carried on and there is much market gardening, but the area is mainly residential.

WALTZ, a popular round dance, introduced from Germany into France at the end of the 18th century and into England in 1812. It is written in 3/4 time and has enlisted the musical interest of many composers. Among these Chopin is supreme. As regards waltzes written expressly to be danced to, the two Johann Strausses (father and son). the famous Viennese composers, may be particularly mentioned. *(See* also DANCE.)

WALVIS BAY (formerly also WALFISH BAY), a harbour and port on the coast of South-West Africa. During German rule in South-West Africa, and technically still, an exclave (374 sq.mi.) of Cape Province; but now administered as part of the mandate. When separated politically from the hinterland, practically no development took place. South-Rest Africa, under German rule, relied on Snakopmund. Now, however, the port of Walvis Bay is beginning to develop. Vessels can lie alongside a concrete wharf, 1,500 ft. long, to which leads a channel. 30 ft. deep. The wharf is fitted with electric cranes. A cold-storage and refrigerating plant has been built, capable of dealing with 150 cattle and 200 or 300 sheep a day, and considerable quantities of chilled meat are exported. Whaling and fishing are also carried on. Walvis Bay is a regular port of call for mail steamers of British, Dutch and German lines. In consequence of its development. Swakopmund has been permanently closed as a port. In 1951 Walvis Bay had 3,329 persons (1,008 Europeans; 2,321 non-Europeans).

WALWORTH, SIR WILLIAM (d. 1385), lord mayor of London, belonged to a good Durham family. He was apprenticed to John Lovekyn, a member of the Fishmongers' guild, and succeeded his master as alderman of Bridge ward in 1368, becoming sheriff in 1370 and lord mayor in 1374. Walworth was appointed one of the tno treasurers of the parliamentary subsidy voted in Oct. 1377, and he frequently appears as partner in loans made to the king. He was one of the leaders of the opposition in London to the king's uncle. John of Gaunt, duke of Lancaster. His most famous exploit was his encounter uith Wat Tyler in 1381, during his second term of office as lord mayor. In June of that year, when Tyler and his followers entered south London, Walworth defended London bridge against them; he nas with Richard II when he met the insurgents at Smithfield, and assisted in slaying their leader *(see* TYLER. WAT), afterward raising the city bodyguard in the king's defense, for which service he was rewarded by knighthood and a pension. He subsequently served on two commissions to restore the peace in the county of Kent. He died in 1385 and was buried in St. Michael's. Crooked Lane.

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II (London, Toronto, 1949).

WAMPUM, tubular shell beads used as a medium of exchange by some North American Indians. The beads were strung into strings, woven into belts or used as embroidered ornaments.

In what is now the northeastern United States, the English called the beads wampum or wampumpeag (derived from one of the eastern Algonkian languages; literally translated, the latter term means "strings of white [shell beads]"). The English in Virginia termed it roanoake; the French esnoguy, *matachias* or *pourceline;* the Dutch, *sewan* or *zeewan.* Wampum is found in archaeological sites east of the Mississippi river. The earliest documentary reference occurs in the Voyages of Jacques Cartier, where, under the year 1535. the following statement appears: "The most precious article they (*i.e.*, the Hurons) possess in this world is *esnoguy,* which is as white as snow. They procure it from shells in the river . . . of which they make a sort of bead. which has the same use among them as gold and silver with us; for they consider it the most valuable article in the world. It has the virtue of stopping nosebleeding; for we tried it."

According to the 16th-century documents, the eastern Indians at that time used wampum for decoration and ceremonial gift exchange. In the first decade of the 17th century, because of the inadequate supply of European-type currency, strings of wampum were used as money by whites and Indians in what is now the eastern United States.

Wampum was used as money through the 17th and first half of the 18th centuries. When machines were invented to mass-produce wampum; the resulting inflation stopped its use as money in the east. However, wampum continued to be used as money by western Indians until about the middle of the 19th century.

From the second half of the 18th century through the 19th century, the most important use of wampum in the east was in the form of belts for purposes of gift exchange. The belts usually contained woven designs which were mnemonic or pictographic devices symbolic of the ceremonial occasion being commemorated.

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WANAMAKER, JOHN (1838–1922), U.S. merchant, who developed one of the country's first large department stores, was born in Philadelphia, Pa.. July 11, 1838, and began his career at 14 as errand boy for a bookstore. He was a clerk in a men's clothing store in 1856, and from 1857 to 1861 served as secretary of the Philadelphia Young Men's Christian association. In 1861 he established with Nathan Brown the clothing house of Brown and Wanamaker, a partnership that continued until the death of Brown in 1868. In 1869 he established John Wanamaker and Company, placing his brother Samuel in charge. In 1875 he bought the freight depot of the Pennsylvania railroad to house this store. It became his "new kind of store," *i.e.,* a collection of specialty shops under one roof, before long one of the largest department stores in the country. In 1896 he acquired the former A. T. Stewart store in New York city. Wanamaker served as postmaster general in Pres. Benjamin Harrison's administration, 1889–93. He died in Philadelphia, Dec. 12, 1922. Wanamaker was noted for his very successful use of advertising and was one of the first to employ advertising agencies.

See H. A. Gibbon, *John Wanamaker* (1926); J. H. Appel, *Business Biography of John Wanamaker* (1930). (J. R. LT.)

WANDSWORTH, a southwestern metropolitan borough (1900) of London. Eng. Pop. (1951) 330,493. Area 14.2 sq.mi. Bounded north by the Thames. it is the largest in area of the metropolitan boroughs and includes Putney. part of Clapham, Streatham, Balham and Upper and Lower Tooting. The name (Wendelesorde in Domesday Book) indicates that it was the homestead of Wendel or Wandel; the Wandle river is a small tributary of the Thames whose valley is still a feature of the main east-west thoroughfare. Huguenot place and the Huguenot burial ground are reminders of the arrival of these refugees in the 17th century and their, introduction of dyeing. calico printing and hatmaking. Improved transport enabled workers in London to live in Wandsworth and later led to an increased density of population and the introduction of industries, chiefly light engineering, brewing and paint manufacture. The borough retains many open spaces. including Tooting Bec common. Putney heath. Streatham common and Ring George's park, and parts of Wandsworth, Clapham, Putney and Wimbledon commons. The annual Oxford and Cambridge boat race starts from Putney bridge. At Wandsworth "The Election of the Mayor of Garratt" (a nearby hamlet), a political burlesque, took place between 1747 and 1796 and drew huge crowds from London. Samuel Foote wrote a comedy called *The Mayor* of *Garratt,* produced in 1763 Clapham church records the Clapham sect—who worked for the abolition of slavery in England—and in William Hewer's house Samuel Pepys died in 1703. Flats, houses, shops. etc., built on the Ackroydon estate at Tibhett's corner, Putney, in 1953–55 included the first group of point-block flats in Great Britain. The borough returns four members to parliament.

WANGANUI, a city and seaport of New Zealand, on the southwest coast of North Island. Pop. (1956) 29.671. The district is chiefly pastoral, and wool is exported, as well as meat and dairy produce, for which there are large refrigerating works. The Wanganui Collegiate school (Church of England) is one of the largest boarding schools in New Zealand. The district was the scene of conflicts with the hlaoris in 1847, 1864 and 1868, and in Moutoa gardens a monument commemorates the battle of that name (May 14, 1864). The settlement was founded in 1842.

WANG YANG-MING (1472–1529), Chinese philosopher and government official, led the revolt against the Neo-Confucianism of Chu Hsi (*q.v.*).

Wang was born in 1472 in the present Hangchow district, son of a cabinet official. Although he could not talk until the age of 5, he obtained the highest degree at 28. He traveled extensively, learned the military arts, was an athlete, practised the Taoist technique of breathing to prolong life and studied Buddhism.

However, his chief interests were public service and teaching. Beginning in 1504, he served successively as assistant in the army and justice departments, exiled official in Kweichow, high official in various provinces, a general suppressing rebellions. secretary of justice, censor and governor. He instituted local administrative systems, established academies of learning and inaugurated the celebrated "community contract." He never allowed this busy career to interrupt his teaching.

He was made an earl at 34. When hc died in 1529, his political enemies denied him the customary honours. However, in 1567 the title "duke of cultural perfection" (*Wen-ch'eng*) was conferred on him and in 1584 he was honoured in the Confucian temple. His conversations, essays, letters and official papers make up *The* Complete *Works* of *Duke Wen-ch'eng,* an indispensable classic of Chinese thought.

The Neo-Confucian idealist movement of Wang Yang-ming arose as a strong reaction against the Neo-Confucian rationalism of Chu Hsi that monopolized Chinese thought from the 12th to the 15th century. Since the beginning of the Ming period. Chu Hsi's interpretation of the Confucian classics had been accepted as the official version which scholars obediently followed in order to pass the civil service examination on their way to officialdom. The result was that the Neo-Confucianism of Chu Hsi became stereotyped, formalistic, narrow and devoid of originality or vigour. Against this empty and lifeless tradition, Wang rose in revolt. In its place he advocated sincere convictions and forthright action originating from one's own intuitive mind, which is at once pure and good. Four concepts stand out prominently in Wang's idealism: (1) love as exemplified in the great man's forming one body with the universe; (2) the identification of the mind with principle (Li); (3) the extension of native knowledge; and (4) the unity of knowledge and conduct.

In forming one body with Heaven and Earth and all things, the great man eliminates selfish desires and obscurations, manifests his clear character and fully develops his nature. This is love. With respect to the universe, love is the will to live, the process of unceasing production and reproduction. With respect to society, love is filial piety, brotherly respect and similar qualities.

In these qualities one's original nature is unfolded, goodness ensues and the principle of Heaven, the categorical imperative, operates at all times.

Following Lu Hsiang-shan (1139–93), Wang equates principle with mind, of which principle is the order and material force *(ch'i)* is the function. Instead of saying that because there is the principle of filial piety, there is the mind to be filial, as Chu Hsi said, Wang says that because there is the mind to be filial, there is the principle of filial piety. Actually, to him they are one and the same and it is the same mind whether in the individual or in the entire universe. As this original mind manifests itself, there is native knowledge. To extend this native knowledge is the supreme duty of man.

As in the case of other Neo-Confucianists *(see* CONFUCIANISM), extension of knowledge depends on investigation. Ho ever, unlike rationalists such as Chu Hsi to whom investigation *(ko)* meant intellectual investigation of things, Wang interpreted *ko* to mean rectification of the mind, for to him all principles are contained in the mind and are discoverable if the mind is clear and calm. Such a state is to be achieved through elimination of selfish desires, self-examination, quiet sitting; in short, the method of tranquillity. In these respects Wang came so close to the Meditation school of Buddhism *(see* BUDDHA AND BUDDHISM) that he was vigorously attacked as a Buddhist in Confucian disguise. However, he also emphasized having a firm purpose, courage. a will to work, rigorous training, social and political responsibility, in short, a life of activity. To him the relationship of tranquillity and activity is one of reality and function and they are therefore not to be sharply contrasted. Furthermore, he strongly attacked the Buddhists' life of emptiness and silence, their inability to assume social responsibility and selfishness in renouncing human relations for their own ends.

The equal emphasis on tranquillity and activity means that extension of native knowledge is no mere contemplation but knowledge translated into action. In Wang's theory knowledge is not complete until it becomes conduct, and conduct is not complete unless it is knowledge itself at work. Knowledge is the will, the beginning; conduct is the work, the accomplishment. At bottom they are a unity. These ideas of Wang's were not fruits of idle speculation but firm convictions attained after strenuous search and struggle. He chose Confucianism only after he had tried athletics, military craft, flowery compositions, the Taoist search for longevity *(see* TAOISM) and Buddhism as a way of life.

A man of strong conviction, he had the courage to protest the arrest of good officials and in consequence suffered the punishment of 40 strokes and was exiled to what is now Kweichow province, a barren wilderness at the time. But being a man of sharp intuition, it was there that he, at 37, lonely but vigorous in soul searching, intuited the principles of investigation of things and extension of knowledge and, a year later, the doctrine of the unity of knowledge and conduct. At 50 he found the truth of native knowledge.

Up to this time and for more than two decades he was an active official in distant parts of China and a successful general in suppressing several major rebellions. During this period his philosophy was evolving step by step just at the time when great decisions had to be made and strong actions taken. It can readily be seen that a philosophy of life arrived at in this way has a special freshness and power. His followers spread practically all over China and the school set off a strong movement that was to overshadow Chu Hsi's rationalism for about 150 years. Its influence extended to Japan, where it is called the Oyomei school; there it produced the greatest leaders of modern reform as well as Japanese Confucian thought.

Toward the end of the 16th century the movement in China began to lose its vitality and degenerated into empty talk and irresponsible conduct. and was eventually replaced by the practical and critical philosophy. However, its influence was again felt in the 20th century. especially in Sun Yat-sen *(q.v.)* and Chinese idealists who, like Wang, demanded strong convictions and decisive action. *See* also CHINESE PHILOSOPHY. (W. C.)

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WAN-HSIEN, an important port on the Yangtze river in Szechwan province. western China. It is the eastern terminus of the east-west highway across central Szechwan by the shortest route to the provincial capital, Ch'eng-tu, in the west. The city is the chief commercial centre for eastern Szechwan and northern Kweichow, and its exports include goatskins and tung oil. From the down-river approach, Wan-Hsien marks the end of the worst rapids and whirlpools of the scenic but dangerous Yangtze gorges, which run for some 195 mi. down to I-ch'ang. Pop. (1953 est.) 100.000. (H. J. Ws.)

WANSTEAD AND WOODFORD, a municipal borough (1937) in the Woodford parliamentary division of Essex, Eng., about 8 mi. N.E. of London bridge. Pop. (1951) 61,623. Area 6 0 sq.mi. It is mainly residential. being a dormitory for London, but has a small amount of light industry including the manufacture of billiard balls. The borough includes 730 ac. of Epping forest, Wanstead flats being the most southerly part of the forest. In Saxon times Wanstead was owned by the monks of St. Peter's, Westminster, and afterward by the bishop of London.

WANTAGE, a market town and urban district in the Abingdon parliamentary division of Berkshire, Eng., lying in White Horse Vale, 25 mi. N.W. of Reading by road. Pop. (1951) 5,090. Area 4.4 sq.mi. It is the birthplace of Alfred the Great. The church of SS. Peter and Paul is Early English and Perpendicular. Agriculture is the main industry, though there is a large iron foundry and many people are employed at army ordnance and air force depots and the Harwell atomic energy research establishment.

WAPENTAKE, an administrative division of the counties of York, Lincoln, Leicester, Nottingham. Derby and Rutland, first clearly referred to at the end of the 10th century, and corresponding to the hundred of other English counties. In the 11th century, the same district might be described either as a wapentake or as a hundred, and the latter term sometimes ousted the former. The word wapentake. of Scandinavian origin, originally signified the clash of arms by which the folk assembled in a local court expressed assent. Danish influence was strong in the counties where wapentakes occur. (ER S.)

WAPITI, an Algonkian word, the name applied to several deer of the red deer group. The true wapiti is *Cervus canadensis* of North America, where it is often called elk. It is the second largest deer in the world, being exceeded only by the true elk (U.S. moose). It stands over five feet at the shoulder and weighs up to 1,000 lb. Its big antlers, characterized by the large fourth tine, may have a five-foot spread.

The name wapiti is also applied to several eastern Asiatic red deer characterized by large size and antlers lacking the crown of points usually developed in the typical red deer. *C. elaphus xanthopygus* and *C. e. congaricus* are such. (J. E. HL.; X.)

WAQIDI, AL- (ABU 'ABDALLAH MOHAMMED IBN 'OMAR AL-WAQIDI) (747–823), Arab historian, was the author of *Kitab al-Maghazi*, a well-known work on Mohammed's campaigns. He was born in Medina and became a corn dealer but after a time fled to Baghdad to escape his creditors. Here Yahya ibn Khalid, the vizier of Harun al-Rashid, gave him means and. some reports say, made him *qadi* of the western district of the city. In 819 he was appointed *qadi* of Rusafa on the east side by the caliph al-Ma'mun, who was his close friend and later his executor. Waqidi died in Baghdad in 823.

BIBLIOGRAPHY.—The first third of *Kitab al-Maghazi* (one leaf missing) was published by A. von Kremer from a Damascus manuscript (1856); A. Sprenger in his *Das Leben und die Lehre des Mohammad* (1861–1865) used a British museum manuscript containing the first half, all but one leaf; J. Wellhausen published an abridged German translation from another British museum manuscript under the title *Muhammed in Medina* (1882).
See also D. S. Margoliouth, *Lectures on Arabic Historians* (1930).

WAR. War in the popular sense is a conflict among political groups involving hostilities of considerable duration and magnitude. In the usage of social science certain qualifications are added. Sociologists usually apply the term to such conflicts only if they are initiated and conducted in accordance with socially recognized forms. They treat war, whether among primitive or advanced peoples. as an institution recognized in custom or in law. Military writers usually confine the term to hostilities in which the contending groups are sufficiently equal in power to render the outcome uncertain for a time. Armed conflicts of powerful states with primitive peoples are usually called pacifications, military expeditions or explorations; with small states, they are called interventions or reprisals; and with internal groups, rebellions or insurrections. Such incidents, if the resistance is sufficient, may achieve a magnitude which entitles them to the name "war." *(See* articles on wars under their names and in the *History* sections of articles on various countries.)

This article is divided into the following sections and subsections:

I. INTERNATIONAL LAW AND WAR

In international lam the concept of the equality of the belligerents was applied during the 18th and 19th centuries to their legal status rather than to their physical power. Thus, a "state of war" or war in the legal sense was distinguished from "hostilities" or war in the material sense (see *The Three Friends,* 166 U.S. 1, 1897) and was defined as the condition which equally permits two or more political groups to contend by armed force. Armed conflict within a state constituted a state of war only if the insurgents or revolutionists had been recognized by the parent state or by other states as "belligerents." Otherwise the situation was technically known as "insurgency." This legal concept of war developed with the legal concept of neutrality which required nonparticipating states to treat the belligerents impartially. In the middle ages the prevailing thought treated n-ar as necessarily just on one side and unjust on the other. "Just war" was a lawful procedure, whereby a competent authority, by proper declaration. and with proper motives. employed armed force outside his normal jurisdiction to defend rights, to rectify wrongs or to punish crimes. This concept was accepted by Grotius who said in *The* Law *of War and Peace* (1635): "It is the duty of those who keep out of a war to do nothing whereby he who supports a wicked cause may be rendered more powerful, or whereby the movements of him who wages a just war may be hampered." Grotius, however. opened the way to neutrality by adding. "In a doubtful matter. however, those at peace should show themselves impartial to either side." Cornelius van Bynkershoek. in the 18th century, developed the law of neutrality from the principle that "the question of justice and injustice does not concern the neutral." thus incorporating in international law the ideas which post-Renaissance theories of sovereignty had developed among political writers and in the practice of states. The sovereign was deemed free to initiate war for "reason of state." War was a prerogative of the sovereign as the duel was a prerogative of the gentleman. Third states must treat war as a fact and be impartial toward the belligerents unless one of them violated neutral rights. This legal concept of war was embodied in the legislation of many states after the United States neutrality law of 1794, and in the Hague conventions of 1907, but it was never accepted in Catholic theory which continued the medieval tradition, or in popular thinking and government propaganda, which often referred to the relative justice of the causes of the belligerents. Pres. Woodrow Wilson's statement on the outbreak of World War I that Americans should be "impartial in thought as well as in action" was widely criticized, although he was actually reiterating a portion of Washington's farewell address and seeking to provide moral foundations for the prevailing legal theory.

Subsequent developments tended to revert to the Grotian theory. War was "outlawed"; *i.e.,* international law ceased to recognize a state of war as a condition in which the belligerents are equally entitled to carry on their conflict by armed force. but assumed that one is the aggressor and the other the victim.

(Q. W.)

The advocates of the outlawry of war theory felt that so long as the institution of war remained respectable and enjoyed a recognized place in the field of international relations, the root of the evil remained. Their solution of the problem was, in part. to oust war from its privileged position by denying it a legal status and placing a state indulging in hostilities against another state beyond the pale.

The statesmen primarily responsible for the idea of bringing about the renunciation of war by means of an ad *hoc* treaty were Aristide Briand. French minister of foreign affairs, and Frank B. Rellogg. United States secretary of state. In 1927 Briand proposed to the Gnited States the conclusion of a bilateral treaty covering the ground suggested by the advocates of the outlawry of war. In replying to this proposal, Secretary Kellogg suggested that instead of contenting themselves with a bilateral declaration. the two governments might make a more signal contribution to world peace by joining in an effort to obtain the concurrence of a large group of powers.

The draft multilateral treaty proposed by the United States on June 23, 1928, was promptly accepted by 14 other governments, signed at Paris on Aug. 27. 1928, and subsequently ratified by 63 states. It is commonly known as the Pact of Paris or the Rellogg-Briand pact. Its terms mere, in part, as follows:

ARTICLE I

The High Contracting Parties solemnly declare in the names of their respective peoples that they condemn recourse to war for the solution of international controversies, and renounce it as an instrument of national policy in their relations with one another.

ARTICLE II

The High Contracting Parties agree that the settlement or solution of all disputes or conflicts of whatever nature or oi whatever origin they may be, which may arise among them, shall never be sought except by pacific means.

Although at the time great hopes were entertained as to the effect which these declarations would have in the preservation of peace, they had no observable deterrent effect upon the aggressions which shortly followed in Manchuria in 1931 or in China proper at a later stage; nor upon the Italian invasion of Ethiopia, the German-Italian interventions in Spain, or any of those which finally culminated in World War II.

The Kellogg pact and other agreements for the renunciation of war, however. had important legal effects. They made it expedient for states to refrain from formal declarations of war, induced states to refuse to recognize the fruits of aggression (the Stimson doctrine), justified states in refusing to observe neutral obligations for the benefit of aggressors (United States sale of destroyers to Great Britain and Lend-Lease act, 1940, 1941) and provided the legal basis for definition of the crime of aggressive war at the Nürnberg and Tokyo trials after World War II (see WAR CRIMES). Thus these agreements, now incorporated in the United Nations charter, can be said to have "outlawed war" in the legal sense of a situation in which contending states are equally entitled to use armed force to settle their dispute. (N. AL.; X.)

The **United Nations.**—As stated in the United Nations charter, "all members shall give the United Xations every assistance in any action it takes in accordance with the present Charter and shall refrain from giving assistance to any state against which the United Nations is taking preventive or enforcement action." (Art. 2, par. **5.)** It is true, opportunity was given for impartiality if the United Nations failed to determine which party mas the aggressor. This contingency, however, was not anticipated because it was assumed that the Security council would meet its "primary responsibility for the maintenance of international peace and security," (art. 24) by performing its obligation to "determine the existence of any threat to the peace, breach of the peace, or act of aggression . . . and decide what measures shall be taken . . . to maintain or restore international peace and security." (Art. 39.)

These provisions of the charter gave more positive form to the changes in international law wrought by the Covenant of the League of Nations (1920), which required discriminatory treatment against the state which resorted to hostilities in violation of its covenants, and the Kellogg pact. Since the latter instrument condemned war and obliged the parties to renounce war as an instrument of national policy, and never to seek the settlement of any dispute or conflict except by pacific means. it was difficult to see how hostilities could begin unless one or both had violated their obligations. The concept that war was outlawed was given practical application in the policies observed by most states in discriminating against Japan in its Manchurian and Chinese hostilities, against Italy in the Ethiopian invasion, against Hitler in his invasions which led to World War II and against the North Korean and Chinese Communists after their aggressions against the Korean Republic in 1950. The Stimson doctrine (1931) calling for nonrecognition of fruits of aggression, the U.S. Lend-Lease act (1941) to aid the victims of aggression, and the Niirnberg trials declining to recognize the aggressor state's declaration of war as an "act of state" shielding its agents from criminal prosecution, were logical consequences of this outlawry of war.

Hostilities occurring after the Kellogg-Briand pact were not "states of war" in the sense understood in 19th century international law. Hostilities were permitted by international law only if exercised by a state within its domestic jurisdiction, in necessary self-defense, or in pursuance of its rights or duties under the Kellogg-Briand pact, the United Nations charter or other valid treaty. Otherwise the initiation of hostilities, even if formally declared "war," had become illegal. No state could in principle initiate a state of war in which it and its enemy would be legally entitled to equal treatment by other states.

Doubtless because of the inadequacies of the procedures of the United Nations, hostilities might occur in which no authoritative decision would be given distinguishing the aggressor from the defender. In such a situation different states might reach different conclusions and some might maintain neutrality. The new international law outlawing war might, for a long time, prove ineffective in producing the practical results intended as did, for long periods of time, national legislation outlawing private dueling. Furthermore, declarations or other acts initiating hostilities, ineffective as they might be to produce a legal state of war under international law, would doubtless continue to produce that state under the domestic law of the enacting belligerent. Special war powers would become exercisable, and legislation and treaties applicable in time of war would be invoked. In international law, however, the critical problem for determining the legal consequences of hostilities for both participants and nonparticipants was not "when did war begin and end?" but "who was the aggressor?" *(See* also *The Law* of *War*, below.)

II. TYPES OF WAR

Apart from the distinction between war in the legal sense and war in the material sense, wars have been classified as limited and absolute. The latter term refers to wars the object of which is the extermination or unconditional surrender of the enemy. Limited wars are fought to gain reparation for a particular injury, to acquire a particular territory or advantage or to gain recognition of a particuiar claim. As K. von Clausewitz pointed out, there is a tendency for all wars, however limited their original aim, to become absolute if belligerents are equal in power and tenacity.

Wars have also been classified as "international" when between states in the same community of nations, "imperial" when between states in different communities of nations or of very different civilization, and "civil" when between the government and a rebelling or insurgent group in the same state. In a list of 278 wars participated in by the members of the modern community of nations from 1480 to World War II, 135 were international, 65 imperial and 78 civil. *(See* Q. Wright, *A Study* of *War*, 1942, p. 641 ff.) These wars varied greatly in magnitude, from relatively minor episodes involving only two small countries and lasting only a few months, to such events as the Thirty Years' War, the Seven Years' War, the Napoleonic Wars and World Wars I and II, involving all of the great powers, many other states, millions of casualties, and, with the exception of the first, extending all over the world. The civil wars, including the French Huguenot wars of the 16th century, the Great Rebellion and the German Thirty Years' War in the 17th century, the French Revolution in the 18th century, the American Civil War and the Chinese Taiping rebellion in the 19th century, and the Russian and Chinese revolutions in the 20th century, were extraordinarily costly in life. Imperial wars were as a rule the least costly in life because of the usual marked disparity in military power between the belligerents. Each of 15 international wars during the modern period (four in the 17th, seven in the 18th, two in the 19th and two in the 20th century) included substantially all of the great powers as belligerents. Five of these were consequences or causes of contemporaneous civil wars.

Wars during the modern period have averaged four years in length, though the range is large. Long wars such as the Thirty Years' War were usually interspersed with truces. Wars of considerable duration have usually been divided into "campaigns" conducted in one area under one command for one season. These, in turn, have been composed of "battles" in which forces come into direct contact for one or two days and "sieges" in which direct contact may be maintained for a longer time. Night and winter fighting, liowever, became more practicable and these distinctions were less significant in World Wars I and II. Fighting was practically continuous, although campaigns could be distinguished by geographical separation. Wars showed a slight tendency to decrease in length during the modern period, but in all other aspects they tended to increase in magnitude. There were more battles, more participants, larger forces, larger numbers of casualties, more extensive areas of occupation and greater mechanization resulting in much heavier economic costs. This tendency was by no means continuous. The costs of the Thirty Years' War of the 17th century were very great. World War II, however, was greater in all these respects than any other war in history.

War can be considered from a number of points of view. It is characterized by intentional violence and thus can be classed with crime, police action, executions, duels, prize fights, gladiatorial combats, mob violence, insurrections, rebellions. interventions, pacifications and reprisals. It is also a process for solving conflict and can, therefore, be classed with negotiation, mediation, conciliation, arbitration, and adjudication as well as with fights, duels, strikes, elections and legislative procedures. In modern times, war has usually been considered an abnormal social or legal situation and thus resembles states of martial law, of anarchy and of high tension. War also characterizes a type of intergroup relations and thus falls in a category which includes alliance, entente, friendship, strained relations, cold war and breach of relations. The connotation of the term war can hardly be appreciated unless these numerous aspects are borne in mind.

This wealth of connotation has resulted in wide metaphorical extensions of the term war to almost any opposition deemed important. Literature is full of references to wars between economic classes, between the sexes, between the generations. Industrial warfare is waged by strikes and lockouts. Party wars are conducted by oratory and ballots. There are wars of words, of books, of opinions; mars against disease, crime and poverty; wars among species of animals and plants resulting in the displacement of one by the other; wars of bacteria and insects against man. These metaphorical uses indicate no clear discrimination between "competition" where groups or individuals are striving for limited resources or opportunities without necessarily any consciousness of one another, and "conflict" where groups or individuals are consciously opposing one another. The concept war seems more applicable to the latter situation. Thus the "struggle for existence" which, according to Darwin, accounted for organic evolution and the "economic competition" which regulates prices and distribution in a free economy have no real analogy to war. There are, however, phenomena among animals such as the sexual combat of stags, the slave-taking activities of ants, the struggle for dominance among monkeys and the defense of the nesting site by birds which have an analogy to war.

The study of war has become a discipline with a large literature from the points of view of social science, of law, of practice and of history. War has also figured largely in literature, poetry, art and rhetoric. It has been an absorbing topic of human interest and has commanded admiration as well as detraction with the latter attitude gaining in popularity after great and destructive wars. Opposition to war reached a high point in public opinion, at least among democratic countries, after both World Wars I and II.

III. THE SOCIOLOGY OF WAR

1. Causes **of** War.—War has been a variable phenomenon in human history. Wars have been more frequent, more intense, more extensive and longer in some periods of history than in others. Some pairs of states have fought frequently, some not at all. Some states have been more at war than others. This variability suggests that the causes of war are to be found in the varying social institutions and relations rather than in any constant characteristics of human nature. Nevertheless, it is men that make war, and there must be qualities of human nature which make men capable of initiating and participating in war when the circumstances are suitable.

Among animals and primitive peoples, wars consist of brief attacks by individuals or small groups upon others with whom they recognize few social relations. Such wars, and the same is true of imperial wars by civilized states against savages. are only one step removed from the hunt. Their psychological causes are however more varied. The drives of dominance, sex, territory and revenge are more important than that of food. The occurrence of the appropriate stimulus to one of these drives and obstruction to its smooth realization causes hostility. Among primitive peoples group customs regulate the expression of these drives and determine the circumstances when hostility, whether in the form of feud or war, is appropriate. Tribal mores tend to become more warlike as culture becomes more complex, technology more efficient, government more integrated, and extragroup contacts more abundant.

As civilization advances, the belligerents increasingly recognize themselves as members of some supergroup. This supergroup may, as in civil wars, be a highly organized state or it may be a group with no organization at all, such, for example, as that which included both Islam and Christendom in the middle ages. "International wars" take place among state members of a supergroup with a very decentralized organization but with some social standards and interests recognized by all the members. The superficial cause of such wars lies in the desire of each state to continue to exist and the necessity it feels to be sufficiently prepared to win any war which might end its existence. All the states appreciate that the supergroup itself is insufficiently organized to protect them. The necessity that each feels to protect itself leads to the condition of "power politics." The stability of such a system tends to decline if the number of states diminishes, if the disparity in power between the great and the small increases, if military technology favours the offensive, if the technology of communication and transport shrinks effective distances and reduces geographical barriers, and if the growth of population outdistances the food supply and deteriorates standards of living. The progress of a civilization tends to all of these results and consequently the cultural and social solidarity and the opposition to war which civilization also develops are counterbalanced by these conditions which render the power equilibrium less stable. Efforts are usually made to strengthen the organization of the supercommunity so that it can more effectively regulate the relations of the members, settle their disputes peaceably and prevent hostilities. Such efforts may for a period increase stability, but the insistence of states upon retaining autonomy and sovereignty and their ideological differences offer obstacles to such efforts. The trend of civilizations after a certain progress toward solidarity has therefore been toward less stability and more severe wars usually ending in universal conquest.

The establishment of a "universal state" does not, however, stop wars. Civil wars occur within states, often because the government is too centralized, especially if the state is large and its culture heterogeneous. Local groups with peculiar institutions or cultural characteristics feel oppressed by the tendency of the supergroup to enforce uniformity. Wars of revolt occur which, though perhaps less frequent, are more bloody than the wars of defense or aggression in the system of power equilibrium.

When people of widely different cultures or ideals come in contact, as by discovery or the emergence of new religions and ideologies, imperial wars occur for the expansion of culture, religion, economic opportunity or political power. These are frequently waged in a peculiarly barbarous manner because the parties have so little in common. Each is a wolf to the other. But as there is usually great disparity in technological efficiency, conquest may take place aithout much bloodshed.

These illustrations suggest that after a certain stage of civilization aars are in some measure caused by either too much or too little political centralization of the supercommunity. Psychological drives of individuals and the culture and organization of the fighting groups play a part but relatively less important than in animal and primitive war. The adequacy of the degree of political centralization of a supergroup can only be determined relatively to the development of other of its aspects. Thus, with the advance of a civilization the recurrence of war may be attributed to the failure of co-ordination among the various aspects of the developing supergroup. These aspects include: contacts through communication and trade; understanding through standardization or complementarity of culture and values; co-operation manifesting mutual confidence and acceptance of common ends; and organization to maintain law, settle controversies and suppress violence. A rapid increase of contacts with no development of the other aspects stimulates imperial wars, usually initiated by the group equipped with the most advanced military techniques. A rapid centralization of organization while the other aspects of the supercommunity lag is likely to lead to civil wars initiated by the group whose institutions and ideologies are least harmonious with those of the majority. A lag in centralization of organization behind the other aspects leads to international wars initiated by the most aggressive state or by the state against which time is running in the power competition. Peace depends upon the development of the various aspects of the civilization at the same rate.

Civilizations have been organized in various ways at different stages of their history. Western civilization became organized in antiquity in the highly centralized Roman empire, in the middle ages in the Catholic Church which lacked material power but maintained common standards of value, and in the modern period in the system of sovereign territorial states, united through a weak system of international law and the practice of balance of power politics. Each of these systems maintained relative peace and stability for about a century, the *Pax Romana* of the and century, the *Pax Ecclesiae* of the 13th century, and the *Pax Britannica* of the 19th century. During these periods the various aspects of the European community were developing synchronously. Roman legions, however, had to defend the peace against barbarians on the periphery, the popes had to manifest the solidarity of Christendom by crusades against the infidels, and Great Britain had to act as balancer in Europe, utilizing its superior sea power and its overseas empire. These periods of peace ended when the regulating authorities became weak or when the emergence of new ideologies, the development of new contacts, the progress of science and invention. increases in population or exhaustion of resources produced disharmonies beyond their capacity to adjust.

A similar analysis may explain the varying probability of war between different pairs of states. The relationships between any two states may be expressed in terms of "distances." The

United States and Canada were at war in 1812 and in conditions of great tension in 1840 and 1890. They came nearer to one another technologically in the sense that their people communicated and traded more abundantly. They also came nearer ideologically in the sense that the values and culture patterns of their peoples became more similar. Social distances between the tno countries also shrank as co-operation between their governments and citizens increased. Finally there was a shrinkage in political distance as they accepted common political institutions and organizations such as the International Joint commission (1909), the Permanent Joint Board of Defense (1940), the United Nations (1945) and the North Atlantic pact (1949). These changes proceeded synchronously; relations between the tno countries became more friendly, and the probability of war diminished. On the other hand, the United States had never been at war with Russia, regarded Russia as its first friend in the Civil War period and was an ally fighting a common enemy in 1945, but by mid-century there was great tension between the two countries. The technological distance had decreased with the progress of aviation and the possibilities of atomic bombing, but ideological and social distances had increased. Common membership in the United Nations may be considered as registering some decrease in political distance. yet in view of the "iron curtain" and the failure of the Soviet Union, until 1954, to join the specialized agencies. the decrease in political distance had been slight.

Differentials in the rate of change in these various aspects of the "distances" between two states seem to be more significant in determining the probability of war than the magnitude of the distances themselves. Rapid change in any one of these aspects of distance unaccompanied by parallel changes in the others is likely to lead to tensions and war. It is to be observed, however, that in general wars. the orientation of states because of alliances may result in pairs of states being at war with each other contrary to expectations which would have been drawn from the changes in their distance from one another. As a civilization shrinks, all distances tend to be reduced and wars tend to become general. Consequently, analysis of the probability of war between pairs of states becomes a less useful guide than analysis of the supercommunity as a whole.

Analysis of its internal composition may indicate the probability that a state will initiate war. A state that seeks to co-ordinate all the activities of its citizens to comprehensive ends, admitting little local, functional or individual autonomy, usually finds it necessary to deflect latent resentments by focusing them upon an external enemy. It is doubtfui whether a highly centralized, totalitarian dictatorship can exist without such a scapegoat. Democratic states that permit much internal competition and conflict among political parties, business concerns, propaganda organizations. religious movements and individual opinions have less need of an external enemy, but their lack of unity makes them vulnerable to fifth column penetrations or attacks by aggressive neighbours. Disparities in the forms of organization and in the power of states decrease the stability of a system of power politics.

The state, though composed of lesser groups, is eventually composed of individuals and it is in the minds of individuals that, as stated by the constitution of the United Nations Educational, Scientific and Cultural organization (UNESCO), wars are made. Psychologists generally agree that there is nothing in human nature that makes war inevitable, but the circumstances of early education, social discipline and political loyalty develop latent aggressive tendencies in most people, which can be focused upon a political enemy. The child may suppress the aggressive disposition which he feels toward his parents in the process of training for social behaviour and which he feels whenever he is frustrated in achieving his objectives. He learns that co-operation pays in the "in-group" and so he displaces these latent aggressions upon an "out-group." As the area of co-operation expands, the outgroup becomes a foreign state, or in a bipolar world, the organization at the opposite pole.

This analysis suggests that modifications in early education, greater understanding of the psychological processes involved, opportunities for relieving aggression upon impersonal enemies of humanity like disease and war itself, general allegiance to some universal values such as those expressed in the Universal Declaration of Human Rights. and the cultivation of a spirit of tolerance, comprehension, and appreciation by each people of the diverse cultures of the world, might reduce or divert the acquired psychic characteristics which produce intergroup tensions and war.

If we consider the human race as a whole, it is clear that the causes of war have greatly changed in history. War was originally a function of the internal structure of each fighting unit, and, as there were very many of these units, the probability of any unit of a class being at war at a given time might have been calculated from statistical averages. The change has been in the direction of reducing the number of fighting units so that there is less statistical basis for such calculations. Change has also been in the direction of integrating this smaller number of units into a single unit so that war has tended to become a function, not of a fighting unit, but of the entire human community of which all fighting units are parts. Thus the problem of war has shifted from that of classifying fighting units to that of analyzing the organization of human society as a whole. The freedom of the individual fighting unit to escape war through intelligence has, therefore, been reduced but the freedom of the human race as a whole to escape war has been increased provided it can understand and control itself. Predictions from being based upon the analysis and measurement of numerous independent agencies insusceptible of central control has come to be based upon the analysis of a few personalities exercising central control. The moral and subjective factors have tended to become more important than the material and objective factors. War can less and less be treated from the deterministic point of view. More and more it must be treated from the moral point of view. The individual can less profitably be interested in studying the historical causes of war in order to decide a policy for himself or his group. He can more profitably be interested in the engineering of peace for the human race as a whole.

2. Consequences of War.—The political consequences of war have been of major importance in history. War has been the principal instrument for creating states and empires, and it has also destroyed states and empires through absorption by conquest and through disintegration by successful rebellion. On a larger scale, war has made major contributions toward developing and integrating the historic civilizations, but also toward their eventual disintegration and destruction. Unlike science and technology, which have tended toward the continuous civilization of man, war has produced great oscillations over periods of one or two millenniums.

In the modern period, from the age of discoveries to the 20th century, war tended to integrate historic civilizations and national states into one world whose peoples engaged in continuous communication and trade, recognized many common standards of value, acknowledged the rule of international law, and co-operated through international unions for numerous economic, social and political ends. From the 17th to the 20th century, wars became less frequent. Europe as the centre of the world prospered under the *Pax Britannica* of the 19th century and maintained a high degree of order but at the expense of many imperial and civil wars in the extra-European world.

After World War I, the consciousness of one world and the effort to organize it through the League of Nations and the United Nations became more widespread. New techniques of war had, however, encouraged aggression by governments and parties opposed to the humanitarian, liberal, democratic and tolerant standards which had become widely accepted throughout the world. The necessities imposed by the unprecedented devastations of the world wars themselves and the rise of totalitarian despotisms as their consequence had initiated a process of disintegration. Under post-World War II conditions the political effect of war may have changed. World Wars I and II had tended to disintegrate civilization though efforts to control war and develop international co-operation through the United Nations had arisen.

War has had economic consequences which have varied in importance and in direction; its destruction of life and property tended to increase during the modern period, although until World War I the major wars tended to be less frequent. The increasing economic destructiveness of war for both sides when waged between states of similar industrial development made statesmen more reluctant to resort to it. Such considerations have postponed wars, and it has been suggested that the suicidal effect of hydrogen-bomb war may permanently prevent resort to such war.

On the other hand. war, unless excessively destructive, intensifies social cohesion within the fighting group and stimulates economic activity. Among industrial states it creates full employment during the war and in the period of preparation before, and of reconstruction. after. Birth rates usually sink during the war, but rise afterward, compensating for war losses. John Stuart Mill commented on the rapidity with which populations recovered economically from war. These countereffects manifested themselves more slowly after World War I. Distortion of production and international trade resulted in extraordinary currency fluctuations, unparalleled depressions, and policies of national autarchy. The physical destruction of World War II was greater and the economic division of the world more profound, but the controls within each of the economic areas was more adequate, and reconstruction proceeded no less rapidly than after World War I. But the deteriorating influence of war upon economic progress was greater as manifested by the long delay in restoring either economic or political peace.

The effects of war on population and cultural standards are equally momentous. Losses of life directly attributable to war have varied greatly among primitive peoples, among the historic civilizations, and in different periods in the life of each of these civilizations. European wars have tended to be progressively more destructive of life from the 15th century onward, though the 17th century was exceptionally destructive and the 19th exceptionally peaceful. It has been estimated that some 10% of all deaths in modern civilization can be attributed directly or indirectly to war. Deaths from war-spread epidemics and from war-induced famines have been much greater than deaths of soldiers and civilians through direct action of belligerents. These indirect effects upon population, however, were reduced through the progress of medicine and sanitation. (See Wright, *A* Study of War, pp. 212, 246, 570.)

War losses have probably been adversely selective and have tended to deteriorate racial stocks. Great wars have been followed by crime waves, anti-intellectual movements, hordes of displaced persons, widespread persecutions, the growth of intolerance and unrest and. in general, deterioration of the standards which have usually been thought to characterize civilization. On some people, however, the moral effects have been the opposite. Great wars have been followed by strong antiwar movements.

With the progress of science and technology, augmenting the destructiveness of weapons upon civilian as well as armed forces, with increasing communications and general awareness of conditions throughout the world, and with more effective control of other periodic visitations which formerly upset human societies, such as pestilence and famine, war has had a more and more catastrophic effect on human existence whether viewed politically, economically, socially or culturally.

3. Control of War. — Efforts to control war have been made in all civilizations, especially in periods after unusually devastating wars. The Napoleonic Wars induced numerous peace societies in England and the United States. Associations for promoting arbitration and the development of international law were stimulated by the mid-19th century wars of nationalism. The League to Enforce Peace and other organizations to promote international control of war both in neutral and belligerent countries became active while World War I was still in progress. During the interwar period, discussions of the control of war were continuous and abundant both within and outside the League of Nations (*q.v.*), and this discussion was augmented by the outbreak of World War II and the establishment of the United Nations (*q.v.*).

The control of war has been urged since the earliest records through individual pacifism and nonresistance. Various Christian and Hindu sects have especially supported this method. Movements of neutrality and isolation adopted by some states as national policies have also been supported as contributions to peace. Such efforts can hardly eliminate mar unless their influence is universal. A world largely nonresisting or neutral may even stimulate aggressors to initiate war, although, as Gandhi argued, if nonresistance is carried to the limit. the conqueror may find himself frustrated. For a full account of the history of this approach, see PACIFISM.

The control of war has also been urged by the very different method of political'action to stabilize the balance of power, to create a universal empire or to establish and strengthen international organization. Following World War II, movements to develop the United Nations into a world government were prominent. In a culturally heterogeneous world, such efforts imply some group coercion which itself may result in war. Efforts designed to maintain the balance of power were relatively effective during the 19th century when Britain was in a favourable position to serve as balancer, but under less favourable conditions, activity by a state to restore the balance may be interpreted by others as manifestation of aggressive intentions and may precipitate war. In fact, preventive war has been considered a necessary instrument of balance of power politics. World empire implies war to create it. even if the object is eventual peace. International organization, if based only on consent, is ineffective against aggression, and if based on coercion implies, as does the balance of power, war as a possible instrument. World government, contemplating a voluntary federation of states rather than their initial compulsion as in the case of empire, cannot be established until sufficient solidarity exists in the world to permit universal consent. Furthermore. federations when not compelled to cohere by danger of invasion have tended to disintegrate The problem of world government differs greatly from that of territorially limited government.

Economic reforms in the direction of free trade have been urged not only to promote prosperity but also by men like Richard Cobden and Cordell Hull to prevent war Socialists from an opposite point of view have urged the social control of economic activity with the same dual purpose on the theory that capitalistic competition, and the class struggles and imperial expansions it is said to engender, had been the major cause of war in modern history. Economic liberalism has probably contributed to the stabilization of peace when. as during much of the 19th century, political relations were themselves stable, but there is no evidence that it can in itself make them stable. The Marxist analysis of the cause of war has been vigorously contested on grounds both of theory and history. Experience with socialism organized by national governments provides no evidence of its alleged peacefulness. On the contrary, the more their economies have been centrally planned the more states have become autocratic, despotic and aggressive. As a consequence, international trade has declined, economic differentials at national boundaries have been augmented, international co-operation has languished, and international tensions have increased.

Educational activity emphasizing the costs of war and attempting to create attitudes deemed appropriate to a peaceful world have been prominent in the writings of such philosophers as Erasmus and William James, and in the work of peace societies. After World War I, education at all levels, at least in the democracies, gave great emphasis to international relations, international organizations and the problem of war. UNESCO was dedicated to the promotion of peace and security through activities in the fields of education, science and culture. The findings of social psychology concerning the influence of individual frustrations, attitudes and tensions upon intergroup relations presented opportunities for education at all levels, transnational co-operation in all fields and mass communication of all kinds.

Military interest in the control of war has looked toward reduction of armaments, prohibition of particularly destructive or aggressive weapons and regulation of the conduct of war. Doubting the possibility of eliminating war altogether, moderation of its human and economic cost was urged. Legal interest in the control of war was directed, especially after the growth of modern international law in the 16th and 17th centuries, toward regulation of both the initiation and the conduct of war, and toward development of methods for settling international disputes peacefully. These efforts at times undoubtedly influenced the occurrence and conduct of war, but they never achieved the results hoped for by their advocates. Rapidly changing military technologies and sentiments of more intense nationalism weakened the influence of such regulations.

Plans to control war failed to solve the dilemmas arising from the fact that the necessary universality of acceptance requires coercion which implies war as an instrument, or time which implies the continuance of self-help in the short run, or revolution, destroying national loyalties, which implies violence at least in the short run. Many ideal systems for the control of war might work if peoples and governments would accept them sincerely, universally and simultaneously, but the problems of lack of confidence, of the nonconcurring group, and of the transitional period are not easy to deal with. The problem of controlling war may have to be considered not as action to realize a plan, but as a continuous process of adjustment to maintain stability in a complex world. Such adjustment requires continuous action on all fronts—educational, economic, political, military and legal—to maintain balance between the local and the universal, the short run and the long run, coercion and consent, the individual and the group.

IV. THE LAW OF WAR

1. Initiation **of** War.—Even primitive peoples usually observe certain formalities on the initiation of war, and the states of the historic civilizations not only required such formalities, but often recognized that war was just only if the initiating group had sufficient cause and proper motives. They sometimes explicitly forbade all war in certain places and in certain times, as did the medieval peace and truce of God.

International law in the 18th and 19th centuries abandoned these requirements of justice and treated war as a fact which began with the first hostile act by a sovereign state intended to initiate war. The practice of formal declaration of war was abandoned in most instances. Nineteenth-century international law, however, recognized certain requirements of justice in the initiation of hostilities short of war. Thus reprisals were permissible only for the purpose of remedying a legal injury after peaceful means had failed and if proportioned in severity to that injury. Hostilities in self-defense were permissible only in case of instant and overwhelming necessity to prevent irreparable injury to a state's territory, officials or nationals, and if confined to such necessity. Intervention was permissible only on the basis of a treaty with the state in whose territory the action took place, provided that treaty had not been made with one faction of a civil war.

The 20th-century movements to regulate the initiation of war involved all earlier methods. The first Hague convention of 1899 recognized the general interest of all members of the community of nations in preventing the outbreak of war and the third Hague convention of 1907 required a declaration or an ultimatum with a time limit before initiating hostilities. Treaties neutralizing certain areas or states, such as Switzerland (1815) and Belgium (1839) increased in number, and "cooling-off treaties" such as the Bryan treaties made by the United States in 1913 prohibited war during a period of time when the disputing states were obliged to attempt conciliation. The League of Nations covenant, the Kellogg-Briand pact and the United Nations charter included general prohibitions upon the initiation of war. Considering the general ratification of these treaties, any armed hostility became illegal under international law unless permitted by legally defined circumstances. These circumstances include hostilities to suppress mob violence, insurrection or rebellion within the state's domestic jurisdiction, hostilities for necessary individual or collective self-defense. hostilities in pursuance of express permissions in a treaty binding on the state in whose territory the action takes place, or hostilities under authority of the United Nations or in pursuance of obligations undertaken in the charter.

2. Conduct of War.—Rules for the conduct of war are no less characteristic of all cultures and civilizations than are the rules for the initiation of war. Usually, however, no clear distinction has been made between rules of expediency such as principles of strategy and tactics, rules of discipline such as prohibitions against unauthorized seizures or hostilities by subordinates, and rules of international law such as those relating to the treatment of prisoners of war and respect for flags of truce. These three types of prescription were confused by some of the early jurists of international law such as Balthazar Ayala. Grotius, however, confined his treatment to rules of international law, though he distinguished what is permissible to a belligerent deduced from the nature of war and what is desirable drawn from better practices giving consideration to morality. humanity and mutual interest. Grotius' distinction is recognized in modern rules of war. codified in the Geneva and Hague conventions and developed by practice, juristic commentary and judicial opinion. These rules permit a belligerent to exercise certain extraordinary powers beyond those which a state enjoys in time of peace. These include the power to invade and occupy enemy territory, to destroy enemy armed forces, to requisition and confiscate types of enemy property, to visit, search, capture and condemn certain types of neutral property at sea. These exercises of power are considered "military necessities" if the enemy is to be brought to submission. The law of war, however, restricts the exercise of these belligerent powers from considerations of humanity, mutual convenience of the belligerents and neutral interest. Wanton cruelty would not forward the strategic interests of a belligerent and is likely to impair those interests by arousing adverse neutral opinion. Perfidy, such as the misuse of flags of truce and violation of armistices, makes useless these symbols and agreements, confidence in which is in the mutual interest of the belligerents. Unnecessary injury to neutrals may make them enemies. Rules forbidding injuries to the enemy of this type are therefore sanctioned by self-interest.

Some rules of war, such as those prohibiting the destruction of enemy property, are specifically subject to nonobservance in circumstances of "military necessity." (Fourth Hague convention, 1907, reg. art. 23 g.) Other rules are stated absolutely such as that forbidding the killing of enemy persons who have surrendered (ibid., 23 c). It is, however, recognized that most rules may be overridden in circumstances justifying reprisals, that is, retaliatory measures to compel enemies to observe the law. Reprisals against prisoners of war were, however, explicitly forbidden by the Geneva convention of 1929 (art. 2).

The jural character of rules of war is indicated by their sanctions which reside not only in the mutual interests of the belligerents, but also in the protests and possible action by neutrals, in reprisals by the other belligerent, and in judicial proceedings. Such proceedings are required before condemnation of maritime captures and before punishment of alleged war criminals. While such proceedings have usually been conducted against enemy or neutral individuals in prize courts and military tribunals of one belligerent, proposals were made for international tribunals as, for instance, the proposed International Prize court suggested at the Hague conference of 1907. The Nurnberg and Tokyo tribunals after World War II were international in the sense that they were based on agreements among many of the United Nations. The Axis powers were, however, not represented and the jurisdiction of the tribunals extended only to Axis nationals. It was argued that this discrimination was justified because the United Nations, comprising a large portion of the world's population, was competent to represent the community of nations, and the Axis poners, not being lawful belligerents. had no claim to participate. The opinion rendered by the numerous international and national war crimes tribunals after World War II greatly developed the law of war, especially on such subjects as the defense of superior orders. the killing of hostages, the justifiability of reprisals, and the liabilities of judges, doctors and administrators for inhumanities.

While the rules for the conduct of war have developed especially for application during "states of war" when belligerents could be considered legally equal, they have also been applied with some modification in cases of insurrection, intervention, occupation, reprisals and other "hostilities short of war." Juridical analysis of the legal consequences of aggression has concluded that an "aggressor" acquires no new powers from his unlawful initiation of hostilities. Consequently the aggressor is liable to compensate for all losses of life and property received by his victim or by third states if such losses resulted from acts illegal under the international law of peace. On the other hand, the defender acquires all the powers of a belligerent against the aggressor and the powers which a belligerent has in relation to neutrals against nonparticipants. But in exercising these powers, even the defender is bound to observe the humanitarian restrictions imposed by the traditional law of war. (Draft Convention on Aggression, Research in International Law, American Journal of *International* Law, vol. 33, Nov. 1939, p. 823 ff.)

3. Termination of War.—Wars have usually been terminated by treaties of peace, but in some cases one belligerent has been conquered and his entire territory annexed, and in others, peace has been generally recognized after prolonged cessation of hostilities without a treaty. Hostilities usually terminate by armistice or capitulation before termination of the war. Though hostilities ended in 1945, World War II continued against Germany until declared ended by the western Allies in 1951, and against Japan until the peace treaty with that country came into force in 1952.

Under 19th-century international law, apart from special provisions in the treaty of peace, the termination of war automatically restored peaceful relations, liberated prisoners of war, revived treaties which had been suspended by war and restored property the title to which had not been transferred. Opinions differed as to whether territorial boundaries were fixed by the line of military occupation (uti possidetis) or were restored to the prewar position (status *quo* ante bellum), but opinion tended to the latter view as the distinction, insisted upon in the Hague convention, between "military occupation" and "completed conquest" became accepted. However, the issue was usually not important because the treaty of peace determined the boundaries.

The outlawry of war in international law which developed after World War I raised new issues in respect to the termination of hostilities. The aggressor is considered guilty of an international delinquency and consequently should not, in principle, participate as an equal in the making of peace. Furthermore, treaties, in principle, should be mutually beneficial to the parties and an imposed peace is not likely to have this character. This fact has always made the enforcement of treaties of peace especially difficult, and the implication of the Stimson doctrine, that treaties made under duress against the state are invalid, might, under the new international law, render such treaties legally ineffective. The theory has therefore been suggested that the defender and its allies. acting as agents of the communitv of nations to suppress aggression have, in principle, the right to demand unconditional surrender of the aggressor and to establish oeace. The situation is said to be analogous to that of a state which has suppressed insurrection or rebellion within its territory. The use of the term "unconditional surrender" by Pres. F. D. Roosevelt at Casablanca (1943) to describe the conditions for ending hostilities with the Axis powers recalled the use of this term by Gen. Ulysses S. Grant at Appomattox and suggested that the action of the United Nations against the Axis was not war but the suppression of an insurrection against the world community.

The war crimes trials against the Axis leaders accorded with this analogy, although after the American Civil War, southern leaders were granted an amnesty after being indicted. Treaties of peace were concluded by the United Nations with Italy, Finland, Hungary, Bulgaria and Rumania, but the treaties did not conform to the traditional type because they included the novel provision that, though the Axis powers were expected to ratify, the treaties would come into force when ratified by the Soviet Union, the United Kingdom, the United States and France. They were, therefore, in principle, declarations of peace by the UN. The western powers made peace with the German Federal Republic in 1951 by unilateral declarations following negotiations of "contracts" ending the occupation, and with Japan in 1952 when a peace treaty of traditional type with that country went into force.

(Q. W.)

V. WAR AND MILITARY POLICY

War in the military sense is the art of forwarding group ends by the use of armed force; in Clausewitz's famous phrase, "the continuance of politics by other means." It includes military policy, strategy and tactics. (Tactics and strategy are treated under those headings; see also ARMY; AIR FORCES and related articles.)

Military policy is a branch of foreign policy. The latter has the general objective of securing the existence and forwarding the interests of the state. Military policy co-ordinates military means to these ends in time of peace as well as of war. It requires the identification of the potential enemy; the estimate of his strength and his weakness: the development of military resources, weapons and plans; and, generally, the continuous co-ordination of these activities with diplomacy. Ordinarily, the authority responsible for defense is organized separately from the foreign office responsible for diplomacy, but it is not easy to distinguish the functions of the two sharply. The capacity to make and retain allies and to advance mutual interests by peaceful means is perhaps the most important element in defense in time of war as well as of peace. The maintenance of this capacity is in the hands of the foreign office which is sometimes called the first line of defense.

The defense department or departments frequently develop policies which conflict with those of the foreign office. Military policy, which emphasizes military preparedness and the use of military threats or action to achieve national interests, tends to create international suspicion and to induce opposing coalitions. Consequently, countries which concentrate on military policy are more likely to initiate wars, to win the first battles, but to lose the war, than are those which concentrate on foreign policy.

States have varied greatly in military policy. In some, professional military men dominate the government and the mailed fist is only slightly concealed beneath the velvet glove in the conduct of foreign policy. In such states domestic policy is subordinated to military requirements in materials, resources and population, and in the maintenance of secrecy. morale and civilian obedience. Individual freedom is thereby reduced, the government controls economy, military forces are large and on the alert, and plans for mobilization and attack are continually developed by the military staffs. Such states have been characterized as "garrison states."

The opposite type insists on subordinating the professional military men to civilians at the head of the defense departments who are, in turn, subordinated to the chief executive or the legislature responsive to popular opinion. The foreign office and diplomacy usually occupy a position superior to the defense departments and usually minimize the use of force or threats. Military preparedness lags and if, as a last resort, armed force is used, materials, weapons and plans have to be in considerable measure improvised. The high economic level and the development of science and individual initiative which are likely to characterize such a state may, however, provide a suitable basis for such improvisation. Herbert Spencer distinguished these military and industrial types of states, but most actual states occupy points halfway between, varying considerably in military policy according to the changing tensions of international relations.

Military policy generally has a close relation to geographic position, political history and social ideals. States without geographical barriers protecting them from invasion of powerful enemies and with a history of frequent invasion are likely to be more dominated by military policy than are states which have long felt secure behind the shelter of mountains, deserts or oceans. Opinion in such states is likely to accept national power and efficiency as more worthy ideals than individual liberty and democratic discussion. The existence of these ideals will reciprocally influence the character of the state.

States also differ in the particular characteristics of their military policy. Some states emphasize the army, some the navy, some the air force. Some states give primary consideration to the armed forces, some to allies. Some emphasize weapons in being, some industrial potential. During the 19th century Great Britain emphasized sea power, Germany land power and the United States minimized all the armed services except when actually engaged in war, relying for security upon the oceans and the presumably friendly relations with Great Britain, which controlled the seas.

Conditions common to all states impose some limitations upon military policy. The nature of the objectives of the two opposing groups influences the intensity of the conflict. As a man threatened with murder will resist more fiercely than one threatened only with defeat in a boxing or wrestling match, so a group facing extermination or enslavement will make more effort than one which fears only the loss of a distant colony or a frontier fortress. In either sort of war the actual fighters will of course do their utmost, for no man ever killed or risked being killed wholly in cold blood. The difference will be the extent to which the furious emotions of combat will spread throughout the nation or other fighting group and the corresponding proportion of the available resources which will be diverted to military purposes. In practice, wars of extermination are rare. Each side prefers to ease its own task by giving the other something to hope for in case of surrender. Prolonged slaughter both frightens and disgusts normal men; they begin to fear the consequences to themselves should it continue indefinitely. Another check upon war is what may be called the irreducible minimum of individualism. Wars are community affairs in which individuals willingly participate only to the extent that they can identify themselves with their community through national patriotism or any other sort of loyalty. If any community is pushed too hard, the moral forces of loyalty and consequent self-sacrifice become exhausted and are replaced by the desire for peace at any price. These three, rational fear, disgust and the irreducible minimum of individualism combine to form a moral limitation upon military policy.

Wars not intended to end in the permanent political destruction of the conquered group may be called politically limited. Politically unlimited conflicts, although not so exceptional as wars of extermination, are historically rare. Even wars which temporarily reduce the conquered to impotence are greatly outnumbered by those in which the political aim of the conqueror is only to weaken the conquered without depriving them of independence. Modern instances are the Spanish-American War, in which the U.S aim of destroying Spanish sovereignty in Cuba was accomplished without the necessity for invading Spain itself, and the Russo-Japanese War of 1904 in which the Japanese aim of driving the Russians from Manchuria was accomplished without invading Russia proper. At the opposite extreme from the policy of extermination is the policy of "cold war," or "war of nerves," in which the object is to persuade another state to modify its policy and yield some political point by the mere threat of war without any actual fighting or casualties whatsoever. Between the policies of extermination and threat, the possible gradations are almost infinite.

Economic requirements always limit military policy. Fighting men cannot get their own living but must be supported either by the noncombatant parts of their own community or by seizing wealth belonging to their enemies. In practice, however, the moral and political limitations almost invariably create an imperative desire for peace long before the economic resources of the fighting group have been exhausted to the point of famine and pestilence. Nor is the degree of limitation concerned with the wealth or poverty of the fighting group. The question is entirely one of proportion, of whether or not the social order is strained by the diversion of a dangerous percentage of the available wealth to military and therefore to economically unproductive purposes.

Technical conditions which include the nature and the destructiveness of weapons, the level of tactical and strategic knowledge and the degree of peacetime preparedness, affect military policy especially by influencing the probable duration of war. The social destructiveness of war is not, however, directly related to the physical destructiveness of weapons. Periods of strictly limited and of imperfectly limited war have followed each other alternately without the slightest change in weapons. In every period the tools of peace are the weapons of war; in other words, the scientific knowledge and manufacturing skill which is available for the design and manufacture of arms equals that which is available for construction and for the other forms of producing wealth. Gunpowder was discovered toward the beginning of the modern scientific development which extended and enriched European civilization. A society which can manufacture poison gas can also produce antigas defense. On the other hand. two unarmed groups could kill each other off to the last man if they chose.

At the same time a military policy providing better armament, or organization, or more skillful commanders may effect a rapid victory in a struggle with a power of approximately equal resources. Similarly, technical superiority may permit a small, weak group to resist for a long time, sometimes even to conquer a group stronger than itself in every other respect.

Technological inventions during the 20th century, especially the airplane, radio and the atom bomb, reduced the protective influence of geographical barriers. and induced all states with sufficient power to attempt an independent policy to pay more attention to military policy. These inventions increased the disparity of military power between great and small states and induced some of the latter to abandon military policy altogether, placing themselves under the protection of a great neighbour. The increase of the destructiveness of war had. it is true, provided a strong impulse for the subordination of military policy to international organization, giving greater assurance of security through law. International institutions had not yet created confidence in the reliability of collective security. After World War II, military policy tended to dominate in all of the great powers.

VI. HISTORY OF WAR

The study of hostilities among animals can contribute knowledge of typical psychological situations leading to war; of the influence of specialized techniques (such as the panther's striking power, the antelope's fleetness, the buffalo herd's mass charge, the tortoise's heavy armour, the co-operativeness of the social insects) upon the frequency and intensity of war; of the relative survival value of different techniques upon the individual, the group and the species; and of the relationship of conflict, competition, co-operation, territorial control, hierarchic dominance, and other social and psychological factors related to hostilities upon the course of organic and social evolution.

War properly so-called, however. is a human phenomenon and its history may be divided into primitive, historic and modern warfare roughly in accordance with major inventions in the fields of communication and weapons. Historic warfare is distinguished from primitive warfare by the fact that it occurred among groups that used writing and usually the horse. Modern warfare began among groups that used printing and the gun. These inventions were rapidly followed by the steamboat, locomotive, motorcar and airplane; the telegraph, telephone, radio and radar; the rifle, machine gun and the chemical and atomic bomb; until warfare came to be conducted by instruments of communication, transport and destruction greatly extending the biological equipment of man or animals.

Primitive war was usually highly formalized. Ostensibly it had the object of vindicating the group's mores which were offended, or thought to have been offended, by a member of another tribe. War was seldom fought for economic gain or political conquest among the hunting and collecting peoples. With the advent of herding and agriculture the latter objectives played an increasing role. Whatever its ostensible purpose, primitive war served to manifest the unity of the fighting group, its distinctiveness from its neighbours and the reality of its customs and institutions. War distinguished the co-operating "in-groups" from all opposing "out-groups," thus contributing to its social solidarity.

Historic warfare arose when agriculture. communications and political organization had developed sufficiently to permit division of labour, the accumulation of surpluses and states of large area and population. Its characteristics differed among various civilizations and at different stages in the same civilization. The civilizations of Babylonia, of classical antiquity and of Japan appear to have been much more warlike than those of Egypt, China and India (see Wright, op. *cit.*, p. 572).

An individual civilization usually began with many groups, each with a ruler conscious of the religion, the organization and the economic needs of the group, struggling to maintain the group against the pressure of others and to increase its power. The interest of the group was identified with the interest of the ruler to maintain and augment his position, wealth and glory. Such struggles tended to reduce the number of independent groups by conquest—the principle of the fish in ancient Indian philosophy because it had been observed that the great fishes smalloned the smaller. The destructiveness of warfare tended to increase with the size of belligerents and the progress of military invention. The war of dash and maneuver tended to be succeeded by the war of mass and attrition, usually ending in the unification of the civilization by universal conquest. This was followed by over-centralization, corruption and decay, permitting the external and internal barbarians eventually to destroy the civilization and to begin the development of a new one. The great wars which usually preceded universal conquest were frequently accompanied by unsuccessful efforts at conciliation, disarmament and peaceful federation. This course of change can be studied in the civilizations of Egypt, Mesopotamia, China and India; and there is some evidence of similar changes in the warfare of the civilizations of Mexico, the Andes, Gaul and central Asia. The historic record is, however, clearer for the classic civilization of ancient Greece and Rome and the Christian civilization of medieval Europe.

1. Ancient War.—The early Greeks were in touch with the older Oriental civilizations, concerning which there is considerable information. One of the earliest Sumerian sculptures from Babylonia, probably dating from about 4000 B.C., shows soldiers fighting in close order, wearing helmets and carrying spears and shields. The chief technical innovation in oriental warfare of which there is knowledge was the introduction of the horse; with the aid of this powerful and originally terrifying beast, the Hyksos, an Asiatic and probably nomadic tribe, temporarily conquered Egypt about 1750 B.C. When first known to the Greeks, the orientals had long possessed organized and disciplined armies equipped with metal weapons, and to some extent with metal armour. They had infantry, cavalry, missile-using auxiliaries, fortifications and warships, distinguished from the merchant ships of the day by sharp proms or rams and propelled like those merchantmen by oars, with sails as auxiliary power. Existing Egyptian models show companies of soldiers uniformly equipped and marching in step. One oriental people, the Assyrians, had made conquest their chief business, specializing in war waged with great energy and cruelty until they themselves had been annihilated.

The Greek civilization, which afterward became Greco-Roman, entered in 431 B.C. a period of great and destructive wars lasting until 29 B.C. The Greek political unit was the city-state, which worshiped gods who were primarily local deities. Consequently, when the increasing pressure of population in 5th-century Greece could no longer be eased by colonization, there was no moral unity either political or religious sufficient to limit strife strictly. The first of the great Greek internal struggles, the Peloponnesian War between confederacies of city-states led respectively by Athens and Sparta, continued for 27 years with two short pauses, producing such a crop of atrocities that thereafter the tone of Greek life was permanently lowered. No lasting peace resulted from Athens' defeat. The rise of the half-Greek kingdom of Macedonia to dominance in Greece and the rapid conquest of the vast Persian empire by Alexander the Great enormously extended the area of Greek culture without ending its internal conflicts. The conquest and assimilation of the Mediterranean world by Rome, of which the chief military incident was the defeat of the Semitic, north African power of Carthage in spite of the temporarily successful invasion of Italy by a Carthaginian army under Hannibal, unified Greco-Roman civilization in what was, in a sense, a confederation of city-states. The last century of Roman expansion, however, saw a series of Roman civil wars which, although they did not affect the unity of the state, were accompanied by massacres and bred an intense longing for peace.

Technically the art of war improved throughout the period, with armies gradually changing from civic militias to mercenary forces Although all free citizens seem to have been legally liable for service in these militias, the recruiting field was narrowed by the universality of slavery and because the citizens had to find their equipment. It was not worthwhile to mobilize more than a handful of those too poor to buy armour, since (except for a brief interval under Alexander and his immediate successors) heavy infantry was the chief arm. The principal weapon of the Greek heavy infantryman was a thrusting spear, the formation being a single deep line called the phalanx. During the pre-Roman period light infantry, cavalry and siege artillery improved; catapults were sometimes used in open warfare as "field artillery." The Romans returned to dependence upon a civic militia of heavy infantry, but in a new form, the legion. They replaced the thrusting spear with two heavy throwing spears, and fought at close quarters with a short thrusting sword which could be effectively used in formations more flexible than the phalanx; the latter therefore could be out-maneuvered. Also, the legion stood in three lines, permitting successive shots and keeping the reserves out of the moral strain of being close behind the immediate combatants. Distant campaigning compelled the professionalizing of the legion coincidentally with the beginning of the Roman civil wars.

In A.D. 29 Augustus became emperor and established a strict limitation of war. He reduced the numbers of the professional army, which he set at about 333,000, and this tiny constabulary long guarded and policed the Roman world from the Atlantic to the Euphrates and from the Rhine to upper Egypt. He systematically disarmed the free civilians, who became unwarlike and remained so until long after ancient times.

The internal decline of Roman society was accompanied by a lowering of the quality of the Roman troops, which could no longer be paid or disciplined as regularly as before. Consequently, increased numbers had to be raised, the support of which burdened the diminishing revenues. By about A.D. 400, numbers may have reached 750,000. The army became chiefly barbarian in personnel. partly because barbarians were cheap to maintain compared with civilized men; partly because the latter were increasingly unwarlike. Meanwhile two combined causes made armoured cavalry superior to infantry; first, the need for mobility in an army used chiefly for running down raiders; second, the lowering of military quality which made infantry unable to resist cavalry charges without massing in close formations covered by hedges of thrusting spears. In turn, these close formations lowered infantry offensive power, making cavalry the offensive arm.

Nevertheless, except for the south and east coasts of Britain and perhaps a strip along the Danubian frontier, the Roman armies everywhere prevented the permanent occupation of imperial territory by the outer barbarians. In the 5th century, as the material side of civilization continued to decline, the reality of local government in the western provinces was taken over by barbarian hereditary commanders or barbaric auxiliary units in the Roman army. This process, however, is generally recognized by historical scholarship to have differed greatly from successful invasion. The commanders in question were usually Romanized or at least half-Romanized; in every case except the mutinous Vandal chieftain in Africa they acted legally as deputies of the emperors, and none except the Vandal ever made war on an emperor.

2. Medieval War.—The middle ages, from about A.D. 500 to 1500, strictly limited warfare within Christendom by a new moral unity centring in the catholic, *i.e.*, universal, church. Early in the period the empire gradually became Christendom, as the moral authority of the church increased, while the power of the emperors declined.

Technically, armoured cavalry remained the chief arm throughout the period, but before A.D. 800 the typical soldier in the west was no longer a professional, but a feudal militiaman. Professional armies, being expensive, were always small compared with the populations supporting them. To be effective they had to be regularly paid and capable of rapid movement over long distances, which conditions the debased Roman society, too impoverished to maintain its road system, could no longer fulfill. After the loss of many provinces to the fanatical Moslems, the western part of the diminished remnant of Christendom—its peoples still disarmed as they had been since Augustus—had to meet a new trial: devastation by mobile and ferocious raiders. Scandinavian sea pirates called Vikings, Magyar horsemen and Moslems. A remedy was found by organizing western Christendom for local defense on an aristocratic militia system under hereditary leaders. most of whom were descended from the wealthy class of the earlier dark ages, although some were "self-made."

Superficially; it is hard to recognize medieval wars as limited; all rich laymen were soldiers, and medieval literature is full of tales of battles, and medieval art full of every sort of military symbol. Nevertheless, the evidence is clear that the frequent armed strife between medieval Christians was socially trivial. The Plantagenet and Valois families could squabbie over the crown of France through the Hundred Years' War without general and lasting strain to the social order in France through such prolonged hostilities. Large armies operating far from their bases were exceptional; volunteer forces were raised for special occasions, usually crusades against non-Christians. The 50,000 volunteers with whom William the Conqueror is recorded to have invaded England were numerous for such a campaign. Private wars between nobles seem to have troubled general public order less than the violence incidental to modern labour strikes.

The essence of the strict medieval limitation of war was that prolonged offensive campaigns on a large scale within Christendom were made impossible. In general, Christians felt Christendom to be one country whose differences were unimportant compared with the gulf between Christian and non-Christian. Technically, limitation was assured by the nature of the military obligation and the taxing system. All freemen except the highest were bound by oath to serve an immediate superior in arms at their own expense; but except for the defense of their own locality they had to serve for 40 days only in each year. Beyond that time their superior had to pay them, and this the law and custom of the time forbade. The ordinary expenses of government had to be met by the hereditary ruler from the rents and dues from lands which he individually owned; he could not increase these rents and dues because they were fixed by custom. Emergency taxation was a free grant to the feudal superior by his inferiors, usually to a king by his great vassals, which they could refuse at will. Consequently most medieval armies were tiny. In the Albigensian crusade the decisive battle of Muret was won by a striking force of 900 armoured cavalry, supported only by an even smaller body of ill-armed infantry; while in famous fights like Poitiers and Agincourt the victors, the Black Prince and Henry V of England, commanded numbers of fewer than 8,000 and 15,000 respectively.

Through the early and central middle ages a typical army consisted primarily of armoured cavalry. Usually, but not always, infantry were ill-armed and of secondary value. On the defensive the armoured horsemen would habitually dismount, as Harold's elite did at Hastings, and form the front rank or ranks, while the lesser men stood behind them in a deep mass. On the offensive, although archers might support mounted charges with their fire, the average value of foot soldiers was slight. City militias were usually better than peasant infantrymen. Fortification was prevalent, while siegework declined, so that sieges remained long until near the end of the period.

Warships remained rowing vessels fighting by ramming or retrograded to sailing ships fighting by the primitive method of boarding.

Although the aristocratically commanded feudal militias followed up their success in repelling the Vikings and other raiders of the dark ages by crushing the Spanish Moslems and the pagan Prussians and Lithuanians, and by long maintaining themselves against the Moslems in distant Syria, nevertheless their military shortcomings were obvious. Their character made high training and discipline impossible. Consequently, western sovereigns often chose to use their scanty revenues to hire mercenaries with some professional skill who would at least remain while paid. These mercenaries were usually of a cosmopolitan sort, frequently unemployed and generally hated as savage plunderers. Throughout most of the period. the Byzantine emperors of Constantinople kept up a professional standing army which long maintained much of the high Roman military tradition.

In the 14th and still more in the 15th century the medieval limitation of war began to weaken. The moral authority of the church diminished through the corruption of the higher clergy. Sovereigns became more cynical and cruel. and war, although remaining small in scale, became more ferocious with the increasing employment of the mercenaries just described. At the same time military technique developed. The rise of mercenaries, although socially harmful, was technically a symptom of greater wealth and a more specialized economy. The English longbowman, drawing his bow to the ear, became a valuable auxiliary to the armoured man-at-arms. The Swiss, whose poverty made armour and horses rare among them, developed a true attacking infantry for the first time since the ancient Romans. Although armed chiefly with clumsy long pikes, their great attention to drill made their deep formations both mobile and maneuverable. The appearance of disciplined infantry diminished the importance of cavalry, and by improving pioneer work would in any case have shortened sieges. (See also NAVIES, EARLY HISTORY OF.)

3. Modern War.—Modern civilization was ushered in by the discoveries of Columbus and his contemporaries, bringing most sections of the world into continuous contact with one another; by the integration of modern states under absolute monarchs who claimed temporal sovereignty above the religious claims of Christendom; by the use of the printing press to make people conscious of vernacular languages and national differences; and by the use of gunpowder by sovereigns to reduce the castles and the autonomy of the feudal nobility. The first effective use of gunpowder was in siege artillery which, against fortifications unsuited to counter battery work, made 15th-century sieges rapid affairs. In 1453 the siege by the Turks of Constantinople, the most strongly fortified of medieval cities, lasted only jj days. Toward the end of the 15th century the French and Turkish governments raised small, permanent standing armies.

War has been an important factor in spreading western civilization throughout the world and in creating the conditions for a world civilization. Four phases can be distinguished in the history of modern war, the first three lasting nearly 150 years.

The ***Religious*** Wars.—In the first phase, ending in 1648, the chief military events were the religious wars. After about 50 years, during which the diminishing limitation of war inherited from the middle ages was further weakened, the moral unity upon which that limitation had rested was destroyed by the appearance of various Protestant religious bodies determined upon the reform of the church. When added to the struggle for power of the rising princes, the fearful popular passions resulting from this theological conflict produced a series of savage and de'structive wars culminating in the Thirty Years' War, the most horrible military episode in western history prior to the 20th century.

Throughout this phase, armies remained small in proportion to population, because much of the medieval feeling against taxation continued. The Spanish army which invaded the Netherlands in 1566 and proved invincible to the Dutch in mobile warfare numbered only 11,000; the peace strength of the largest early 17th century standing armies in Christendom, the French and Swedish, was only 15,000 each; and until after the end of the religious wars, concentrations of 20,000 men were seldom seen on either side in a battle.

The destructiveness and horror of the wars of the time resulted from the nature of the troops and the absence of a regular supply system. Militias of the medieval sort still existed but continued to decline. and were seldom used for serious fighting except in the case of civic militias defending towns. The typical soldier was the temporarily hired and ruffianly cosmopolitan mercenary, socially similar to his late-medieval predecessors in evil. The irregularity of his employment seldom permitted his' higher commanders to control him firmly. Indiscipline was increased by irregularity in pay; sovereigns were tempted to enlist more men than they could long support. The high discipline in the armies of Spain, the first military power of the period, owed much to the constant stream of bullion from Mexico and Peru. Worst of all was the chronic lack of an efficient commissariat. In the French and German religious struggles even a commander desirous of controlling his men was usually compelled to let them scatter to forage in order to live. The hardened scoundrels who ordinarily composed these foraging parties became a curse to the civil population.

No such orgies of wanton destruction and violent crime as those of the Thirty Years' War had been seen in Europe since the Viking raids of the 9th century. The constant ravaging bred famine and pestilence. Cannibalism was frequent; usually it was the dead bodies of executed criminals which were eaten, but once, in Alsace, prisoners were actually, killed for food. Historians long held that three-quarters of the German-speaking peoples perished, and later estimates of a loss of one-third put the dead at 7,000,000.

Tactically the wars of the time showed a rapid development of the revolutionary influence of gunpowder. Both siege and field artillery became handier and more mobile. In the early 16th century, before fortifications suitable both for resisting shot and for mounting cannon of their own were designed, sieges were lightning affairs. In 1523 the strong but old-fashioned defenses of Landstiihl in the Rhineland were battered down in one day. Later, however, earthworks and stone towers of a new type, capable of offering a long resistance, were developed. Field artillery scored its chief successes early in the period; at Ravenna in 1512 both French and Spanish guns played a great part, the French pieces contributing greatly to the final victory; and at Marignano in 1515 the French field pieces, firing upon the deep Swiss formations, prepared the way for the last great success of armoured cavalry of the medieval type. Increasing poverty caused by the religious wars seems later to have reduced the proportionate number of guns available. Both infantry and cavalry were increasingly armed with hand firearms. Late 16th-century cavalry tended to abandon the lance for the pistol, although afterward a return to shock action took place. Infantry muskets which could kill a horse at 400 paces—if they chanced to hit him—are found early in the period, and before its end about three-fifths of the average infantry unit were musketeers, the rest being pikemen for close combat. The use of armour steadily decreased; to be strong enough to turn bullets it had to be unbearably heavy.

In naval warfare the gun became the chief weapon. Since many guns made ships too heavy to be rowed, sails became the chief propellant outside of the Mediterranean where some row galleys were still found useful in the frequent summer calms. Tactics under sail, however, developed only slowly.

During the middle phase of the agonizing Thirty Years' War, Gustavus Adolphus of Sweden, in his brief but brilliant career, showed that the efficiency of armies could be increased and the social destructiveness of war simultaneously decreased by a regular supply service which permitted the men to be kept with the colours. Toward the end of that struggle the weakness of governments permitted the appearance of peace propaganda by broadsheets and other means. The peace of Westphalia (1648) established the doctrine of territorial sovereignty. Europe was permanently divided in religion under the theory that the sovereign could decide the religion of his subjects.

The 18th-Century Limited Wars.—From the end of the Thirty Years' War in 1648 to the attempt of the revolutionary French republic to enforce universal compulsory service in 1793, a strict limitation of war prevailed.

After the Thirty Years' War Europe was sick of blood, as ancient Rome had been after the civil wars before Augustus, and as the 20th century world was to be after 1918. The medieval idea of legitimate, hereditary government remained, together with much of the medieval social order and institutions. Upon these foundations, and especially upon the classical culture then common to all educated men. a new moral unity was built by means of a humanist cult of moderation, reason and decorum. Anything, so felt the men of Louis XIV's day, was better than the destructive passions which they despised under the common name of "enthusiasm."

The late 17th- and 18th-century conduct of land warfare carried further the military reforms of Gustavus Adolphus. Although a certain "floating supply" of irregularly employed cosmopolitan mercenaries remained, armies became permanent standing forces loyal to their sovereigns, who in western Europe were also their national leaders. Uniforms seem first to have been introduced under Louis XIV. Compared with the straggling and usually criminal plunderers who had preceded them, the new standing armies were habitually and fully supplied by an elaborate system of magazines, and were at the same time strictly disciplined, both to increase their tactical efficiency and to prevent their harming either friendly or nominally hostile civilians. Gen. Thomas Gage, commanding for England in Boston in 1774–7j, hanged two of his own soldiers merely for breaking into a colonist's shop. Under such conditions service in the ranks was little better than honourable slavery, so that only the more adventurous individuals or the poor would enlist. Frequent desertions furnished another argument in favour of strict control. Outside Prussia, militia service as a citizen-soldier almost disappeared. Only in Prussia was there a real system of training reserves for the standing army by a partial and highly selective system of compulsory service which spared the middle class and all artisans, taking only such peasants as could be spared from necessary farm labour.

Until about 1700 a dwindling proportion of infantry still carried pikes, but after that date the introduction of the bayonet made the musket and bayonet the universal weapons of infantry, and infantry tactics were directed toward developing the greatest possible firepower. A highly specialized tactical system adapted to the unfenced open-field agriculture of most of central and western Europe was devised. When deployed for battle the men stood in shallow formations usually three deep, and marched slowly forward to close with the enemy, carefully keeping their alignment, because any who advanced beyond their comrades would have their ears blown in by the detonation of the coming discharge. The high point of the art was to "reserve fire" until very near, to compel the enemy to throw away his fire by firing too soon, and then to pour in one's own volley at murderously close range while the enemy was reloading. All firing was supposed to be by volleys at command, and a single "perfect volley," like Wolfe's at Quebec in 1759, might decide a general action. The point about reserving fire explains the much misunderstood incident of the English officer who, at Fontenoy in 1745, taunted the French guards to fire first. Although he may have been drunk, he was by no means merely playing the fool; behind his bravado lay a sound tactical principle. The disappearance of the pike somewhat increased the combative value of cavalry. On the other hand, the shallow infantry formations diminished that of artillery; in no important battle do guns seem to have been decisive.

Although military numbers increased, especially around 1700 toward the end of Louis XIV's reign, in accordance with the general increase in population, aggregate wealth and strictness of political organization, nevertheless those numbers remained far smaller in proportion to population as compared with conscript forces of the 20th century. France in the time of Louis XIV had a population of about 19,000,000; if fully mobilized under universal service this would have given him nearly 2,000,000 soldiers, whereas his greatest numbers may not have exceeded 300,000. Eighteenth-century governments, although stronger than their early modern and medieval predecessors, had only limited authority over the persons and purses of the governed; and economies could not sustain more than 3% of the population in the field.

The humanist reverence for moderation and reason, together with the restricted numbers of the armies, their professional character and the high standard of training and discipline necessary for the tactics of the day, resulted in an economical conduct of war. Since governments seldom desired to destroy a rival government, but only to gain concessions from it, wars were for limited political objectives. Generals could not rashly expend soldiers trained for many years and not easy to replace. Accordingly, as in most professional armies throughout history, he who won by skill and craft was more admired than he who won by mere pounding. Superficially this seems contradicted by the amazing battle losses—the Russians at Zorndorf in 1758 had 37% and the Prussians 30% casualties in a few hours—and also by the extreme boldness of commanders like Marlborough, Charles XII of Sweden and Frederick. But the contradiction is more apparent than real: Marlborough was relieved for incurring excessive losses; Charles XII was admittedly rash to folly; and Frederick through all his daring offensives was always careful to keep his army in being to fight another year. Although in weak hands such methods degenerated into slackness and formalism, the essential reasonableness of the effort to win without excessive bloodshed was recognized.

The same desire for economical warfare was reflected in the part played by fortresses and entrenched lines. The great military engineer Sebastien Vauban constantly insisted that the besieging troops should keep covered, advance by sapping and wear down the garrison by their fire instead of assaulting. His chief technical invention was that of "parallels," successive entrenched lines to shelter the besieging infantry.

Naval tactics appropriate to the sailing ship fighting by gunfire were devised. Since ships are always much longer than they are broad, they can mount more guns on the broadside than either ahead or astern. Consequently the best formation of such a fleet is in line ahead which permits all broadsides to fire. Before 1700 warships had become specialized into ships of the line and lighter craft, the former being more stoutly constructed and mounting heavier batteries. Throughout most of the period naval battles were fought in parallel lines. Toward the end, however, the frequently indecisive results of such engagements and their disadvantage to the fleet (which, being to windward, must receive hostile broadsides without effective reply while bearing down to close quarters) led to the more decisive procedure of attempting to break the hostile line by cutting it in pieces.

Revolutionary and National War.—The great and destructive wars after 1793 were characterized by the widely extended authority of governments over the governed, the expression of this authority being the universal compulsory-service mass army with its corollaries of almost unlimited taxation and the regimentation of civilian life. All these things were first attempted by the revolutionary French, and few prolonged wars of the sort ended, otherwise than in the destruction of the government of the defeated side by revolution. The vast authority necessary for such colossal efforts was later to be called total or totalitarian.

After the destruction of the 18th-century humanistic moral unity which had insufficiently appealed to the imagination and had therefore attracted no strong loyalty, no moral force able to end or moderate potential strife was found. The destructiveness of war even to the victor, the material advantages of international trade. and the stability of the European balance of power regulated by British policy supported by sea power, limited fighting in Europe during the century between the Napoleonic Wars and World War I. During that century all the wars in Europe together cost few more lives than did the American Civil War (1861–65), itself less costly in life than the Lopez War in South America (1865-jo) , and the Chinese Taiping rebellion (1850–64). The driving force of interclass struggle for political and economic equality, and of international conflict for national self-determination and imperial expansion increased tensions during the latter part oi this period and led to the two most destructive wars of history from 1914 to 1945.

The first episode of the period is that of the Revolutionary-Napoleonic wars between France on one side and on the other, England, supported by a series of temporary coalitions, the last of which finally crushed Napoleon in 181j. In Aug. 1793 the French revolutionary politicians: justly fearing for their lives because of what all Europe felt to be their crimes! and terrified by the threatened dissolution of the French regular army, passed the first universal compulsory-service law in history. Although the immediate tangible result of this law has been much debated, it was, very logically, accompanied by attempts to control and compel the labour of the civilian population. Meanwhile new tactics and strategy were developed. The raw revolutionary levies could not be sufficientlydisciplined to stand in close formations and fire volleys at command Profiting perhaps by the experience of French officerswho had served in the American Revolution, those levies discovered the effectiveness of fire at will by agile swarms of skirmishers who offered no target for the volleys of the hostile regulars. For bayonet charges the revolutionaries formed in tumultuous columns of shouting men. At the same time their very deficiencies helped them to march well; the chaos of their supply system freed them from the slow movement and distribution of food to and from magazines, and compelled them to live off the country. Their lack of tents and baggage wagons left them unencumbered. Their new formations and their mobility. together with favourable chances of war against the sluggishly led armies of the First Coalition, saved the republic.

The high talent of Napoleon systematized the new procedure. For years his rapid marches. bold attacks, and contempt for the accepted rules of war bewildered opponents. Under him the French, who had already taken the offensive before his rise to power, entered every capital in Europe from Madrid to Moscow. Preoccupied with numbers, he used the conscription law of 1798, which replaced the original law of 1793 and made men liable from their 20th to their 25th year, to give him constantly larger armies. Another innovation was the concentration of guns in great batteries, thus making artillery again a decisive arm

Nevertheless his successes only increased his difficulties. England, secure from invasion through her superior fleet, could probably have been worn down had Napoleon achieved a true peace on the continent; but this he could not do. Although the Revolutionary-Napoleonic ideas appealed to certain elements, Europe could neither be revolutionized nor permanently cowed. Napoleon's constant aggressions, his violations of neutral states and the humiliating treaties imposed upon temporarily helpless enemies bred permanent distrust and desire for revenge. Chronic looting by the French angered Europe Rivals began to learn his methods; Austria, and to some extent Prussia, copied the French mass army.

In vain Napoleon increased his numbers. Feeling himself constantly driven to advance still further while an undefeated continental power remained, in 1812 he led into Russia the largest field army yet known to history, nearly 500,000 men. When inflexible Russian national spirit and the climate brought disaster, his political position at once began to crumble, as one by one every continental power turned against him. Although exhausted France raised another almost equally large army, French military quality was now declining. and in the autumn of 1813 the victory of overwhelming allied numbers at Leipzig was the beginning of the end.

The military history of the 99 years from Napoleon's fall to 1914 was marked by the survival of the mass army and by the absence (except for the American Civil War) of prolonged mass warfare. At first, universal service survived only precariously through military theory and through the action of Prussia. In a Europe as sick of blood as after the Thirty Years' War, a moderate peace was made with France and a short-lived attempt was made to renew the 18th-century limitation. France and Austria, although both retained universal legal liability for service, drafted so few men and for such long terms that their armies became professional in spirit. When in 1830 a Dutch force besieged the citadel of Antwerp, a mutual agreement to spare the town by confining firing and active operations to the side of the citadel which faced the open country was made in 18th century fashion. For a full generation Europe saw no war between great powers.

Nevertheless, 18th-century humanistic moderation could not really be revived. The closely connected forces of democracy and nationalism, both intertwined with the rise of the commercial middle class and with the romantic movement in thought and letters. again became active. A capital instance of romanticism was the undue admiration for Napoleon. Dazzled by his victories and moved by the melodrama of his meteoric rise and fall, men insufficiently considered the proved weaknesses of his political and military system. The work of both great 19th-century theorists of war, the French-Swiss, Antoine Jomini, and still more the Prussian, Clausewitz, is touched with this error. Clausewitz, although a profounder philosopher than Jomini, too often calls Napoleon "the god of war." Meanwhile Prussia, a poor but vehemently ambitious power, carried the revolutionary French idea of universal service even further by adding universal peacetime training.

Toward the middle of the 19th century strife between the great European powers was renewed with the wars for Italian and German unification and the Crimean War to check the ambition of Russia. The stability of the balance of power prevented these wars from spreading or seriously straining the social order of Europe. The American Civil War, a four years' war of exhaustion in which the defeated South fought to the last gasp, showed that fearful struggles were still possible. Socially, 1861–65 followed the Revolutionary-Napoleonic pattern of fierce popular passions and of mass armies raised by compulsory service. Technically, however, this was the first of the industrial wars. Machine industry and ease of communication by steamship and railway specialized the economy of various regions, making them vulnerable to blockade. The South had imported manufactured goods from the North and from Europe, paying for them by exporting tobacco and especially cotton, so that the cutting of its external communications by the North damaged it. Railroads also made it possible to supply large armies more easily and permit rapid strategic movement; steamships made movement at sea independent of winds, and at the same time tied fleets more closely to their bases by necessitating regular supplies of fuel. Other effects of industrialism upon naval warfare were evident in ironclad ships, anchored mines, torpedoes and a rudimentary submarine.

The first effect of industrialism upon land. tactics was to strengthen the defensive by arming the infantry of both sides with rifles, thus suddenly increasing the effective range of hand firearms from less than 100 to more than 600 yd. Cavalry charges, close infantry formations and volleys at command became equally impossible, and toward the close of the struggle troops in the presence of an enemy formed a habit of entrenching in order to live at all. The combination of rifle fire and entrenchment helped to postpone tactical decisions, thus tending toward a strategy of exhaustion. The use of railroads, on the other hand, made it possible for commanders to move troops rapidly and contributed to offensive power and the ultimate victory of the Union.

The significance of the new strong defensive, however, was lost upon Europe. The able Prussian chief of staff, Count Helmuth Carl von Moltke, is said to have contemptuously called the American Civil War, "a struggle between two armed mobs. . . from which nothing could be learned." European soldiers continued to believe in rapid decisions obtained by dashing, Napoleonic offensives. This belief, plus the skillful use of railroads, produced the rapid Prussian victories of 1866 and 1870. In 1866 Austria was beaten in seven weeks. In 1870 the French regular army was put out of action in four weeks. The real significance of both cases was the political weakness and inferior command of the victims. Austria was a dynastic state with no general patriotism; the France of 1870 was riddled with faction, while Moltke had developed a railroad system permitting rapid mobilization and a decentralized system of command suited to large-scale operations, since it left subordinate commanders free to act according to circumstances.

The moderate peace made in 1866 eventually led to an Austro-Prussian alliance, but the immoderate terms of 1871—by which not only German-speaking Alsace, but also French-speaking Lorraine were taken from France—produced lasting political strain.

Meanwhile every continental European power and also Japan hastened to organize a mass army on Prussian lines and to imitate Moltke's system of command and general staff. Although no two great European powers fired a shot at each other until 1914, the expense of the colossal armies and of the increasingly large and complicated warships which made up the battle fleets resulted in heavy political and financial strain.

During the 43 years of armed peace there developed an exaggerated cult of the offensive, regardless of the defensive strength of existing weapons. In vain did the Russo-Turkish, Anglo-Boer, Russo-Japanese and Balkan Wars repeat the lesson of entrenchment and a postponed decision. Before 1866 the rifle had become a breechloader; it became a magazine rifle and was next supplemented by the machine gun. Soldiers closed their minds and continued to estimate the strength of armies chiefly in terms of infantry numbers.

World Wars.—World War I began with the Austrian invasion of Serbia on July 29, 1914, followed by the entry of Germany as ally of Austria, of Russia as protector of Serbia, and of France and England in entente with Russia, later joined by Japan, Italy and the United States. After six weeks' fighting the two largest field armies ever seen, each of nearly 2,000,000 men and both seeking a rapid decision by means of a neo-Napoleonic offensive, found themselves stalemated in trench lines which soon stretched from Switzerland to the North Sea. As the most extreme measures, including the violation of neutral Belgium by the Germans in order to turn the French left, proved indecisive throughout this first phase of movement, so the failure to break the trench barrier determined the entire course of the war. Without room to maneuvre and thus condemned to frontal attacks, for more than four years the neo-Napoleonic generals who had despised fortification failed to solve the problem in siege warfare set by modern fire power, especially by the machine gun, combined with trenches and barbed wire. Notwithstanding delusive instances in which success repeatedly seemed within reach, every assault finally failed in mud and blood. Attempts to crush the defensive by multiplying guns and shells finally resulted in bombardments so severe that assaulting troops themselves could not advance across the chaos of shell craters.

Although all nations had declared war in a mood of exaltation, the most intense official propaganda could not keep the spirit of the original belligerents from being worn down by the long, grinding struggle. The enormous authority of governments and the use made of the credit system merely hastened collapse by intensifying the various war efforts. In 1917 the comparatively primitive social order of Russia dissolved after something like 8,000,000 casualties had been inflicted upon its ill-equipped armies, and France threatened to break down as large sections of its army mutinied. In 1918 the governments of Austria and Germany were overthrown by revolution, while their armies, although on the verge of dissolution, were still in the field. Total losses were estimated at 10,000,000 soldiers and an equal number of civilians dead, and 20,000,000 wounded as a direct result of hostilities, and another 20,000,000 dead from war-spread epidemics and famines throughout the world. Economic costs were estimated at $338,000,000,000, of which $186,000,000,000 were direct costs. This estimate did not consider the gains from war-stimulated production or the losses during and after the war from war-produced distortions in currencies and trade. (See Wright, *op. cit.*, p. 219; see also WAR FINANCE: COST OF WORLD WARS I AND II.)

Statesmen, soldiers and peoples everywhere agreed that such results must not be repeated. A political attempt was made to limit war through a League of Nations, but the United States failed to join and a treaty was imposed upon Germany which followed the evil precedent of those made by the French Revolution and Napoleon in that it neither reconciled the two parties nor destroyed the defeated politically.

Simultaneously there began an active discussion of military theory. On the one hand, serious military efforts would henceforward require even further extensions of governmental regimentation of all life. All policy must concentrate on success. On the other hand, a victory won by the methods and at the ruinous cost of 1914–18 was worth winning only on the melancholy assumption that the consequences of defeat might perhaps have been even worse. Thus the war of gigantic efforts and sacrifices was to be politically intensified and at the same time militarily moderated.

In general, the French and British authorities during the interwar period hoped to avoid undue loss by relying upon naval blockade while acting on the defensive by land, to which end the French strongly fortified their frontier with Germany in the Maginot line. The Germans, on the contrary, planned to achieve a quick decision. Under a dictatorial government they rearranged their national life, both to resist blockade and to build powerful striking forces.

The means by which the Germans hoped to gain a rapid and economical decision were based upon certain technical developments of the latter part of World War I, especially the high training of a military elite and the use of new, highly mobile military instruments. Intensive training had made possible the considerable success of their new offensive method of 1917–18, which involved extraordinary secrecy in the approach march. then a sudden and short bombardment without preliminary ranging shots, and finally a dashing advance in which the protection of the flanks of the leading units was left to the reserves at the disposal of the higher command. The motive power of two new instruments. the tank and the plane, was the internal combustion engine. In Nov. 1917 several hundred British tanks, without preliminary bombardment, had suddenly broken through the German front in an attack which if adequately supported by the British higher command might have ended the war. Planes, originally used only for reconnaissance and regulating long-range artillery fire, were fitted with bombs for attacking surface targets and with machine guns useful either against such targets or against other planes. The use of tanks and planes in highly trained hands and in co-operation with the older ground arms promised abundant opportunity for the rapidity and surprise which are the soul of maneuvre.

World War II began in Sept. 1939 with a German attack on Poland followed by the entry of France and England in fulfillment of their guarantees to Poland. Germany had rapid and cheaply bought successes in Poland in Sept. 1939 and in Norway, the Netherlands and France in May and June 1940. The Germans officially estimated their losses at 200,000, of which only 40,000 were killed. These figures may be compared with the French loss of 500,000 at Verdun in 1916, the German loss of more than half that number, and the British of more than 60.000 on the first day of the Somme attack alone. The Germans claimed to have captured some 400,000 prisoners in Poland, and 2,000,000 in the west in 1939–40. Even assuming the German admissions were far too low, the contrast of this first stage of the war with 1914–18 is striking.

The German method was to make every effort to achieve surprise, closely co-ordinating the action of planes and mechanized ground forces with each other and with infantry and artillery. A prominent feature was the rapid division and envelopment of large hostile forces through the sudden creation of deep salients thrust forward by mechanized columns. Throughout, the aim was to win by speed and maneuvre, confusing the hostile command and troops, rather than pounding on the latter in the 1914–18 fashion.

After the occupation of western Europe to the Pyrenees, Germany turned to the invasion of Britain by bombing docks, airports, factories and cities, but the superior quality of British fighters and aid from the United States saved the island from invasion. Germany, and Italy which had attacked France just before that country's fall in June 1940, then turned to the invasion of the Balkans, Greece and North Africa and in June 1941 to a mass attack on Russia. Russian defense in depth turned the tide at Stalingrad in the autumn of 1942 after Leningrad and Moscow had been under long bombardment and the Ukraine occupied to the Caucasus. Japan, at war with China since 1937, attacked the U.S. fleet at Pearl Harbor in Dec. 1941 and rapidly spread its empire through southeast Asia, the Netherlands Indies and the Pacific to the borders of India, Australia and Hawaii. In the summer of 1942, German forces in the Caucasus and Egypt, and Japanese forces in the Indian ocean threatened to meet at Suez. They failed to do so, however. and in Nov. 1942 the tide turned with U.S. victory at Guadalcanal in the Solomons, British victory at El Alamein in Egypt, Russian victory at Stalingrad and Allied landings in North Africa. The Allied nations, with their industrial machine in full production and their armies. air forces and navies increasing in power, moved in from the South Pacific: North Africa and the British channel. preceded by intensive strategic bombing after air superiority had been acquired in all theatres. The Russian and western Allies joined hands on the Elbe in April 1945 and the atomic bomb gave the *coup de grace* to Japan in August of that year.

The general horror at the mass massacres by the Nazis, the general alarm at the rapid initial success of Axis aggressions, and the general acceptance, at least formally, of the Atlantic charter (Aug. 21. 1941) and the Declaration of United Nations (Jan. 1, 1942) had produced a military coalition of the non-Axis world. The productive power of the United States, the tenacity of the British, Russians and Chinese, and the co-operative planning of the chiefs of staff brought overwhelming power to bear and induced unconditional surrender of .Italy on Sept. 8. 1943, of Germany on May 4, 1945, and of Japan on Sept. 2, 1945. The losses were greater than those of World War I in men (estimated 22,000.000 military and civilian dead and 34,000,000 wounded), four times greater in wealth (estimated $1,348,000,000,000 of which $1,167,-000,000,000 were direct military costs) and greatest of all in social and political disturbance. Long after hostilities ceased the cold war between Communist and non-Cdmmunist portions of the world: which had begun soon after the Yalta conference (Jan. 1945) marking the high point of the United Nations unity, was still going on. The two halves of the world were engaged in a race in both conventional and atomic armaments, and there had been small wars in which they opposed each other—in Greece, Vietnam, and especially in Korea. The Korean war, the first instance in which an international organization had utilized military force to suppress aggression, may have marked a new departure in the history of war. In these hostilities, which lasted three years (1950–53), 1,000,000 North Korean and Chinese Communist forces were in the field and an almost equal number were under the United Nations command, mostly from the Korean Republic and the United States, but including forces from 1 j other members of the United Nations. The battle dead on both sides were estimated to have exceeded 1,000,000 (United States: 34,000), which, added to the civilian deaths in Korea; totaled about 5,000,000.

The failure of the Maginot line and the rapid advances. first of the Axis and then of the United Nations, convinced many that the offensive had permanently gained over the defensive. The combined air-tank-infantry attack on land. new devices for amphibious landing, Schnorkel-equipped submarines, and strategic bombing culminating in the atomic bomb had prevented the deadlock of 1914–18 from recurring. Science, however, had begun to produce land mines, antitank guns and rockets with proximity fuses to stop the land and amphibious attack; sonar detection and air-borne rockets to destroy submarines; homing torpedoes and air-borne bombs to destroy capital ships; radar detection, jet planes, proximity fuses with antiaircraft guns, rockets, ram jets and guided missiles to stop the air attack. The offensive, on the other hand, was developing hydrogen bombs, intercontinental ballistic missiles and earth satellites. Thus the balance of offensive and defensive power was uncertain. But the Geneva Summit conference in August 195 j suggested that there was a general conviction among the governments that both sides in the cold war had sufficient retaliatory power to make hydrogen-bomb war suicidal, thus establishing an atomic stalemate in which no rational statesman would voluntarily initiate such a war. The possibility of wars not using such weapons (as in Korea) remained, with the danger that such a war might develop into a general war. Efforts continue to promote stability and a relaxation of tensions by negotiating political settlements. disarmament agreements and collective security arrangements t~ prevent small wars.

Whatever might be the balance of offensive and defensive, however, it seemed clear that science, industrial production and propaganda had become major instruments of war, and that war had come to be too destructive &en to the victor to be a useful instrument of policy. Nevertheless, political ingenuity was unable to construct an equilibrium of power or world institutions for law enforcement to control it.

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WAR, ARTICLES OF. In the United States, a code of regulations that formerly provided for the disciplinary government and administration of criminal justice in the U.S. army and air force. The comparable regulations in the U.S. navy were known as the Articles for the Government of the Navy and those for the coast guard as Disciplinary Laws of the Coast Guard. All were superseded in May 1951 by the Uniform Code of Military Justice that applied to all branches of the armed forces under the department of defense. The Articles of War trace their origin to the time of the American Revolution when the British army was regulated by the Mutiny act and the British Articles of War. These regulations were well-known to the colonists and were used as a guide in drafting the American military code.

Whatever its name, a military code consists of a system of rules specifying offenses for which a soldier may be tried. These offenses may be military in nature such as desertion, mutiny or cowardice, or they may be offenses which are regarded as crimes in civil life, such as murder, rape, larceny or arson. A military code also sets forth the procedure to be followed and frequently provides for safeguards to the soldier in the form of the right to counsel, appellate review, protection against compulsory incrimination and other rights generally provided to a person accused of crime. In the United States the military codes have always been established under art, i of the constitution which gives congress the power to make rules for the government and regulation of the land and naval forces rather than under the judiciary article of the constitution. *See* MILITARY LAW.

See also *Manual for Courts-Martial, United States, 1951* and Gordon R. Young (ed.), *The Army Almanac* (1959), *ch.* 17. (G. W. HI.)

WAR, LAWS OF: *see* LAWS OF WAR.

WARBECK, PERKIN (*c.* 1474–1499), English pretender, was executed for conspiring with the earl of Warwick (of the house of York) to contest the right of Henry VII (Tudor) to the throne. He was the son of Jean de Werbecque, a poor burgess of Tournai in Flanders, and his wife Katherine de Faro. According to his confession made in 1497, which may be accepted as substantially true, he spent part of his boyhood with various masters at Antwerp and Middelburg; went to Portugal about 1489 with the wife of the Yorkist, Sir Edward Brampton; spent a year there in the service of a knight named Peter Vacz de Cogna; and then entered the service of a Breton merchant named Pregent Meno, who took him to Ireland in 1491. There, by his own account, the citizens of Cork, seeing him dressed in his master's silks, insisted that he must be Edward, earl of Warwick, or a bastard son of Richard III. Eventually he was persuaded to impersonate Richard, duke of York, the younger of the murdered sons of Edward IV, and received encouragement from the earls of Desmond and Kildare. He was then invited to France by Charles VIII, but had to leave that country because of the treaty of Étaples between Charles and Henry VII (Nov. 1492). He went to the Netherlands, where he was welcomed as her nephew by the dowager duchess of Burgundy, Margaret, sister of Edward IV and Henry VII's bitter enemy. In 1493 Henry, who already knew the true name and history of the pretender. protested to the Burgundian government and to the regent Maximilian against Margaret's activities. When they refused to interfere, he prohibited all trade with the Netherlands (Sept. 1493). Two months later Warbeck mas accepted as a royal prince by Maximilian at Vienna. Next summer both were back in the Netherlands, Maximilian acknowledging Warbeck as rightful king of England. James IV of Scotland and a number of prominent men in England were drawn into the conspiracy, but through the treachery of Sir Robert Clifford, Henry VII discovered its details and the executions of Sir William Stanley and a number of Warbeck's English supporters broke the back of the plot.

Nevertheless in June 1495 Warbeck sailed from Flanders with perhaps 1,400 or 1,500 troops provided by Maximilian. On July 3 he appeared off Deal, but a few of his men who landed were captured and the attempt was a fiasco. An attempt on Waterford in Ireland, with Desmond's help. was no more successful and Warbeck then sailed off to Scotland. James IV welcomed him; arranged his marriage to Katherine Gordon, daughter of the earl of Huntly; and in Sept. 1496 helped him in a brief raid into Northumberland. Next year Warbeck went off to take advantage of the Cornish rebellion which had broken out in May as a protest against the direct tax proposed by the king to meet the cost of repelling the Scottish advances. However, by the time he landed at Whitesand bay, near Land's End (Sept. 7), the rebellion was over. Some country people did join him and he advanced as far as Taunton. There, on the approach of the royal forces, he deserted his followers on Sept. 21 and fled to sanctuary at Beaulieu in Hampshire. A week later he surrendered upon promise of pardon and made. full confession to the king. He was at first kept in very easy custody, but after attempting flight in June 1498 was more rigorously imprisoned and also made to repeat his confession twice in public. On Nov. 23, 1499, he was hanged for endeavouring to escape from the Tower with the earl of Warwick. (R. B. WM.)

WARBLER, a bird name applied to certain small song birds which belong to two quite different groups: new world warblers which form the family Parulidae and old world warblers of the family Sylviidae.

New World Warblers or Wood Warblers.—These comprise about 120 species of small songbirds (up to seven inches long), which form the new world family Parulidae (formerly Compsothlypidae or Mniotiltidae). Although these birds are closely related to the new world tanagers, they take their name from their superficial resemblance in form, structure and habits to the distantly related old world warblers, from which they differ most obviously in such technical details as having nine primary flight quills instead of ten as the old world warblers have.

The wood warblers are mainly North and Central American but a few live in South America. These birds live in forest, brush or in swampy grass country. They are active insect eaters, most species gleaning for their food from leaves and twigs or grass, for which their thin bills fit them; but the black and white warbler, *Mniotilta varia,* creeps along tree trunks and some species such as the ovenbird (*q.v.*) *Seiurus aurocapillus,* and the water thrushes, *Seiurus* species, walk (not hop) on the ground. Some species also fly out and catch insects on the wing. In eastern United States the autumn migrating birds are conspicuous in wood lot and hedgerow as they go southward to their winter quarters, often traveling in loose flocks. In colour, grays, olives and yellows predominate and the brighter males are often conspicuously marked with yellow, orange, red, black or white. Some species are brown above and spotted below.

G. RONALD AUSTING FROM NATIONAL AUDUBON SOCIETY

YELLOW WARBLER (DENDROICA PETECHIA)

Many wood warblers have weak, lisping songs but a few have loud voices. The nest usually is a simple cup in a tree or bush, but it may be placed on the ground or hidden in a hole, either in a tree or in the ground; the ovenbird makes a covered nest on the forest floor. The two to five eggs are usually white, speckled with brown, and the young are hatched with little or no down. Both parents share nest duties.

Among the better-known North American species are the gaily coloured yellow warbler, *Dendroica petechia;* the black and orange redstart, *Setophaga ruticilla,* of gardens and orchards (*see* REDSTART); the black-throated green warbler, *Dendroica virens,* with bright yellow cheeks and black throat, of woodlands; the yellow-breasted chat, *Icteria virens,* with its long tail and heavy bill, that skulks in thickets and gives an unusually loud variety of calls; and the yellowthroat (*q.v.*), Geothlypis trichas, with its black mask, that lives in bulrushes and marshy thickets.

Old World Warblers.—The family Sylviidae contains about 400 species, which are intimately related to the thrushes (family Turdidae) and the old world flycatchers (family Muscicapidae). Their name refers to the well-developed songs of some species. The family occurs mainly from Europe and Asia to Australia and Africa, but a few of these birds, notably the kinglet (Regulus) and gnatcatcher (*q.v.*) (*Polioptila*), live in the Americas. Many of these warblers in Europe are familiar enough to have received special names, such as the blackcap (*q.v.*) (Sylvia *atricapilla*), the mhitethroat (*q.v.*) (Sylvia communis), the chiffchaff (*Phylloscopus* collybita) and the goldcrest (*q.v.*), which in America is called a kinglet.

These warblers are mostly small birds (up to 12 in. long) with slender bills adapted for feeding on insects which they capture by gleaning actively among the leaves and twigs of the trees and shrubs, or among the grasses of upland or marsh, wherever the different species live. In colour they are variable but mostly dull: some tree warblers are predominantly green and olive; some grass warblers are streaked brown, buff and black above; others are more boldly marked; and the wren warblers of Australia may be black and white or with bright chestnut or shining blue in bold patterns. Usually the sexes are alike in appearance.

The birds pair and their nests vary from simple cups to domed structures placed in trees, bushes or grass, or hidden in the ground. The tailorbirds of the Indian region sew leaves together into purse-shaped containers for their nests. The eggs, from 3 to 12 in number, are usually speckled and the young, which may hatch downy or naked, are cared for by both parents. (A. L. Rd.)

WARBURG, OTTO HEINRICH (1883–), German biochemist (b. Freiburg, Baden, Oct. 8, 1883), son of the physicist Emil Warburg (1846–1931), was awarded the 1931 Nobel prize in medicine and physiology "for his discovery of the nature and mode of action of the respiratory enzyme." After studying at Berlin and at Heidelberg under Emil Fischer and others, he obtained doctorates in chemistry (1906) and in medicine (1911). In 1930 he was appointed director of the Max Planck Institute for Cell Physiology in Berlin-Dahlem. He concerned himself chiefly with the investigation of vital processes by physical and chemical methods. His work threw entirely new light on the complicated mechanisms by which oxidation and reduction is brought about in living cells. He showed that every breathing cell contains a respiratory enzyme, the nature of which he established as a ferrous organic dye.

His observations and methods found important applications in the study of cancer and one of his most important publications was Stoffwechsel der *Tumoren* (English trans. The *Metabolism of Tumours,* 1930). Warburg devised instruments and techniques which are widely used by chemists and physiologists. He became a member of the Royal society in 1934. (W. J. Bp.)

WARBURTON, WILLIAM (1698–1779). English critic and bishop of Gloucester, participant in many literary quarrels and an early advocate of abolition of the slave trade, was born at Newark, Nottinghamshire, on Dec. 4, 1698, son of the town clerk. He was ordained in 1727. During 18 years in the parish of Brant Broughton, Lincolnshire, to which he was appointed in 1728, he wrote The Alliance Between Church and State (1736) and The *Divine* Legation of Moses in two volumes (1737–41). In the latter, his best-known work, he demonstrated, on deist principles, the divine authority of the Mosaic writings, which deists denied.

Warburton won Alexander Pope's friendship through a series of articles in The Works of the Learned (1738–39) defending the Essay on Man against the *Examen* of Jean Pierre de Crousaz. Through Pope he met Murray, afterward Lord Mansfield, and Ralph Allen, who, said Johnson, "gave him his niece and his estate, and, by consequence, a bishopric." Warburton's edition of Shakespeare, incorporating Pope's earlier work, appeared in 1747, Sir Thomas Hammer's unauthorized use of his earlier notes on Shakespeare led to a heated controversy. Warburton defended his Divine Legation against continuing attacks, and disputed with Bolingbroke over Pope's behaviour in regard to the Patriot King. His edition of Pope's works appeared in 1751. A series of preferments culminated in his appointment to the see of Gloucester in 1759. He defended revealed religion in his View of Lord *Boling*broke's Philosophy (1754) and Remarks (1757). His biographer Richard Hurd shared in the writing of Remarks, which was directed toward Hume's Natural History of Religion. In 1762 he attacked Methodism in The Doctrine of Grace. He died at Gloucester on June 7, 1779.

Warburton's works were edited (7 vol., 1788) by Hurd with a biographical preface, and the correspondence between the two friends—an important contribution to the literary history of the period—was edited by Parr in 1808.

See John ***Selby*** Watson, ***Life of Warburton.*** (**Pa.** H.)

WAR COLLEGES (in some countries called staff colleges), institutions for the instruction of military officers in the art of war. They form the highest level of military education. Officers are usually assigned to them between the ages of 30 and 40 for periods of 6 to 12 months. They are distinct from technical military schools, and deal only with the higher direction of war, grand strategy and staff work.

In the United States the Naval War college (founded 1884) at Newport, R.I., the Army War college (1901) at Carlisle barracks, Pa., and the Air War college (1946) at Montgomery, Ala., are maintained by the three services separately. The National War college (1946) at Washington, D.C., takes 100 to 125 officers from all the services each year, preparing them for the highest staff and command responsibilities and especially for joint commands. The Industrial College of the Armed Forces, also at Washington, trains officers in logistics and industrial mobilization.

In Great Britain the navy, army and air force each have their own staff college. In addition the ministry of defense maintains the Joint Services Staff college (for instruction in interservice staff duties) and the Imperial Defence college. At the latter, founded in 1927, courses of one year's duration are attended by service officers from all commonwealth countries and by civil servants, with the object of promoting close co-operation in military planning at the higher level. There is also a Civil Defence Staff college, maintained by the home office, where short courses are held for those responsible for organizing civil defense.

Australia, Canada, India and Pakistan have their own war and staff colleges (under various names), each of which reserves vacancies in its courses for British service officers and those of other commonwealth countries.

At the United States, British and commonwealth colleges vacancies are often allotted to officers of the armed forces of allied and friendly countries.

In France the system is similar with the three armed services operating war colleges. Higher phases of instruction are given in the Cours Supérieur Interarmées (joint services advanced course), the Centre des Hautes Etudes Militaires (centre of advanced military studies) and the Institut des Hautes Etudes de Défense Nationale (national defense college of higher studies).

Higher military education in the Soviet Union is more specialized, and great stress is laid on technical preparation. At Leningrad there is the Budyenny Military Electrotechnical academy, and also the Military Air Engineering academy. At Moscow the Zhukovski Air Engineering academy trains engineers, aerodynamicists and aircraft designers.

The Frunze Military academy, also at Moscow, is a staff and command school, training officers of all services for duties up to the level of army corps commands. The topmost level of military education in the Soviet Union is the Voroshilov Higher Military academy in Moscow. Roughly equivalent to the National War college in Washington, it prepares selected, mature officers of all the services for the highest commands.

Co-ordination and guidance of all higher military education in the Soviet Union is vested in a special organization, GUVVUZ, or Managing Department of Higher Military Teaching Establishments. The chief of GUVVUZ is on the staff of the defense ministry and also is a deputy minister of education, linking the military and educational bureaucracies.

Most countries with sizable military forces have war colleges.

At Paris, the NATO Defense college prepares selectqd officers from the North Atlantic alliance countries for NATO staff and command duties. (W. H. HR.; C. N. B.)

WAR CONTROL OF FOOD. Evolved by trial and error in World War I, food control became in World War II an indispensable part of war economy. Shortage of food arises in time of war partly because supply is reduced by enemy action and partly because demand is increased by the needs of the fighting services and by higher incomes of civilians. In countries like Great Britain, dependent for more than half its food on imports, food shortage during both wars was accentuated by loss of shipping and scarcity of foreign exchange. Food control became necessary for (1) maintenance of an adequate supply in spite of reduced imports; (2) regulation of prices, margins and profits; and (3) ensuring an even flow of distribution and a fair allocation of supplies to consumers. (See RATIONING.) (E. M. H. L.)

UNITED STATES

World War I.—The first United States experience with food control on a significant scale was obtained during World War I. On Aug. 10, 1917, legislation was enacted giving the president extensive powers to control production, distribution and prices of foods, feeds, fuel, fertilizer and items used in their production. President Wilson immediately established the United States Food administration and appointed Herbert Hoover food administrator.

In the administration of the Food Control act, particular importance was attached to the problems of cereals, sugar and fats. The act made special provision for guaranteed minimum wheat prices to encourage production. For a similar purpose with respect to lard and pork, the Food administration also announced that it would attempt to maintain hog prices. Buying and selling of critical foodstuffs was centralized to control the influence on prices and assure supplies for the government and for export. An International Sugar committee was formed to buy the Cuban crop for allocation among the allied countries, and domestic sugar supplies were purchased for resale at pooled prices.

Other activities of the Food administration covered a wide range and applied in some measure to nearly all foods. Prominent among these activities were efforts to limit price advances, with particular emphasis upon the limitation of margins and maximum rates of profit for food processors and distributors. The major reliance was placed upon so-called "voluntary controls" of various types, although extensive use was also made of the broad licensing powers conferred by the Food Control act. Administration was decentralized so far as possible, and state, county, municipal or local agencies were given a considerable degree of independence in carrying out some activities.

World War II.—In World War II food control was undertaken on a much larger scale. Little reliance was placed upon voluntary methods; compulsory controls, sometimes of great complexity, were used in a wide variety of situations.

Activities during the period of defense preparation and through most of the first year following the attack on Pearl Harbor in Dec. 1941 reflected the controlling official view that food would not become a significant element in United States mobilization for war. On the contrary, it was feared for a time that problems of farm price and income support would be made more difficult, since in 1939 the first effect of war in Europe was a further reduction in the foreign demand for United States agricultural produce. Immediately after the invasion of Poland, Secretary of Agriculture Henry A. Wallace set up an advisory council to consult on wartime problems of agriculture. This council maintained the general position that such adjustments as might subsequently be required should come through voluntary co-operation between government and the food industry rather than the imposition of regulations.

Several significant proposals for action on the food front were attempted within the National Defense Advisory commission, reestablished by the president on May 28, 1940. The staff of the co-ordinator of national defense purchases took the lead in proposing the reorganization and advance planning of food procurement by the military. Representatives of the consumer advisor co-operated on these procurement problems and initiated the commission's recommendation to the secretary of agriculture which led to his first action to secure an increase in hog production in 1941. Staff members of several divisions within the NDAC collaborated with representatives of the department of agriculture, bureau of the census and the bureau of the budget in formulating plans for gathering comprehensive information regarding the adequacy of available food storage space. This proposal was rejected by the NDAC transportation division at the insistence of its warehousing representative, with one result that in 1945 the special committee to investigate food shortages for the house of representatives reported "one of the fundamental mistakes made in the war-food program was in the failure to expand cold-storage space in keeping with the increases in production which farmers were asked to make."

During the life of the NDAC, the agricultural adviser, Chester C. Davis, called attention to some of the important food problems that might be in the offing. In testifying on the proposed lend-lease legislation, he took the lead in advocating that it be made applicable to food. In March 1941, Davis also recommended to the president that he establish a food organization headed by a strong administrator, to obtain information regarding food supplies and requirements and carry out other features of the government's food program. The president rejected this proposal and transferred the functions of the agricultural division of NDAC to the department of agriculture on the grounds that it had the facilities for co-ordinated action with regard to food and could avoid confusion and duplication. The president added that since the British were interested in obtaining only a few commodities for which quite complete information was available "it seems inadvisable just now to risk creating the alarm that might arise from a broad survey of agricultural supplies . . . . For the same reason, I do not think that we need to establish an office of food supply or food administration at this time."

This decision more or less set the limits within which food problems would be considered for the next several months. The department of agriculture would undertake such co-ordination of its established peacetime activities as seemed necessary to promise "first the guarantee of an adequate supply of food for the needs of this nation and supplemental needs of those nations whose defense is essential to this country, and, second, the provision of sufficient agricultural raw materials for expanded defense production." (Letter from the president to the secretary of agrioulture, May 1941.) It also would assume full responsibility for programming and procurement of food to be supplied on lend-lease. Co-ordination of military procurement was continued in the Office of Production Management, established in Jan. 1941. Some food responsibilities also were assumed by the Office of Price Administration and Civilian Supply, created by executive order in April 1941, although authority was vague and only minor problems of food pricing were expected to arise, chiefly in connection with imported items. In this period limited activity also was undertaken on such matters as export control, import control, foreign development, and foreign procurement, by a succession of agencies: the Office of Export Control, established in July 1940; the Economic Defense board, created in July 1941; and the Board of Economic Warfare, formed in April 1942.

Creation of the War Production board and enactment of the Emergency Price Control act in Jan. 1942 increased the complexity of agency relationships in dealing with food matters. Powers of the WPB covered allocation; planning of food and fibre requirements; control of industrial capacity, raw materials and labour used in the manufacture of food supplies and equipment; and assignments of shipping space for the importation of foods. Under the allocation authority, WPB determined when food commodities should be rationed and delegated authority for rationing to OPA through directives issued by the chairman.

The Price Control act made OPA responsible for preventing inflationary price rises, but effectively restricted this responsibility by making price control action on agricultural commodities subject to special standards and requiring prior approval by the secretary of agriculture. During the period of congressional deliberation which resulted in the inclusion of these provisions demanded by agricultural interests, there began the controversy between OPA and the department of agriculture which intermittently characterized their relations thereafter.

By the fall of 1942 the arrangements for handling food problems began to be recognized as inadequate. Shortages of meats, fats and oils, dairy products and processed foods were becoming apparent. With full employment and higher money incomes for low-income families, together with the shortages of other goods which limited alternative spending opportunities, the domestic civilian demand for food—particularly for animal products—was increasing rapidly. Military requirements were expanding. Great Britain and the U.S.S.R. were requesting large quantities of food under lend-lease arrangements, and already difficulties were arising in filling these requirements with appropriate types of foodstuffs. Finally, the Allied invasion of North Africa in Nov. 1942 brought up the problem of food for liberated people.

Important aspects of the general problem had been outlined early in the year in a report submitted by a committee established to examine the fats and oils situation. This led to an exchange of correspondence between the chairman of WPB and the secretary of agriculture over the possibility of revising the existing assignment of food responsibilities, but no action was taken at that time. Subsequently an attempt was made to reconcile conflicting proposals for the co-ordination of food activities in the establishment of a food requirements committee in June 1942. The secretary of agriculture was made chairman of this committee, which reported to the chairman of WPB and comprised representatives of agencies having significant food responsibilities. In practice this committee did not prove to be an effective administrative device.

Food price control continued to give rise to many difficulties. During the summer of 1942 friction between the OPA and the department of agriculture became acute over questions relating to the agricultural commodities to be controlled, the levels at which ceilings should be fixed, farmer liability under penalty provisions of price regulations, and relationships between ceilings and the price supports used to encourage production. In Oct. 1942, the Price Control act was amended by enactment of the Economic Stabilization act which modified somewhat the special standards applicable to agricultural commodities. In the same month the Office of Economic Stabilization was established by an executive order which gave the director authority to settle differences over food price policies. Under this arrangement, differences between agencies over food matters were to be referred to the chairman of the WPB if they involved supply or distribution, but to the director of economic stabilization if they related to pricing problems. The OES did not attempt to participate in the formulation of integrated programs, and mostly preferred to take jurisdiction after agency disagreements had become clearly defined. Hence it performed a function of arbitration and compromise, but contributed little toward the reconciliation of fundamental conflict between the price stabilization program and the system of floor prices administered by the department of agriculture.

In Dec. 1942, President Roosevelt issued an executive order directing the secretary of agriculture to "assume full responsibility for and control over the nation's food program" and transferring to him additional authority, largely from WPB. Subsequent orders were issued and organizational changes were made within the department, including the establishment of a War Food administration in March 1943 and its abolition in June 1945. But the order issued in Dec. 1942 fixed the main pattern of food administration for the remainder of the war.

Under this arrangement the department of agriculture assumed primary responsibility for the co-ordination and direction of activities relating to: (1) the planning of food requirements, both domestic and export; (2) food production and processing; (3) allocation, distribution, and priority controls; and (4) procurement of food by the military services and buying for lend-lease, foreign relief and other government programs. An extensive system of interagency committees was developed for administration of the requirements and allocations work, and for participation in the Combined Food board—an agency that had been established in June 1942 to facilitate consultation among British, Canadian and United States food authorities. These functions, together with its position as procurement agency, gave the department control over food shipments for lend-lease and foreign relief, over the control of commercial exports, and over the development of production on procurement of foods from other countries. To encourage production, goals were announced for each important commodity, and returns to farmers were supported through commodity loans, direct purchase and subsidies, as well as by allowing market prices to advance. To ensure proper distribution of supplies and aid public procurement, a variety of food distribution orders and reservation, or "set aside," orders were issued. Allocation decisions governed the supplies available for rationing. Administration of food rationing remained in the OPA, along with price control, and was affected very little by the transfer of allocation powers from WPB to the department. Development of the various detailed regulations, orders and other methods that were used for food and related items in itself represented a considerable accomplishment. There were many imperfections, administration at times was lax or unstable, and sometimes evasion or violation was extensive. Although action often was belated and frequently received much criticism, real progress was made in the development of control techniques applicable to the problems that were recognized.

After enactment of the Economic Stabilization act, the rapid advance of prices was effectively checked in 1943. Up to that time, food prices as a group had increased by approximately 40% over their level in 1940. From then on they changed relatively little until controls were suspended.

The appearance of shortages in 1942 and the prospect of other difficulties ahead focused attention upon food rationing. Controls were put into effect for sugar in April 1942, for coffee in Nov. 1942, on processed foods in March 1943, and for meats, fats and certain dairy products also in March 1943. It was estimated that these programs covered roughly one-third of the food distributed for civilian use. Although some features were obviously inadequate, rationing was remarkably effective at first. This effectiveness deteriorated, however, especially in the case of the most important meats and fats program, and effective control was lost well before rationing was abolished.

From 1941 onward, increased production of any item found to be in short supply was generally emphasized as the most important goal of wartime food policy. By 1944 food production reached a record level officially estimated at 38% above the 1935–39 average. Out of the supplies available, the country provisioned the best-fed military forces in history, maintained restricted commercial exports, and expanded lend-lease food allocations until in 1943 they amounted to slightly more than 8% of the total. But the largest part of the increase in supply was absorbed by the continuous rise in domestic civilian consumption.

The expansion in gross agricultural output that made possible these increases was mostly accomplished by the end of 1942. It was achieved with moderately expanded acreage, a curtailed labour supply, limited additions to farm equipment, and an increase in the use of fertilizer. Most important of all, it benefited from favourable weather conditions that continued throughout the war.

Involved in this expansion was a spectacular increase in the production of oil-bearing crops to a high in 1943 that was 86% above the 1940 level. This was of particular importance in partially compensating the curtailment of imports. The largest components in the total expansion, however, consisted of increases in feed production and in livestock production brought about by the rise in civilian consumer demand and official emphasis upon the alleviation of meat shortages. The upsurge in livestock production reached its peak in 1943, but remained high for the remainder of the war period.

Policies during 1944–45 reflected alternate fear of excessive food surpluses and concern over shortages. In the spring of 1944 it was believed that the war in Europe would be over by the end of the year, and government procurement was curtailed. Record marketings of hogs created temporary gluts in stockyards and processing plants. To provide outlets for the enlarged supplies of pork and lard, export controls were lifted and meat rationing was in effect suspended. As a result, civilians in 1944 consumed 2,500,000,000 lb. more meat than had been estimated as their requirement. Per capita meat consumption for the year was approximately 150 lb. compared with a prewar average of 126 lb.

By late summer. markets had been cleared but the policy of holding down government inventories mas continued. In the late fall and winter it became apparent that optimistic expectations had not materialized and that commitments for lend-lease and relief requirements could not be filled in the months ahead. Attempts were made to restore the effectiveness of rationing and other controls, but the deterioration had gone too far. The early months of 1945 saw a genuine crisis in the administration of food affairs.

After the German collapse in May and the Japanese surrender in Aug. 1945, most food controls were abolished or relaxed in response to new fears of price-depressing surpluses. This action did not anticipate the acute need for additional food that would soon arise in Europe and some other parts of the world—needs that were aggravated but not caused by disappointing yields abroad. Hence the most important food crisis of the war developed about six months after the cessation of hostilities.

In Feb. 1946 Pres. Harry S. Truman asked 12 prominent citizens to collaborate with former President Hoover in working out a voluntary program to conserve food grain for export in the pattern of the action he had directed during World War I. Although production continued to be large, and after 1943 some progress had been made in shifting the emphasis from feed and livestock to the production of food grains, the supplies simply were not available. The reserves of wheat had been fed to livestock after the so-called "surpluses" of feed grains on hand at the beginning of the war had been used up in the expansion of livestock production. (See also INDUSTRY AND TRADE, WAR CONTROL OF.)

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GREAT BRITAIN

World War I.—During the first tno years of World War I food traders continued to operate much as in normal times. Business as urual and the free play of supply and demand were accompanied by steadily rising prices with wages lagging behind. The earliest example of state interference in Great Britain nas the creation in Aug. 1914 of a royal commission to undertake the purchase and import of sugar. when supplies from central Europe were cut off. Early in 1915 the board of trade undertook the import of meat for the army but left civilian supplies to private trade.

On April 1, 1916, the use of cereals and sugar for brewing was limited, and in Oct. 1916 a royal commission on wheat supplies was established. leading to bulk buying of imported wheat and other cereals on behalf of the Allied governments. This was followed by the appointment of Lord Devonport as the first food controller. To economize wheat by increasing the rate of flour extraction the flour mills were taken over and run on government account as from April 1917. In June 1917 Lord Devonport mas succeeded by Lord Rhondda who brought with him U. F. Wintour and E. F. Wise from the war office with far-reaching plans for controlling supplies, prices and distribution. The price of bread was reduced with the aid of a subsidy from one shilling to ninepence for a four-pound loaf. A descending scale of prices was fixed for livestock. which was partly designed to give effect to a policy of reducing the number of cattle. This was followed early in 1918 by the institution of government purchase and slaughter of livestock and centralized distribution of both home-produced and imported meat.

This ambitious scheme, conceived and organized by Sir Francis Boys as director of meat supplies in 1917 and 1918, was bequeathed by him to his successor Sir Henry Turner in 1940, who directed it during and after World War II. Under Lord Khondda not only cereals, sugar and meat but butter and cheese, bacon and ham, oils and fats, canned goods. eggs, tea and fruits were imported by the government. Home-produced food, such as milk, fish: potatoes and vegetables! proved more difficult to control; when maximum prices were fixed without control of the supply, as for rabbits, they tended to disappear from the shops.

From 1917 to 1921 the ministry's turnover was £1,200,000,000 on which its net profit after paying expenses was about £7,000,000; in addition the wheat commission's loss on the bread subsidy was £138,000,000, and the sugar commission ended with a loss of £22,000,000 in 1921.

Distribution and Ration Levels.—The first step in control of distribution mas taken in Nov. 1916 when allocations of sugar to wholesalers were cut to 60% of the amount issued in 1915. The wholesalers were responsible for passing on the cuts to retailers and manufacturers. This made no allowances for changes in trade or movements of population and since it gave no assurance of fair distribution to consumers, led to queues and growing unrest. For nearly a year the cabinet could not make up its mind to authorize rationing, partly for fear that it mould encourage the enemy, and it was not till Jan. 1918 that rationing of sugar was started. Queues for butter, margarine and meat were the next problem, and local rationing schemes were authorized. In London half a million people were standing in queues every Saturday during January and February; but after the rationing of these foods started on Feb. 25 queues practically vanished. On April 7 meat rationing was applied to the whole country. Finally on July 14, 1918. only four months before the Armistice, new ration books were issued covering sugar, meat, bacon and fats.

World War 11.—Experience gained in World War I made it clear that in the event of another war food control would be essential. At the outbreak of war in 1939, free markets for grain, sugar, meat, dairy produce and oilseeds were suspended, prices were frozen. stocks at home and afloat were requisitioned, and the ministry became the sole buyer of imported supplies. In the absence of a ministry of shipping the ministry of food made its own chartering arrangements with a committee of the Baltic exchange; all refrigerated space was voluntarily placed at the ministry's disposal by the liners' conferences. Imports of less essential foods were allowed to continue for several months without hindrance and it was not till March 1940 that control of imports and shipping was complete enough to ensure that the best use could be made of the limited tonnage available. Buying agencies were established abroad and bulk contracts were made with overseas governments or producers' organizations. In 1941 a British food mission was sent to the U.S. and in 1942 co-operated in setting up a Combined Food board charged with the duty of allocating world exports of basic foods. On arrival at British ports the task of handling, storage and distribution to wholesalers or processors was entrusted to special wartime associations of importers acting as the ministry's agents.

In World War I the wheat commission employed a few selected brokers and the device of creating *ad hoc* wartime companies to act as the ministry's agents had been applied only to oilseeds which were handled by the United Kingdom Oilseed Brokers association. In World War II this device was applied with minor variations to most food imports. Thus the first-hand distribution of meat was carried out by the Meat Importers National Defence Association Ltd. (M.I.N.D.A.L.), of bacon by B.I.N.D.A.L., of butter and cheese by a Butter and Cheese association, and of imported and home produced eggs by the National Eggs Distributors association. By means of a collective contract with the whole of a trade it was possible to override existing trade connections without giving rise to charges of discrimination or claims for compensation and to provide an agreed rate of remuneration for services rendered by the trade as a whole. The trade was given an incentive to operate economically by pooling its resources and dividing the work and remuneration equitably among its members.

Control of Home-Produced Food.—One of the chief differences between the two wars lay in the more complete control of home-produced food. In this the ministry was helped by prewar producers' marketing boards, especially for milk and potatoes, whose organizations were well adapted to centralized control. In England and Wales all milk collected from farms was bought at fixed prices by the Milk Marketing board who then sold it to the ministry for allocation to distributors and manufacturers of milk products. Potato growers received a fixed price negotiated each year and the ministry undertook to buy any surplus not disposed of through private channels. By controlling transport and prices it was able to ensure a regular flow of potato supplies and encourage the storage of long-keeping varieties. Deteriorating and surplus stocks were disposed of for processing or feeding to stock.

For the control of home-grown cereals the ministry relied on grain merchants certified under the prewar Wheat act. All millable wheat went to controlled flour mills to be milled into flour of a prescribed grist. When the extraction rate was raised to 85% or more, imported white flour and sometimes a small amount of other cereals were added as an admixture. Sugar beet was collected as in peacetime by the beet factories. Control of eggs was exercised through authorized packing stations where eggs were bought on the ministry's account and resold at a subsidized price to retailers for allocation to consumers. The most elaborate scheme was that for meat and livestock, which was based on the 1918 plan referred to. Each farmer had to sell his livestock for slaughter through specified collecting centres, or, in the case of pigs, at bacon factories, where they were graded and paid for by the ministry's agents. The ministry prohibited private slaughter, save in exceptional cases, and slaughtering was concentrated in 600–800 slaughterhouses instead of about 16,000 before the war. In this way leakages to the black market were virtually eliminated, and all meat, except rabbits, game and poultry, was obtained by the ministry for resale to retail-butchers to meet the ration requirements of their registered customers. As in 1918, wholesale distribution of both home-produced and imported meat was entrusted to eight regional Wholesale Meat Supply associations, which were wartime companies including as members all dealers and distributors of imported and home-produced meat.

Control *of* Prices *and* Profits.—In World War II prices were more effectively controlled than in World War I. Relations between the ministry and the food trades started on a basis of mutual confidence which was further developed under Lord M'oolton who became minister of food in 1940. Plans of control had been worked out beforehand and two general principles had been agreed, first that so far as possible no firm should be allowed to improve its competitive position as a result of war; and secondly, that so far as loss of trade or good will was inevitable, it should be fairly spread without discrimination. This led to willing cooperation. when the emergency arose: not only between the food trades and the government but between traders themselves, which found its expression in the formation of wartime associations and the acceptance of pooling based on prewar turnover. Execution and policing of food-control measures, once they were accepted as necessary and workable: could be delegated to representative bodies of traders; and regulations imposed by statutory order were reinforced, and sometimes rendered unnecessary, by detailed rules adopted by trade organizations themselves. On Sept. 1, 1939, two days before the declaration of war, the provision exchanges undertook to hold the existing level of wholesale prices for a wide range of foods until statutory orders could be made. The closing of the Liverpool grain futures market and the settlement and liquidation of existing contracts was carried out by voluntary arrangement with the Defence committee of the Corn Trade federation: the ministry stepping into the shoes of the first seller and last buyer in each chain and guaranteeing the settlement of intermediate positions where the outbreak of war prevented fulfilment of contract.

Up to the end of 1939 the chief cause of the rise in food prices was the increase in freight rates and the devaluation of the pound. In Dec. 1939 it was decided to stabilize food prices with the aid of subsidies. Starting with £13,000,000 in the first year of war, food subsidies grew to £168,000,000 in 1944–45. (After the war they reached £465,000,000 in 1948–49.) The food items in the cost of living index were kept stable at a level between 20% and 25% above that ruling in Aug. 1939; during World War I the food index was twice the prewar level by July 1917 and reached 230 by Oct. 1918. Including the cost of subsidies the food index would have been 250 in 1918 and 150 in 1944. This ditierence was in part due to the effect of the ministry's bulk buying in restraining inflationary tendencies in world markets. In order to fix prices at retail it was necessary to control prices and profit margins at each stage of processing and distribution based on a fair assessment of costs of handling; in general this could best be achieved where the ministry owned or effectively controlled the product at some stage. The policy of prescribing maximum prices by order without controlling supplies and distribution, as with home-grown fruit and poultry, frequently meant that the goods disappeared from the shops or went to favoured customers. From 1943 onward the ministry was compelled by pressure of public opinion to control prices of fresh vegetables; but since centralized collection and distribution were impossible, either supplies dried up or there was a tendency for price orders to be evaded by conditional sales and inferior grading.

Administration.—The administrative machinery of food control was similar in the two wars. The staff of the ministry at its maximum was 8,000 in 1918 and 10,000 in 1944. In addition 25,000 were employed in 1,800 local food offices in 1918 and 35,000 in 1,250 local food offices in 1944. Rationing, licensing of retailers and caterers and welfare food schemes were the main tasks of the local offices, supervised by 19 divisional food officers in areas corresponding to civil defense regions. These officers represented the minister in relations with regional commissioners and were responsible for emergency feeding arrangements and liaison with the local military authorities. In addition there were area commodity officers for each of the principal commodity control schemes.

Catering.—The number of catering establishments increased from 111,000 serving 11,000,000 meals daily in May 1941 to 147,000 serving 23,000,000 meals in Dec. 1944. The policy mas to provide nearly everyone with an opportunity to supplement household rations. Two thousand British restaurants were opened, and canteens were made compulsory in factories employing more than 250. Industrial canteens grew from 1,500 before the war to 30,500 in 1944. School meals served rose from 250,000 daily before the war to 1.850,000 in Feb. 194j. Special allowances of meat and other foods were provided in canteens for heavy workers, munition workers and school children. Agricultural workers, miners and other workers for whom canteen facilities could not be provided, received a special cheese ration of 12 oz. weekly and in 1944 were assisted by a scheme for providing snacks, sandwiches and pies. By the autumn of 1944 more than 1,000,000 of these packed meals were being served in 5,000 villages. Emergency feeding centres for use after severe bomb attacks, shelter feeding, cooking depots, mobile kitchens and Queen's Messenger convoys, able to move into a raided area and provide tea and snacks within an hour, played a vital part in civil defense. The total amount of food consumed outside the home represented about 9% of total civilian consumption, of which canteens received two-thirds and ordinary restaurants one-third.

Planning of Food Supplies.—Before 1939 imports provided more than half of the United Kingdom's meat, four-fifths of the sugar, nine-tenths of the cereals and nearly all the fats. Only milk, fish: potatoes and vegetables were mainly home produced. Reckoned in nutrients, two-thirds of the calories and more than half the total protein were imported. About 22,000,000 tons of food and feeding stuffs were imported, of which 4,000,000 came from countries occupied by the axis during World War II. Because of the urgent need to release ships for transport of munitions and troops, the ministry of food was able to obtain only about half the prewar tonnage for all its imports during each of the three years 1942–44. Since preference had to be given to the most essential foods, more than 5,000,000 tons of imported foods and nearly 2,000,000 tons of fruit and vegetables had to be dispensed with. The most critical situation developed during 1940–41, when more than 1,000,000 tons of food were sunk at sea and about 250,000 tons were lost or damaged by air attack. Early in 1941 food imports were threatened not only by enemy action but by shortage of dollars to pay for them. After the passing of the Lend-Lease act more than 1,000,000 tons of cheese, lard and canned meat and fish arrived from the C.S. in 1941, and the total rose to 1,700,000 tons in 1943. In 1943 and 1944 about 10% of the nations food, measured in calories, and 18% of its animal protein and fats were obtained under lend-lease. Home production of food nas increased by growing more wheat, potatoes and vegetables, and milk production expanded in spite of reduced oilcake supplies. In the five years 1940–45 total calories never fell more than 10% below prewar standards. At the worst period in 1941 animal protein was reduced by nearly 20% and fats from all sources by 13%. The biggest reductions in that year were in fruit, sugar, meat and fish, offset by increases in milk, bread, flour and potatoes. The pattern of diet became monotonous and less palatable, and rationing lowered the consumption of rationed foods in all except the poorest families; but there was some evidence of improved nutrition at the lowest income levels, mainly the result of increased milk consumption by mothers and children.

Regulation of Stocks.—Under the Essential Commodities (Reserves) act, 1938, the government had acquired before World War II about 500,000 tons of wheat, 150,000 tons of sugar, 240,000 tons of whale oil and 18,000 tons of canned meat. These reserve stocks were barely sufficient to offset the slowing down of arrivals during the early months of the war and at the end of March 1940 total stocks under the ministry's control were at their lowest point, under 3,000,000 tons, of which half were cereals. By the end of 1943, in spite of reduced imports, they had been built up to a peak of 6,668,000 tons. At the end of World War II stocks mere higher than at the beginning and it was possible to release 1,000,000 tons of food for the relief of liberated countries in Europe.

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WAR CONTROL OF SHIPPING. **World War** I.—In July 1914, of 8,000 ocean-going vessels the British empire owned more than 4,000; France, Italy, Belgium and Portugal together owned about 1,000; a further 1,000 were owned by Germany and Austria and were either immobilized or captured; some 2,000 covered the rest of the world. When therefore the Allied organization was developed, in the last year of the war, it was natural that it should be built on the basis of the British system; and the countries associated in this organization, which included the United States, ultimately controlled, with the addition of the neutral tonnage which they had chartered or requisitioned, some 90% of all ocean-going tonnage.

The control was simple, dealing with few units, compared with those exercised by the ministries of munitions or of food. The total prewar value of all ocean-going ships before World War I was not more than £300,000,000. The total amount of steel sunk in the ships lost during the war was only about 5,000,000 tons! that is, not more than 12% of the steel production of the U.S. alone in a single year. On the other hand, the allocation of ships involved choosing between different supply services, giving a preference to wheat over munitions, or coal over ore or vice versa. It involved decisions of policy affecting a vastly wider range.

Before World War I two departments of the British administration were concerned with merchant shipping, the marine department of the board of trade and the transport department of the admiralty. The latter small department, with its limited but varied experience, was gradually thrust by the introduction of the submarine into the central position in prominence.

State Requisitions, **Aug.** 1914.—From the first it was recognized that the government could not act as it did in the South African war, and go into the market as an ordinary charterer. In Aug. 1914 a proclamation was issued giving powers to requisition ships with compensation to the owner.

The powers were chiefly exercised by the transport department. They were limited to the transport of troops from Canada, Australia, India and New Zealand, and to the carriage of supplies from England to France and the front. But though the tonnage requisitioned in the first six months did not exceed some 20% of the British mercantile marine! it was enough to push freights up. Other causes were tending to the same result. Sinkings were indeed in this period more than offset by new building. But a large mass of enemy tonnage was withdrawn from world tonnage and the delays inevitably caused by naval precautions reduced the average amount of transport a vessel could accomplish in a given time. In July 1914 the normal price for a six-months' charter of an ordinary tramp steamer was three shillings a month on the dead weight. By December it had reached six shillings. By the end of the first year, in the summer of 1915, it had reached 15 shillings. This increase not only made the goods carried more expensive but it also reflected the fact that there was already a shortage of shipping space, although the effect of submarine warfare had scarcely been felt.

Blue Book Rates.—These rates did not apply to ships requisitioned by the government. For these ships standard rates—the so-called blue book rates—were fixed on the advice of a committee which met in the first months and, with slight modifications, were applied throughout the war without regard to the outside freight market. They were somewhat in excess of the market when they mere introduced (the rate for an ordinary tramp was then equivalent to about seven shillings per month on the dead weight) but were moderate by comparison with the arrangements made by the government for industries and would have given profits not exceeding those of a boom year in peace. Shipowners' profits became in 1916 the subject of severe and legitimate criticism. On a capital value of some £172,000,000 in 1914 British shipping had by the autumn of 1916 made a net profit of some £262,000,000 (after deducting all payment of taxes). This resulted however not from excessive payments by the government but from competition in the ordinary freight market for the inadequate tonnage left over when the government had taken what it needed.

Shipping in the Second Year.—The strain upon shipping was constantly increasing. Losses increased? averaging 87,000 tons gross per month as compared with 55,000 in the first year. Building fell from 1,000,000 tons in the first year to 500,000 in the second. Naval and military demands increased and the proportion of British tramp tonnage requisitioned rose from 20% to 30%. Demands upon the freight market for the raw materials required for munitions were also serious, and the standard time charter rate (which had been 3 shillings in July 1914) rose to 27 shillings in Dec. 1915 and to nearly 40 shillings by the summer of 1916.

Ship Licensing Committee, Nov. 1916.—In Nov. 1916, a Ship Licensing committee was appointed by the board of trade, with the power to exercise a licence control over British tonnage. The intention was to force ships out of employment that were serving no British or Allied interest, and so make it easier for more important requirements to find their transport. The principle was a sound one as far as it could be applied. But the committee was unable to find, after some months of investigation, more than a negligible amount of tonnage engaged in work that was obviously unimportant; and they were unwilling to prohibit any other employment; therefore, they brought no substantial relief to the general situation. Honever, ineffective for its original purpose, the committee soon assumed a role for which it was much better fitted. It became the executive for putting policy into effect as regards all British tonnage not under requisition. When a "limitation" of freight rates was imposed on the French coal trade it was the Ship Licensing committee which made it effective by refusing licences to ships trying to escape from that trade to more lucrative employment. When the ministry of munitions was anxious about ore imports from Spain or South Africa because colliers found it profitable to hasten back in ballast for another coal cargo, the committee refused licences for such ballast voyages. When the cabinet fixed a limit to the tonnage to be chartered to the Allies the committee enforced the decision as regards chartered ships in conjunction with the transport department which enforced it as regards requisitioned ships.

A second committee established by the board of trade at the same time—the Requisitioning (Carriage of Foodstuffs) committee—had a shorter life. This committee had power to requisition or direct the employment of British ships so as to assist the importation of food or other accessories. In practice it confined its action to the importation of grain (mainly wheat).

The committee directed more vessels than the market by itself was capable of attracting. The effect was immediate and dramatic. North Atlantic freight rates dropped in five months from 16 shillings to 8. Weekly imports increased from 510,000 quarters to 665,000 quarters. But at the moment when the committee was achieving its objects its activities had to be first restricted and then stopped. The reasons are interesting and instructive. Wheat was getting more than its share of tonnage.

Shipping Control **Committees.**—Of these the most interesting was the appointment in Jan. 1916 of the Shipping Control committee, presided over by Lord Curzon and including two well-known shipowners and an eminent financier. A survey led them to the conclusion that a reduction of 13,000,000 tons must be made in British imports, and they therefore recommended the temporary prohibition of all imports, except specified essentials, amounting to a total rate of 13,000,000 tons per annum; the withdrawal of vessels from naval and military service; and the limitation of British tonnage allotted to the Allies to the amount in their service on April 1, 1916. Little came of their three recommendations. A scheme of import prohibitions which, even if fully enforced, would have shut out not 13,000,000 but 4,000,000 tons was approved but in actual application excluded less than 2,000,000 tons.

Imports Restriction.—In 1917 the government appointed an Imports Restriction committee, presided over by Sir Henry Babington Smith and consisting of the principal officials of the board of trade, the ministry of shipping (into which the transport department had now expanded) and the chief departments demanding tonnage: the war office, ministry of munitions, food commission, etc. The instructions given to the committee were to reduce the supply programs by about 500,000 tons a month. But just as the committee was beginning its work, the intensive submarine campaign began; shipping losses increased very seriously; and it grew clear that the monthly reduction required must be at least 1,000,000 tons. The task of selecting commodities for exclusion on this scale was beyond the capacity of the committee, and once more the hope that programs would be reduced within the limits of transport was deceived.

Shipping in the Third Year.—From the summer of 1916 to that of 1917, the shipping situation was more serious than at any previous period. Its gravity was reflected in the increasing freight rates and shipowners' profits, which now reached their maximum. British time-charter rates rose to 40 shillings a ton deadweight, a record, as compared with 3 shillings immediately before the war. In Feb. 1917, the new submarine campaign began and met with immediate success. Within a few months the submarine blockade became a greater danger to the Allies than the surface blockade was to Germany.

Throughout the year the control over commodities was developing both in range and in character. To sugar and wheat, which were already controlled by the Sugar and Wheat commissions, were added all the main articles of food, and the whole was centralized under a newly established ministry of food. The ministry of munitions extended its effective control over all the raw materials of munitions manufacture and indeed over all metals required for all purposes. The war office developed a similar control over flax, hemp, jute, leather, wool and other materials. The board of trade, under somewhat less drastic and more commercial methods, covered the bulk of the remaining imports.

These developments had important consequences on the shipping problem. In the first place, all the imports of the commodities so controlled were government cargoes, and it was natural that they should be transported in requisitioned tonnage. The war office could ask the shipping authority to arrange to carry wool or flax (for whatever purpose it might be used) just as it asked for transport of supplies destined direct for the army. But, in the second place, the incorporation within the government machine of the specialists from the business world who were needed for these intricate and detailed controls, meant that the government had, for the first time, in its service the advice of adequate experts in the activities affected.

The Ministry of Shipping.—The coalition government formed at the end of 1916 established a ministry of shipping, under a shipping controller, Sir Joseph (later Lord) Maclay who had a seat in the cabinet, with statutory powers. The transport department was absorbed in the new ministry, while the Shipping Control committee became an advisory committee to the controller. It was shortly afterward decided to extend requisition at rates based upon blue book terms over all British ships. The comparatively moderate profits on requisitioned ships only made the fantastic profits on free ships more of a public scandal.

Liner Requisition.—A new and ingenious system of liner requisitioning was therefore devised. All liners were formally requisitioned and paid at blue book rates. But the owners continued to run them, taking first any government supplies, then following any other direction they might receive, and if any space remained, offering freight on the market, the freight, however, being henceforth paid to the government. The liner cargoes thus became an integral part of the general transport and supply program, and indeed an increasingly important part of it, amounting at the end to four-fifths of the country's imports.

Tonnage Priority Committee.—Another committee, the Tonnage Priority committee, was of more importance. It was a national committee, consisting of the actual executive officers from the different departments who were handling the several supply arrangements, and its chairman was the parliamentary secretary of the ministry of shipping (Sir Leo Chiozza Money). It brought those who were making competing, and in their total effect impossible, demands upon the shipping authorities into direct contact with each other.

The new and intensive submarine campaign began in Feb. 1917. It converted the shipping difficulties from a serious inconvenience into a grave menace.

In the first 12 months 470 ocean-going ships (1,000 if we count all sizes) had been lost. The continuance of loss at this rate would have brought disaster upon all the Allied campaigns and might even have involved unconditional surrender. At this stage, after much hesitation and conflict of opinion, the convoy system was introduced, and had an immediate success. (See SHIPPING, HISTORY OF: *International* Rivalry.)

The Fourth Year.—By the autumn the situation had become less desperate but more immediately difficult. Two great events had happened. The U.S. entered the war. Finance was at once displaced as the governing consideration in the Allies' policy. Henceforward the Alliance as a whole, was practically self-sufficient. Shipping became definitely the limiting factor. Nor did the entry of the U.S. relieve the actual shortage of tonnage. Its potential building capacity gave a different perspective to the future, but it was undeveloped. And its military effort, so vital a factor in the strategical position, necessarily increased the strain on shipping. At no time during the rest of the war were there as many U.S. ships in war service as those required to carry its own men and stores. The second great event was the striking and dramatic success of the convoy system. From its first introduction it more than counteracted the effect of the new submarine method; and losses were reduced to less than the rate of 1916. In spite, however, of the much greater hope for the future given by both U.S. building capacity and the convoy system, the actual disparity between the shipping available and the demands upon it was greater in the autumn of 1917 than it had ever been. Seventeen million tons deadweight of the world's tonnage had been lost and less than half had been replaced. Great Britain alone had lost 10,000,000 tons, and, even allowing for ships it had bought, built or captured, its net loss was over 4,000,000 tons.. France and Italy had lost about 2,000,000 tons and had built practically nothing. Nor had the U.S. yet begun to build seriously. At the same time the demands upon shipping were greater than at any previous period. All the distant expeditions (except the long abandoned one to the Dardanelles) were fully maintained. The scale of the war in France was continually increasing. The navy was at its maximum strength. Serious food troubles were anticipated in Great Britain, France and Italy. The U.S. military effort, with its great demands on transport, was beginning.

By this time, however, the mechanism for securing economical compression of the British supply demands on transport, for selecting only the most essential, for making the utmost use of shipping available was being rapidly perfected. The big control departments, the food and munitions ministries and the war office, examined and pruned down the demands of their many branches, with the expert knowledge that had been obtained by the incorporation of numberless experts from the different trades now brought within the area of control. The Ship Licensing committee was (to some limited extent) pruning off the more obviously useless employment of ships. The Tonnage Priority committee was examining the demands in more detail and contributing to the same end. Special committees like the Imports Restrictions committee of Jan. 1917 and the later cabinet committees of the same year were forcing the departments to make reductions.

And in this national system the final authority now consisted in a cabinet committee (presided over by Lord Milner) consisting of the ministers in charge of the great ministries concerned, on the one hand of shipping and on the other of the great supply departments, particularly the war office and the ministries of munitions and food, attended by their chief officials.

But by this time the problem was more than national. And the national system required to be supplemented by an international organization which could incorporate the needs of France and Italy and to some extent the U.S. with those of Great Britain and devise a common shipping policy. Controls similar in general character and purpose had been established in France and Italy, but a British cabinet committee could not judge between British and French or Italian needs of sugar or of wheat. Nor could a British shipping department do so. Obviously the persons best qualified were the sugar and the wheat experts of the different countries. On this principle the Allied system was based. "Program committees" were formed of the experts in each main supply (wheat, sugar, meat and fats, oils and seeds, nitrates, hides, wool, flax, hemp and jute, paper, etc.).

These committees submitted their demands first severally to Allied councils of ministers (food and munitions), and then all together to a supreme Allied shipping authority, formed on the same principle.

SHIPPING CONTROL IN WORLD WAR II

Preparations in the Interwar Years.—In World War **I,** as has been shown, the government had to construct a system of control both of shipping and of the supplies of food, munitions and raw materials which it had to carry, without any previous experience. In the subsequent 21 years of peace, memories of the first war were reflected in defense preparations for any further war. The Committee of Imperial Defence had planned a comprehensive war organization; and a part of this had been established even during the last years of peace. In addition arrangements had been made to set up ministries of shipping, food and economic warfare immediately on the outbreak of war; and this was duly done. Before the end of 1939 this national machinery was supplemented by a number of Anglo-French committees covering the whole range of supplies. This Allied system was based upon the one that had been developed in the last year of World War I. Jean Monnet, who had been the principal French representative, at the official level, in the earlier system, was appointed chairman of the Anglo-French co-ordinating committee with a joint mandate from the two prime ministers.

Defects in the Control System on the Outbreak of War.— In reality, as distinct from merely formal structure, it was unhappily far from true to say that the second war started where the first left off. In 1918 the newly created Allied councils for shipping, food and munitions, with some scores of program committees, composed of officials, formed the climax of a system of control which had been gradually hammered into efficiency by three and a half years of war. Commodity programs had been compressed and relieved of all but absolute essentials. Under the pressure of shipping shortage the ministry of shipping had become highly efficient and was at the pivot of the whole Allied supply system; and the officials concerned, both national and Allied, had learned to work with each other. In World War II this process was reversed, the formal structure being first established and the reality of effective, co-ordinated control being gradually developed within it. Moreover there had been some grave mistakes in planning shipping war policy. The mercantile marine department of the board of trade had in 1938 estimated that British shipping alone, even without assistance from neutral tonnage (which in peacetime was bringing in nearly a quarter of British imports), would be able to bring in about 48,000,000 tons. Unhappily the estimate was seriously mistaken. Carrying rapacity proved much less; and the different departments requiring imported supplies proceeded with plans which assumed much more. The mistaken policy of relying on licences was soon corrected and a policy of general shipping requisitioning was announced and began in gradual instalments. The supply programs, however, caused great difficulties; they were pared down to essentials only under the pressure of actual necessity. Dry cargo tonnage was less by about 3,000,000 tons gross than on the outbreak of World War I. The mistake had several causes; undue optimism by the admiralty which, with the new invention of "asdic" for detecting submarines and the tried system of convoy, thought it had mastered the submarine menace; an inadequate allowance for the delays which would result from port congestion, assemblage in convoy and other conditions; and perhaps a general climate, of over-optimism in Whitehall in the "appeasement" period. The same reasons partly explain the reluctance to bring in and store, in peacetime, large quantities of iron ore, grain and timber. With some encouragement, perhaps, from the inactive character of the hostilities in the first period, unwelcome decisions—for example to impose rationing—were postponed; nevertheless, in spite of the fact that shipping losses were at this time comparatively slight, consumption exceeded imports; and there was a drain on the inadequate stocks.

Shipping Stringency in the Early Months of World War 11.—Critical shortages soon began to appear. As early as November wheat stocks fell so far that some mills had to stop work. This situation was relieved but at a considerable cost, partly by buying wheat from North America with dollars instead of Australian wheat with sterling and partly at the expense of other imports. Iron ore imports, for instance, came in at only just over half the quantity demanded, and by Feb. 1940 some works were beginning to close down. This situation was relieved by the switching of requisitioned tramps; but at the end of the first year of war the imports were 2,000,000 tons short of what had been demanded. Both wheat and iron ore moreover were brought in at the expense of timber, of which less than half the quantities demanded were secured. In the meantime the warnings given to the supply department by the ministry of shipping that the earlier estimates of importing capacity were much too optimistic, had little effect. In Jan. 1940 the ministry of supply actually raised its total demands from 23,900,000 to 30,600,000 tons, which put the total import requirements for a year up to 53,700,000 tons, about 10,000,000 tons more than could be actually achieved.

Improvements in Control System.—These difficulties had at least one compensating advantage. They accelerated an improvement in the system for determining priorities and making the most of what transporting capacity was available. The most important early measure was the decision to requisition instead of relying upon licensing. This enabled the ministry, so far as it was itself competent to decide what imports deserved priority, and from what sources of supply, to give immediate effect to its decisions. Imports rapidly increased. In the first three months, September to November (before requisition), the monthly average had been about 3,000,000 tons; in three months, March to May, after requisition, the average had risen to 4,000,000 tons and, though some of this improvement was the result of seasonal conditions, the new system of requisitioning was entitled to most of the credit.

Priorities.—Requisitioning, however, did not solve the question of priorities. So far as the total demands exceeded shipping capacity and there was no superior authority to decide between them, priorities were necessarily determined in practice by the actual allocation of tonnage by the shipping authority. The ministry of shipping, beset by competing demands which it could not satisfy, was involuntarily a master and not a servant of the supply services. As in World War I it eagerly sought a master for itself, which could only be the war cabinet, or some body endowed by it with the requisite authority, to determine priorities between the main demanding departments. The task of creating such an authority was simplified by the fact that two great departments, the ministries of supply and food, were responsible for all but a small fraction of the total demands. If the total allocations between these two ministries could be determined and adjusted suitably from time to time: they could each of them settle their own internal priorities. The ministry of supply, for example, could decide how much iron ore it would get at the expense of timber (since both were within its own control) and similarly the ministry of food how much sugar it would import at the expense of grain.

Review of the Import Program.—The first important step to this end was taken in Dec. 1939. The war cabinet appointed Sir Samuel Hoare (later Lord Templewood) to review the current import program. The proposal was made that the ministry of food should plan on the basis of 19,000,000 to 19,650,000 tons, the ministry of supply 23,640,000, with 1,150,000 for miscellaneous unallocated imports. The total proved a very close estimate and the proposed division, which was endorsed by the cabinet, set a standard for departmental scaling down which was of great value. The process of actual pruning was, however, intricate and unending. It improved gradually as the supply departments acquired more knowledge, skill and effective control of all consumption of imported goods by individuals and by industries. But in detail programs were subject to constant revision with the changing war situation; and the machinery through which the war cabinet exercised its ultimate control had to be given a permanent character.

The normal form of this machinery was that of a Cabinet Imports committee, presided over by a minister and served by a committee of departmental officials from the supply and shipping ministries. Through this machinery, decisions on competing demands which could not be settled at a lower level were taken as they were required.

Anglo-French Organization.—This national system had of course to be intermeshed with the Allied, that is the Anglo-French, organization since French supplies were partly dependent on manufacture in Great Britain and largely upon British shipping, and in some cases Britain's requirements could be aided by switches from France. There were nine separate Allied executives, for shipping, food, armaments and raw materials, oil, air production and supply, economic warfare, textiles and hides, timber and coal requirements. These were composed of officials, both British and French; and a co-ordinating committee, presided over by a permanent chairman appointed jointly by the French and British governments, was formed on a panel system from the chairmen of the executives with a few extra members. Though formally as complete in structure as the Allied system of executives in 1918 it had not in fact achieved an equal efficiency by the time that the fall of France brought it to an end. The stronger departmental organization in Great Britain, the British control of the margin of transferable shipping, the larger proportion of neutral ships on British time charter and the location of the Allied system in London were advantages to the British supply departments only partly compensated by the fact that the chairman of the co-ordinating committee was an able Frenchman. Nevertheless useful work was accomplished. British oil stocks were drawn on and British tankers diverted to give emergency help to the French; and French coal supplies, which had been gravely depleted by an unexpected shortage of coastal ships, severe winter weather, falling coal output in Great Britain and the overrunning of the coal mines of eastern France by the German armies, were replenished by a remarkable increase in shipments in May 1940 to more than 1,750,000 tons.

In the meantime another mistake in the prewar calculations, which aggravated all the difficulties of the earlier months, must be noted. It had been expected that war conditions would throw neutral tonnage on to the market and that the British government would easily acquire it. In fact freights rose and neutral owners had much more attractive opportunities than those offered them by the ministry of shipping. This situation changed after the German invasion of western Europe, when ships of countries previously neutral, especially Norwegian and Danish, came into British control and were important offsets against the increased losses. But in the first six months of the war little of this shipping was available and, as it had brought in a substantial proportion of British imports in peacetime, its sudden loss was a serious blow, the greater because it had not been expected.

Tankers and Oil Supplies.—So far shipping control has been described in the terms of dry-cargo tonnage. It was this which constituted the intricacy of the problem of organization as it was to a large extent transferable from one commodity to another over a very wide range. Tankers, carrying all forms of oil products from oil fuel to petrol, were also, of course, of the utmost importance; and though this kind of British tonnage had been increased by 1,750,000 gross tons since World War I, the increased demand for mechanized civilian and military transport, for warships, army trucks and aeroplanes was even greater; and the danger of a crippling deficiency was very serious at several stages of the war.

Passenger Shipping.—Ordinary passenger travel was almost suspended in the Atlantic and Mediterranean areas. This made enough ships available for the conveyance of troops in the early period of the war, when the struggle was mainly concentrated in western Europe and long-distance troop movements were comparatively small. But a large number of vessels of this type were converted for use as armed merchant cruisers and engaged in convoy work, a service in which many were lost. At a later stage this resulted in a shortage of troop-carrying vessels. Even in the first stage, however, the effect on ordinary imports was of some importance; for most passenger vessels carry goods as well; and vessels taken either for cruiser service or for troop-carrying were almost entirely lost to the importing services. A special liner section was established in the ministry and every effort made to reduce the inevitable loss to a minimum by skilful management.

Building and Losses.—With total tonnage about 1,250,000 gross tons less than in 1914, or 3,000,000 less in the case of dry cargo ships, the current output of merchant ships in British yards on the outbreak of World War II, was less than half of what it had been on the outbreak of World War I. Between 1911 and 1913 the average output had been more than 2,000,000 gross tons; but in every year since 1931 it had been less than 1,000,000. An attempt was made to raise it and a special department, at first attached to the ministry of shipping and later transferred to the admiralty, was formed for the purpose. But merchant ships were in direct competition with naval vessels for both skilled men and materials; and the navy was very inadequately equipped with certain types of ship, especially destroyers and other convoying vessels. That was the impelling reason for the destroyer deal with the United States in the autumn of 1940 and for the expensive use of passenger vessels as armed cruisers; it was also the reason, since a difficult question of priority was involved, for the transfer of responsibility for shipbuilding to the admiralty early in the war. In the event only about 1,000,000 gross tons were turned out in the first year of the war, and British yards never improved much upon this rate; there was regrettably little dilution of skilled by unskilled labour of the kind found possible in the later U.S. shipbuilding. But at the outset many gains were possible from other sources. Enemy shipping was captured; some neutral tonnage acquired; and in the first nine months of the war, when losses were comparatively small, the total gains approximately offset losses, nontankers showing a net gain of 57,000 gross tons (849,000 against 792,000) and tankers a net loss of 33,000 tons (174,000 against 141,000). In this period the stringency was partly caused by the failure of neutral ships trading as such to come to British ports, partly by the delays caused by war conditions, partly by the withdrawal of merchant ships into naval service and partly by increased demands for imported raw materials for the munitions industries. Even in this period, however, though losses were only at an annual rate of about 1,250,000 gross tons, they exceeded the current building output. The other acquisitions from European sources, whether of captured enemy ships or of neutrals in European waters, were in the nature of a single capital gain; no repeated acquisition of this kind could be expected. British building was inelastic. It was soon evident that, if losses increased and if demands also rose with the extension of the war, the only adequate answer must be found, if it could be found at all, across the Atlantic.

The Ministry of Shipping. — Within a few months of the outbreak of hostilities an efficient ministry of shipping had been constructed from a mixed team of shipowners and staff from the shipping offices, civil servants and others drawn from outside. Something of the same composite staff was to be found at this time in all the departments, especially the civilian ones, and in general the precedents of World War I were followed. In the ministry of shipping there was one interesting difference, not perhaps an improvement, as compared with the earlier war. In 1917 there had been a very complete welding of shipping and lay experience, every main branch including both shipowners and civil servants in positions of real responsibility. In one branch a shipowner would be at the head, with a civil servant as his deputy; and in another the positions were reversed. In World War II the association was on the whole between branches controlled by shipowners and others by civil servants. This was partly because, with a more extended Whitehall organization, the number of civil servants of the requisite quality who could be spared for a single ministry was less adequate. But each branch probably lost something from the absence of one or other of the two elements. In this new form of somewhat less intimate association co-operation was on the whole cordial and efficient, under an able director-general, Sir Cyril Hurcomb, a civil servant who had held a responsible post in the ministry of the earlier war.

The Fall of France. — The fall of France in June 1940, while transforming the military situation, also changed the shipping problem and had a considerable impact on organization. The first effect was to give a momentary, and very deceptive, relief to the shipping stringency. Much Norwegian and Danish and some Dutch, tonnage came from the recently invaded countries; no more ships had to be supplied for French imports; no more transport, after Dunkirk, was needed to take men or goods across the English channel. All the longer-term consequences, however, involved the greatest danger of a shipping shortage which would be fatal to the successful continuance of the British war effort. Italy entered the war and the Mediterranean was practically closed, so that men and supplies for the middle east had to go round the Cape of Good Hope. The manufacture of munitions and imports had to be rapidly stepped up to re-equip an army which had come back without guns or trucks. Above all losses were bound to increase. The "asdic" with which French destroyers had been fitted came into the hands of the Germans who thus were enabled to seek and find an answer to it. Hostile submarines and aircraft could operate more closely from French bases. The rate of sinkings more than doubled.

American supplies were now of crucial importance. A British purchasing mission had been established in Ottawa, Canada, at the outbreak of war, and later transferred to New York. It was headed by a Canadian, A. B. Purvis, who was also chairman of an Anglo-French Purchasing board established to co-ordinate the purchases in the United States of the British mission and a similar French mission. On the fall of France both the Anglo-French co-ordinating committee in London and the board in New York came to an end. The former was replaced by a North American Supplies committee, through which the demands of the different departments were transmitted to the British mission in New York. The latter mission was in general placing its orders direct with individual American manufacturers. But the U.S. government was preparing to enlarge its own rearmament; and the task of estimating, and to some extent controlling, competing demands on U.S. industry was entrusted to the treasury, then under Henry Morgenthau. The immediate result was a request for a comprehensive. statement of requirements from overseas. The co-ordinating machinery in London was therefore developed further and a British supply council established at Washington. Purvis was chairman of this council, the other members being representatives of the principal purchasing departments. The main executive work of placing orders was still carried out by the British organization in New York; but general policy was now determined in Washington, to which the centre of gravity passed definitely when the president stepped up the United States' own armament in the summer of 1940.

The first expression of the willingness of President Koosevelt to give greater help was the arrangement in the autumn of 1940 under which 50 old U.S. destroyers were turned over in return for the right to establish United States bases in the West Indies. A few months later, in March 1941, this was followed by the Lend-Lease bill, which ensured that U.S. supplies would not be cut off through the inability of Great Britain to find the dollars to pay for them.

Until this time either finance or shipping might have been the main limiting factor to the extent of Great Britain's overseas supplies and therefore of its war effort. Henceforth for some years the limiting factor was shipping. By the spring of 1941 the danger was imminent. Losses of British or British-controlled tonnage at this time were at the annual rate of nearly 5,000,000 tons gross, or in terms of deadweight 7,700,000 tons. Against these British new building was only at the rate of about 1,400,000 tons deadweight. The shipping at Britain's disposal, thus being reduced at the rate of more than 5,000,000 tons deadweight a year, was already seriously inadequate for the demands on it. In 1938 British dry-cargo imports had totalled 52,000,000 tons; in 1940 they had fallen to 43,500,000 tons. They now fell to a rate of only about 30,000,000, which had to cover not only all food imports but raw materials for munitions manufacture. Oil supplies (including oil fuel for the navy and all industrial purposes and petrol for motor transport and aviation) were in a no less dangerous position; oil stocks had fallen to the danger level of 4,500,000 tons and were still falling rapidly.

The British Shipping Mission to Washington. — Against the grave dangers of starvation, the closing of munitions factories for want of raw materials and the crippling of the British war effort, the only possible source of substantial relief was the United States. The prime minister therefore decided to establish a British shipping mission in Washington. It was headed by Sir Arthur Salter, parliamentary secretary of the ministry of shipping from 1939 and chairman of the North American Supplies committee in London since the fall of France. It was the task of this mission to obtain the largest possible allocation of U.S. tonnage for British services and to urge a great increase in U.S. shipbuilding.

United States Shipping.——Up to this moment no merchant ships had been supplied by the U.S. government, though a few U.S. ships (mainly old laid-up tonnage built in World War I) had been bought for cash. Moreover the United States' resources were very limited. Its overseas mercantile marine consisted of only about 7,000,000 tons (deadweight) of dry-cargo and passenger vessels and about 5,000,000 tons of tankers; and all were fully employed, for the most part in work that seemed essential. American shipbuilding had almost ceased between 1921 and 1937 and, though there had been some revival, the output in 1941 was only 1,000,000 tons deadweight. Besides this, the Neutrality act prevented U.S. ships from entering a war zone; and congress was opposed not only to participation in the war but to all action which might lead to it. On the other hand the president, supported by his principal cabinet members and officials, was determined to do all that was possible in these circuinstances. In a few weeks he had declared Suez to be outside the "war zone" (since Egypt was a neutral) and U.S. ships were allowed to carry British supplies to the near east; and he had ordered the maritime commission to allocate 2,000,000 tons to the war effort. Under this impulse the transport of U.S. goods between the west and the east coast was transferred from shipping through the Panama canal to the railways; oil transport up the east coast was similarly transferred from sea to land. Before the year was over 1,500,000 tons of U.S. dry-cargo tonnage was in British service, and more than 750,000 tons of tankers. The fall in British imports was arrested and oil stocks raised to the full capacity of British storage. Even more important for the future was the decision to raise the building program for 1942 from the current rate of 1,000,000 tons to the astonishing rate of 8,000,000 tons—a decision which was in fact fully implemented.

By Dec. 1941 the problem set in April was solved. On the basis of the war as it then was, that is without Japan as a belligerent or American troops and supplies to transport, shipping resources were adequate. Against total Allied and neutral losses of 6,500,000 tons deadweight, the U.S. building program alone promised 8,000,000 tons, and British and Canadian building a further 2,500,000 tons. (Canada, it should be noted, which had built no overseas vessels before the war, was now by a remarkable effort building almost as much as the United Kingdom.) British imports in 1941 exceeded consumption, dry-cargo stocks and oil stocks each rising by 2,600,000 tons.

After Pearl Harbor.—This situation was completely transformed by the entry into the war of Japan and the United States after Pearl Harbor. Losses greatly increased, being about as high in the first six months of 1942 as in the whole of 1941. In the meantime the shipping demands of the U.S. army and navy were of course very great—exceeding combined building by 2,700,000 tons. It was only in May 1942 that U.S. building, in spite of its immense extension, matched current U.S. losses; and only in August that combined building overtook combined losses. In the meantime greatly increased demands were made on a seriously reduced total tonnage. British dry-cargo imports fell to 23,000,000 tons, and stocks were again depleted. Oil stocks fell similarly. The shipping situation was as serious as it had been in the spring of 1941.

The Combined Board System.—Meanwhile now that the United States was an Allied belligerent, the whole organization in Washington was transformed. No longer did the British missions make contracts with individual industrialists with the assistance of the U.S. administration. All supplies were allotted through U.S. departments under the control of combined Anglo-U.S. boards. The competition was no longer between British war needs and American peace needs but between different war needs.

It is interesting to compare the combined system of supply as it developed in 1942 and 1943 with the Allied system in World War I in 1917 and 1918. In the first war. although there was an elaborate Allied machinery, its working was simplified by the fact that London was the indisputable centre of the whole system. In that war British shipping was throughout supplying assistance to all the Allies, including the United States; and the general American war effort had not been fully extended when hostilities ceased. In World War II the position was reversed. The United States was fully extended. It was its shipping, and its supplies in general, upon which other Allies drew. Increasingly, therefore, Washington became the centre of main supply policy. Nevertheless Washington never became the sole centre in the sense in which London had been in the earlier war; and the combined boards were constituted in both capitals. In 1942 British military effort was equal to that of the U.S. and the British machinery of planning had been more fully developed. Though, therefore, the centre of gravity increasingly moved toward Washington the contribution of each country to supply policy was not unequal. For shipping, a Combined Shipping Adjustment board in Washington was formed, with the chairman of the war shipping administration (Vice-Admiral E. S. Land) as the U.S. member (represented frequently by the deputy administrator, Lewis Douglas) and the head of the British Shipping mission as British member. The major principles to guide transfers of tonnage were discussed at this board; but the bulk of the work continued in the form of constant detailed negotiations between the WSA and the mission (located in the same building). Nothing like a "pool of shipping" in the fullest sense of the term was attempted. Each country managed its own transport, except for occasional interchanges, and the British used the shipping under their own control so far as it would suffice. The real task of the combined system was to determine how much, on what principles and to what services U.S. tonnage should be allotted for British assistance. The president had laid down the main principle that the output of the great U.S. building program should be regarded as available for the combined war effort and allotted according to need; and in applying this principle major importance was attached to the losses sustained by each country. In practice monthly allocations were planned, especially though not exclusively for certain defined services (*e.g.*, transport to the near east, across the Atlantic to the United Kingdom and so on), Great Britain with this assistance supplying its own shipping for the rest. The allocations once made, all subsequent arrangements for British services were made either by the ministry of war transport in London or, as regards shipping from U.S. ports, by the British shipping organization at New York.

United States Shipbuilding.—In the meantime the United States building program for 1943 was raised in March 1942 from 8,000,000 to 14,000,000 tons, and in October to 18,800,000 tons. From Aug. 1942 current combined output exceeded current losses. There was still, however, throughout the year and the following winter, a severe shipping stringency as the military and naval demands were greatly increasing with the extension of the war in the far east and in Europe, for which the previously depleted tonnage was inadequate. By the spring of 1943, however, the new building had transformed the situation. Each month showed a net gain of about 1,000,000 tons. By the summer there were about 6,000,000 tons of U.S. shipping in British service. There was enough cargo tonnage for all the military projects, and every prospect that the continuing net gains would meet any extra demands of the future. There were still difficulties as to passenger ships, escorting vessels and landing craft; but the improvement in the general position enabled some building capacity to be diverted to these special classes of construction. Thus the shipping problem, as a main factor in the Allied war effort, had been solved. As in World War I, success had been the reward of naval protection, increased building, efficient national and Allied systems of organizing and economizing supplies. In 1943 combined building exceeded losses by over 16,000,000 deadweight tons; and it was then evident that, in the last crucial stages of the war, shipping would return to its proper role as the servant of the services which demanded transport, able to supply all that was required of it.

In 1944, therefore, and the remaining months of the war in 1945, the problem of shipping control was of a different character. Total tonnage was adequate for the demands on it and it was increasing every month. In June 1943 the nontanker shipping under British control totalled 14,250,000 gross tons; in December of that year it had risen to more than 15,250,000, and in Sept.

1944 to more than 16,250,000. While gains had increased losses had fallen. In 1944 the gains were 2,287,000 gross tons, the losses 1,017,000, the net gain being thus 1,270,000. In the same year the gains in tanker tonnage were 470,000 dead weight, the losses 226,000, net gain 244,000. In the meantime dry-cargo imports into Great Britain, which had fallen to 22,900,000 tons in 1942 averaged 25,700,000 tons in 1943 and 1944, and stocks of imported food and ram materials were higher by 2,500,000 tons at the end of 1944 than they had been at the end of 1942.

The difficulties that confronted the shipping authorities in supplying the tonnage required for the invasion of Europe in June 1944 and the subsequent operations, though different, were, however, serious. Both ports and the inland transport system were strained to the utmost. Moreover the task of organizing shipping secretly for the vast enterprise of D-day was one of the greatest intricacy. The ships had to be assembled to an exact timetable, and a delay of even a few days would have entailed dispersal for the replenishment of stores and water and incalculable confusion. One day's delay was in fact enforced by rough seas, but no more. The intricate and interlocked arrangements for troop-carrying vessels, cargo ships, naval protecting forces and landing craft worked smoothly both on D-day and after.

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WAR CRIMES. The term war crimes has never been successfully defined. After the end of World War II three categories of this offense against the law of nations came to be recognized: (1) crimes against peace—the planning. preparation, initiation or waging of a war of aggression, or a war in violation of international treaties, agreements or assurances; or participating in a common plan or conspiracy for the accomplishment of any of the foregoing; (2) war crimes (also called conventional war crimes)—violations of the laws or customs of war such as murder, ill-treatment or deportation to slave labour, or for any other purpose, of the civilian population of occupied territory; murder or ill-treatment of prisoners of war or persons on the seas; killing of hostages; plunder of public or private property; wanton destruction of cities, towns or villages or devastation not justified by military necessity; and (3) crimes against humanity—murder, extermination. enslavement, deportation and other inhumane acts committed against any civilian population, before or during a mar, or persecutions on political, racial or religious grounds in execution of or in connection with any other war crime.

Trials of individuals for specific violations of the laws or customs of war (the so-called conventional war crimes) have a long historical basis. Thus, the Scottish national hero Sir William Wallace (*q.v.*) was tried in England in 1305 for the wartime murder of numerous members of the civilian population, during the course of which he allegedly spared "neither age nor sex, monk nor nun." When the American Civil War ended in 186j Henry Wirz, a former Confederate officer, was tried and convicted by a federal military tribunal, and was executed, for the murder of, and for conspiracy to ill-treat, federal prisoners of war confined at the Andersonville prisoner-of-war camp which Wirz had commanded. And the treaty of peace which ended the South African War in 1902 specifically provided that certain acts contrary to the usages of war which had been committed by Boers would be tried by British courts-martial.

World War I.—At the conclusion of World War I a commission on responsibilities was created by the preliminary peace conference, its mission being that of "inquiring into the responsibilities relating to the war." In its report the commission recommended trials before national courts of the victors and, where appropriate, before a high tribunal which would be inter-Allied in composition. The report contemplated war crimes trials for violations of the laws or customs of war (of which it listed 32 categories) and for crimes against humanity. Failure to take the necessary action to prevent or end violations of the laws or customs of war would itself constitute a war crime. The commission recommended that some "special measures" be taken with respect to those responsible for instigating the war and for violating the neutrality of Belgium and Luxembourg. The United States representatives on the commission dissented from those portions of the report that referred to crimes against humanity; to the conclusion that heads of state should be liable to criminal prosecution; and to the conclusion that special measures should be adopted to deal with those responsible for the war. The Japanese representatives made a reservation to the conclusion under which heads of states would be held criminally responsible for political acts and they did not concur in the provision making failure to act to prevent or end violations of the laws or customs of war an affirmative offense.

The Versailles peace treaty in 1919 called for the trial of the former German kaiser, Wilhelm II, by a specially constituted international tribunal (art. 227). The treaty also contained German recognition of the right of the Allies to bring to trial before national or international military tribunals persons accused of having committed acts in violation of the laws or customs of war and an undertaking by the German government to hand such persons over to the Allies for trial (art. 228–230). The treaty contained no provision for trials for the offense of crimes against humanity and only indirectly, as to the former kaiser, was there provision for a trial for the offense of crimes against peace. Inasmuch as the Netherlands. where the kaiser had taken refuge, refused the Allied request for extradition, he was never tried. And because of German resistance to the surrender of those individuals accused of war crimes, the Allies ultimately agreed to permit the cases to be tried by the supreme court of Leipzig (Germany). The results of the trials that followed clearly indicated the ineffectiveness of this method of attempting to punish persons accused of war crimes. The great majority of those tried were acquitted, despite strong evidence of guilt; those convicted received grossly inadequate sentences (and, in several instances, were quickly permitted to escape from prison); and all were treated as heroes by the German press and public.

World War 11.—Beginning early in World War II various announcements were made concerning the intention of the Allies to mete out punishment to those guilty of war crimes. On Oct. 25, 1941, while the United States was still neutral. Pres. Franklin D. Roosevelt called attention to the atrocities being committed by the Nazis in occupied countries. On that same day Prime Minister Winston Churchill associated the British government with the Roosevelt statement and made retribution for these crimes one of the major purposes of the war. On Jan. 13. 1942, the declaration of St. James was signed by the governments in exile of nine countries of Europe that were then occupied by the Nazis. These nations, too, made punishment of war crimes a principal war aim. During the course of the war there were a number of other pronouncements on this subject, the most important of which were (1) the Moscow declaration (Nov. 1, 1943) wherein Roosevelt, Churchill and Marshal Joseph Stalin of the U.S.S.R. stated that at the time of the granting of any armistice to Germany those German officers and men and members of the Nazi party responsible for atrocities, massacres and executions in occupied areas would be sent back to the countries in which their acts had been committed in order that they might be tried and punished "according to the laws of these liberated countries and of the Free Governments which will be erected therein"; and that those "major criminals" whose offenses had no particular geographical location would be punished by a joint decision of the Allied governments; and (2) the Potsdam declaration (July 26, 1945) with respect to Japan, made by Truman, Churchill and Pres. Chiang Kai-shek of China, and later adhered to by the U S S R., which stated that "stern justice shall be meted out to all war criminals including those who have visited cruelties upon our prisoners."

Trial of Nazi Leaders.—During Oct. 1943 representatives of 17 of the Allied nations met in London and established the United Nations War Crimes commission, the functions of which included the investigation of war crimes and the formulation of general measures necessary to ensure the detection, apprehension. trial and punishment of accused war criminals. On Aug. 8, 1945, representatives of the United Kingdom, the United States and the

U.S.S.R. and of the provisional government of France signed the London agreement, which included a charter for an international military tribunal for the trial of the major Axis war criminals whose offenses had no particular geographical location. Nineteen other governments later adhered to this agreement. The first session of the tribunal, which consisted of a member and an alternate appointed by each of the four signatory countries, took place in Berlin on Oct. 18, 1945, under the presidency of the Soviet member, Gen. I. T. Nikitchenko. At that time an indictment uas lodged against 24 of the former Nazi leaders charging them with numerous crimes against peace, conventional war crimes, crimes against humanity and conspiracy, and charging a number of organizations (such as the Gestapo, the Nazi secret police) with being criminal in nature. All subsequent sessions of the tribunal were held in Nurnberg, Ger.. under the presidency of the British member. Lord Justice Sir Geoffrey Lawrence. The other members of the tribunal were Francis Biddle of the United States and Henri Donnedieu de Vabres of France. The judgment of the tribunal was reached on Oct. 1, 1946. 12 of the accused (including Martin Bormann, who was tried *in absentia)* being sentenced to death by hanging and three to life imprisonment. General Nikitchenko dissented from the acquittal of the accused Hjalmar Schacht, Franz von Papen and Hans Fritsche; from the refusal of the tribunal to sentence the accused Rudolf Hess to death; and from the decision not to declare the *Reich* cabinet, the German general staff and the high command of the German armed forces to be criminal organizations.

Trial of Japanese War Leaders.—On Jan. 19, 1946, Gen. Douglas MacArthur, supreme commander for the Allied powers in Japan, issued a charter for an international military tribunal for the far east for the trial of major war criminals in that area. The tribunal which was thereafter appointed ultimately consisted of the representatives of 11 governments (Australia, Canada, China, France, India. the Netherlands, New Zealand, the Philippines, the U.S.S.R., the United Kingdom and the United States). The trial began in Tokyo in May 1946, under the presidency of Sir William Webb of Australia, and concluded with the reading of the judgment on Nov. 12. 1948. The accused were charged with various crimes against peace, murder, other conventional war crimes and crimes against humanity. Of the 25 accused against whom sentences were adjudged, 7 received sentences to death by hanging and 16 to life imprisonment. Dissents were filed by three members of the tribunal, R. Pal of India, Henri Reimburger of France and B. V. A. Roling of the Netherlands.

Subsequent **Proceedings.**—Twelve other trials of major war criminals were held at Nurnberg under international authority. These trials, called the "Subsequent Proceedings," had as their legal basis Control council law no. 10. a law promulgated on Dec. 20. 1945, by the zone commanders of the four powers which were occupying Germany. In addition, there were thousands of Germans and Japanese tried by various national courts, either military or civilian, for conventional war crimes. It has been estimated that over 2,000 separate trials took place (including approximately 950 conducted by the United States, 550 by Great Britain and 275 by Australia) involving many times that number of accused. Included in this category were the trials by United States military commissions of Gen. Tomoyuko Yamashita and Gen. Masaharu Homma in Manila in 1945. Both of these accused unsuccessfully attempted to secure the intervention of the United States supreme court to prevent the imposition of the death sentences which they had received.

Criticism of the Trials.——From the very outset the post-World War II program for the punishment of war criminals was vigorously attacked and vigorously defended, both on political and on legal grounds. One of the legal arguments most frequently advanced against the program was that war crimes trials were ex post facto in that they allegedly punished for acts that had not been criminal when committed. This argument was directed primarily at the offenses of crimes against peace and some of the crimes against humanity.

The Nurnberg tribunal, however, held that long before the Nazi or other aggressions of World War II, a series of international declarations, acts and treaties, culminating in the pact of Paris of 1928, ratified by Germany and nearly all other states, had established a rule of customary international law making aggressive war illegal and the initiation or waging of such a war, with knowledge of its character and freedom of choice, an individual crime. *(See* WAR.) Many of the crimes against humanity and the majority, if not all, of the conventional war crimes (murder, rape, pillage, etc.) are offenses under the criminal law of every civilized nation. As to these offenses the attack was directed at the fact that the vanquished were being tried in the courts of the victors where, it was claimed, they could not receive fair and objective treatment. This particular criticism was heard less and less frequently as time went on and, in the great majority of cases, war crimes courts demonstrated their objectivity and fairness. Much criticism was also directed at the refusal of the courts which tried these cases to entertain such defenses as that the act charged as a war crime had been committed as a matter of military necessity or as a result of the receipt of orders from a superior.

Despite these criticisms, it would appear that trials for war crimes are so well embedded in the laws of war that they may be expected as a sequence to any conflict that ends with one side victorious and the other defeated (Indeed, since the end of World War II conventional war crimes have been the subject of specific international legislation in the Geneva conventions of Aug. 12, 1949, for the protection of war victims.) The passage of time has, however, resulted in a lessening of the antagonism felt toward those individuals who were convicted of war crimes after World War II and who were sentenced to imprisonment. Both the peace treaty with Japan and the Bonn agreements which terminated the occupation of west Germany contained provisions which resulted in advancing the dates of release of all but a few.

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WARD, AARON MONTGOMERY (1843–1913), **U.S.** merchant, who introduced the mail-order method of selling general merchandise, was born in Chatham. N.J., on Feb. 17, 1843. The oldest of seven children, he went to work at an early age in a cooperage to help support his family. In 1859, at the age of 16, he became a salesman in a general store in St. Joseph, Mich., for $6 a month and board; later he was made manager at $100 a month and board. During that period he conceived the idea of a business that would buy goods at wholesale for cash and sell to the consumer by mail for cash with middlemen's costs eliminated. In 1866 he moved to Chicago and worked for various firms as a traveling salesman. In Aug. 1872, with a capital of $1,600. Ward issued his first catalogue, a single sheet listing 30 items. The following year his brother-in-law, George R. Thorne, bought a half interest in the business for $800. The firm prospered.

In 1886 Ward, while retaining the presidency. turned the management over to Thorne and his five sons. During the next 20 years Ward devoted much of his time to the preservation of the natural assets of Chicago's lake front and vigorously opposed attempts to build public or other structures in Grant park. Ward died Dec. 7, 1913, in Highland Park, Ill. (F. W. JN.)

WARD, ARTEMUS (pen name of CHARLES FARRAR BROWNE) (1834–1867), was one of the best and most popular 19th-century U.S. humorists. Born in Waterford. Me., on April 26, 1834. he served as a printer's apprentice in nearby towns and later went to Boston, Mass., to work as a compositor for *The Carpet* Bag, a humour magazine. After spending seven years in Ohio as a journeyman printer, and as "local" editor of the *Toledo Commercial* and the *Cleveland Plain Dealer,* he went to

New York in 1860 to work on *Vanity Fair.* Later he turned to humorous lecturing with considerable success in both the Cnited States and England. His British tour was interrupted by his death in Southampton on March 6, 1867.

Browne's humorous writing was commonplace until 1858, when as local editor of the *Plain Dealer* he created the character Artemus Ward. Adopting the language and viewpoint of Artemus Ward, whom Browne characterized as an itinerant showman, he wrote a series of letters for the *Plain Dealer, Vanity Fuir* and *Punch* in which he commented upon many subjects. His principal books are *Artemus Ward: His Book* (1862); *Artemus Ward: His Travels* (1865); and *Artemus Ward in London* (1867). Of the humorous devices in his writing, misspelling was the most outstanding; the most prominent feature of his lectures was his "dead-pan" delivery. His techniques had considerable influence upon other humorists, including, especially in his role as a lecturer, Mark Twain.

See Don C. Seitz, *Artemus Ward, a Biography and Bibliography* (1919); A. J. Nock (ed.), *Selected Works of Artemus Ward* (1924), an excellent edition of his writings. (J. Q. R.)

WARD, DAME GENEVIÈVE (1838–1922), English actress, was born in New York city on March 27, 1838, and at the age of 18 married Count Constantine de Guerbel. She studied singing in Italy and in Paris, and made her first appearance under the stage name of Ginevra Guerrabella at Bergamo in the opera *Stella di Napoli* (1855). After the loss of her singing voice in 1862 she taught singing in New York, but in 1873 she went to London and began a long dramatic career. In 1918 she published, with Richard Whiting, a volume of reminiscences, *Before and Behind the curtain.* In 1921 she was made a Dame of the British empire. She died on Aug. 18, 1922.

WARD, JAMES (1843–1925), English psychologist and metaphysician, was born at Hull on Jan. 27, 1843. He was educated at the Liverpool institute, at Berlin and Gottingen and at Trinity college, Cambridge; he also worked in the physiological laboratory at Leipzig. Subsequently he devoted himself to psychological research, became fellow of his college in 1875 and university professor of mental philosophy in 1897. His work shows the influence of Leibniz and R. H. Lotze, as well as of evolution. His views are further worked out, through criticism of pluralism and as a theistic interpretation of the world, in his Gifford lectures (*The Realm of Ends,* 1911; 3rd ed., 1920). Ward died on March 4, 1925.

Ward published *Naturalism and Agnosticism* (1899; 3rd ed., 1907); *Heredity and Memory* (1913); *Psychological Principles* (1918; 2nd ed., 1920); *A Study in Kant* (1922); and *Essays in Philosophy,* ed. by W. R. Sorley and G. F. Stout, with memoir by O. W. Campbell (1927); numerous articles in the *Journal of Physiology,* in *Mind* and in *The British Journal of Psychology.*

WARD, JOHN QUINCY ADAMS (1830–1910), U.S. sculptor, was born near Urbana, O., on June 29, 1830. He studied under Henry K. Brown of New York, and by 1861, when he opened a studio there, he had executed busts of the U.S. public officials Josua R. Giddings, Alexander H. Stephens and Hannibal Hamlin, prepared the first sketch for the "Indian Hunter" (Central Park, New York) and made studies among the Indians themselves for the work. In 1863 he became a member of the National Academy of Design in New York, and he was later its president. He died in New York city on May 1, 1910.

WARD, SIR JOSEPH GEORGE, 1ST BART., cr. 1911 (1856–1930), New Zealand politician, was born at Emerald Hill, Melbourne, on April 26. 1856, son of a merchant. At 13 he entered the post and telegraph department. In 1887 he entered parliament as Liberal member for Awarua. Appointed treasurer in the Seddon cabinet of 1893, he was the prime minister's chief lieutenant until Seddon died in 1906, and he then succeeded to the premiership and the leadership of the Liberal party.

His ministry was defeated in Feb. 1912, but Ward returned to office as minister of finance in the national (war) cabinet of 1915–19. In Dec. 1928 he again took office as prime minister. He resigned in May 1930 and died on July 7, 1930.

WARD, LESTER FRANK (1841–1913), U.S. sociologist, the earliest and most prolific of the "founders" of systematic American sociology, was born in Joliet, Ill., June 18, 1841. Privations of his youth are thought to have had a considerable influence on his later social philosophy of amelioration and progress. After serving in the Union army during the Civil War, he graduated from Columbian college (later George Washington university), Washington, D.C., in 1869, and from the law school in 1871. He did not practise law but turned to government service, mainly in geology, botany and paleobotany. He was called to a professorship in sociology at Brown university in 1906 by his admirer and collaborator, James Q. Dealey, and taught there until his death on April 18, 1913. He made some significant contributions to botany, notably his theory of sympodial development.

In the formulation of his sociological system, Ward was greatly influenced by Auguste Comte (*q.v.*), especially in his conception of sociology as the fundamental social science and the guide to sound and effective planning for a better social future. Ward's sociological conceptions were mainly a synthesis of: (1) his own views on the relations between cosmic and social energy; (2) the principles of organic development derived in part from his paleobotany; (3) Hegelian dialectic; (4) Wilhelm Wundt's notion of "creative synthesis"; (5) hedonistic psychology; (6) social Darwinism; and (7) Comte's dictum that the primary responsibility of sociology is to plan a better future based on sociological teachings.

Ward adopted a dynamic and telic attitude toward sociology, decrying a static and descriptive approach and holding that sociology should be primarily concerned with social function rather than social structure. He divided sociology into two main fields, pure and applied. The former deals mainly with the origins and organization of social life, the latter with "the artificial means of accelerating the spontaneous processes of nature" through the application of sociological principles, as embodied in realistic education. Ward's main interest and contribution was in applied sociology and social betterment.

Ward renounced the doctrine that mankind must depend upon the slow, wasteful and bloody processes of cosmic and biological evolution to assure the development of society and contended that the development of sociology and of the social sciences in general had by then presented mankind with a sound and reliable body of information and adequate social techniques whereby the social future could be scientifically planned and a better era assured and hastened. Such a planned or "telic" society Ward called a "Sociocracy," and its dynamic agent was to be realistic education. He suggested the institution of a great academy of the social sciences in Washington which would inform! advise and guide legislators in the needed social planning. Social scientists would occupy much the same role as did the sociologist-priests in Comte's plan for a social utopia. Ward's emphasis on studying function rather than structure and on social planning later exerted considerable influence on Thorstein Veblen (*q.v.*) and the institutional economists.

Ward's most impressive book was his pioneer *Dynamic Sociology,* 2 vol. (1883), which embodied his earlier synthesis of the field and principles of sociology; it was brought down to date and condensed in his *Outlines of Sociology* (1898). *Pure Sociology* (1903) is the final summation of his theory; it is presented in more clear and elementary form in Dealey and Ward's *Textbook of Sociology* (1905). *Applied Sociology* (1904) is the authoritative exposition of Ward's notions of "social telesis." a sociocracy and social planning. Ward's intellectual autobiography is *Glimpses oj the Cosmos* (6 vol., 1913–18).

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(H. E. BAR.)

WARD, MARY AUGUSTA (MRS. HUMPHRY WARD) (1851–1920), British novelist, was born on June 11, 1851, at Hobart, Tasmania, where her father, Thomas Arnold (1824–1900), was then an inspector of schools. She was brought up mainly at Oxford, and her early associations with a life of scholarship and religious conflict are deeply marked in her own later literary career. She was brought into close connection during this period with Edward Hartopp Cradock, who was principal of Brasenose college from 1853 till his death in 1886, some of whose characteristics went into the portrait of the "Squire" in *Robert Elsmere.* In 1872 she married Thomas Humphry Ward.

In 1881 she published her first book, *Milly and Olly,* a child's story illustrated by Lady (then Mrs.) Alma-Tadema. This was followed in 1884 by a more ambitious, though slight, study of modern life. *Miss Bretherton,* the story of an actress. In 1885 Mrs. Ward published an admirable translation of the *Journal Intime* of the Swiss philosopher Henri Amiel, with a critical introduction. In Feb. 1888 appeared *Robert Elsmere,* a powerful novel tracing the mental evolution of an English clergyman. The character of Elsmere owed much to reminiscences both of T. H. Green, the philosopher, and of J. R. Green, the historian. The book was reviewed by W. E. Gladstone in the *Nineteenth Century* (May 1888, "Robert Elsmere and the Battle of Belief"), and made its author famous.

Mrs. Ward's next novel, *David Grieve,* was published in 1892. In 1895 appeared the short tragedy, the *Story of Bessie Costrell.* Mrs. Ward's next long novel, *Helbeck of Bannisdale* (1898), treated of the clash between the ascetic ideal of Roman Catholicism and modern life. The element of Catholic and humanistic ideals entered also into *Eleanor* (1900), in which, however, the author relied more on the ordinary arts of the novelist. In *Lady Rose's Daughter* (1903)—dramatized as *Agatha* in 1905—and *The Marriage of William Ashe* (1905), modern tales founded on the stories respectively of Mlle. de Lespinasse and Lady Caroline Lamb, she relied entirely and with success upon social portraiture. Later novels were *Fenwick's Career* (1906), *Diana Mallory* (1908), *Daphne* (1909), *Canadian Born* (1910), *The Case of Richard Meynell* (1911), *Delia Blanchflower* (1913), *The War and Elizabeth* (1918), etc. Mrs. Ward died in London on March 24, 1920.

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WARD, WILFRID PHILIP (1856–1916), British man of letters, was born at Ware, Hertfordshire, on Jan. 2, 1856, the second son of William George Ward. In 1906 he became editor of the *Dublin Review.* He died in London on April 8, 1916. His works include: *W. G. Ward and the Oxford Movement* (1889); *W. G. Ward and the Catholic Revival* (1893); *Life and Times of Cardinal Wiseman* (1897); *Life of John Henry Cardinal Newman* (1912) and several volumes of essays.

WARD, WILLIAM GEORGE (1812–1882), English Roman Catholic theologian, was born on March 21, 1812. He was educated at Christ Church and Lincoln college, Oxford, and became a fellow of Balliol in 1834. He regarded Newman as a mere antiquary. When he was persuaded to hear Newman preach, he at once became a disciple. He took deacon's orders in 1838 and priest's orders in 1840. From that period Ward and his associates worked for union with the Church of Rome; in 1844 he published *Ideal of a Christian Church,* in which he openly contended that the only hope for the Church of England lay in submission to the Church of Rome. The University of Oxford was invited, on Feb. 13, 1845, to condemn "Tract XC," to censure the *Ideal* and to degrade Ward from his degrees. The two latter propositions were carried and "Tract XC" only escaped censure by the *non placet* of the proctors, Guillemard and Church. The condemnation precipitated an exodus to Rome. Ward left the Church of England in Sept. 1845, and was followed by many others, including Newman himself. In 1868 he became editor of the *Dublin Review.* He died July 6, 1882.

See *William George Ward and the Oxford Movement* (1889) and *William George Ward and the Catholic Revival* (1893), both by his son Wilfrid Philip Ward.

WARD, that which guards or watches, and that which is guarded or watched. In architecture the inner courts of a fortified place are called wards; *e.g.,* the upper and lower wards of Windsor castle *(see* CASTLE). The "ward" in a lock is the ridge of metal which fits exactly into the corresponding "ward" or slot of the key *(see* LOCK). Boroughs, cities and parishes may be divided into wards, for the conducting of local elections, etc. In the same way, large establishments, such as hospitals, asylums, etc., are divided into wards. In law, "ward" is a term for minors or persons under guardianship *(see* INFANT; MARRIAGE; ROMAN LAW).

An electoral division in U.S. municipalities is called a ward. Except where the commission and city-manager forms of government are used, the municipal legislative branch is a city council made up of representatives from the various wards of the city. The wards are supposed to be of about equal population, each ward having either one or two aldermen, chosen by the qualified voters of the ward, in the city council. Each ward is divided into one or more voting precincts or divisions. *See* C. C. Maxey, *An Outline of Municipal Government* (1923).

WAR DEBTS: *see* INTER-ALLIED DEBTS.

WARDEN, a word frequently employed in the ordinary sense of a watchman or guardian, but more usually in England in the sense of a chief or head official. The lords wardens of the marches, for example, were powerful nobles appointed to guard the borders of Scotland and of Wales; they held their lands *per baroniam,* the king's writ not running against them, and they had extensive rights of administrating justice. The chief officer of the ancient stannaries of Cornwall has the title of lord warden *(see* STANNARIES) as has also the governor of Dover castle *(see* CINQUE PORTS).

WAR DEPARTMENT: *see* GOVERNMENT DEPARTMENTS.

WARDHA, a town and district in Bombay state, India. They take their name from the Wardha river. The town of Wardha, well known as the last headquarters of Mahatma Gandhi, was established on a treeless black soil plain at the old village of Palakwari in 1866 at the spot where the branch line to Warora was expected to take off. Pop. (1951) 39,827

WARDHA DISTRICT was carved out of Nagpur in 1862. Area 2,429 sq.mi.; pop. (1951) 538,903. There are cotton mills at Hinganghat and Pulgaon. The language is Marathi.

WARDLAW, HENRY (d. 1440), son of Sir Andrew Wardlaw, was educated at Oxford and Paris and nominated by the papal court at Avignon bishop of St. Andrews (consecrated 1403). He was tutor to James I, restored the cathedral, and, on the return of James from England, became one of his principal advisers. He persecuted the Wycliffites. Wardlaw issued the charter of foundation of St. Andrews university, in 1411.

WARDROBE, a portable upright cupboard for storing clothes. The earliest wardrobe was a chest, and it was not until some degree of luxury was attained in regal palaces and the castles of powerful nobles that separate accommodation was provided for the sumptuous apparel of the great. The name of wardrobe was then given to a room in which the wall-space was filled with cupboards and lockers. As a "hanging cupboard" it dates back to the early 17th century. For probably 100 years such pieces, massive, but often with well-carved fronts, were made in fair numbers. During the 18th century the tallboy or highboy was much used for clothes. Toward its end, however, the wardrobe began to develop into its modern form, with a hanging cupboard at each side, a press in the upper part of the central portion and drawers below. As a rule it was of mahogany, but as soon as satinwood and other finely-grained foreign oods began to be obtainable in considerable quantities, many elaborately and even magnificently inlaid wardrobes were made.

WARDROBES, THE. Although originally *garderoba* (wardrobe) and *camera* (bedroom) were synonymous, *garderoba* was early distinguished as the small room attached to the bedchamber, where clothes were kept and articles of value stored. Mediaeval kings and emperors, magnates of church and state, all had a wardrobe as well as a bedroom. But no continental *vestiarium* (wardrobe) experienced such development as that through which the *garderoba* of the kings of England passed. From a place of deposit, a mere adjunct of the king's chamber (*q.v.*), the king's wardrobe in England grew into a third treasury, and, in the 13th century, dispossessing the chamber as the financial and directive agent of the royal household (*q.v.*), became a full administrative department. Not even the wardrobe of the popes, which enjoyed some measure of authority between the 6th and the 11th centuries, can compare with it, while the wardrobe of the kings of France was always a subordinate branch of the chamber.

The increasing administrative burden of the chamber, relieved only partially by the growth and independent establishment of the exchequer (*q.v.*), imposed further duties upon the *garderoba regis* (king's wardrobe). So ably did it discharge them that, by the end of John's reign, it had developed into a rudimentary office, and before long took over from the chamber the routine work of the household. A clerical keeper or treasurer, and a lay steward, were responsible for its management, their revenue mainly coming from the exchequer, to which the keeper accounted. His statements were attested by the controller, his immediate subordinate, also a clerk, who kept a counter-roll of receipts and expenses. Under Edward I the controller became the recognized keeper of the privy seal (*see* SEALS), and the cofferer who was the third clerical officer, obtained definite title and position. Beginning as the personal clerk of the keeper, he rose to be chief bookkeeper and cashier, and the usual *locum tenens* of the keeper. By the close of the 13th century, because public matters claimed more and more of the attention of the chancery, the wardrobe had become the household secretariat; the domestic 'chancery as well as the domestic exchequer. Nor did it fulfil only domestic and peaceful functions. As the household was the nucleus of the army when the king waged war in person, the wardrobe then undertook the financial administration of the campaigns. The finances of most of Edward I's expeditions. of the Scottish offensives of Edward II and Edward III, and of a number of the campaigns of the Hundred Years' War, were administered in this way.

Thus the king's wardrobe, or wardrobe of the household, came to have a wider military and a political importance. The reason lay in its all-round usefulness. Its machinery was adaptable, and its officers, appointed by word of mouth. were directly answerable to the king. Its funds could be augmented or diminished at need, and. although its accounts had to be submitted to the exchequer for audit, it actually spent the money. It also had the use of a seal which, though in the first instance personal to the sovereign, could be and was increasingly employed in state business. These and similar considerations commended the wardrobe to king, aristocracy and ministers alike. Yet the jealous and vigilant barons did not hesitate to attack the wardrobe whenever they felt it was being used as an instrument of prerogative. It mas, for example, a result of the baronial ordinances of 1311, that in 1312 the privy seal was taken away from the controller and given a keeper all to itself.

The Great Wardrobe.—Differentiation and centralization were as ceaselessly at work within the mardrobe as without. Since both chamber and wardrobe accompained the household wherever it went, they needed places in which to store their heavier and bulkier commodities. Rooms in the king's manors were set apart for this purpose, the wardrobe being held responsible for the custody and replenishment of the stocks kept in them. A subdepartment, the great wardrobe, *magna garderoba regis*, a term in use by 1253, constituted itself to direct the necessary labour. The description "great" referred to the size and quantity of the goods stored, not to the status of the office, which was inferior to the king's wardrobe. The clerk of the great wardrobe was its head, and to begin with, all its officials, excluding the two or three stationed with the more important stores, followed the court. Up to 1324 the clerk was financed by the wardrobe, but from that year he received his revenue from, and accounted to, the exchequer, except for a brief return to former usage between 1351 and 1360. Owing to the nature and variety of the work, it was practically impossible for the clerk or his assistants to reside continually in the household. The great wardrobe was not simply a depository. Besides collecting, safeguarding and distributing goods, it also manufactured and repaired them.

The Tower of London was its first centre, but from the beginning of the 14th century, houses in the city of London were also used. Among them was a house in Bassishaw (Basinghall) ward, near the weekly cloth markets of Weavers' Hall and Bakewell Hall, and the house in Lombard street which had once belonged to the Bardi merchants. Larger and better quarters were bought in 1361, in the parish of St. Andrew's by Baynard's Castle. Here the office and its staff lived until the great fire of 1666. They then found accommodation in Buckingham street in the Savoy, but later removed to Great Queen street.

Hardly had the great wardrobe taken shape before the privy wardrobe, *priuata garderoba regis,* made its appearance as a travelling store for chamber, wardrobe and great wardrobe. There had early been in the household a small wardrobe of robes arid arms for current use, but only toward the end of the 13th century did it develop even a modest organization. Its officers were as much chamber as mardrobe servants, and such money as they needed was supplied by the wardrobe or the great wardrobe. Although their work was the care and transport of articles wanted from day to day, they soon found it advisable to have a central depository. Between 1323 and 1344 they set up a store in the Tower of London, chiefly of arms and armour. This, used by chamber and great wardrobe as well as by the household, came to be known as the privy wardrobe in the Tower. The keepers of this wardrobe, also clerks of the chamber until 1356, took their revenue from the exchequer, which also audited their accounts. Before 1360 it had separated itself from the household though it left behind a small privy wardorbe, which survived well into the 16th century, to carry on its original work. By 1399 it was as independent of great wardrobe arid chamber as it was of the household. It was looted by the peasants in revolt in 1381.

In consequence of both internal and external differentiation, and with the adoption of special means for financing war, under parliamentary control the king's wardrobe, from the latter part of the 14th century generally described as "the household," slowly degenerated into a simple office of household accounts. The process was not materially hindered even when the treasurer of war was the treasurer of the household. The privy wardrobe in the Tower lost both name and identity in the 15th century with its transformation into the king's armouries in the Tower. But the great wardrobe. still the storehouse for the household, came to be known as "the wardrobe." The cofferer of the household and the officers of the great wardrobe were suppressed in 1782 by Burke's act for economical reform. Such of their duties as were retained were divided among the lord chamberlain (*q.v.*), the lord steward (*q.v.*), and the surveyor of the buildings.

See T. F. Tout, *The Place of the Reign of Edward II in English History* (1914, bibl.); J. C. Davies, *The Baronial Opposition to Edward II* (1918, bibl.); T. F. Tout, *Chapters in the Administrative History of Mediaeval England*, 5 vol. (1920–30). (D. M. B.)

WARE, the name of a father and two sons, all ordained ministers, leaders of the Unitarian movement at the time of its development as a distinct religious denomination in the United States.

HENRY WARE (1764–1845) was born in Sherborn, Mass., on April 1, 1764 and graduated from Harvard in 1785. He came into prominence in 1805 when he was named Hollis professor of divinity at Harvard. His election precipitated the Unitarian controversy, since it indicated that control of the college was no longer in the hands of the Calvinists. In 1820 Ware defended his theological liberalism in a pamphlet debate with Leonard Woods of Andover Theological seminary which attracted wide attention. He died at Cambridge, Mass., on July 12, 1845. Henry Ware was married three times and was the father of 19 children; a number of his children and grandchildren achieved distinction.

HENRY WARE (1794–1843), son of the elder Henry by his first wife, was born in Hingham, Mass.: on April 21, 1794, and graduated from Harvard in 1812. After serving as minister of the Second church in Boston, where Emerson became his colleague and successor, he was called in 1830 to a professorship at the Harvard Divinity school. His talents were pastoral and practical rather than theological, but he was a gifted preacher and his influence on his students was profound. He died at Framingham, Mass., on Sept. 22,1843.

WILLIAM WARE (1797–1852), also son of Henry Sr. and his first wife, was born in Hingham, on Aug. 3. 1797, graduated from Harvard in 1816. In 1821 he became minister of the newly organized Unitarian church in New York city, where he stayed 15 years. The remainder of his career was devoted to literature. He wrote three historical romances dealing with the early growth of Christianity, the best known being *Zenobia* (1837). His work is a reminder of the close relationship between Unitarianism and literary culture in the flowering of New England. He died at Cambridge, Mass., on Feb. 19, 1852.

See George *H.* Williams (ed.), *The Harvard Divinity School* (1954); John Ware, *Memoir of the Life of Henry Ware, Jr.* (1846). (C. *WT.*)

WARE, WILLIAM ROBERT (1832–1915), U.S. architect and educator, established the first school of architecture in the United States. He was born in Cambridge, Mass., on May 27, 1832. After graduation from Harvard he worked in the New York atelier of Richard Morris Hunt (*q.v.*) and later formed a partnership with Henry Van Brunt in Boston, where he gave instruction to their assistants. Among the many buildings executed by the firm were several for Harvard including Memorial hall and alterations to the library, adapting for the first time in America Henri Labrouste's system of stack construction.

In 1865 Ware was appointed to establish a school of architecture at the Massachusetts Institute of Technology, Cambridge. To supplement his training with Hunt, Ware made a year's survey of schools and apprenticeship in Europe and England. His theories of teaching stated in his *Outline of a Course of Architectural Instruction* (1866; reprinted 1942) emphasized architectural design within a liberal arts background, leaving technical training in construction for postgraduate office practice. Ware went to Columbia university in 1881 to organize courses in architecture and he remained there until his retirement in 1903. He died in Milton, Mass., June 9, 1915. His writings include *Modern Perspective* (1883) and *The American Vignola* (1902–06). (CE. S.)

WARE, an urban district in the East Hertfordshire parliamentary division of Hertfordshire, Eng., on the Lea, 3 mi. N E. of Hertford. Pop. (1951) 8,253. Area 2.1 sq.mi. It is an ancient malting town with some factories making pharmaceutical and surgical goods, furniture, plastics, rail cars and coaches. The huge 16th-century "Great Bed of Ware," preserved in the Victoria and Albert museum, London, was formerly in various local inns. The Priory, founded in the 14th century, is now the administrative headquarters; Ware park, in the 16th century owned by the Fanshawes, is now a hospital.

WAREHAM, a municipal borough in the parliamentary division of South Dorset, Eng., 17 mi. S.E. of Dorchester by road, between the Frome and Piddle rivers. Pop. (1951) 2,745. Area 1.1 sq.mi. The site as the gateway to the Isle of Purbeck has been occupied from very early times, and earthworks round the town are probably Saxon. St. Martin's church, said to have been founded by St. Aldhelm about 701, was rebuilt in the 11th century, neglected for centuries and rededicated in 1936. Edward the Martyr (d. 978) was buried in Lady St. Mary's church but was later removed to Shaftesbury abbey, the marble coffin remaining at the church, however.

Wareham priory existed in 876 and was destroyed by Canute in 1015. The castle existed before 1086 and was the scene of much fighting during the civil wars.

In the 10th century there was a mint at Wareham, then a thriving port. Purbeck was at that time more of an island than it is now, with marshes high up the Frome valley. It is a peninsula about 15 mi. long and 8 mi. wide, whose low sandy shores on the north skirt Poole harbour and Studland bay, and whose rising coast on the south culminates in the limestone cliffs of St. Alban's or St. Aldhelm's head, 400 ft. above the sea. A range of chalk downs runs west-east across the peninsula, ending in vertical cliffs north of Swanage; in the south are limestone quarries which produce the so-called Purbeck marble.

WARENNE, EARLS. The Warennes derived their surname from the river of Guarenne or Varenne and the little town of the same name near Arques in Normandy. William de Warenne, who crossed with William I in 1066, was a distant cousin of the Conqueror, his grandmother having been the sister of Gunnora, wife of Richard I of Normandy. De Warenne received as his share of English spoil some 300 manors in Yorkshire, Norfolk, Surrey and Sussex, including Lewes castle. He was wounded at the siege of Pevensey and died in 1089, a year after he had received the title of earl of Surrey. Both he and his successors were more commonly styled Earl Warenne than earl of Surrey.

His son William, 2nd earl (c. 1071–1138), was a suitor for the hand of Matilda of Scotland, afterward queen of Henry I. He was temporarily deprived of his earldom in 1101 for his support of Robert, duke of Normandy, but he commanded at the battle of Tenchebrai (1106) and was governor of Rouen in 1135.

William de Warenne, 3rd earl (d. 1148), was, with his half-brother Robert de Beaumont, earl of Leicester, present at the battle of Lincoln, where his flight early in the day contributed to Stephen's defeat.

He remained faithful to the queen during Stephen's imprisonment, and in 1146 he took the cross, and was killed near Laodicea in Jan. 1148.

His daughter and heiress, Isabel, married in 1153 William de Blois, second son of King Stephen and Matilda of Boulogne, and in 1163 Hamelin Plantagenet, natural son of Geoffrey, count of Anjou. Both Isabel's husbands appear to have borne the title of Earl Warenne.

Earl Hamelin was one of those who at the council of Northampton denounced Becket as a traitor; he remained faithful to his half-brother Henry II during the trouble with the king's sons, and in Richard I's absence on the crusade he supported the government against the intrigues of Prince John.

William de Warenne (d. 1240), son of Isabel and Hamelin, who succeeded to the earldom in 1202, enjoyed the special confidence of King John. In 1216, however, as the king's situation became desperate. the earl repented of his loyalty and, shortly before the death of John, made terms with Prince Louis. He returned to his lawful allegiance immediately upon the accession of Henry III and was, during his minority, a loyal supporter of the crown. He disliked, however, the royal favourites who came into power after 1227 and used his influence to protect Hubert de Burgh when the latter had been removed from office by their efforts (1232). Warenne's relations with the king became strained in course of time. In 1238 he was evidently regarded as a leader of the baronial opposition, for the great council appointed him as one of the treasurers who were to prevent the king from squandering the subsidy voted in that year.

His son John de Warenne (*c.* 1231–1304) succeeded in 1240 and at a later date bore the style of earl of Surrey and Sussex. In the battle of Lewes (1264) he fought under Prince Edward and on the defeat of the royal army fled with the queen to France. His estates were confiscated but were subsequently restored. He served in Edward I's Welsh campaigns and took a still more prominent part in Scottish affairs, being the king's lieutenant in Scotland in 1296–97.

In Sept. 1297 he advanced to Stirling and, giving way to the clamour of his soldiers, was defeated by William Wallace on the 11th. He invaded Scotland early the next year with a fresh army and, joining Edward in the second expedition of that year, commanded the rear at Falkirk.

John de Warenne (1286–1347) succeeded his grandfather in 1304 and was knighted along with the prince of Wales in 1306 two days after his marriage with the prince's niece Joanna, daughter of Eleanor of England, countess of Bar. From that time onward he was much engaged in the Scottish wars, in which he had a personal interest, since John Baliol was his cousin and at one time his ward.

As there were no children of his marriage, his nephew Richard Fitzalan II, earl of Arundel (*c.* 1307–1376), became heir to his estates and the earldom of Surrey. His northern estates reverted to the crown, and the southern estates held by Joanna of Bar during her lifetime passed to Fitzalan. The Warrens of Poynton, barons of Stockport, descended from one of Earl Warenne's illegitimate sons by Isabella de Holland.

See G. E. C(*okayne*), *Complete Peerage,* vol. vii (1896); and John Watson, *Memoirs of the Ancient Earls of Warren or Surrey* (2 vol., *1782).*

WARFIELD, DAVID (1866–1951), U.S. actor, was born in San Francisco. Calif., on Nov. 28, 1866. His first contact with the theatre was as an usher at the Bush Street theatre in San Francisco, and his first speaking role was in *The Ticket of Leave Man,* performed in Napa, Calif., in 1888. In 1890 he arrived in New York city and began performing monologues and light comedy sketches. It was David Belasco who, seeing him perform in the slapstick Jewish comedy of the Weber and Fields company, gave him his first serious acting opportunity. Beginning in 1901 with *The Auctioneer,* Warfield was starred in one Belasco success after another. His portrayal of Anton von Barwig in Charles Klein's *The Music Master* was so successful that he performed the role more than 1,000 times between 1904 and 1907. Other successes were *A Grand Army Man* (1907), *The Return* of *Peter Grimm* (1911) and *The Merchant of Venice* (1922). Warfield died in New York city on June 27, 1951. (S. W. H.)

WAR FINANCE: COST OF WORLD WARS I AND II. This article discusses the nature of the costs of war and then presents an estimate of the costs of World Wars I and II. In later sections the methods used to finance these wars are outlined and evaluated, and some of the common fallacies regarding war finance are analyzed.

NATURE AND ESTIMATE OF AMOUNT

The most important costs of war are not measurable by the yardstick of money. The noneconomic and psychic costs of wars are not reducible to simple monetary terms. They include such costs as "blood. sweat and tears," terror, anxiety, bereavement, hatred. moral degradation, physical and mental disease and impairment and loss of life. To these must be added such real private and social costs as depletion of natural resources, lost productioq, shifts of working populations to war pursuits in which they are untrained and unproductive, housing shortages, lowering of living standards due to shortages of food. clothing and living conveniences, lowered birth rates, unrequited depreciation and obsolescence of capital equipment.

Thus the national income of Germany was impaired in both World Wars I and II by loss of territory and population. France suffered the loss of such natural resources as coal mines and forests. Britain suffered from reduction of labour power. The Balkan countries were tortured by starvation. All or nearly all warring countries lost economic efficiency, although these real costs of war differed in both kind and degree for the various belligerents.

For practical purposes, however, war finance is restricted to the direct money costs of public expenditures, revenues, debts and administration brought about by wars. The study of war finance also includes consideration of the impact of public policies dealing with war finance (taxation, borrowing, inflation, etc.) upon the national economies, primarily but not exclusively, of belligerent countries. Thus, for example, the war finance problems of the United States in World War I began before actual belligerence in 1917, and in World War II before actual belligerence in 1941.

Even with this restricted definition, there is wide variance between estimates of the money costs of both World Wars I and II. One of the primary causes of this variance is disagreement as to the proper duration of the war period itself. The period prior to the commencement of actual hostilities, covering defense and preparedness costs assignable specifically to a war, is not unambiguous. Neither is the period after the close of the war, covering postwar reconstruction costs or foreign aid. Determinations were made, but they contain elements of arbitrary judgment and are not always in agreement with each other. For World War I, some computations were founded on the assumption that the war ended with the Armistice of Nov. 1918. Others placed the end at the signing of the various peace treaties of 1919–20. Others included the cost of policing occupied areas, such as the Rhineland. Still others included payments for demobilization of men and reconversion of war industries. Some, finally, extended the postwar period so as to offset war costs by compensation for war damages, but added costs of reconstruction, of mar pensions and allowances, and foreign exchange lost as a result of depreciated domestic currencies.

The analysis given in Table I of the money costs of World War I is based upon studies by Edwin R. A. Seligman of Columbia university, and covers national budgets for the war years. Without detailed allowance for exchange variations, the costs of the belligerent nations were converted into U.S. dollars to afford a rough basis of comparison. These estimates were designed to allow for normal growth in peace expenditures, including peacetime military expenditures. The estimates made no allowance for price-level changes.

Table I.—Total War Expenditures: World War I
(in 000,000s)

Great Britain	Aug. 4, 1914—March 31, 1919	£8,601	$41,887	
Australia	Aug. 4, 1914—March 31, 1919	291	1,461	
New Zealand	Aug. 4, 1914—March 31, 1919	76	365	
Canada	Aug. 4, 1914—Aug. 31, 1919		1,545	
South Africa	Aug. 4, 1914—March 31, 1919	33	243	
India	Aug. 4, 1914—March 31, 1919	119	584	
British empire				$46,085
France	Aug. 3, 1914—March 31, 1919	169,000 fr.	$32,617	
Russia	Aug. 1, 1914—Oct. 31, 1917	51,500 Rb.	26,522	
Italy	May 23, 1915—May 31, 1919	L. 81,016	15,636	
Belgium	Aug. 2, 1914—Oct. 31, 1918	5,900 fr.	1,387	
Rumania	Aug 27, 1916—Oct. 31, 1918		907	
Serbia	July 28, 1914—Oct. 31, 1918		635	
United States	April 5, 1917—June 30, 1919		32,261	
Entente powers				$109,965
Germany	Aug. 1, 1914—Oct. 31, 1919	204,268 M.	$48,616	
Austria-Hungary	July 28, 1914—July 31, 1919	119,504 kr.	24,858	
Turkey	Nov. 3, 1914—Oct. 31, 1918		1,802	
Bulgaria	Oct. 4, 1915—Oct. 31, 1918		732	
Central powers				$76,008
Total				$232,058
Loans to Allies				
Great Britain		£1,739	$8,467	
France		6,700 fr.	1,293	
Germany		9,500 M.	2,261	
United States			9,102	
Total				$21,123
Total net war expenditures*				$210,935

*"The figures cover the cost of the war up to a period from six to twelve months after the conclusion of hostilities. In many countries however, large expenses directly connected with the winding up of the war continued, and in any final statement the prodigious figures of the cost of reconstruction and reparation would have to be added. These will without much doubt ultimately well-nigh double the above estimate." Edwin R. A. Seligman, *Essays in Taxation,* 10th ed., rev., p. 7.57, Macmillan Company (New York, 1925).

According to Seligman, the total gross cost of World War I during the fiscal years of combat alone amounted to $232,058,000,000, while the net cost reached $210,935,000,000. Computing average daily expenditures for the various countries. Seligman found that for Great Britain the figures ranged from $9,500,000 (1915) to $32,500,000 (1918). Corresponding figures are: for Germany $13,000,000 (1914) to $34,500,000 (1918); for Italy, $4,500,000 (1914) to $10,500,000 (1918); for Russia, $5,800,000 to $47,000,000. For the U.S. the second month of the war showed a cost of $15,000,000 per day. which increased to nearly $50,000,000 in Oct. 1918. The daily war expenditures for all belligerents averaged $164,500,000.

The interwar period was characterized by an overlapping of national payments of principal and interest on national debts, veterans' pensions and relief costs of World War I with the rising military expenditures preparatory to World War II. The additional costs stemming from the world-wide depression of the 1930s also reduced the possibility of repayment of earlier mar obligations. Many times in history the total costs of an earlier war had not been met when a later war began. Great Britain, for example, may be said never to have finished paying for the Napoleonic Wars. The extent of the overlap in the case of World Wars I and II, however. was unprecedented.

As of the latter 1950s the total costs of World War II had not yet been estimated with either the precision or the reliability of the Seligman estimates of the total costs of World War I. In the case of one major belligerent, China, no estimates worth reproducing appeared to be available. If we ignore costs incurred after June 1948 (interest on war debts, pensions and care of veterans, grants-in-aid and credits for rehabilitation and reconstruction, etc.) the highly tentative results of Table II may be presented. As will be noted from this table itself, the beginning and ending dates differ for the several belligerents, and the omission of data for China leads to a serious underestimate. The total in U.S. dollars (at 1956 value) comes nevertheless to nearly $1,167,000,000,000, or nearly three times the 1956 gross national product of the U.S. World War II was a "million million dollar war," even in the restrictive meaning of war finance and with the restrictive choice of beginning and of ending dates used in this article. The National Industrial Conference board predicted that by 1972 the total costs of World War II to the U.S. alone may rise to $700,000,000,000 as the volume of continuing costs increases steadily.

TABLE 11.—*Estimated Minimum Costs of World War 11*

Country	Cost
U.S. (July 1, 1940–June 30, 1946)	$387,000,000,000
Germany	272,000,000,000
U.S.S.R.	192,000,000,000
United Kingdom	120,000,000,000
Italy	94,000,000,000
Japan	56,000,000,000
Canada	15,680,000,000
France (1935 to the capitulation)	9,000,000,000
(after Normandy landings)	6,000,000,000
South American countries	8,000,000,000
Belgium	3,250,000,000
Poland (to fall of Warsaw)	1,550,000,000
Netherlands (to invasion)	925,000,000
Czechoslovakia (1935 to invasion)	800,000,000
Greece (1935–42)	220,000,000
Yugoslavia (1935–42)	200,000,000
Mexico	200,000,000
China (estimates unreliable)	...
Estimated minimum costs of World War II	$1,166,825,000,000

METHODS OF FINANCING

War costs are met by a number of fiscal methods in various combinations, of which the following are the most important: (1) Taxes; these may be either direct—on the income and wealth of individuals and corporate bodies—or indirect—mainly sales and excise levies on goods and services. (2) Compulsory loans; these include compulsory purchases of public securities and taxes made more acceptable by promises of future partial refunds, with or without interest. (3) Voluntary domestic loans; these involve the purchase of public securities either from voluntary savings or from credit created by banking systems. (4) Foreign loans; these loans may be of two types: in cash or credits in the foreign country, or in goods or in kind (lend-lease). (5) Creation of money (the printing of new paper money) either by the public treasury or by a central bank or other semipublic institution.

None of these methods of financing is limited to war costs, but many are used almost exclusively for this purpose. Many novel, interesting and far-reaching expedients which sometimes proved of permanent value have been devised under each head, to meet the added demands of war periods.

Taxes.——For example, in the U.S. the expansion of the importance of the personal income tax came as a result of World Wars I and II. In each conflict, the rates for the higher brackets were increased drastically, although never to the 100% level proposed by Pres. Franklin D. Roosevelt in 1942 for incomes over $25,000. At the same time, exemptions were lowered to such a point that the income tax became for the first time a "mass base tax" during World War II. A further change in income tax administration which appeared to be permanent was a shift in 1943 to a "pay-as-you-go" or deduction-at-source system, which enabled high wartime rates to produce tax yields a year sooner than they would have done otherwise. (This shift was accompanied by partial forgiveness of 1942 taxes due on the prior lagged basis.) (See INCOME TAX.)

Wartime corporate income-tax rates were raised and supplemented by excess-profits levies on all corporate income substantially above a prewar base and affecting a relatively high percentage of capital income. These excess-profits taxes, at rates up to 85%, were deemed unfair to growing companies and were also accused of encouraging wasteful expenditures. They were replaced after the close of hostilities. (See EXCESS-PROFITS TAX.) Proposals to apply the same principle to taxation of differential incomes of individuals were made many times but were not enacted.

A number of European and Asian countries experimented with capital levies and special taxes upon the property of persons not suffering war losses. A similar proposal was made but not enacted in Great Britain after World War I. (See CAPITAL LEVY.) Capital levies had not as of the latter 1950s found much backing in the U.S., perhaps because the distinctions between war sufferers and others were less marked than in countries with relatively larger losses in manpower or capital through bombing or invasion.

Before World War I the U.S. federal government's excise taxes were largely limited to levies on tobacco products and liquors. The exigencies of war finance produced a multitude of "nuisance taxes," mainly on semiluxuries. It is conceivable that these might have been combined into a federal sales tax in World War II, had not state sales taxes previously pre-empted much of the field. At any rate, proposals for federal sales taxes were voted down, as were proposals for spending taxes to be added to the income tax. (A spendings tax is essentially an income tax with a savings deduction.) In Great Britain and many other belligerent countries. general sales levies did result. and at high rates. The British purchase tax was $16\frac{2}{3}\%$ on most items and $33\frac{1}{3}\%$ on luxuries.

Compulsory Loans.—Compulsory loans have been generally frowned upon by specialists in public finance, although a certain amount of public pressure has often accompanied subscription to voluntary ones. With the publication of John Maynard Keynes's How *to* Pay for *the War* (1939) there came a substantial revision of this appraisal. particularly in Great Britain and the dominions. Part of the increased income tax of the smaller taxpayers in the United Kingdom was made refundable after the war at a time chosen by the state. This form of taxation was not particularly successful. Payments seem to have been looked upon as taxes by the payers, and refunds were never made in purchasing power equivalent to what was promised.

Voluntary Domestic Loans.—In considering voluntary loans, one must distinguish between purchases by nonbankers from voluntary savings and purchases by bankers and others from credit created by bank expansion. The first type of loan is generally not inflationary in its effects. although occasionally purchasers of government securities may require credit expansion for other investment projects. The second type of loan is approximately as inflationary as would be the printing of the same amount of new paper currency.

In both World Wars I and II, the second more than the first, attempts were made to place loans primarily with voluntary savers who would, it was hoped. reduce private consumption and private investment in order to buy and hold government securities. (The holding throughout the war and postwar emergency is of course as important for financial stability as the initial purchase.) These attempts were not entirely successful in the case of any major belligerent power. In World War I the main inducement was high interest rates, which became higher as the combat progressed. In World War II receipt of high interest by the public creditor was frowned upon generally as a maldistribution of income akin to profiteering. Rates were held down, giving rise to the phrase "two per cent war." but purchasers were effectively guaranteed against capital losses by express or implied promises of governments and central bankers to repurchase the securities at or above par. This process of guaranteeing bond prices led to monetization of much of the public debt, since the promises concerned could not be fulfilled except by credit expansion to repurchase the debt offered for resale. In both wars a wide variety of securities of varying rates and maturities was offered, designed to fit the desires of different classes of lenders. In general, the longer the issue, the higher the rate was. In the U.S., in World War II, banks and corporations were not permitted to hold some of the most attractive (highest yield) long-term issues, the so-called Series E bonds, and private individuals' holdings were also restricted in amount. An important difference between British and U.S. practice was the widespread use by the British of perpetual annuities (consols) with no due date whatever. The longest U.S. issues were 25-year bonds, paid at maturity with the proceeds of refunding issues.

Even with the inducements of high interest rates in World War I, and price fixing in World War II, much of the voluntary domestic lending was done by the commercial banks, who either held the securities themselves or advanced credit for others to buy them. Either procedure produces an increase in "checkbook money" and, therefore, inflationary pressure. Over the five fiscal years 1941–46 inclusive, the U.S. banking system absorbed $89,300,000,000 of federal securities, as against $131,400,000,000 for all other investors. (See Table VI.)

Foreign Loans.—Foreign lending shifts part of the cost of a war from the borrowing to the lending country. If the loan is repaid subsequently, lending permits the war cost of the war generation in the borrowing country to be shifted to the subsequent generation which repays the loan. This special case is interesting, because it is the only one which permits politicians to do what they usually advertise they intend to do, namely, to share the cost of a war with future generations. If the lending country is also a belligerent, the loan increases the cost of war as far as it (the lending country) is concerned, the increase being reimbursed to a subsequent generation if the loan is repaid. Even here, if we view the world as a unit, the cost of the war is borne by the war generation, but from the point of view of the borrowing country alone. there has been a partial escape.

In both World Wars I and II the United States was the major lending country. In World War I and shortly thereafter, U.S. loans took the conventional form of dollar credits in the Cnited States. The face amount of the loans was scaled down substantially in subsequent negotiations, but it proved impossible for the European debtors to repay them except indirectly—out of the proceeds of private U.S. loans to Germany and German reparations payments to the Allies. A major reason for the difficulty in payment was the high U.S. tariff, which hampered the sale of European goods in the United States. After U.S. loans to Germany ceased (1928–29), dollars for reparations payments were no longer available to the German government for reparations and the triangular repayment process on the U.S. war debts broke down.

TABLE III.—*World War I Debts Owed to the United States as of June 30, 1948*
(in $000,000. Figures are rounded and will not necessarily add to totals)

Country	Total debts	Total payment	Funded debt
Armenia	$ 29.2	...	...
Austria	26.0	$ .9	$ 25.9
Belgium	528.5	52.2	400.7
Czechoslovakia	188.8	20.1	165.2
Estonia	26.2	1.2	16.5
Finland	8.1	8.3	7.5
France	4,837.8	486.1	3,863.6
Great Britain	6,871.4	2,024.8	4,368.0
Greece	38.2	4.1	31.5
Hungary	2.9	.6	1.9
Italy	2,067.2	100.8	2,004.9
Latvia	10.8	.8	6.9
Lithuania	9.7	1.2	6.2
Poland	327.9	22.6	206.1
Rumania	80.3	4.8	63.9
Russia	481.7	8.8	...
Yugoslavia	64.3	2.6	61.6
Total	$15,599.2	$2,752.4	$11,230.5

Source: *Annual Report of the Secretary of the Treasury for the Fiscal Year Ended June 30, 1948*, p. 552.

President Hoover granted a year's moratorium in 1931, and payment was not resumed by the major debtors. (Finland was for many years the exception to this rule.) Table III indicates the amount outstanding as $15,600,000,000 as of June 30, 1948.

TABLE IV.—*Lend-Lease Aid—By Category and Country, March 11, 1941, to Dec. 31, 1945*
(in $000)

Category	British empire	U.S.S.R.	Other countries	Total
Ammunition	$ 2,118,319	$ 481,953	$ 358,718	$ 2,958,990
Ordnance	922,546	301,795	246,225	1,470,566
Aircraft	3,684,894	1,189,200	461,232	5,335,326
Aircraft engines, parts, etc.	2,343,654	375,168	151,963	2,870,785
Tanks and ordnance vehicles	2,850,786	618,129	400,280	3,869,195
Motor vehicles and parts	931,034	1,150,806	391,404	2,473,244
Watercraft	3,017,331	689,205	326,743	4,033,279
Foods	3,406,531	1,726,023	238,091	5,370,645
Other agricultural products	864,792	28,885	17,381	911,058
Machinery	818,779	1,576,674	57,057	2,452,510
Metals	1,366,479	878,996	120,287	2,365,762
Petroleum products	2,333,672	134,160	93,142	2,560,974
Other supplies	3,225,198	1,314,248	1,530,643	6,070,089
Rental of ships, etc.	2,006,279	473,819	200,459	2,680,557
Servicing, repair of ships, etc.	326,054	120,442	21,199	467,695
Miscellaneous expenses	536,956	81,967	7,700	626,623
Total	$30,753,304	$11,141,470	$ 4,622,524	$46,517,298

In World War II a larger volume of U.S. lending was carried on in kind, through the medium of lend-lease (see INTER-ALLIED DEBTS). Repayment (sometimes in the form of the specific goods lent. *i.e.*, warships, and sometimes in the form of "reverse lend-lease") was only fractional, as of the latter 1950s, but the

TABLE V.—*Reverse Lend-Lease Aid Received by the U.S., by Category, Cumulative to Sept. 2, 1945**

Category	Amount
Capital installations	$1,664,915,000
Foodstuffs	512,875,000
Clothing	91,089,000
Petroleum and coal products	1,684,629,000
Air force supplies and equipment	474,622,000
Other military supplies and equipment	1,189,739,000
Shipping and other transportation	1,349,421,000
Other services	504,744,000
Raw materials and food shipped to U.S.	347,288,000
Total	$7,819,322,000

*Revised as of Sept. 30, 1946.

acrimony of the "war debt" controversy of the 1920s and early 1930s had been avoided. thanks to the lend-lease expedient. Table IV gives a commodity and country breakdown of the $46,500,000,000 of lend-lease aid expended by the United States between March 1941 and Dec. 1945. The country breakdown, which is perhaps the more revealing, indicates that two-thirds of the total went to the British Commonwealth countries and nearly one-fourth to the U.S.S.R. Table V gives only a commodity breakdown of the $7,800,000,000 of reverse lend-lease received by the U.S., almost entirely from commonwealth countries.

Creation of Money.—The most forthright form of inflationary financing is resort to the printing of new paper money. It is also normally the last resort, to which governments turn when they cannot collect taxes and when their credit breaks down. Usually the printing is not done by the government directly, but by the central bank which then lends the newly printed money to the government. The most extreme examples of this sort of financing have occurred in the wake of wars which have been lost, or have been highly destructive, or both. Austria, Germany. Hungary, Poland, Rumania and Russia suffered major "hyperinflations" after World War I. China, France, Greece, Hungary, Italy, Japan and Poland were among the major victims after World War II. (See Table VII.) In the U.S. and Great Britain, monetary expansion was confined initially to credit or checkbook money, the result of the creation of deposit credits by the commercial banking system. Expansion of currency was limited to amounts needed as a consequence of general monetary expansion and the results thereof.

Of all these alternative forms of war finance, only the foreign loans enable cost to be shifted from the generation which fights the war—in the borrowing country—to the generation which repays the loan. Of all these alternatives, none avoid inflation from the supply side (reduction of real output) unless they produce actual treasury surpluses (or unless real output is not in fact reduced). Taxation and domestic lending by nonbankers, if sufficient in amount, can, however, prevent inflation from the demand side, by reducing private demand for goods and services in the same proportion as government demand is increased. Prices of specific goods and services will, however, rise and fall sharply even in this case, for the wartime composition of demand is different from the peacetime one. There is no system of war finance which can prevent upward pressure on the price of steel, but some systems of war finance can balance such a rise by forcing down the prices (net of tax) of peacetime goods like candy, cigarettes and so on.

Good resolutions to avoid borrowing and inflation are common

TABLE VI.—*Federal Fiscal Activities and Their Relationship to the Nation's Financial Structure; Fiscal Years 1941 Through 1936*

(in $000,000,000. Figures are rounded out and will not necessarily add to totals)

Item	1941	1942	1943	1944	1945	1946	Total 6 years
A. Federal expenditures, deficit and borrowing							
Federal expenditures	1	34.2	79.7	95.3	100.0	64.0	387.0
Less: taxes‡	7.6	12.8	22.3	44.1	46.5	43.0	176.3
Equals: deficit	6.2	21.4	57.4	51.1	53.6	20.9	210.6
Plus: increase in treasury general-fund balance	*.7	.4	6.5	10.7	4.5	−10.5	12.3
Plus: net trust-fund expenditures, etc.		*	−1.0	−.2	−2.4	1.3	−2.3
Equals: net increase in federal securities outstanding6	6.9	21.8	63.0	61.6	55.7	11.8	220.7
B. Creation of gross-income flow							
Federal expenditures	14	34	80	95	100	64	387
State and local government expenditures	9	8	8	8	8	9	50
Business expenditures for capital goods	17	16	2	3	4	18	60
Expenditures for consumers' goods and services	69	78	87	94	102	111	545
Aggregate spendings, resulting in equivalent gross-income flow	109	137	177	200	214	205	1,042
C. Uses of gross-income Aow							
Cross-income flow	109	137	177	200	214	205	1,042
Less: federal taxes$	8	13	22	44	46	43	176
Less: state and local taxes	9	10	10	10	10	10	59
Equals: private income after taxes	92	114	145	146	158	152	807
Less: private spendings.	86	94	89	97	106	132	605
Equals: private income saved	5	20	56	49	52	20	202
Plus: state and local surplus	1	1	2	2	2	1	9
Equals: total income saved.	6	21	57	51	54	21	211
D. Sources of grow-th of major liquid assets of nonbank investors							
Federal deficit	6.2	21.4	57.4	51.1	53.6	20.9	210.6
Set federal trust-fund kxpenditures, etc.			−1.0	−.2	−2.4	1.3	−2.3
Other credit-expansion factors							
Increase in monetary gold and silver.	2.9	.3	−.4	−1.6	−1.2	−.1	−.1
Increase in bank loans and other investments	3.0	−.4	−3.1	3.1	3.2	4.7	10.4
Increase in miscellaneous bank assets, etc.	−.3	.6	.9	−1.4	−.6	2.2	1.5
Subtotal	5.6	.5	−2.6	.2	1.4	6.7	11.8
Less: increase in bank liabilities and capital (other than currency and deposits)	.2	*	.2	.6	.7	1.0	2.8
Total of other credit-expansion factors.	5.4	.5	−2.8	−.4	.6	5.7	8.9
Equals: increase in major liquid assets of nonbank investors	11.5	21.9	53.7	50.5	51.8	28.0	217.3
E. Composition of increase in major liquid assets of nonbank investors,							
Money savings:							
Currency	1.5	2.7	4.9	5.1	4.2	1.4	19.8
Commercial bank accounts:							
Demand.	6.0	4.5	14.6	4.0	8.6	11.4	49.2
Time	.4	−.3	1.0	3.7	6.0	5.3	16.9
Total money savings	7.9		21.4	12.8	18.7	18.1	8j.g
Federal securities	3.6	1	32.2	37.7	33.1	9.9	131.4
Total	11.5	21.9	53.7	50.5	51.8	28.0	217.3
F. Money savings of nonbank investors and bank absorption of federal securities							
Money savings of nonbank investors	7.9	6.9	21.4	12.8	18.7	18.1	85.9
Plus: increase in treasury general-fund balance.	.7	.4	6.5	10.7	4.5	−10.5	12.3
Equals: total incase in deposits and currency	8.6	7.3	28.0	23.4	23.3	7.6	98.2
Less: other credit-espansion factors (*see* D above).	5.4	.5	−2.8	−.4	.6	5.7	8.9
Equals: net bank absorption of federal securities	3.2	6.8	30.7	23.9	22.6	1.9	89.3

*Less than $50,000,000. †Includes net operating outlays of government corporations. ‡Net federal budgetary receipts, §Interest-bearing securities issued or guaranteed by the U.S. government. Excludes transactions in Commodity Credit corporation demand obligations which had not been reported in time for inclusion in the statement publishedin the daily treasury statement for the end of the fiscal year.

Source: *Annual Report of the Secretary uf the Treasury on the State of the Finances, for Fiscal Year Ended June 30, 1946*, p. 74.

at the outbreak of every major war. They are, however. forgotten as soon as the tax burden which would be necessary for such a purpose becomes apparent A major belligerent is considered highly fortunate if it can meet half its war costs by taxation The U.S was perhaps the wealthiest participant in both World Wars I and II. At the start of U.S. participation in World War II, Henry Morgenthau. Jr.. secretary of the treasury. affirmed his intention to finance the war at least two-thirds by taxation. (The World War I proportion had been approximately one-third.) But over the six fiscal years 1941–46 inclusive. the record (Table VI) shows that of $387,000,000,000 of federal expenditures. $220,700,000.000 (57.3%) was in fact met by borrowing.

EVALUATION OF FINANCING METHODS

Problems of Taxation.— Single-minded reliance on taxation in war finance would not be an unmixed blessing. High taxation reduces the popularity of war and perhaps reduces morale. meaning the will to attack or to resist. It may therefore lose the mar in the name of sound finance. There are also fears of adverse reactions on productive effort and efficiency, supported by much evidence in individual examples but nothing definitive for an economy as a whole. The Australian statistical economist Colin Clark has propounded the thesis. leaning most heavily upon French experience, that taxes aggregating more than 25% or 30% of the national income of a democratic country may themselves be inflationary (even if they can be enacted and enforced for a long period, which Clark doubts) in that they reduce total supply to an even greater extent than they reduce total demand. Clark's statistical estimate is tentative and may be too low, but it is plausible that some such limit to taxation must exist well short of 100%, particularly in countries which try to maintain most of their civil liberties in wartime.

Perhaps even more important than the aggregate tax burden is the question of its distribution among social and income classes. Spokesmen for each group in war situations proclaim their patriotism and willingness to shoulder increased burdens — provided only that other groups bear their fair shares as well. (Concepts of fairness, in this matter as in many others, differ widely from group to group.) Representatives of labour, for example, have been in the Anglo-Saxon countries the main advocates of increased rates in the higher brackets, together nith higher corporate and excess-profit levies, as bases of war finance. Business spokesmen, on the other hand, prefer to concentrate income-tax increases in the lower brackets and to broaden the income-tax base by lowering exemptions. while expanding the scope of indirect (excise) taxation.

Inflationary Finance.— Maior reliance on voluntarv loans. whether from domestic or foreign sources. made out of genuine saving, is hardly possible for important powers in prolonged wars, although tsarist Russia made a valiant attempt to finance World War I by this means. Sooner or later. in the case of a destructive modern war the prospects for repayment deteriorate As a result, the borrowing country must create the money or credit which is ostensibly being lent to it. and the economy passes to some form of inflationary finance.

An almost infallible sign that passage to inflationary finance is contemplated, or has already occurred. is the suspension of the convertibility of the national currency into gold (World War I) or into the more stable currencies of the world, such as the Swiss franc and the U S. dollar (World War II).

Inflationary finance does not necessarily lead to immediate inflation. In the earlier stages of hostilities, as in 1939–40 in Britain and 1941–42 in the U.S.. there may exist substantial reserves of labour and other resources nhich are unemployed involuntarily. These can be put to work at existing nages and prices as a result of increased demand. which can itself be created by inflationary war finance. Even in these cases. "bottlenecks" of fully employed resources appear early in the expansion process. trade unions and trade associations take advantage of the situation to raise wages and prices which they consider "substandard" or "unfairly low" before full employment or production is reached, and inflation gets under way in appreciable measure before any point identifiable as "full employment" is attained. In the discussion which follows, inflationary war finance will be treated as meaning actual inflation, despite the possibility of an interval in which it does not.

There are two major objections to wartime inflation, whether financed by the printing press or by credit expansion. The first standard objection is that inflation distributes the burden of war costs in an arbitrary and capricious manner. The distribution among the citizens depends on the fixity of their incomes rather than the amounts. Creditors, *renfiers* and pensioners, rich and poor alike, are ordinarily the hardest hit, followed by landlords, civil servants and other salaried employees. At the other extreme, positive gains accrue to heavy debtors, rich and poor alike: including speculators who, foreseeing inflation, deliberately put themselves in a debtor position in order to buy real assets. The second standard objection to wartime inflation is that after the process reaches a certain point not easily identified, it is at least as effective in lowering production as high wartime taxes mould have been. Inflation, generally speaking, puts a greater premium on hoarding of raw materials and durable goods; on holding of real estate, jewelry, foreign exchange and a wide variety of other assets, relative to most types of productive activity, than exists in normal times. Therefore, resources shift from productive to nonproductive uses, so that the production and employment effects of inflation eventually prove disappointing, particularly if the economy passes to a situation of "hyperinflation" in which the price level rises faster than the money supply. This is not to deny the major claim made for inflation. namely that its earlier and milder stages usually encourage both production and employment. This is generally true so long as the inflating country's money illusion persists in considerable degree, which may be quite long in countries without recent inflationary history. Money illusion is a term applied to people's tendencies to regard a dollar as a dollar, or a franc as a franc, whatever may be happening to its purchasing power. Money illusion has been important in inducing people to hold larger money balances during the earlier stages of an inflation than they otherwise would have done, and likewise in inducing them to work more effectively and increase production in response to higher money returns. It therefore serves to increase output and employment, and simultaneously to retard inflation.

TABLE VII.—*Price Index Numbers, Selected Countries, Illustrating Effects of World War II*
(Aug. 1948 as per cent of Jan.–June 1939)

country	Wholesale prices	Cost of living
Argentina	273.5	‡
Australia	173.0	143.1
Austria	449.0*	450.0
Belgium	390.0	380.8
Brazil	302*	371.3
Bulgaria	808.2	‡
Canada	216.1	157.3
China	‡	305×10^6
Czechoslovakia	321.6	282.7
Denmark	236.9	166.9
Egypt	983.5	818.1
France	1,930.0	1,578.5
Germany (west)	‡	160.0†
Greece	25,200.0	25,221.0
Hungary	‡	450.0
India	358.0	310.5
Ireland	229.9	175.8
Italy	5,700.0	5,160.0
Japan	11,467.0	15,000.0*
Mexico	280.5	326.9
Setherlands	178.1	202.0
Norway	276.7	158.0
Poland	‡	12,820.0
Spain	329.3	289.8
Sweden	198.2	153.6
Switzerland	217.7	162.9
Turkey	448.4	331.6
United Kingdom	225.9	167.j
United States	221.9	176.6

*Rough estimate. †Year 1948, as per cent of Jan.–June 1939. ‡Not available. Source: A. J. Brown, *The Great Inflation, 1939–1951*, Tables III and IV, pp. 302–305, published for the Royal Institute of International Affairs by the Oxford University Press (1955).

Despite the strictures of economists and financiers against war inflation and inflationary war finance, it is almost impossible in practice for an important democratic power to wage a major war without a considerable rise in its general price level. This is particularly true if the country starts from a situation at or near full employment. The democratic political process apparently requires considerable time before any adequate program of noninflationary finance can be prepared. and before its burden distribution (as well as the total burden) can be made palatable to the representatives of the electorate. The more realistic question is whether war inflation can be reversed after hostilities end. Again there is no mechanical reason nhy it cannot be reversed; the problem is the political one of resistance by business. labour, agricultural and debtor economic interests. After World War I a reversal was attempted in Britain, the U S , Japan and a few other countries, in the name of commercial morality and sound finance. The method used was the accumulation of gold reserves and eventual return to the pre-1914 gold standard at the pre-1914 price of gold This reversal was successful only temporarily. and then in the depths of a severe economic depression intensified by these deflationary policies. After World War II the fear of reneued depression outweighed considerations of financial morality. Deflationary measures were limited to "currency reforms," featuring partial confiscation of wartime savings which had been held in currency or public securities. They had varying degrees of success and equity—those in west Germany and the U.S.S.R. being apparently the most effective. In no country had the general price level by 1956 returned to its pre-1939 level, and price index numbers have been reconstructed on a postwar base (usually 1947–49). (*See* Table VII.)

Suppressed Inflation.—This discussion of inflation has dealt up to this point with the ordinary or "open" variety. In open inflation any increases in the supply of money, or decreases in the supply of goods, are permitted to exercise their full influence on all prices. Open inflation, however, is seldom if ever tolerated in wartime without some restraints. In World Wars I and II particularly, and in the second more effectively than in the first, inflation was to a considerable extent suppressed or repressed by direct controls over individual prices, wages, rents and so on. At the controlled prices of goods and services, demand generally exceeded supply, and the more so since part of the supply was usually diverted to free. illegal or "black" markets. (In defeated or badly weakened countries, especially, this diversion eventually caused the breakdown of much or all of the control system.)

Because it involves continuous maintenance of imbalance betueen demand and supply, suppressed inflation has been called a "disequilibrium system" by a leading U.S. exponent, J. K. Galbraith For many of the more important groups of commodities, price controls were supplemented by quantitative restrictions on demand, such as rationing of consumption goods and allocation of labour and production goods. Proposals for generalized "expenditure rationing" of all goods were made by a group at the Oxford Institute of Statistics during World War II and again by a group at Stanford university, Stanford, Calif., in the early 1950s when the Korean conflict threatened to expand. They were not adopted, however. and for most goods and services rationing was quite informal during both wars. Pure chance: favouritism and "tie-in sales" by dealers, time available for shopping and waiting in line and barter arrangements were perhaps the four most important factors in determining who got what among the scarcer items.

The disequilibrium system of suppressed inflation was probably less damaging to public morale in Great Britain and the U.S. in both World Wars I and II than rival systems which might have led to heavier taxation or more inflation. There were complaints about controls and shortages, and substantial evasion, but until shortages became really acute citizens did not resent the savings forced on them by the disequilibrium system as much as they would probably have resented taxation so drastic as to make savings impossible at wartime levels of consumption, or open inflation in which the value of their savings would have evaporated visibly. It was further anticipated, both in Great Britain and the U.S., that World War II in particular would be followed after a short boom by return to the depressed conditions of the 1930s. In the case of such a depression, the accumulated wartime savings could have been released to support economic activity without risk of inflation. Anticipated depression and possible unemployment in the postwar period also encouraged accumulation of savings during wartime, and aided the maintenance of the disequilibrium system itself. As is well known, however, the predictions of postwar depression proved entirely erroneous, at least in the "cold war" atmosphere of the decade 1946–55.

In no country was it practicable after World War II to retain wartime savings immobile in cash or government securities, awaiting the long-postponed postwar depression. In the U.S. the controls of the disequilibrium system were repealed piecemeal within 18 months of the close of World War II. (They might have broken down in a wave of violations had they remained on the books.) The subsequent rush to spend drove U.S. prices to levels approximately predictable from the wartime accumulation of liquid assets—money, credit and government securities convertible into cash without risk of loss. This is not to say that the inflation mould have proceeded no further in the absence of controls than it did after their repeal. On the contrary, greater over-all monetary expansion might have been required if massive inflation had begun earlier. At any rate: the wartime savers were expropriated by the postwar price rise quite as they would have been by open inflation during the war—but the postwar price raise came too late to affect wartime morale and war production.

In Britain. the Netherlands and the Scandinavian countries, controls mere retained for several years longer and removed only gradually. None of these economies had by 1956 returned completely to its pre-1939 pattern of freedom. The difficulties which developed were different from the U.S. ones. In a regime of controls, it was not always easy to provide incentives to work, to invest, to move from place to place or from one activity to another, for people who could live off their past savings or present earnings as comfortably as the rationing system permitted. Another problem was that of obtaining sufficient exports to pay for these countries' necessary imports, since at the low controlled prices the home market stood willing and eager to buy all that was produced. A third problem was the relative unprofitability of controlled (essential) production as compared with uncontrolled (nonessential) lines. and the constant threat of drawing productive resources precisely where they were least wanted.

It is highly probable that suppressed inflation, or the disequilibrium system. will underlie the war finance of participants in any future major war, at least in its early stages (before adequate and equitable tax revisions can be made). It seems doubtful, on the other hand. whether the unique morale benefits of suppressed inflation, as compared either with taxation or open inflation, can be expected to recur until their history in World War II and its aftermath is largely forgotten.

SOME FALLACIES OF WAR FINANCE

A number of the more pervasive fallacies of war finance have been touched upon in the foregoing discussion, but it may be worth while to consider them explicitly in view of their popularity as wish fulfillment among both voters and politicians.

Transfer of Costs to Future Generations.—Perhaps the most important and widespread of such fallacies is the fixed idea that a country can, by borrowing or by other forms of financial legerdemain, transfer its war costs to future generations (without borrowing abroad during wartime) and thus evade them so far as concerns the wartime generation itself. Unfortunately for this hardy perennial, there are real costs underlying the monetary ones, the real costs being goods and services. When the government uses these real goods and services for war, it bids them away from other spenders once and for all. These other spenders pay these real costs in goods and services at the time they are bid away. No manipulation of borrowing and lending can conceal this. On the other hand, if the resources used by the government in wartime are not bid away from others but from involuntary unemployment, they do not cost the government anything whatever in real terms—at least in the limited sense in which "cost" is being discussed here. If the government finances itself by taxes, the taxpayers pay the cost, although in some cases they may shift it to others by the intricate processes of tax shifting. If the government finances itself by loans, it is the savers and lenders who are deprived of real goods and services. If the government raises funds in mays which lead to open inflation. the cost is borne by the fixed income groups. If there is suppressed inflation. the cost is borne by consumers and others aho, unable to buy what they want at controlled prices, are forced to save instead.

When a war loan is subsequently repaid, there is no assumption of the cost of the war by the postwar generation as a whole. but only a transfer from the taxpaying to the bond-holding members of this generation. Similarly when the network of controls of a disequilibrium system are removed after a war, there is a transfer between groups in the postwar generation. The gain is to the nartime savers who can now buy all they want, and the loss is to the fixed-income members of the postwar generation whose purchasing power is cut. If the controls are lifted in conditions of depression and unemployment, the gain to the wartime savers or their heirs will involve no balancing loss. The involuntary savers of wartime, or their successors, will recover postwar approximately what they lost in wartime. On the theory of shifting war costs to postwar generations, however, their fate should have been precisely the reverse.

"The Boche Will **Pay"** Theory.—If the costs of war cannot be shifted to future generations in one's own country (except, again, by foreign loans floated during wartime), it follows that they cannot be shifted to future generations of one's allies or enemies, even if one's country emerges completely victorious. The opposite view, embodied in the slogan, "The Boche will pay," dominated French war finance in World War I, and the attempt somehow to "make the Boche pay" in later decades explains French intransigence on the issue of reparations.

To the extent mar indemnities can be collected, victorious countries are repaid after the war for part or all of their mar costs and defeated countries must pay the corresponding postwar increment to their war costs. The war costs themselves, however, meaning the real goods and services, will have been paid in the first instance by each country on its own, and by the generation which fought the war. A country may be fortunate enough to have its war costs repaid in part or in full by defeated enemies after the close of hostilities, but it cannot avoid paying those costs at the outset.

The receipt of reparations, or the repayment of war loans, is not an unmixed blessing to all econoinic interest groups in the receiving countries. Payment is ordinarily made in part by increasing the paying country's exports of goods and services to the rest of the world, including the receiving country, and in part by reducing the paying country's imports of goods and services from the rest of the world, again including the receiving country. These processes are not normally looked on with favour by either the export industries or the import-competing industries of the receiving country, who sometimes attempt to check them by export subsidies, high tariffsor import restrictions. It goes without saying that if the receiving country is an important trading partner of the paying country, such restrictions reduce greatly the likelihood of the reparations ever being collected or the war loans ever being repaid.

TABLE VIII.—*National Debt and Annual Interest Charge, U.S., Selected Years, 1916–50, Showing Effects of World Wars I and II*

Year ending (June 30)	Total gross debt in ($000,000,000)	Annual interest charge (in $000,000)	Per cent of gross national product	
			Principal	Interest
1916	1.2	23	2	Less than 0.05
1919	25.5	1,054	35	1.4
1930	16.2	606	18	0.7
1939	45.9	1,149	50	1.3
1950	257.4	5,613	100	2.2

Source: Henry C. Murphy, "Debt Management," in Kenyon E. Poole, *Fiscal Policy and the American Economy,* Prentice-Hall, Inc. (1951).

Effectiveness of the Disequilibrium System.—It is generally fallacious to believe that direct controls. or the disequilibrium system. can permit a war to be financed with neither heavy taxation nor price inflation. This belief is correct only to the extent that the controls concerned are retained indefinitely after the close of hostilities, or at least until the onset of a postwar depression or stagnation, and are then repealed gradually so as to maintain purchasing power. However, such a postwar depression or stagnation may never come, and in most actual situations the controls are repealed or nullified early enough to generate postwar inflation, or else the abnormal savings they have induced are expropriated by a capital levy or a currency reform.

Effectiveness **of** a Balanced Budget.—Even when a war begins in a situation of full employment of resources, it is widely believed that a balanced government budget will suffice to prevent inflation, and the aim of war finance on the taxation side is limited to achieving such a balance. This belief, too, is usually false, and a surplus budget will usually be required to prevent inflation. There are two reasons for this result, which K. E. Boulding called "the principle of overfinance." (1) The supply of goods and services may fall, by reason of war damage and diversion of resources to military uses. If so, maintenance of the peacetime volume of money demand will produce inflationary results. (2) A balanced budget taxes marginal dollars from those who would otherwise have saved some portion, and transfers them to a government which spends the entire amount. There is then a net expansionary effect. To compensate for it. a budget surplus mould be desirable, but this is highly difficult to achieve under wartime conditions.

Effectiveness **of** Sales **of Securities.**—When it comes to loan finance, popular thinking does not distinguish adequately between the effects of sales of securities to the banking system and sales to genuine (nonbank) savers. To put the matter differently, the public draws too sharp a distinction between financing a war by printing new money and by bank credit expansion. Sales of securities, particularly long-term securities, to nonbankers is a real alternative to taxation and inflation, unless there is an express or implied guarantee to repurchase these securities whenever their market price declines. This is equally true of sales to bankers, if they increase their holdings of government securities by reducing their holdings of commercial paper or other assets. On the other hand, loans financed by the lender (or his banker) either by the printing of new paper money or by the creation of checkbook money on the books of a commercial bank are just as inflationary as any other means of currency or credit expansion.

Bankruptcy.—Whether war loans are domestic or foreign, from savers or from banks, inflationary or noninflationary, they increase the borrowing country's national debt. Table VIII illustrates the effects of World Wars I and II on the national debt of the U.S. and its annual interest charge.

A discussion of war finance need not involve full treatment of the related subjects of debt burden and debt management. One important fallacy, however. should be mentioned, namely. that a domestically held debt may bankrupt the borrowing government. This is not correct. In the first place, the principal may never come due if, as in the British case, it takes the form of perpetual annuities or consols. In the second place, when portions of the principal come due, they can be repaid by new borrowings, known as refunding issues, if they cannot be paid out of current surpluses. Finally, even if a refunding issue cannot be floated on terms satisfactory to the government, payment can always be made in money printed for the purpose of debt retirement. Governments possess monetary sovereignty or, as A. P. Lerner has put it, "Money is a creature of the State." A government may choose to repudiate a debt, or to meet it by inflationary means, but however large its outstanding obligations and however meagre the resources available to meet them. it cannot be forced into bankruptcy against its will save by another government. See also **Inflation and Deflation; Debt, Public.**

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(E. H. He.; Mn. B.)

WARGLA: see Warqla.

WAR GRAVES. The United States maintains a national cemetery system in which any member of the armed forces who dies during or after honourable service in war or in peace may, upon application being made to the quartermaster general. receive a grave site marked with a durable headstone and be buried with military honours. This award includes burial space for spouses and minor dependent children. Provision is also made for supplying a government headstone to mark the graves of the far greater number of military dead—about 80% of the whole—for whom burial in private cemeteries may have been provided. The American Battle Monuments commission. an independent authority established in 1923 and reporting directly to the president, administers two groups of military cemeteries in foreign lands, one serving as a memorial to those dead of World War I whose relatives requested burial abroad, the other similarly associated with World War 1 With interments restricted to war fatalities, only these cemeteries may be regarded as war graves in the strictest sense of the term.

Without precedent in history, excepting possibly the example of the ancient Greek city-states which paid signal honours to their citizen soldiers slain in battle, American burial practices may, in part, be attributed to extraordinary conditions formerly encountered by the regular military establishment in the Indian borderlands. In those days post commanders were compelled to bury all the dead of their garrison communities. Also important has been the traditional policy of reliance on citizen levies in time of war.

During the Civil War the federal government recognized the obligation of affording a decent burial to all who fell in defense of the republic. Army regulations required individual burial in registered graves. and an act of congress. approved April 16, **1862,** authorized the president "to purchase cemetery grounds . . . to be used as a national Cemetery." This led to the establishment in 1864 of Arlington National cemetery (*q.v.*) near Washington, D.C.. the best-known national cemetery. Between 1862 and 1870 a total of 299,696 Union dead mere laid to rest in 73 national cemeteries. Recovery of many of these remains from scattered battlefields and reinterment in a national cemetery served to commit the national government to an obligation to return war dead to their native soil. The graves of soldiers who served in the Confederate states army were subsequently marked at public cost by a distinctive marble slab. The precedent of the 1860s was applied without question to the Spanish-American War, the Philippine insurrection and the north China expedition. Furthermore, the nation assumed another obligation of far-reaching consequence in according to next of kin of the dead brought back from these distant theatres the privilege of selecting a national cemetery or some private burial ground as the final resting place. Another major tenet of policy emerged from World War I when in deference to wishes expressed by many relatives of the dead, the government made provision for permanent burial overseas.

World War I.—When the United States took up arms against Germany in 1917, the secretary of war established a specialized organization consisting principally of quartermaster graves registration companies for care of the dead. Identification tags became a required item of equipment for every soldier. Trained in the techniques of body identification, the theatre graves registration service performed an unprecedented feat by identifying over 95% of all fatalities.

Return of World War I remains came to a culmination with the entombment of the Unknown Soldier at Arlington National cemetery on Nov. 11, 1921. Of approximately 79,000 World War I fatalities, 46,520 were shipped to the United States, with 5,800 going to national cemeteries and 31,591, including the unknown dead, being interred in eight national military cemeteries—one in England, one in Belgium and six in France. Established and developed over a period of 11 years, these cemeteries remained under administration of the war department until 1934, when they were transferred to the American Battle Monuments commission.

World War II.—Despite the destructiveness of World War II, there were no basic changes in U.S. policy or organizational arrangements for care of the dead and final disposition of remains. Yet the mechanization of tactical units, together with the increased power and range of air fleets, transformed warfare from prolonged battles of attrition between sluggish infantry masses to violent conflicts between mobile formations, endowed with firepower never before delivered in action. Ocean tides claimed the bodies of many slain in amphibious assault landings; air routes to distant targets behind enemy lines were strewn with the remains of fallen airmen. The fragmentation of bodies, particularly those recovered from plane wrecks and incinerated tanks, imposed difficult problems of identification. In brief, a new situation demanded refinements in the application of techniques and improvements in details of organization.

Following World War II, the secretary of war established the American Graves Registration service, with separate overseas commands under direction of the quartermaster general. The memorial division of the office of the quartermaster general served much as a special staff in the planning and general supervision of operations. The postwar graves registration organization was charged with final disposition of the dead of all armed services—the army, navy, marine corps and coast guard services—as well as several civilian agencies, such as the maritime commission and the American Red Cross.

After consultation with leading experts, the quartermaster general established central identification laboratories in which unidentified remains were subjected to X-ray and fluoroscopic examination. Anthropologists then applied their techniques to skeletal remains for determination of race, sex, approximate height and age and probable cause of death. Many such examinations led to individual identification of airplane and tank crew members, while others disclosed evidence for consideration of the War Crimes commission. Out of 360.812 World War II fatalities, 281,857 were recovered, leaving 78,955 "nonrecoverable" dead. Of those recovered 273,366 (96.98%) were identified. These unknown dead numbered 8,491.

The American Graves Registration service completed its task on Dec. 31, 1951, having shipped 171,264 casketed remains to the United States and 3,803 to next of kin in foreign countries for burial in private cemeteries. Of those returned to the United States, 38,472 were interred in national cemeteries. The National Memorial Cemetery of the Pacific, at Honolulu, T.H., and the Puerto Rico National cemetery, both of which were established subsequent to hostilities, received 13,652 war remains. In addition, the American Graves Registration service completed approximately 93,130 interments in 14 newly established military cemeteries. Including 8 cemeteries of World War I, the American Battle Monuments commission administers 22 cemeteries—2 in England, 3 in Belgium, 1 in the Netherlands, 1 in Luxembourg, 11 in France, 2 in Italy, 1 near the site of ancient Carthage in north Africa and 1 at Manila in the Philippine Islands. Aside from war graves proper, the commission administers the American cemetery at Mexico City (established 1850) which harbours 750 unknown American dead of the Mexican War.

Korean Conflict.—The United Nations reaction to communist aggression in Korea called forth all the refinements of mortuary methods developed during World War II. Graves registration forces assigned to the U.S. 8th army evacuated the dead of all UN contingents to several temporary cemeteries established in southern Korea. Flags of the various nations marked national plots, all flying with the standard of the UN. With the assistance of U.S. officers, the Korean army organized its own graves registration service for the care of Korean dead.

Upon decision to adopt the unprecedented expedient of returning American remains before the conclusion of a major military operation, all American fatalities were evacuated directly from the place of death to the central identification laboratory at Kokura, Jap., for identification and casketing prior to shipment to the San Francisco port of embarkation. Remains previously buried were exhumed and sent through Kokura to San Francisco. The Graves Registration service then established a single cemetery at Tanggok, near Pusan, to serve as the final resting place for other United Nations war dead.

As a result of communist tactics of evasion, many of the remains of UN servicemen who fell between the Yalu river and the armistice line of 1952 were never recovered. Of 36,922 American fatalities, 29,730 were recovered. Of this number 28.730 were identified and returned to the United States. Numbering 853, the unknown dead were interred in the National Memorial Cemetery of the Pacific. Approximately 20% of the remains returned to the United States went to national cemeteries.

By the mid-1950s the national cemetery system included 87 "installations" under the department of the army and 12 assigned to the department of the interior for administration. Altogether these cemeteries contained 719,873 interments (1956), of which 151,789, mostly Civil War remains, were unknown. With about 125,000 burials in the overseas military cemeteries, the U.S. government afforded perpetual care for approximately 850,000 graves of its military dead. As defined in an act of congress (62 Stat. 234; 24 U.S. Supp. iv, 281) the following were eligible for burial in the national cemetery system: (1) those who died while serving in the armed forces of the United States, namely male and female members of the army, navy. marine corps, air force and coast guard service; (2) those who died subsequent to service in the armed forces; (3) U.S. citizens who served during war in the armed forces of an allied nation; (4) spouses and minor dependents of persons named in the three preceding categories.

Any individual falling within the first three categories, either male or female, might, upon application, at the death of his or her spouse, receive a grave site together with the reservation of an adjoining site. In event of remarriage, the surviving veteran, if desirous of burial beside the second spouse, had the option of disinterring the first one at personal expense. The award of two grave sites also applies when the veteran dies first. Dependents may be buried in either of the two allotted sites. (E. SE.)

GREAT BRITAIN

The Imperial War Graves commission (renamed the Commonwealth War Graves commission in April 1960) assumed responsibility for the permanent marking and care of the graves of those members of the British fighting services who fell in World Wars I and II, which were deemed to have ended, for the commission's purposes, on Aug. 31, 1921, and Dec. 31, 1947, respectively.

The origins of the commission may be traced to the imagination of Sir Fabian Ware who directed a mobile unit which the British Red Cross society and the Order of St. John of Jerusalem sent out to the western front in Sept. 1914 to search for missing soldiers.

A branch of the army, at first financed by the Red Cross. was formed in 1915 to register, mark and care for the graves of the fallen and in 1916 a directorate of graves registration and inquiries at the war office was created. The year 1916 also saw the formation, under the presidency of the prince of Wales, of a national committee for the care of soldiers' graves. to which dominion representatives were appointed. In March 1917 the prince of Wales sent to the prime minister a memorandum proposing that a permanent organization representing all parts of the empire should be formed to care for the graves. The proposal was endorsed by the Imperial War conference of that year. and the Imperial War Graves commission was thereupon constituted under royal charter on May 21, 1917. The commission guided by Sir Fabian Ware recommended; and in June 1918, the Imperial War conference decided that the cost of carrying out the commission's decisions should be borne by the respective governments in proportion to the numbers of the graves of their dead. Furthermore, when the commission obtained, in 1940, a supplemental charter extending its powers to cover the permanent marking and care of the graves of World War II, the participating governments agreed that the work should continue to be financed on this principle.

The commission decided to base its work on the principle of equality of treatment and thus to mark every known grave with a headstone of the same simple design. This headstone stood 2 ft. 8 in. above the ground and was 1 ft. 3 in. broad and 3 in. thick. At the top was engraved the badge of the regiment or unit; then followed the rank, name, unit, date of death and age; below these was incised the appropriate religious emblem; and at the foot a personal inscription chosen by the relatives. In Dec. 1939 the commission decided to adopt the same design for the graves of World War II. In every cemetery containing more than 40 graves was placed a tall Cross of Sacrifice, to which was fixed a crusader's sword of bronze. In the largest cemeteries was placed another central memorial—the great altarlike Stone of Remembrance, bearing the .inscription "Their Name Liveth For Evermore." The effect aimed at was that of an English garden, with the headstones standing in long flower borders in a setting of mown lawn, there being no grave mounds. In France, Belgium, the Netherlands and Germany the caretakers appointed were for the most part British ex-servicemen.

The marking of graves was only a part of the commission's task of commemoration, for large numbers of the dead of both wars had no known burial place. Accordingly, memorials recording the names in stone or bronze were built or planned in all the countries where the major campaigns were fought. Such were the Menin gate at Ypres, Belgium, the Somme memorial at Thiepval, France, the Gallipoli memorial at Cape Helles, Turkey. and the Salonika memorial at Lake Doiran, Greece. Such, too. were the R'orld War II memorials at Bayeux, Groesbeek near Nijmegen, Cassino, El Alamein, Singapore, Rangoon and Dunkirk. The main naval memorials were erected at Chatham, Portsmouth and Plymouth, and extensions to these bore the names of those lost in World War II. The largest memorial to the air forces of the commonwealth was built on Cooper's hill, above Runnymede, Surrey. The memorial to the merchant navy and fishing fleets was built on Tower hill, London, the missing dead of World War II being commemorated on an extension erected in Tower Hill gardens.

The cemeteries, graves and memorials of World War I were protected by a series of international agreements, which were revised to apply to World War II. In each country the commission's authority under the agreement is exercised by a joint committee of distinguished foreign and commonwealth members. In 191j France undertook to buy the sites of all mar cemeteries and granted to the Allied nations the perpetual "enjoyment" of such lands. Other governments followed this example.

The commission published for World War I a series of printed registers, containing lists of the dead, with brief details. A similar series was begun after World War II. The work of the commission is illustrated in a series of books of fine photographs of cemeteries and memorials entitled "Their Name Liveth." A supplemental charter of 1941 empowered the commission to compile a record of civilian subjects of the crown dying by enemy action.

To provide income for the permanent maintenance of the graves, cemeteries and memorials of World War I, it was agreed in 1926 that an endowment fund be established by the United Kingdom and dominion governments. The fund when completed in 1940 amounted to £6.000.000. but the income from this sum became insufficient to meet costs, and the additional income required was provided by annual grants by the Cnited Kingdom and other commonwealth governments. The commission commemorated 1,104,-890 dead of the commonwealth who fell in World War I. The total for World War II was 571,000. (F. C. SI.)

WARHAM, WILLIAM (*c.* 1450–1532), archbishop of Canterbury during the period of Henry VIII's divorce from Catherine of Aragon. He belonged to a Hampshire family and was educated at Winchester and New college. Oxford. Later he took holy orders and became master of the rolls in 1494. He helped to arrange the marriage between Prince Arthur and Catherine of Aragon (1496); and was partly responsible for negotiating treaties with Scotland, Burgundy and Maximilian I. In 1502 Warham was consecrated bishop of London and became keeper of the great seal; in 1504 he became lord chancellor and archbishop of Canterbury. In 1509 he married and then crowned Henry VIII and Catherine of Aragon but. gradually withdrawing into the background, he resigned the office of lord chancellor in 1515 and was succeeded by Cardinal Wolsey. This resignation was possibly a result of his dislike of Henry's foreign policy.

Warham was present at the Field of Cloth of Gold in 1520, and he assisted Wolsey as assessor during the secret inquiry into the validity of Henry's marriage with Catherine in 1527. Throughout the divorce proceedings Warham's position was essentially that of an old and weary man. He was named as one of the counselors to assist the queen but, fearing to incur the king's displeasure and using his favourite phrase, *ira principis mors est* ("the wrath of the ruler means death"). he gave her very little help; and he signed the letter to Clement VII which urged the pope to assent to Henry's wish. Afterward it was proposed that the archbishop himself should try the case but this suggestion came to nothing.

He presided over the convocation of 1531, when the clergy of the province of Canterbury voted £100,000 to the king in order to avoid the penalties of praemunire and accepted Henry as supreme head of the church with the saving clause "so far as the law of Christ allows." In his concluding years, however, the archbishop showed rather more independence. In Feb. 1532 he protested against all acts concerning the church passed by the parliament which had met in 1529, but. it should be noted. this did not prevent the important proceedings which secured the complete submission of the church to the state later in the same year. Against this further compliance with Henry's wishes Warham drew up a protest; he likened the action of Henry VIII to that of Henry II and urged Magna Carta in defense of the liberties of the church.

He died on Aug. 22, 1532, and was buried in Canterbury cathedral. Warham was chancellor of Oxford university from 1506 until his death. Although opposed to reform, he was connected with the English humanists, and there is a sympathetic account of his. personal characteristics in Erasmus' *Ecclesiastes.*

See W. F. Hook, *Lives of the Archbishops of Canterbury,* vol. vi (London, 1860–76); J. Gairdner in *Dictionary of National Biography,* vol. lix (1899); J. D. Mackie, *The Earlier Tudors, 1485–1558* (Oxford, Toronto, 1952).

WARKWORTH, a town of Northumberland, Eng., 40 mi. N. of Newcastle by road, contained almost entirely within a loop of the river Coquet. $1\frac{1}{2}$ mi. above its entry into the North sea. Pop. (1951) 922. Area 1.8. sq.mi. Warkworth lies on the coastal road connecting Amble with Alnwick which crosses the Coquet by a narrow stone bridge of two round arches dating from the 14th century. The southern end is guarded by a gatehouse now in ruins. The nearby church of weathered sandstone has a Norman nave and chancel and a tower built about 1200 and a 14th-century spire. The ruins of the castle dominating the town include masonry dating back to about 1200, the magnificent Lion tower forming an imposing entrance to the Great hall and a 15th-century keep. Upstream lie 14th-century remains of the famous Hermitage, the outer portion built in stone and the inner chapel and chamber hewn from the sandstone cliff. (E. M. Hw.)

WARMING, JOHANNES EUGENIUS (EUGEN) **BÜLOW** (1841–1924), Danish botanist, best known for his pioneering nork in plant ecology. was born at Manø on Nov 3, 1841. and received the Ph D degree (Copenhagen) in 1871 He was professor of botany at the Royal Institute of Technology, Stockholm (1882–85), and professor of botany and director of the botanical garden at Copenhagen (1885–1911). Warming traveled to Brazil (1863–66), to Greenland (1884), to Finnmark in Nornay (1885) and to the West Indies and Venezuela (1890–92). He died at Copenhagen on April 2, 1924.

Warming's nearly 300 publications covered several aspects of botany He contributed significantly to knonledge of the nature of ovules (1878) and published a monograph on the Podostemaceae (1881–1901) His first attempt to classify life forms of flowering plants nas in *Om skudbygning, overvintrmg og foryngelse* (1884; "On Shoot Structure. Wintering and Rejuvenation"). his life-form system appearing in final version in *økologiens grundformer* (1923; "Fundamental Ecology"). *Om Grønlands vegetation* (1888, "On Greenland's Vegetation") and *Lagoa Santa* (1892: a study of Brazilian flora) are classic accounts of arctic and tropical vegetation. respectively. In 1895 Warming published his *Plantesamfund* (Eng. trans. *Oecology of Plants,* 1925), a work that laid the foundation of modern plant ecology and gave great impetus to the study of this science. The far-reaching influence of this work was due in large part to the ingenious manner in which the author elucidated the relation between plants and external environment. Warming's *Dansk plantevaekst* (1906–19; "Danish Vegetation ") described vegetation of Danish beaches, marshes and forests His textbooks. *Haandbog* i *den systematiske botanik* (1879; Eng. ed., *Handbook of Systematic Botany,* 1895) and *Den almindelige botanik* (1880; "General Botany") were translated into several languages.

See C. Christensen, *Den Danske botaniks historie* (1924–26), which includes a listing of Warming's publications; V. Meisen (ed), *Prominent Danish Scientists Through the Ages* (1932). (J. W. TT.)

WARM SPRINGS, a centre for aftertreatment of poliomyelitis, located in Meriwether county, Ga., U.S., about 70 mi. S.W. of Atlanta. The celebrated springs return to the surface 800 gal. of water per minute at a temperature of about 88° F. Indians are said to have believed in their miraculous healing qualities and in the 19th century Georgians popularized the springs as a holiday resort. The national prominence of Warm Springs dates from Franklin D. Roosevelt's visit following an attack of polio in 1921. Convinced that the warm aaters would aid in the aftercare of polio victims who needed supported exercise, Roosevelt organized the Warm Springs foundation in 1927. This nonprofit corporation has since developed a complete medical community there. Roosevelt died at Warm Springs on April 12, 1945; the "Little White House," his residence there, is now open to the public. The village of Warm Springs, 1 mi. S.W. of the springs, developed as a railroad junction for the resort and was incorporated under its present name in 1924. (J. N. A)

WARNER, CHARLES DUDLEY (1829–1900), U.S. essayist and novelist, was born in Plainfield, Mass., on Sept. 12, 1829. In 1851 Warner graduated from Hamilton college, Clinton, N.Y. In 1858 he received a bachelor of laws from the University of Pennsylvania, and later practised law in Chicago (1858–60). In 1861 he began to edit the *Hartford* (Conn.) *Courant* and the series of sketches which he wrote for that paper gained him a national reputation; they were collected in *My Summer* in *a Garden* (1870). He wrote ten travel books. With Mark Twain he collaborated on *The Gilded Age* (1873), a novel of unscrupulous politics in post-Civil War Washington. Warner was the first editor of the "American Men of Letters Series." In 1889 he published *A Little Journey in the World,* the first part of his trilogy concerning the making, misuse and final loss of a great fortune; *The Golden House* (1895) and *That Fortune* (1899) completed the work. He died in Hartford on Oct. 20. 1900.

WARNER ROBINS, a city of Houston county, in central Georgia, U.S., is 16 mi. S. of Macon. In 1940 it was known as Wellston and was a small village of about 50 inhabitants beside the Georgia Southern and Florida railroad. When the federal government later built an army air base there, the city sprang into being like a boom town of gold rush days. It was incorporated in 1933 under its new name, honouring Brig. Gen. Augustine Warner Robins. one of the founders of the modern U.S. air force. The depot that was to occupy the base was activated one month before the Japanese attack on Pearl Harbor. In July 1946 the depot was designated Warner Robins air matériel area, as part of the air matériel command. The base later became the home of the 14th air force ("Flying Tigers"). In 1952 the air force base was declared permanent. By mid-20th century the population had increased to about 8,000 and it more than doubled in the decade 1950–60. (For comparative population figures *see* table in GEORGIA: *Population.*) A modern school system has been developed and the city has many civic and fraternal organizations and several health, nelfare and recreational agencies. (S. B. K)

WAR OF 1812. A conflict that began June 18, 1812, with a declaration of war on Great Britain by the United States. It was terminated by a treaty of peace signed at Ghent, Belg., Dec. 24, 1814, and approved by the U.S. senate on Feb. 16, 1815.

Causes.—The long struggle between Great Britain and Napoleonic France, covering most of the period between 1793 and 1815, led both belligerents to infringe on the rights and impair the interests of neutrals. Great Britain incurred additional American resentment by its actions along the frontier between Canada and northwestern United States. The early years of the Anglo-French war were beneficial to American shippers, who, as neutrals, were able to trade with both belligerents. In particular. American shippers were able to supplant French and Spanish ships in the carrying trade between France and Spain and their West Indian colonies. But this form of trade was ended. or rendered hazardous, by the decision of the British courts in the case of the American ship "Essex" in 1805. The courts in this case held that U.S. ships could not carry goods from French colonies to France even when the voyage was broken by stopping at a U.S. port. In the same year the British naval victory at Trafalgar (Oct. 21) ended Napoleon's hope of invading England and led him to attempt to ruin England by excluding its trade and products from the continent of Europe. Napoleon's "continental system" was embodied in his Berlin and Milan decrees (Nov. 21, 1806, and Dec. 17. 1807), which not only barred British ships from all ports under French control, but declared the British Isles under blockade. They threatened with confiscation any neutral vessel that visited a British port. paid British duties or even allowed itself to be searched by a British cruiser. Meanwhile the British. in two orders in council (Jan. 7 and Nov. 11, 1807), announced. in effect, a blockade of the ports of France. its possessions and its allies. and forbade neutral vessels to enter such ports unless they first called at British ports and paid British duties on their cargoes. Thus Napoleon, whose object was to ruin British commerce, announced: "No trade with or through England." Great Britain, whose object was to keep that commerce alive, countered with: "No trade except through England." An American merchant vessel seeking to trade with Europe could not conform to both enactments. If it obeyed one party, it courted confiscation by the other. To the United States, both British orders and French decrees instituted mere "paper blockades," contrary to the principles of international law.

There was little to choose between the impositions of the belligerents on neutral trade, but British naval policy added another grievance in the form of impressment (*q.v.*). The impressing of British subjects for enforced service in the Royal Navy was a practice to which the United States could not object so long as it was applied to British subjects on British soil or on British merchant vessels. But controversy arose when the British asserted a right to stop American ships on the high seas and remove seamen whom the captors alleged to be British subjects and, in some cases, deserters from the Royal Navy. The U.S. merchant marine did, in fact, harbour many fugitives from British naval service who attempted to conceal their identity with false certificates of American citizenship. Another difficulty arose from the fact that the

British rule of indelible allegiance conflicted with the U.S. policy of naturalization. The same man might be a British subject under British lam and a U.S. citizen under U.S. law. The United States not only complained of the rough-and-ready methods by which British naval officers determined, without appeal, the allegiance of sailors on Americah ships; it condemned the invasion of American ships for the purpose of impressment as a violation of U.S. sovereignty. Offers to exclude British deserters from American ships in return for abandonment of impressment were rejected by the British government. A climax in the controversy occurred in June 1807, when the British frigate "Leopard" fired upon the U.S. frigate "Chesapeake" and removed four sailors alleged to be British deserters. In this attack on a public vessel, the British realized that they had gone too far and eventually made amends.

Pres. Thomas Jefferson (*q.v.*) was unwilling either to submit meekly to infringement of American rights or to defend them by force of arms. Under his leadership congress adopted a policy of "peaceable coercion," designed to exact respect for American rights by economic pressure. The Embargo act (Dec. 22, 1807) closed all U.S. ports to foreign commerce and permitted only coastwise trade. When the embargo proved more injurious to the United States than to the great belligerents, it was repealed (March 1, 1809) in favour of the milder Non-Intercourse act, which opened American trade to all countries except France and England. This was, in turn, replaced by a third measure (May 1, 1810), which removed restrictions on trade but provided for revival of nonintercourse against whichever belligerent should fail to revoke its orders in council or decrees in the event of such revocation by the other. Napoleon thereupon pretended to revoke the Berlin and Milan decrees insofar as they affected the United States, and Pres. James Madison (*q.v.*), accepting fiction as fact, revived nonintercourse against Great Britain in Feb. 1811. When England still refused to revoke the orders in council, Madison, in Nov. 1811, urged congress to prepare the nation for war, and on June 1, 1812, in a special message, urged a declaration of war against Great Britain. Congress, in spite of strong opposition, especially from New England and New York, responded with a declaration of war that Madison signed on June 18. Two days before, peaceable coercion had won a tardy victory in a British announcement that the orders in council were to be revoked, but, because of the slowness of transatlantic communication, news of this action did not reach the U.S. government for several weeks.

Early in his administration, Madison had warned the British government that failure to modify its commercial restrictions might mean war with the United States. The most urgent demand for war, however, had come not from the president but from a group of congressmen, most of them young men newly elected in 1810 to the 12th congress. These men, the "war hawks," coming mainly from western and southern states, included Peter B. Porter of western New York, Henry Clay (*q.v.*) of Kentucky (chosen speaker of the house of representatives), Felix Grundy of Tennessee and John C. Calhoun (*q.v.*) of South Carolina. Fiery and aggressive, they bitterly resented the economic injuries and the national humiliation to which the United States had been subjected. The westerners had an additional grievance in the supposed British connection with a new outbreak of Indian hostility in the northwest. British authorities in Canada were sympathetic with the efforts of the Shawnee leader, Tecumseh, to check the advance of white settlement into the Indian country. Without actually inciting the Indians to hostilities against the Americans, British agents supplied them with arms and ammunition as means of retaining their friendship. When more than 60 American soldiers were killed and 100 wounded in a surprise attack on Gov. William Henry Harrison's frontier army by the Indians at Tippecanoe (Nov. 7, 1811), westerners blamed the British and raised the cry that only by expelling the British from Canada could the frontier enjoy security. In the south, especially in Georgia and Tennessee, the "war hawks" expected to utilize war with England to wrest Florida from England's ally, Spain. The importance of this frontier expansionist urge as a motive for war is problematical. At most, it was secondary to the maritime grievances. The western desire for Canada, however, must be coupled with the rankling of the impressment issue to explain why the mar went on after news of the repeal of the orders in council reached America.

Military and Naval Events. — The congress that declared war after a seven-month debate had done little to strengthen the army or navy or to supply the treasury with funds, and the United States entered the war inexcusably ill prepared. The chief feàture of the war was expected to be the invasion of Canada, yet the U.S. government had failed to ensure control of Lakes Erie, Ontario and Champlain. Because of the British command of Lake Erie, the frontier post of Detroit (with an army of 2,000 men) was surrendered by Brig. Gen. William Hull to the British under Maj. Gen. Isaac Brock in the second month of the war. A few weeks later, attempts to invade Canada on the Niagara frontier and via Lake Champlain were complete fiascoes. Meanwhile, Commodore Isaac Hull (*q.v.*) put to sea in command of the "Constitution" (*q.v.*) and on Aug. 19 captured the British frigate "Guerrière." The year 1813, though marked by many failures, brought two notable successes to American arms in the northern theatre: the destruction of the British squadron on Lake Erie by Master Commandant Oliver Hazard Perry's fleet (Sept. 10, 1813) and the ensuing victory of Maj. Gen. William Henry Harrison's army over Brig. Gen. Henry A. Procter's British and Indians at the battle of the Thames on Oct. 5, 1813 (see THAMES, BATTLE OF THE).

By the summer of 1814 the United States at last had a well-trained army in the Niagara region, commanded by competent officers (Maj. Gen. Jacob Brown and Brig. Gen. Winfield Scott), but this advantage was counterbalanced by the arrival in Canada of veteran British regiments, released from service in Europe by the defeat and first exile of Napoleon. The hard-fought battles of Chippawa (July 5, 1814) and Lundy's Lane (July 25, 1814) restored American military prestige but accomplished little else. Another American naval victory, this time on Lake Champlain (Sept. 11, 1814), saved New York from a projected invasion via the Hudson valley. Elsewhere the British took the offensive. Despite the American recapture of Detroit, British forces held Michilimackinac, controlled access to Lake Michigan and occupied the Mississippi river as far south as northern Illinois. An amphibious British force ravaged the shores of Chesapeake bay and burned the public buildings in Washington, D.C. (in retaliation for similar American acts at Toronto), but was repulsed at Baltimore. It was during the attack on Raltimore that Francis Scott Key (*q.v.*) composed "The Star-Spangled Banner," now the U.S. national anthem. Another British army under Lieut. Gen. Sir Edward Pakenham landed near the mouth of the Mississippi river, but on Jan. 8, 1815, was defeated with heavy losses in the battle of New Orleans by the defenders under Maj. Gen. Andrew Jackson.

Meanwhile, U.S. frigates, sloops of war and privateers had inflicted heavy damage on British commerce and had won great acclaim by their victories in a large majority of duels with British naval vessels of similar ratings. Their victories, salutary to American morale. failed to disturb Britain's control of the sea through its vastly superior navy. Before the war ended, most U.S. naval vessels were captured or shut up in port, and the commercial blockade of the American coasts was complete.

Peace Negotiations. — On Dec. 24, 1814, two weeks before the battle of New Orleans, a treaty of peace had been signed at Ghent, Belg., where British and American commissioners had met in August as an indirect consequence of an offer of mediation by Tsar Alexander of Russia. The United States had fared so badly in the war that it was in no position to ask cessions of territory and finally dropped even its demand for the abandonment of impressment. It proposed merely a return to the situation before the war (status quo *ante bellum*). The British, on the other hand, came to Ghent with formidable demands — a permanent Indian reservation in the northwest, retention of several forts on U.S. soil and cessions of territory in Maine, in New York and between Lake Superior and the upper Mississippi. The Americans refused all these demands, and their position was strengthened by news of British defeats at Baltimore and on Lake Champlain, and by the advice given to the British government by the duke of Wellington, who argued that territorial exactions were not warranted by the military situation. The British, consequently, accepted the U.S. proposal for restoration of the prewar situation, with certain provisions in behalf of Indian tribes who had helped the British.

Though the treaty fulfilled not one of the U.S. objectives in the war, it received unanimous approval of the senate on Feb. 16, 1815, and was joyously hailed by the public. It headed off a potentially separatist movement in New England, where both the war and the commercial restrictions which preceded it had been extremely unpopular. New England opposition culminated in the Hartford convention (Dec. 1814–Jan. 1815). This gathering, in spite of some secessionist talk, went no further than to propose certain amendments to the constitution, and, with the coming of the news of peace, the convention and its proposals were quickly forgotten. Though the United States gained none of its avowed aims in the war, popular mythology soon converted defeat into victory. This process was facilitated by several circumstances: the series of military successes in the war's closing months left a taste of victory; the end of the war in Europe brought an end also to the issues of impressment and paper blockades; finally, the war did actually subdue Indian resistance, since Tecumseh died in the battle of the Thames and the Creek confederacy in the south was crushed by Andrew Jackson in 1814. Indirectly, this Creek war paved the way for the acquisition of Florida in 1819. The war marked the end of a period of American dependence on Europe and gave a stimulus to the sense of nationality in the United States. *See* also UNITED STATES (OF AMERICA): *History;* and Index references under "War of 1512" in the Index volume.

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(J. W. PR.)

WAR OFFICE, BRITISH.[1] The term applies to (1) the building which houses the controlling staff of the army, and (2) the controlling staff itself. As regards the local habitation of the staff, in Cromwellian days this was often in the field and was the tent of the secretary to the commander in chief whose official title was secretary at war.

After the Restoration (1660), George Monk, as lord general, took up his residence at a house in Whitehall called the Cockpit and this became the headquarters of the army. About 1684 the headquarters were moved to the "horse guards," *i.e.,* the barracks of the king's guards at Whitehall, and there it remained until 1856 when it moved to Buckingham house, Pall Mall. In 1907 it moved to its quarters in Whitehall.

From the Earliest Times to the Crimean War (1854–56).— The details of the early administrative history of the army are very obscure. William the Conqueror created the offices of high constable and marshal and their duties appear to have been somewhat analogous to those of the contemporary adjutant general and quartermaster general.

Although the origin of the board of ordnance is obscure it was certainly in existence in the early part of the 14th century, and it is the oldest military office with a continuous history. Charles II created the title master general of ordnance in 1664. The headquarters of the board were for centuries at the Tower of London. In 1855 the letters patent for the board were revoked and its duties vested in the secretary of state for war. In the 18th century, the office of master general of the ordnance was held by the chief military leaders and generally carried with it cabinet rank. Marlborough was twice master general of ordnance.

The office of secretary of state for war appears to have had its origin in a council of war of Charles I. The clerk to Charles' council was the secretary at war and he had a counterpart in the New Model army. After the Restoration he became secretary at war to all the forces in England and Wales, and was in fact nothing more than the private secretary of the commander in chief. When Monk (who had become duke of Albemarle) died in 1670 the office of secretary at war grew in importance, because of the fact that Charles II did not appoint a commander in chief. Gradually the office became separated from that of the commander in chief, arriving at complete divorcement in 1704, when the office became a political post. In 1794 was created a new post, the secretary of state for war, and in 1801, because the armies were largely employed in the West Indies, the direction of colonial affairs was transferred from the home office to the secretary of state for war who became secretary of state for war and the colonies. In 1855 the office of secretary at war was merged into that of the secretary of state, but it was not finally abolished until 1863.

The office of the deputy secretary at war appears to have been created at least before the 18th century. The holder of the appointment was the senior permanent official in the department of the secretary at mar. When the departments of the secretary of state and secretary at war were amalgamated the post was abolished and in its place that of permanent undersecretary of state created. The office of the commander in chief dates back to the Restoration. At various times the title has been captain general, generalissimo: general on the staff and lord general. The first holder of the appointment was the duke of Albemarle, whose special charge was the care of men while the board of ordnance looked after the matériel. In the 17th century when the commander in chief was on foreign service, many of his duties were usurped by the secretary at war.

The office of adjutant general to the forces originated in the parliamentary army. After the Restoration the first appointment was made in 1673. From 1685 there was a continuous line of adjutants general. The quartermaster general first appeared in 1686. Previous to this his duties had been carried out by the provost marshal, scout master general and the harbinger.

The office of commissary general of musters was established just after the Restoration and abolished in 1818. The chief duty of the commissary general of musters was to keep up the establishment and to issue a certificate to the paymaster general for the actual number of men serving. At the outset of the standing army the medical service was entirely regimental, but in 1663 was initiated central control which developed into a directorate in the early part of the 19th century.

From the Crimean War (1854–56) **to** 1904.—Military administration underwent great changes during the period following the outbreak of the Crimean War. The duties of the secretary of state for war were divorced from those of the colonies; the commissariat office was transferred to the war department; the office of secretary at war was merged into that of the secretary of state; the board of general officers and the medical department were absorbed by the war department, and the war department became known as the war office. The military control remained in the hands of the commander in chief, while the secretary of state was responsible to parliament. However, under the War Office act (1870) the final welding was effected and the secretary of state became responsible for all military administration.

After the Esher Report: 1904 Onward.—The next great change took place when, following the publication of the Esher report (Feb. 1904), the issue of letters patent abolished the office of commander in chief and established an army council on the same lines as the board of admiralty, with the characteristic feature of a civilian minister—the secretary of state for war—presiding over a body composed jointly of junior ministers, the permanent undersecretary of state and military members of council with a civilian secretary. The main constitutional feature of the changes in organization was that an imperial general staff was established whose chief was, as first military member of the army council, subject to the presidency of the secretary of state, though it has always been well understood that, as prescribed by the Esher report, there should be no civilian interference in purely military matters except on the broadest questions of policy.

The pattern set in 1904 was in general adhered to thereafter, and may be said to have stood the test of two world wars. In the

[1]The permission of the controller of H.M. stationery office has been obtained for the inclusion of this article.

intervening years there were important developments arising from general changes in the defense structure, and from increasing specialization, besides numerous changes of nomenclature. World War I was marked by the creation of the ministry of munitions, the ministry of pensions, the air ministry and the ministry of national service. All these relieved the war office of important functions. (See also GOVERNMENT DEPARTMENTS.)

In the years between World Wars I and II the main changes were that, by order in council, commanders in chief in the field were taken outside the control of the war office except for certain restricted and somewhat technical purposes, and that, inside the office, a number of duties were transferred to the master general of the ordnance from the quartermaster general, who remained responsible for supply and quartering. The first important change in war office organization brought about by World War II was that the duty of providing the army with armaments and vehicles was taken outside the office altogether and transferred to the ministry of supply, with the consequent abolition of the historic post of master general of the ordnance. Coupled with this change was a strengthening of the organization for fulfilling the duties of the general staff in connection with research and development in the fields of weapons and vehicles. Under the general supervision of the chief of the imperial general staff, an officer with the style of deputy chief of the imperial general staff and the rank of lieutenant general, and himself a member of the army council, became responsible for this work and for organization. He was given the help of a civilian scientific adviser, and the relationship of the general staff to the ministry of supply was that the former prescribed what the army needed and the latter, so far as financial and technical conditions allowed, provided it.

The second change of outstanding importance was that, with the formation of the chief of staffs committee, under the minister of defense, the general staff, always in fact responsible for strategy to the cabinet as a whole rather than to the secretary of state, became in principle as well as in fact responsible to the minister of defense. After the ministry of defense had become, in 1947, a permanent part of British constitutional arrangements, the secretary of state for war, in common with the other heads of service departments, ceased to sit in the cabinet. The appointment in 1956 of a full-time chairman of the chiefs of staff committee, replacing the system whereby either the first sea lord, the chief of imperial general staff or the chief of air staff took the chair at meetings, was a further step in making the imperial general staff part of an interdepartmental team responsible to the cabinet through the minister of defense rather than part of the war office staff, which in name it still was. This process was carried one stage further by the arrangements set out in the white paper *Central Organisation for Defence* (Cond. 476 of 1958) whereby "The Chiefs of Staff are responsible through the Chief of the Defence Staff to the Minister of Defence for the conduct of military operations."

For the equivalent government department in the U.S., *see* GOVERNMENT DEPARTMENTS: *United States*. (T. *J. E.*; W. T. Ws.)

WARP AND WEFT. Warp threads are those that run lengthwise of the fabric; weft threads run transversely. In the manufacturing of practically all kinds of woven textures, there are many differences: (1) the raw material from which uarp is made is almost invariably of a higher grade than that used for weft; (2) the number of turns per inch or "twist" in warp threads usually exceeds that in the weft threads or picks; (3) multiple-fold or multiple-ply yarns are more often used for warp than for weft; (4) coloured threads appear in both, but much more frequently in the warp; (5) the fibrous material from which warp threads are made may be the same as that used for the weft threads, or the two may be entirely different; (6) warp threads are often starched or sized, but ueft threads are seldom so treated.

Except for knitted fabrics or other similar structures in which one series of yarns only is used, the warp and weft threads interweave together to form the structure of the fabric and to give it complex designs. *See* WEAVING.

WAR PENSIONS. The first pension law in the United States was passed by congress on Sept. 29, 1789. It provided that "The military pensions which have been granted and paid by the States respectively . . . shall be continued and paid by the United States." A treasury surplus motivated Pres. James Monroe to urge congress to establish a service pension for all Revolutionary soldiers in need. This law, enacted on March 18, 1818, the first to pay pensions on the basis of honourable military service and not on disability, resulted in so many veterans applying for pensions that the surplus quickly was wiped out. On May 1 of that year congress authorized a "scythe of retrenchment" in the form of an act that took one-third of the pensioners off the rolls.

The pendulum soon swung the other way. Laws passed in 1828, 1832 and 1833 granted full pay for life to certain surviving Revolutionary War soldiers. On March 18, 1836, a law was passed extending benefits to volunteers or militiamen called into United States service to suppress Indian depredations in Florida.

Service pensions for veterans of the War of 1812 were not authorized until Feb. 14, 1871. This law was liberalized on March 9, 1878, by reducing the minimum service requirement from 60 days to 14 days, and by authorizing pensions to widows of War of 1812 veterans, irrespective of the date of marriage.

The United States broadened its pension system by an act of July 14, 1862, the "general law pension system," which granted pensions to veterans and their dependents because of disability or death due to service. In 1887 congress passed a service pension bill for Mexican War soldiers. At least 60 days' service or participation in a battle was required for a service pension.

One of the most controversial service pensions for U.S. veterans was that finally granted to those aho served in the Civil War. Pres. Benjamin Harrison signed it on June 27, 1890.

Service pensions for Indian war veterans followed, in an act of July 27, 1892. For Spanish-American War veterans. the pensions were authorized in an act of June 5, 1920. The latter law also provided service pensions for survivors of the China relief expedition and the Philippine insurrection. Pensions for widows and minor children of Spanish-American War, Philippine insurrection and Chinese Boxer rebellion veterans were granted by a law passed July 16, 1918. Six years after the Armistice ended World War I, congress provided an adjusted compensation or "bonus" for the servicemen who fought in that war.

Several amendments to the bonus law mainly extended the deadline for filing applications. But in Jan. 1936, congress passed a law allowing veterans to exchange adjusted compensation certificates for government bonds carrying 3% interest. The bonds matured in 1946, but were redeemable at any time before that date. A law passed July 3, 1930, provided a disability allowance for World War I veterans, depending on the degree of permanent incapacitation.

This act, together with all other pension and compensation acts for service from and including the Spanish-American War, was repealed by an act of March 20, 1933, which overhauled the entire U.S. system of relief for veterans and dependents of deceased veterans. The new act of 1933, as amended, provided for the payment of compensation at wartime rates for death or disability incurred in Sine of duty during the Spanish-American War, the Philippine insurrection, Boxer rebellion, World War I and any future wars. Peacetime rates—80% of wartime rates—were payable for service-connected death or disability incurred on or after April 21, 1898, during other than wartime periods. For those with disability exceeding 50%, the law also provided additional allowances for wife, child and dependent parents.

From 1944 to 1957 a number of laws were passed increasing rates of compensation and pension. As of Jan. 1, 1958, veterans were entitled to compensation for disabilities incurred due to service, assuming a discharge other than dishonourable. Additional amounts were payable for dependents if the veteran was 50% or more disabled. Disability pensions were payable to veterans uhose total and permanent disability was not due to service, assuming eligibility based on a discharge other than dishonourable and assuming his income was not over $1,400 a year without dependents, or $2,700 a year if he was married or had a minor child. Death pension benefits might be paid to an eligible widow and to children where the veteran died of causes not due to service.

The Servicemen's and Veteran's Survivor Benefits act became effective Jan. 1, 1957. Eligible surviving widows, children and dependent parents of all servicemen and veterans who died on or after Jan. 1, 1957, as a result of service were not eligible for benefits under any previous law. If the serviceman or veteran died prior to Jan. 1, 1957, benefits were determined under the previous law, but a surviving dependent who received such benefit might elect benefits under the Survivor Benefits act if such an election nould be financially advantageous. Under the Survivor Benefits act. payments were monthly and the rate of payment was partially related to military pay.

For service-connected deaths occurring prior to Jan. 1, 1957, examples of monthly payment rates to eligible survivors were: widow. no child. $87; widow. one child, $121 (each additional child, $29); no widow, one child, $67; no widow. two children. $94; no nidow, three children, $122 (each additional child, $23); one parent. $75; two parents each $40.

For service-connected deaths occurring on or after Jan. 1. 1957, examples of monthly payment rates to eligible survivors were: widow, one child $112 plus 12% of the current basic pay of the rank held by the veteran at the time of his death; no additional allonance, in general, for children of an eligible widow; no widow, one child. $70; two children, $100; three children, $130; and $25 for each additional child Parents might receive benefits subject to income limitations For example. a single parent with an income under $1,7jo per year might receive benefits at a rate ranging from $15 to $7j monthly.

Death compensation for surviving disabled children of such serviceman or veteran also varied depending upon the date of death, and with such factors as the length of time the child was unable to support himself, whether his eligible widowed mother was still living and whether the child received benefits under the War Orphans Educational Assistance act.

The Survivor Benefits act was also designed to revise the six months death gratuity which ranged from $800 to a maximum of $3,000 and it also extended social security coverage to armed forces personnel on a contributory basis

In the early days of the nation. pensions were granted only by acts of congress. Later, the executive branch of the government was given authority to grant pensions under limits set by law.

The administration of pension and compensation laws has historically fallen upon the secretary of war or the department of the interior, but after July 21, 1930, the pension bureau became part of the Veterans administration (*q.v.*). These compensation and pension benefits, so administered, are generally exempt from creditor's claims and from legal process, except for claims of the United States arising under laws relating to veterans.

(C. R GY. J. W. CE.)

Great Britain.—War pensions in Great Britain are the responsibility of the ministry of pensions and national insurance. This department was formed in 1953 by the amalgamation of the ministry of pensions—set up in 1916 to deal with the great number of claims then arising from World War I and to take over existing war pensions from the service departments, including pensions from the South African War and some earlier wars—with the ministry of national insurance. At the time of this amalgamation certain functions relating to medical and surgical treatment for war pensioners. previously performed by the ministry of pensions, were transferred to the ministry of health and the department of health for Scotland. The ministry of pensions and national insurance is also responsible for pensions for death or disablement resulting from service in the armed forces after Sept. 2, 1939, and for war pensions to former members of the mercantile marine, etc., civil defense forces and to war-injured civilians. Pensions for death or disablement resulting from service in the armed forces between Oct. 1, 1921, and Sept. 2, 1939, remained the responsibility of the respective service department as do all purely service pensions.

War disablement pensions are granted when the disablement can be certified as either attributable to or aggravated by service. Entitlement to pension is not necessarily established because the person concerned has been invalided from the armed forces. But nhere a person leaves the forces by invaliding or otherwise there is no onus on him to prove that his disablement was the result of service if the claim is made not later than seven years after service terminated, and the benefit of any reasonable doubt is always given to him; if he has been invalided on account of disability nhich nas not noted when his service began there is a presumption that the condition was the result of service unless the evidence establishes otherwise. The determination of entitlement to pension is vested in the minister, but appeals against unfavourable decisions may be made to an independent statutory body, the Pensions Appeal tribunal. Appeals against a decision of a Pensions Appeal tribunal may be made to the high court on a point of law.

When entitlement is admitted pension is granted in accordance nith a medical assessment of the war disablement without reference to earning capacity or employment factors. This assessment is based on a comparison of the pensioner with a normal healthy person, the extent of the nar d~sablementbeing expressed as a percentage. 100% representing total incapacity. (Pension is payable while war disablement to the extent of 20% or more exists. If the d~sablementfalls to less than 20% a settlement is made by means of a gratuity or weekly payments for a limited period or both.) If the disability is not attributable to but only aggravated by service, pension may be discontinued on the ground that such aggravation has passed away.

A war disablement pension comprises a basic amount related to the medical assessment, with certain additions according to the individual circumstances. The basic amount in 1958 was 85*s.* a week for 100% disablement for a pensioner whose rank was private soldier or equivalent with higher rates according to rank; *e.g.*, 91*s.* 8*d* for a sergeant. £346 a year for a captain. To these amounts may be added an allowance for a wife, 10*s.* a week (£36 a year for officers) and allowances for children, 7*s.* 6*d.* a week for each child (officers, £30 a year). Both the basic amount and the additions for family are proportionate to the degree of disablement (thus a sergeant whose disablement was assessed at 50% and who had a nife and one child would receive 54*s* 7*d*). But if a partially disabled pensioner has to undergo treatment for his war disablement and is thereby prevented from working he receives allowances which bring his pension up to the 100% level.

Although the medical assessment on which the basic amount of pension is decided is made independent of the earning capacity of the disabled person, employment factors are recognized in connection nith two supplementary allowances. An unemployability supplement of 55*s.* meekly can be awarded when war disablement is the main cause of a pensioner's being unable to work over a long period. Secondly. where a partially disabled pensioner is able to work but is prevented by his nar disablement from following work of his former standard he may be granted an allonance of up to 34*s.* a week, or such smaller sum as will bring his pension up to the 100% rate. Other supplementary grants include an allomance for attendance payable to a pensioner receiving 100% pension and living at home who requires the help of another person. The maximum grant is 70*s.* a week. For a pensioner who wears an artificial limb, or whose disability otherwise causes extra wear and tear of clothing, there is an allowance of £6 or £10 a year. There is an allowance of either 20*s.* or 10*s.* a week for the provision of comforts for certain very severely disabled pensioners. There is also an age allowance at rates ranging from 5*s.* to 15*s.* a week for pensioners who are aged 6; years or more and whose pensioned disablement is 40% or over.

About 1,900 of the most severely handicapped pensioners are provided with motorcars. Tax and insurance are borne by the health departments and an annual allowance is paid to the pensioner toward upkeep. Less severely disabled pensioners are provided with weather-protected motor tricycles and are paid a small petrol (gasoline) duty allowance. The health departments are responsible for the supply of the cars and tricycles and for the payment of the annual allowances referred tb in this paragraph.

The ministry of pensions and national insurance is responsible for arranging for medical and surgical treatment where the need for it arises from the disablement resulting from service but the health departments are responsible for the actual provision of the treatment, including the supply of all kinds of surgical and medical aids and appliances.

War pensions are granted to widows and, under certain conditions, to parents and other dependents of members of the armed forces whose death is certified to be caused by or hastened by service, the general rules as to determination of entitlement applying as in disablement claims. For the widow who is over 40 years of age or has a child in her care or is incapable of self-support, the basic rate of pension is 66s. a week, with higher rates according to her husband's rank; for the widow with none of these qualifications the rate is 20*s*. a week with addition according to rank. Additional allowances are paid to widows for their children, the rate being 25s. a week for each child (£73 a year in the case of an officer's widow). The widow of a member of the armed forces below commissioned rank who has a child in her care may receive a supplement in respect to her rent of the amount by which the rent exceeds 6s. a week, subject to a maximum payment of 25s. weekly. For a child who has lost both father and mother the rate of pension is 30*s*. weekly up to 15 years of age and then 40*s*. (£112 10*s*. a year for an officer's child). These pensions can be supplemented according to the circumstances. A pension may be granted to a parent (or other dependent) who is in pecuniary need. In determining need consideration is given to the support which the deceased person gave or could be expected to have given had he survived. The maximum pension is 27*s*. 6d. weekly to one parent and 40*s*. to two parents (£95 and £120 a year respectively in the case of an officer). Parents' pensions can be claimed at any time even though the parents were not in pecuniary need at the time the son died. The allowances for children of disabled men or of widows are payable until the age of 16 (18 in the case of officers) and they may be continued beyond this where the child is a student, an apprentice or is incapable of self-support by reason of infirmity. Education allowances for children may also be paid in addition to the normal allowances. These education allowances are designed to help parents with school fees and incidental expenses. The maximum rate for each child is £80 a year. War pension allowances for children are payable in addition to the national family allowances.

At Dec. 31, 1957, over 580,000 war disablement pensions were being paid. About 238,000 of these related to World War I and earlier wars and nearly 343,000 to World War II and later service in the armed forces. The latter total included 3,800 pensions to former members of the mercantile marine and 13,800 pensions to former members of the civil defense forces and civilians injured by enemy action. Of the 580,000 disablement pensioners about 446,000 were married and were receiving allowances for their wives and for 386,000 children. Nearly 17,400 pensioners were receiving unemployability supplements, about 15,800 the allowance for lowered standard of occupation, 9,300 the allowance for attendance, 20,700 the comforts allowance and 55,600 the age allowance. About 14,500 women were receiving war disablement pensions. The total number of war widows' pensions being paid was 154,200 — 82,400 relating to the World War I. About 75,100 parents, orphans and other dependents were receiving pensions, 24,200 from World War I. About 29,300 war pensioners are resident overseas (including 7,900 in Canada and 3,900 in the United States). Expenditure in respect of actual war pensions and allowances was approximately £88,700,000 in the financial year 1956–57—£36,700,000 in respect to World War I. Cumulative expenditure on war pensions after Aug. 4, 1914, was nearly £2,630,000,000 by March 1957. (T. W. C.)

WARQLA (OUARGLA), a town of the Algerian Sahara. Pop. (1954) 6,456, the majority of mixed Berber and Negro blood. It is walled and is entered by six gateways, which are fortified. The French fort, barracks, hospital and other buildings are south of the native town. The oasis in which Warqla is situated contains two or three other small fortified *ksurs* or villages, the largest and most picturesque being Ruissat. The population of the oasis is (1954) 27,034.

WARRANT, in law, indicates an authority in writing empowering a person to do an act or to execute an office. The term is applied to a great variety of documents of very different kinds.

Executive and Administrative. — While the royal prerogative was insufficiently defined and limited, a great many executive acts were authorized by royal warrant (per speciale *mandatum regis*) which now either depend on statute or are dealt with by departments of State without the need of recourse to the personal authority of the sovereign. There is hardly any exercise of the royal will which does not depend on the issue of a warrant attended with the strictest formalities designed to secure the responsibility of some minister for it, in illustration of the great constitutional principle that "the King cannot act alone." (See PREROGATIVE; PRIVY COUNCIL.) Under present constitutional practice royal warrants are as a general rule countersigned by a member of the cabinet or other responsible officer of State. By an act of 1435 (18 Hen. VI. c. 1) letters patent under the great seal must bear the date of the royal warrant delivered to the chancellor for their issue. This act still applies to all patents, except for inventions. The form and countersignature of warrants for affixing the great seal is regulated by the Great Seal Act 1884. Pardon, which was granted for centuries only by letters patent under the great seal, has since 1827 in England and 1828 in Ireland been granted in case of felony by warrant under the royal sign manual countersigned by a secretary of State (7 and 8 Geo. IV. c. 28, s. 13; 9 Geo. IV. c. 54, s. 33). The prerogative of the crown with reference to the control of the navy and army is largely exercised by the issue of warrants. In 1871 the purchase of commissions in the army was abolished by royal warrant. The convocation of naval courts-martial and the appointment of judge-advocate and provost-marshal at such court is by warrant of the Admiralty or of the officer on foreign or detached service who by his commission is entitled to convene such a court. (See Naval Discipline Act 1866, s. 58; Army Act 1881, s. 179.) A general court-martial for the army is constituted by royal warrant or convened by an officer authorized to convene such court, or his lawful delegate (Army Act 1881, s. 48). Appointments to certain offices under the crown are made by warrant of the king or of the appropriate department of State. In the navy and army the officers called warrant officers are so styled because they are appointed by warrant and do not hold commissions. Certain tradesmen to the court are described as "warrant holders," because of the mode of their appointment. Abuses of claims to this distinction are punishable (Merchandise Marks Act 1887, s. 20; Patents Act 1883, s. 107). The issue of warrants under the hand of a secretary of State, so far as they affect personal liberty, depends in every case on statute, *e.g.*, as to the surrender of fugitive criminals (EXTRADITION), or the deportation of undesirable aliens (see ALIEN), or the bringing of prisoners as witnesses in courts of justice. The right of a secretary of State by express warrant in writing to detain or open letters in the post office was recognized by orders in council and proclamations in the 17th century and by various acts, and is retained in the Post Office Act 1836 (s. 25).

Judicial and Quasi-Judicial Warrants. — Unless a statute otherwise provides a judicial warrant must be in writing under the seal, if any, of the court, or under the hand and (or) seal of the functionary who grants it. Committal for breach of privilege of the House of Commons is by warrant of the Speaker. During the Tudor and Stuart reigns frequent attempts were made by the crown and great officers of State to interfere with personal liberty, especially as to offences of State. The legality of these proceedings was challenged by the judges in Elizabeth's reign. On the abolition of the Star Chamber it was enacted (16 Car. I. c. 10) that if any person be imprisoned by warrant of the king in person, of the council board, or any of the privy council, he is entitled to a writ of habeas corpus, and the courts may examine into the legality of the cause of detention. This enactment, and the Habeas Corpus Act 1679, put an end to the interference of the executive with matters belonging to the judicature; but until 1763 there survived a practice by which a secretary of State issued warrants to arrest individuals for State offences, and to search or seize the books and papers of the accused. The latter practice was examined and declared illegal in the famous case of *Entick* v. Carrington (19 How. St. Tr. 1030) where it was held that a secretary of State is the king's private secretary and has not, as such, the authority of a magistrate to issue a warrant. Still more important were the cases of *Leach* v. *Money* (19 St. Tr. 1001) and *Willus* v. *Wood* which declared the illegality of "general" or "uncertain" warranty, *i.e.,* warrants which do not testify the name of the person to be arrested. All privy councillors are included in the commission of the peace for every county. The council itself is said to have power to issue warrants of arrest for high treason, but the power, if it exists, is in abeyance in England. As a result of the gradual restriction of the royal prerogative, the term warrant has come in modern times oftenest to be used of documents issuing from courts of justice. Few documents issuing from the superior courts are called warrants. In these courts writs and orders are more generally used. In courts of record which try indictments a "bench warrant" is sometimes used for the arrest of an absent defendant, but the word warrant has for judicial purposes become most closely associated with the jurisdiction of justices of the peace. As a general rule no one can be arrested for a misdemeanour. But to this rule there are many statutory exceptions, as in the case of street offences, gambling, cruelty to animals, offences against the person, profanity and other misdemeanours, also of a breach of the peace actually committed in the presence of a constable. In the case of felonies, no warrant is necessary. At common law a justice of the peace, a sheriff, a coroner, a constable and even a private person, may arrest any one without warrant for a treason, felony or breach of the peace committed, or attempted to be committed, in his presence. A constable (whether a constable at common law or a police constable appointed under the Police Acts) may arrest a person indicted for felony; a constable or a private person may arrest on reasonable suspicion that he who is arrested has committed a felony. But in the latter case he does so at his peril, for he must prove (what the constable need not) that there has been an actual commission of the crime by some one, as well as a reasonable ground for suspecting the particular person. What is a reasonable ground it is of course impossible to define, but, in the case of a constable, a charge by a person not manifestly unworthy of credit is generally regarded as sufficient. An accused person who has been bailed may be arrested by his bail, and the police may assist in the arrest. In neither case is a warrant necessary. Nor is it necessary for the apprehension of one against whom the hue and cry is raised. The king cannot arrest in person or by verbal command, as no action would lie against him for wrongful arrest. In those cases in which arrest without warrant is illegal or is found inexpedient, information in writing or on oath is laid before a justice of the peace setting forth the nature of the offence charged and to some extent the nature of the evidence implicating the accused; and upon this information, if sufficient in the opinion of the justice applied to, he issues his warrant for the arrest of the person incriminated. The warrant, if issued by a competent court as to a matter over which it has jurisdiction, becomes a judicial authority to the person who executes it, and resistance to such a warrant is a criminal offence. The issue of a warrant by a justice of the peace is a judicial act, and provided he is acting within his jurisdiction, he cannot be sued for a "false imprisonment" by the person arrested, even though he has acted unreasonably in issuing it and the prisoner is acquitted. Speaking generally, a constable to whom a warrant is issued is protected from any action at law for executing it if it was apparently legal on the face of it, because he is bound to obey it. But if he arrested the wrong person or arrested without having the warrant in his possession, he is liable in an action for "false imprisonment." Entry upon the land or seizure of property cannot as a rule be justified except under judicial warrant. The only common law warrant of this kind is the search warrant, which may be granted for the purpose of searching for stolen goods. Special powers for issuing such warrants are given by the Army, Merchant Shipping, Customs, Pawnbrokers and Stamp Acts, and for the discovery of explosives or appliances for coining and forgery. The Official Secrets Acts of 1911 to 1920 are remarkable in that they disperse with the necessity of the intervention of a justice of the peace in the case of a search for official documents and enable the constable to make such a search on the order of a superintendent of police if it appears that "immediate action is necessary." The Criminal Law Amendment Act 1885 allows the issue of search warrants where it is suspected that a female is unlawfully detained for immoral purposes. Execution of the decisions of a court of summary jurisdiction is secured by warrants, part of the process of the court, such as warrants of distress or commitment. A warrant may also issue for the apprehension of a witness whose attendance cannot be otherwise assured. The forms of warrants used by justices in indictable cases are scheduled to the Indictable Offences Act 1848. Those used for summary jurisdiction are contained in the Summary Jurisdiction Rules of 1886.

As a general rule, warrants must be executed within the local jurisdiction of the officer who issued them. Warrants, etc., issued by a judge of the High Court run through England, in criminal as well as in civil cases: and the same rule applies as to courts having bankruptcy jurisdiction. The warrants of justices of the peace can be executed on fresh pursuit within 7 m. of the boundary of the jurisdiction, and if properly backed by a local justice or officer in any other part of the British Isles. *(See* SUMMARY JURISDICTION.) There is also a special provision as to executing warrants in the border counties of England and Scotland. Under the Extradition Acts and Fugitive Offenders Act 1881 provision is made for the issue of warrants in aid of foreign and colonial justice; but the foreign and colonial warrants have no force in the United Kingdom. The word is used as to a few judicial or quasi-judicial matters of civil concern, *e.g.,* warrant to arrest a ship in an admiralty action *in rem;* and in the county courts warrants to the bailiffs of the court are used where in the High Court a writ to the sheriff would be issued, *e.g.,* for attachment, execution, possession and delivery.

Financial and Commercial. — Payment out of the Treasury is generally made upon warrant. Treasury warrants are regulated by many of the acts dealing with the national debt.

Payment of dividends by trading corporations and companies is generally made by means of dividend warrants. Mercantile warrants are instruments giving a right to the delivery of goods, generally those deposited at a dock or warehouse, and by mercantile custom regarded as documents of title to goods.

Scotland. — By art. xxiv. of the Articles of Union royal warrants were to continue to be kept as before the union. The Secretary for Scotland Act 1885 enabled the crown by royal warrant to appoint the secretary to be vice-president of the Scotch Education Department. The lord advocate's warrant runs throughout the whole of Scotland. Warrants issued by courts of summary jurisdiction agree in the main with those in use in England, though their names are not the same. *(See* SUMMARY JURISDICTION.) There are many statutory provisions as to other warrants.

(W. F. C.)

UNITED STATES

Judicial warrants can be divided into the two classes of warrants of arrest and warrants of search and seizure. The use of general or John Doe warrants, which did not specify the name of the person to be arrested nor the place to be searched nor the character of the goods to be seized, and the use of writs of assistance having a like effect, a practice condemned in 1763 by Lord Camden in *Entick* v. *Carrington* (19 How. St. Tr. 1030) and one of the abuses complained of by the colonists in the Revolutionary War, led to the prohibition of the issuance of such warrants by constitutional provisions. The 4th amendment to the U.S. Constitution thus provides against unreasonable searches and seizures and prohibits the issuance of any warrant "but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the person or things to be seized." Though this amendment is only a limitation upon the powers of the Federal Government, similar restrictions upon the States are to be found in the State Constitutions.

Warrants of arrest, which are necessary where under the common law or under statutory provision no power to arrest without warrant may be exercised, may be issued by those officers designated by the State or Federal statutes. These ordinarily include judges, U.S. commissioners, justices of the peace and judicial or quasi-judicial officers of municipal corporations. A similar power is conferred upon certain administrative officers in the exercise of their functions, the commonest example being that of warrants issued by the Department of Labor in the deportation of aliens. Under the traditional laws of parliamentary privilege a power to issue warrants of arrest for breach of privilege resides in the speaker of a legislative assembly or the president of a senate. The warrant issues at the behest of the complainant upon a complaint setting forth the facts or information upon which the guilt of the offender is based. Probable cause must be shown in the sense that the complainant must make out a *prima facie* case for concluding that the person accused was guilty of the crime. The complaint must be accompanied by the affidavit of the complainant. The forms and requisites governing the issuance of the warrant must be strictly complied with. The legality of the warrant and the arrest thereunder can be contested by a *habeas corpus* (*q.v.*) proceeding or by an action for false imprisonment. Analogous to the ordinary warrant of arrest is the bench warrant which is issued by the court itself for arrest for contempt or after indictment found or against a recalcitrant witness.

The issuance of search warrants is governed generally by the same limitations surrounding warrants of arrest. The description of the property to be seized must be so particular that the officer charged with the execution of the warrant will be left with no discretion respecting the property to be taken. It may issue for the recovery of stolen property, for the seizure of property used for the commission of a crime or in the possession of a person intending to use it for such a purpose. The warrant should be executed only during the day-time but the officers when resisted may forcibly enter the premises. In its execution its limitations must be strictly observed, and the search confined to the character of goods enumerated in the warrant. Resistance to its execution is punishable. The legality of its issuance is in some instances reviewable by writ of certiorari to a superior tribunal. In all cases the legality of its issuahce and execution can be contested by an action of trespass against the officer. In order to make more effective the constitutional prohibition against unreasonable searches and seizures the Federal courts refuse to admit any evidence obtained as a result of a search without a warrant or under an illegal warrant. The majority of the State courts, however, admit such evidence and leave the complainant to his civil action against the offending officer. The enforcement of the constitutional protection against unreasonable searches and seizures has become a matter of intense moment in the prosecution of offenses against the 18th amendment and legislation under it seeking to make effective the constitutional prohibition against the sale, manufacture and transportation of intoxicating liquor. The assertion of these new and penetrating powers of government has, in communities where their assertion is regarded as an infringement upon the liberty of the citizens, precipitated issues akin to those that agitated the citizenry during the controversy over general warrants and writs of assistance.

Other judicial warrants may be briefly adverted to. The escape warrant is issued for the recapture of prisoners who have escaped from custody. The warrant of commitment is the process by which a court directs a ministerial officer to take a person to prison either before or after trial. Orders directing the execution of an offender are known as death warrants, commonly issued by the governor of the State. In some States their issuance is by statute a prerequisite to the execution of the death sentence; in others the pronouncement of the sentence in open court is sufficient authority for its execution. The landlord's warrant is directed by a landlord to a constable to levy upon the goods of his tenant and sell them in order to constrain the latter to pay the rent. Under the Federal Bankruptcy Act of 1898, Section 69, a judge may issue a warrant to a marshal authorizing him to seize the property of a bankrupt upon proof that the latter is neglecting his property or allowing it to deteriorate. A tax warrant is the authority under which a collector is authorized to collect taxes.

Numerous other warrants of a financial or commercial nature are also known to the American law. The term warrant is used to apply to an order or draft for the payment of an indebtedness. School warrants thus issue for the payment of an indebtedness incurred by a school board or district. Like a check or draft it is a conditional payment of the debt. Similarly there are municipal warrants, treasury warrants, State warrants, reclamation warrants, dividend or interest warrants of private corporations. Land warrants are transferable certificates issued by the Government entitling the holder to a specific tract of public land. A warrant of attorney is a writing addressed to one or more attorneys authorizing them to appear in court in behalf of the person who gives the warrant and confess judgment in favour of some particular person named in the warrant. They are commonly used to facilitate the collection of negotiable instruments and such a provision authorizing the confession of judgment on the note is commonly appended to the negotiable instrument. Some States by statute prohibit judgments by such confession. (J. M. LA.)

WARRANT OF ATTORNEY. A warrant of attorney to confess judgment is a security for money (now practically obsolete) in the form of an authority to a solicitor named by a creditor, empowering him to sign judgment in an action against the debtor for the sum due, with a clause that the warrant shall not be put into force in case of due payment.

WARRANTY, etymologically, another form of guarantee (*q.v.*). It is used, however, in a rather different sense. The sense common to both words is that of the collateral contract. A warranty expresses the collateral responsibility of the principal actor, while guarantee expresses that of his surety. It differs from a condition in that a condition forms the basis of the contract and a breach of it discharges from the contract, and from a representation in that the latter does not affect the contract unless made a part of it expressly, or by implication as in contracts of insurance and other contracts *uberrimae fidei,* or unless it be fraudulent. These distinctions are not always maintained. Thus in the Real Property act 1845, s. 4, condition seems to be used for warranty.

Warranty as it affected the law of real property was, before the passing of the Real Property Limitation act, 1833, and the Fines and Recoveries act, 1833, a matter of the highest importance. A warranty in a conveyance was a covenant real annexed to an estate of freehold, and either expressed in a clause of warranty or implied in cases where a feudal relation might exist between feoffor and feoffee. The warranty, as described by Littleton, s. 364b, 697, was an outgrowth of feudalism, and something very like it is to be found in the *Liber Feudorum.* At the time of Glanvill the heir was bound to warrant the reasonable donations of his ancestor. Warranty was one of the elements in Bracton's definition of homage, 78*b*, *"juris vinculum quo quis astringitur ad warrantizandum defendendurn et acquietandum tenentem suum in seisina versus omnes."* For an express warranty the word *warrantizo* or warrant was necessary. The word give implied a warranty, as did an exchange and certain kinds of partition. In order to bind heirs a clause of warranty was required. This was either lineal, collateral or commencing by disseisin. The feoffor or his heirs were bound by voucher to warranty or judgment in a writ of *warrantia chartae* to yield other lands to the feoffee in case of the eviction of the latter. Vouching to warranty was a part of the old fictitious proceedings in a common recovery in use for the purpose of barring an entail before the Fines and Recoveries act. Warranty is now superseded by covenants for title. The more usual of these are now by the Conveyancing act, 1881, deemed to be implied in conveyances. For the implied warranties of title and quality *see* SALE OF GOODS. Vouching to warranty was at one time important in the law of personalty as well as of realty. Warranty, as it exists at present in the law of personalty, is either express or implied. The principal cases of implied warranty occur in the contracts of sale and insurance. There is also an implied warranty in other kinds of contract; *e.g.,* of seaworthiness by the shipowner in a contract between him and a charterer for the hire of a ship. In all cases of implied warranty the warranty may be excluded by the special terms of the contract. For breach of warranty an action may be brought directly, or the breach may be used as ground for a counterclaim or for reduction of damages, but the breach will not in the case of a warranty proper entitle the person suffering by it to a rescission of the contract. Thus in a sale the property passes although the warranty be broken. In some cases warranties on sale are the subject of statutory enactments, as the merchandise marks acts and the sale of food and drugs acts.

Scotland. — Warranty is a term imported into Scots law in connection with mercantile law. Differing from the English interpretation it signifies a material condition of the contract, breach of which discharges from the contract in the option of the other party (see Sale of Goods act, 1893, ss. 53 [5] and 62 [1]). The term native to Scots law is warrandice. It occurs in connection with deeds transferring land or discharging obligations, and is in the form of a warranty by the grantor that his title is good. Warrandice is either real or personal. Real warrandice is that whereby warrandice lands are made over, as indemnity for those conveyed, to assure the person to whom they were conveyed from loss by the appearance of a superior title. Real warrandice is implied in excambion or exchange of lands. Its effect is that the excamber, in case of eviction, may recover possession of his original lands. Personal warrandice is either express or implied. There is an implied warrandice in every onerous deed. Express warrandice may be either simple, against the future acts of the grantor; from fact and deed, against the grantor's own acts whether past or future; or absolute, *i.e.*, against acts and deeds whether (1) of the grantor or (2) of a third prior to the date of the deed. A clause of warrandice is the Scottish equivalent of the English covenants for title. By the Titles to Land Consolidation (Scotland) Amendment act, 1869, a clause of warrandice in the form given in the schedule to the act imports absolute warrandice as regards the lands and the title deeds thereof, and warrandice from fact and deed as regards the rents.

United States. — In the United States the common law warranty accompanying the conveyances of real property seems never to have been known. Personal covenants of title were developed in its place and with greater vigour than in England inasmuch as purchasers were unaccustomed to examine titles with the particularity that is common in England. These covenants of title generally embrace the covenant of seisin or right to convey, the covenant against incumbrances, the covenant for quiet enjoyment and of warranty. This modern covenant of warranty, which is not recognized in England, is quite different from the common law covenant of warranty. Under this covenant the grantor warrants that he will defend the grantee against all lawful claims by third persons. In some states by statute these covenants are implied from the simple terms granting the estate; in other states by statute no such covenants are implied but must be express. The quitclaim conveyance ordinarily imports no covenants, but as altered by statute in some states it carries with it a covenant of title. In sales of personal property, warranties are governed by sec. 12–16 of the Uniform Sales act. Any affirmation of fact or promise by the seller relating to the goods and inducing the buyer to purchase them is regarded as an express warranty. In the absence of express warranties the buyer is protected by the implication of warranties of title and quality. In contradistinction to the English law of sale, rescission for breach of warranty is permitted. The buyer may tender back the goods and recover the purchase price. (See SALE OF GOODS.) Sec. 65 and 66 of the Uniform Negotiable Instruments law govern the character of warranties that accompany the transfer of negotiable instruments with or without indorsement. Warranty in insurance law operates to relieve the insurer of liability for breach thereof. Legislation commonly provides that no statements of fact made by the insured shall be regarded as warranties relieving the insurer of liability unless made with the intention to deceive or material to the risk.

WARRAU (WARRAUNAN or GUARAUNAN), an independent linguistic stock of South American Indians, mostly concentrated in the delta of the Orinoco river but also scattered through the coastal portions of British and Dutch Guiana (Surinam) as far east as the Coppename river. At one time they may have occupied part of Trinidad. The Warrau probably originally represented an early, simple cultural stratum whose culture was enriched before the European discovery by contact with neighbouring Arawak and Carib. Typical of the delta Warrau are rectangular pile huts raised above the water or swamp. Entire villages, with streets and plazas, were formerly constructed on a common platform of logs, resting on poles sunk into the mud or on the trunks of trees. Fishing is more important than hunting, and the Warrau are famous canoemen. Manioc is the staple cultivated food plant, with maize given a secondary place. Men go naked except for a penis sheath or string. Women wear aprons of palm fibre strings or of bark cloth. Both sexes remove all hair from face and body. Baskets are usually woven by men, as are also hammocks and cotton bands. Pottery is scarce and crude and reportedly is dried in the sun rather than fired. Plural wives are the rule. Both bride and groom are whipped as part of the marriage ceremony. The people are fond of music and dancing. and each settlement has its community music master. The important supernatural beings are: Abore, who invented all things; Korroremana, the creator of males; and the spirits of the forest, water and sky. Each village has a headman and also a shaman or medicine man. The latter is believed to control spirits whom he contacts while in a trance induced by drinking green tobacco juice.

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WARREN, SIR CHARLES (1840–1927), English soldier and archaeologist, was born at Bangor, Wales, on Feb. 7, 1840. In 1857 he entered the royal engineers. From 1861 to 1865 he was engaged in a survey of Gibraltar, but then went to Palestine where he became interested in archaeology. He conducted excavations at Jerusalem until 1870. and made for the Palestine Exploration fund the first systematic archaeological survey of the Holy Land. He published The Recovery of Jerusalem (1871), and, with C. R. Conder. The Survey of Western Palestine (1884). In 1876, on the outbreak of the Kaffir War, he commanded the Diamond Fields horse. He quelled an uprising in Bechuanaland, and in 1879. as administrator of Griqualand West he organized a force to defend the Transvaal. In 1884 he explored in Arabia Petraea, but before the year was over was again sent to South Africa to restore order in Bechuanaland. He proclaimed the territory south of the Malopo river a crown colony under the name of British Bechuanaland. He served in the Boer War as lieutenant general in command of the 5th division but after the British disaster at the Tugela river was transferred to an administrative post. He died at Weston-supermare, Eng., on Jan. 21, 1927. Among the more notable of his later books was *On* the Veldt in the Seventies (1902).

WARREN, EARL (1891–), 14th chief justice of the United States, is best known in the field of jurisprudence for his 1954 opinion declaring racial segregation in the public schools unconstitutional. Born on March 19, 1891, in Los Angeles, Calif., and raised in Bakersfield, he was educated in the Kern county public schools and at the University of California, Berkeley (B.L., 1912; J.D., 1914). He served successively as clerk for a state legislative committee (1919), deputy city attorney for Oakland (1919–20), deputy district attorney (1920–25) and district attorney (1925–39) for Alameda county and attorney general of California (1939–43). Elected governor of his native state for three terms (1943–53), Warren received wide popular support from both parties. Only once—in 1948 when he was the Republican candidate for vice-president — did he ever lose an election. He was named chief justice by Pres. Dwight D. Eisenhower in 1953.

In 1954 Warren spoke for a unanimous court in the school-segregation cases (Brown v. Board of Education, 347 U.S. 483), which are among the most important decisions in the court's history. "In the field of public education," Warren stated, "the doctrine of 'separate but equal' has no place. Separate educational facilities are inherently unequal." Other notable opinions by Warren included: Cooper v. Aaron (358 U.S. 1, 1958), reaffirming and explaining the school-segregation decisions; *U.S.* v. *Harriss* (347 U.S. 612, 1954), sustaining the constitutionality of the Federal Lobbying act; Quinn v. U.S. (349 U.S. 155, 1955) and *Watkins* v. *U.S.* (354 U.S. 178, 1957), protecting the rights of witnesses before congressional investigating committees; Pennsylvania v. *Nelson* (350 U.S. 497. 1956) barring enforcement of state sedition laws that duplicate federal legislation on the same subject; and Trop v. *Dulles* (356 U.S. 86, 1958), invalidating a federal statute revoking the citizenship of deserters from the armed forces. Although voting often in support of government (*e.g.*, antitrust) regulation in the economic area, Warren also showed a marked sensitivity to claims of governmental infringement of civil liberties. Accused by some of a disregard for precedent and a proneness to sweeping liberal judgments, he was hailed by others as a courageous leader seeking to adapt legal rules to rnodern conditions in the light of moral considerations. (E. E. P.)

WARREN, GOUVERNEUR KEMBLE (1830–1882), U.S. army officer in American Civil War, was born at Cold Spring, N.Y., on Jan. 8, 1830. After graduating from West Point in 1850, he became an engineer officer, served on mapping and lndian expeditions, and was appointed assistant professor of mathematics at West Point in 1859. When the Civil War broke out, he joined the 5th New York volunteers, with whom he fought at Big Bethel. Promoted to brigadier general in 1862 for distinguished service on the peninsula, he took part in the second battle of Bull Run, Antietam and Chancellorsville. In 1863 he was named chief engineer of the army of the Potomac. His greatest moment came at the battle of Gettysburg, where he commandeered Vincent's brigade just in time to occupy the vital summit of Little Round Top, an exploit which probably saved the day for the Union. In 1864 and 1865, he ably commanded the 5th corps at the Wilderness and Spotsylvania, Cold Harbor and Petersburg, but, after the battle of Five Forks, was relieved by Gen. Philip H. Sheridan for alleged dilatoriness. A court of inquiry completely exonerated him in 1881–82. Warren was an efficient officer who displayed initiative at crucial moments. He died at Newport, R.I., Aug. 8, 1882.

See Emerson Gifford Taylor, *Gouverneur* Kemble *Warren (1932).* (H. L. T.)

WARREN, JOSEPH (1741–1775), U.S. soldier and patriot, born at Roxbury, Mass., June 11, 1741. He graduated at Harvard college in 1759, studied medicine at Boston, and soon acquired a high reputation in his profession. The passage of the Stamp act aroused his patriotic sympathies and brought him in close connection with Samuel Adams. John Adams and Josiah Quincy, Jr., as a leader of the popular party. He drafted the "Suffolk Resolves," which urged forcible opposition to Great Britain, if such should be necessary, pledged submission to such measures as the Continental Congress might recommend, and favoured the calling of a provincial congress. These resolves were unanimously adopted by a convention at Milton (*q.v.*) on Sept. 9, 1774. Warren was a member of the first three provincial congresses (1774–75), president of the third, and an active member of the committee of public safety. On June 14, 1775, he was commissioned a major general, but three days later, and before his commission was made out, he took part as a volunteer, under the orders of Putnam and Prescott, in the battle of Bunker Hill (Breed's Hill), where he was killed.

WARREN, ROBERT PENN (1905–), U.S. writer best known for his novels, was born in Guthrie, Ky., on April 24, 1905. In 1921 he entered Vanderbilt university in Nashville, Tenn., intending to study science, but after meeting Donald Davidson and John Crowe Ransom he turned to literary studies, joining the group of poets called the "Fugitives." Later he was associated with the "Agrarians," being one of the contributors to their I'll *Take* My *Stand* (1930).

Warren graduated from Vanderbilt in 1925, took an M.A. at the University of California, Berkeley, in 1927, did further graduate study at Yale, 1927–28, and took a bachelor of literature in 1930 at Oxford, where he was a Rhodes scholar. From 1930 to 1957 he taught at Southwestern college at Memphis, Tenn., Vanderbilt university, Louisiana State university, Baton Rouge, the University of Minnesota. Minneapolis, and Yale university. With Cleanth Brooks he edited the influential *Southern Review* (1935–42) and several widely used textbooks (including *Understanding Poetry).*

Warren's poetry includes *Selected Poems, 1923–1943* (1944), *Brother to Dragons* (1953) and *Promises* (1957; Pulitzer prize for poetry, 1958). *The Circus in the Attic* (1948) is a collection of short stories. His novels include *Night Rider* (1939), *At Heaven's Gate* (1943), *All the King's Men* (1946; Pulitzer prize for fiction, 1947), *World Enough and Time* (1950), *Band of Angels* (1955) and *The Cave* (1959). He collected some of his critical pieces in *Selected Essays* (1958). In most of Warren's work, whether in verse or prose, there are vigorous handling of southern subject matter, technical virtuosity, symbolical intensity and a religious attitude that might be called neo-Calvinistic. (R. St.)

WARREN, a city of Ohio, U.S., on the Mahoning river 15 mi. N.W. of Youngstown; the seat of Trumbull county. The population in 1960 was 59.648. (For comparative population figures see table in OHIO: *Population*) Warren is a central city of the Youngstown-Warren standard metropolitan statistical area (*see* YOUNGSTOWN). It was founded in 1799 by Ephraim Quinby of Washington, Pa., a stockholder in the Connecticut Land company, mhich in 1795 had purchased from the state of Connecticut, for $1,200,000, about 3,000,000 ac. of land in that portion of the present state of Ohio retained by Connecticut when it ceded its western lands to the federal government in 1786—an area known historically as the Western Reserve. For $1,625 Quinby purchased 441 ac. from the company and founded the settlement which he named for Moses Warren, a surveyor for the company. In 1800, upon the organization of Ohio territory, the entire Western Reserve was attached to it, as Trumbull county, and in 1803 Warren became the county seat. (The modern Trumbull county is greatly reduced in area, several other counties having been formed subsequently.) Warren was incorporated as a village in 1334 and as a city in 1869. It became a port in 1840 upon completion of the Pennsylvania and Ohio canal from Pittsburgh to Akron (nhere it connected with the Ohio and Erie canal); the canal mas used until the mid-1850s, by which time it was replaced by railroads. Modern transportation facilities also include the Ohio turnpike and the Youngstown municipal airport, both of which are within 9 mi.

Iron, steel and electrical products are leading industries. W. D. and J. W. Packard produced early electric lamps and the Packard automobile there. Packard Music hall in the city is a centre of culture and entertainment. Dana's Musical institute, founded in Warren in 1869, was moved to Youngstown and became a part of Youngstomn university in 1941. (N. W. AD.)

WARRINGTON, a market town, municipal (1847), county and parliamentary borough of Lancashire, Eng., 18 mi. W.S.W. of Manchester on the north bank of the Mersey and the Manchester Ship canal. Pop. (1951) 80,694. Wilderspool, south of Warrington was a walled town of the Romans. In the Domesday survey the Warrington hundred consisted of nearly ten hides of land and covered several parishes. The manor and hundred were granted to Paganus de Vilars, the first lord of Warrington. William le Boteler obtained the first royal charter to hold a fair in 1255. For nearly 700 years the town has had two weekly markets, and two annual fairs held in July and November. Hermit friars of the order of St. Augustine established a friary there toward the end of the 13th century. Warrington declared for the king during the Civil War but surrendered in 1643. In 1648 the Scots under the duke of Hamilton surrendered to Cromwell in the town. In 1651 the Scottish army, commanded by King Charles II, was defeated at Warrington bridge. A grammar school, established by Sir Thomas Boteler in 1526, was controlled by the local education authority after 1933 and new premises were opened in 1940. A bluecoat school mas founded in 1665. The Warrington academy was established in 1757 to provide education for dissenters who were debarred from entry to established universities. Its tutors included Joseph Priestley (*q.v.*) and John Aiken, Warrington circulating library, founded in 1760, formed the nucleus of the Warrington municipal library founded in 1848; it was the first English library supported by local rates. Bank park, purchased by the corporation in 1872, surrounds Bank hall, an 16th-century building now the tonn hall. St. Elphin's church (Decorated style) has a lofty central tower and spire and the crypt of a much earlier church beneath the chancel. Warrington manufactures iron, steel, metal and nire products, leather and cotton goods, paper products. chemicals, soap, gas stoves and fork trucks. It has large engineering works and breweries.

WARKISTON, ARCHIBALD JOHNSTON, LORD (1611–1663), Scottish judge and statesman, son of James Johnston. was baptized on March 28, 1611, educated at Glasgow and passed advocate at the Scottish bar in 1633. In 1637 he drew up the remonstrances of the Covenanting leaders against Charles I's attempt to force the English liturgy upon Scotland and. with Alexander Henderson, was a principal author of the National covenant of 1638. In June 1639 he took part in the negotiations leading to the treaty of Berwick. when his firm attitude displeased the king. He was appointed in 1640 to attend the general of the army and the committee and on June 23 wrote to Lord Savile asking for definite support and the acceptance of the National covenant by the leading opposition peers in England. In October he was a commissioner for negotiating the treaty of Ripon. In 1641 he led the opposition on the point of control of state appointments during the king's visit to Scotland.

In accordance with the king's short-lived policy of conciliation Johnston was appointed a lord of session. Nov. 13, 1641, with the title of Lord Warriston. and was knighted and given a pension. In the same month the parliament appointed him a commissioner at Westminster for settling the affairs of Scotland, and he was later (1643) made a member of the committee of both kingdoms, which directed the military operations. Early in 1644 he took his seat in the Assembly of Divines, where he was strongly opposed to independency and to lay control in ecclesiastical affairs. He was also member for Edinburgh in the Scottish parliament (1643–47) and speaker of the barons. In Oct. 1646, Johnston was made king's advocate after Charles had surrendered himself to the Scots. In 1648 he became the leader of the Remonstrants, the party opposed to the "engagement" concluded by the predominant party with Charles at Carisbrooke. (See ENGLISH HISTORY.) In October, after the defeat of the "engagers" at Preston he met Cromwell at Edinburgh and helped to promote the Act of Classes (Jan. 23, 1649), disqualifying royalists; but after the king's execution good 'relations with Crornwell were broken off, and Johnston was officially present at the proclamation of Charles II as king in 1649 at Edinburgh. On March so, he was appointed lord clerk register; in May 1650 he pronounced sentence on the earl of Montrose. After the defeat of Dunbar (Sept. 3, 1650) at which Johnston was present, he urged the removal of David Leslie from the command, and on Sept. 21 delivered a violent speech in Charles's presence attributing all the troubles to the opposition of the Stuarts to the Reformation.

Johnston now committed himself to the faction of the Remonstrants who desired to exclude the king and whom he represented in London in 1656. On July 9, 1657, he was restored by Cromwell to his office of lord clerk register, and on Nov. 3 was made a commissioner for the administration of justice in Scotland. He sat in the upper chamber of Cromwell's parliament (Jan. 1658) and of Richard Cromwell's parliament; and on the latter's abdication and the restoration of the Rump, he was chosen a member of the council of state and continued in the administration as a member of the committee of public safety.

At the Restoration he escaped abroad and was condemned to death in his absence (May 13, 1661). In 1663 he was discovered at Rouen and with the consent of Louis XIV was brought over and imprisoned in the Tower. Taken to Edinburgh in June and confined in the Tolbooth, he was hanged at the Market Cross on July 22. His head was exposed on the Netherbow and afterward buried with his body in Greyfriars churchyard.

Johnston was a man of energy. His devotion to the Scottish Church amounted to fanaticism. He had by nature no republican leanings. When, however, Presbyterianism was attacked, he desired, like Pym, to restrict the royal prerogative. His acceptance of office under Cromwell hardly deserves the censure it has received. But in his dying speech he condemned the act as a fault which he had committed in order to provide for his numerous family. Johnston was wanting in consideration for his opponents. He was hated by Charles I, whose statecraft was vanquished by his inflexible purpose, and by Charles II, whom he rebuked for his dissolute conduct.

See W. Morison, *Johnston of Warriston* (1901); *Diary of Sir A. J. Warriston, 1650–54, ed. by D.* H. Fleming (Scottish Hist. Soc., 1919).

WARRNAMBOOL, seaside and tourist resort in Villiers shire, Victoria, Austr., 165 mi. S.W. by rail from Melbourne. Pop. (1961) 15,697. The town first became important as a port for exporting the products, mainly agricultural, of the closely settled hinterland. Later its wide streets, fine buildings and parks and commanding position on the coast made it popular as a resort. The surrounding district produces wool, wheat, potatoes and dairy products.

WARSAW (Polish WARSZAWA), *wojewodztwa* (province) of Poland. Area 11,353 sq.mi. Pop. (1960) without the city of Warsaw, 2,314.800. The province of Warsaw. formerly the principality of Mazovia, is situated in the great central plain and drained by the Vistula and its affluents. In the north the Baltic uplands begin; in the south the province includes part of the southern plateau. The plain is sandy and not very fertile and suffers much from the periodic inundations of the Vistula, particularly near the confluence of the Bug and Narew. Thrifty Mazovian peasants, however, prosecuted the cultivation of the soil with considerable success. The principal crops are rye, oats, barley, wheat and potatoes, while beetroot is cultivated for sugar in some areas. Gardening and beekeeping are also practised. There are large forests, particularly in the north where there are also wide marshes, especially on the Wkra near Mlawa. The shipping of the Vistula is an important occupation, as are the agricultural industries: flour milling, distilleries, breweries and sugar factories. Saw mills and match factories and especially tanneries also became important. There is an important industrial area including the metal industries, the manufacture of machinery, locomotives and other goods at Warsaw and the textile manufactures of Zyrardów, forming a link between Warsaw and Lodz.

The chief towns are Warsaw (*q.v.*), Plock (pop. [1960], 42,000), Wloclawek (pop. [1960] 63,000), Zyrardów, Gostynin, Grojec, Plonsk, Radzymin, Sochaczew, Ciechanow, Wlochy, Mlawa, Pultusk and Przasnysz.

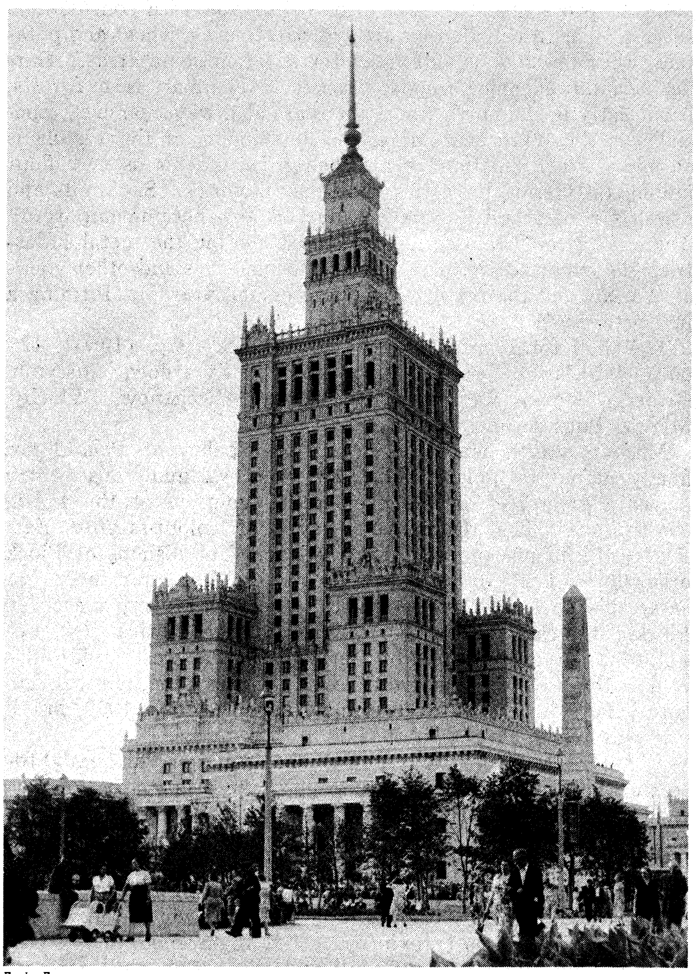
Mazovia was a semi-independent principality of Poland not finally united to Poland till 1529, when its numerous gentry played a great part in the democratic evolution of the Polish constitution. The region sent waves of colonists into East Prussia, Lithuania and even the Ukraine. The bishops of Plock originally had all Mazovia as their diocese, but later there was an archbishopric at Warsaw, which in the 16th century succeeded Plock as the capital city. Warsaw became the political centre of Poland when the advance of Germany in the west and Polish colonization of Lithuania and the Ukraine threw the political centre of the state eastward. Germany occupied it in 1939, but it was returned to Poland in 1945.

WARSAW (Polish WARSZAWA), the capital of Poland and the seat of the Roman Catholic archbishop (the primate of Poland), is situated on the Vistula. The capital's greater part lies on the left bank, on the terrace rising about 360 ft. above sea level and 105 ft. above the river which there has a breadth of 450 to 650 yd. The two parts of the town are connected by three road and two railway bridges. The area of the city, which ranks as a separate *wojewodztwo* (province), rose from 46 sq.mi. to 54 sq.mi. between 1920 and 1939; after World War II it was increased to 172 sq.mi. Pop. (1939 est.) 1,289,000; (1945 est.) 153,000; (1950) 803,888; (1960) 1,136,000.

Although a great part of the Warsaw that existed before 1939 was destroyed in World War II, it was rebuilt by the 1950s on the skeleton of its old streets and avenues. The medieval Stare Miasto (old town), with its picturesque market place and narrow streets. and the 14th-century Gothic cathedral of St. John, was faithfully reconstructed as it had been and so mas the main thoroughfare running southward. The central point of old Warsaw was the royal castle (Zamek) situated between the old town and the Vistula. Built by the dukes of Mazovia, enlarged by Sigismund II Augustus and Sigismund III Vasa. embellished by Stanislaw II Poniatowski. it was destroyed by the Germans in 1944. In Castle square stands Warsaw's finest monument, the column of King Sigismund III Vasa. erected in 1043 and re-erected in 1949.

At this point begins Krakowskie Przedmiescie (Cracom boulevard). the most imposing thoroughfare of the city, dating back to the 15th century and lined by palaces and churches. The oldest is

St. Anne's (1454), where the Gothic style is harmoniously blended with the baroque. Three other notable churches of Cracow boulevard are the Carmelites' (1672). which is baroque with a stone façade; the church of the Order of Visitation (1728–61), with the most beautiful rococo interior in Warsaw; and the Holy Cross church (1682–1757), containing the heart of Frédéric Chopin. Among the palaces of Krakowskie Przedmiescie the largest is that of the council of ministers. built in 1643 and rebuilt in neoclassic style in 1818. Further on is the University of Warsaw (1818) in the former Casimir palace. At the southern end of the boulevard stands the neoclassic Staszic palace) built by Antonio Corazzi (1822), housing scientific institutions. In the front of Staszic palace stands the monument of Nicolaus Copernicus, the famous Polish astronomer, by B. Thordwaldsen (1830). In the same boulevard is the monument of Adam Mickiewicz, Poland's greatest poet, by Cyprian Godebski (1898).



P. I. P.

PALACE OF SCIENCE AND CULTURE (1951–55), WARSAW

Nowy Swiat (New World) street (18th- and early 19th-century with houses in neoclassic style), is the continuation of Krakowskie Przedmiescie. Further south it becomes Ujazdow avenue, Warsaw's Champs-Elysées, laid out in 1731, with 19th-century residences now housing many embassies. At the end of the avenue stands Belweder (Belvedere) palace, built in the 17th century and reconstructed in 1822 in classic style. This palace's garden is contiguous with Lazienki park—the pride of Warsaw—formerly a royal hunting grounds. In the middle of the park stands Lazienki palace (1784–93), built by Stanislaw II Poniatowski, a masterpiece of Polish classicism. with an open-air theatre. It contains the monuments of John III Sobieski (1788) and Prince Joseph Poniatowski. by Thordwaldsen. The last-named is a replica in bronze of the original which stood in the Saxon square but was destroyed by the Germans in World War II. The replica was a gift of the citizens of Copenhagen. A monument to Chopin (by Waclaw Szymanowski) in the Ujazdow avenue, destroyed by the Germans in 1940, was recast and unveiled in May 1958.

Parallel to Ujazdow avenue is Marszalkowska street, a central business thoroughfare with a new residential district: Constitution square (1952) and the Palace of Science and Culture (1951–55). This palace, with a congress hall for 3.000, museums, exhibition galleries, two theatres and a motion-picture theatre, is also the seat of the Polish academy of sciences. A gift of the U.S.S.R., it has 30 stories and is 757 ft. high. While the first thoroughfare, with its three successive names, looks almost exactly as it was before World War II, Marszalkowska street is modern in appearance.

There are two main west–east thoroughfares. One is Jerusalem avenue connecting the former suburb of Praga, on the right bank of the Vistula across the Poniatowski bridge (1913), with the main railway station. The other, more to the north, is General Swierczewski street (1949) connecting the centre of the city, by way of a 200-yd. tunnel and the Slasko-Dabrowski (formerly Kierbedz) bridge, with Praga. In Jerusalem avenue stands the National museum. with galleries of Polish and other European paintings and collections of decorative art. ,It is the most important of Warsaw's 1j museums. At the point where Jerusalem avenue crosses Nowy Swiat stands the big building of the central committee of the Polish United Workers' party (1948–51).

Among other palaces worth noting are: the Primate's palace, built in 1605 and rebuilt in classic style; Krasinski palace (1676–95), Warsaw's finest baroque building; Ostrogski palace (159j and 1690), now housing the Chopin institute; and the former treasury buildings (1825), by Corazzi, now the,town hall. There are 17 theatres including the opera house, the Polish theatre (1913) and the National theatre, the tradition of which dates back to 1765. Grand theatre (1825–32), another work of Corazzi, with imposing classic porticoes, was destroyed by the Germans in 1939, but was reconstructed in the 1950s. Saxon gardens (1725) in the city's centre, is Warsaw's oldest public gardens, adorned with sculptures. Contiguous to it is Saxon (now Victory) square with the tomb of the Unknown Soldier (1923). In the middle of the former Jewish quarter of Muranow stands the monument of the Heroes of the Ghetto (1947), commemorating the Jewish rising against the Nazis in 1943. Besides the university, Warsaw has a school of engineering or Politechnika (1902), schools of commerce (1906), a school of agriculture (1906) and academies of medicine, arts and sciences.

In the southern outskirts is the baroque rural seat of John III Sobieski, Wilanow (1674–92), built in a fine baroque style by Augusto Locci. After World War II a monument of Sobieski was moved there from Lwow, now in the U.S.S.R. The Zoological gardens (1928) are on the right bank of the Vistula. The city also has seven sports stadiums, with a huge Decennium stadium (1955) for 80,000 spectators, built on the right bank, near Poniatowski bridge. There are seven railway stations in the town which is connected by six trunk lines with Vienna, Berlin, Danzig, Leningrad. Moscow and Kiev. Two long-distance lines (to Lodz and to Gliwice in Silesia) were electrified in 1957. The airport of Okecie, $4\frac{1}{4}$ mi. south from the city's centre, has direct permanent communications with ten European capitals and the seven biggest Polish cities. There is also a river port at Zeran.

Warsaw's industrial establishments suffered enormous destruction in 1939–44, but postwar reconstruction and development changed the city into one of the important industrial centres of the country. There are foundries and steelworks. automobile, motorcycle and tractor factories, electrical. pharmaceutical 'and chemical industries, printing works and factories for ready-made clothes and food products. The tailors and the famous Warsaw shoemakers that, before World War II, were the most numerous of the several thousand small shops where articles were made by hand, regained their importance after 1957.

History.—Warsaw became a city at the turn of the 13th and 14th centuries. It was protected by walls with two gates and a number of towers. There was also a small castle, the seat of the local castellany. As early as 1339 Warsaw was an important town, a papal tribunal being held there during a dispute between the

Polish cronn and the Teutonic order. In the middle of the 14th century it became the capital of the duchy of Mazovia (Mazowsze). In 1526 Warsaw together with Mazovia was incorporated into the Polish crown. In 1568 the first permanent bridge was built across the Vistula and the town became an important trade centre between Poland and Lithuania. On March 16, 1596, by decision of King Sigismund III, it became the capital of Poland and the royal seat. It had then 15,000 inhabitants. Numerous palaces and residences were built and new fortifications erected. In 1655–56 the town was destroyed and burned by the Swedish army of Charles X Gustavus but rapid reconstruction followed during the reign of John III Sobieski. At the beginning of the 18th century it suffered great economic losses, increased by pestilence during the War of the Polish Succession. Under the Saxon (Wettin) kings reconstruction was planned along the main wide thoroughfares running south of the old town. The greatest development in many fields followed during the reign of Stanislaw II Poniatowski, the last king of Poland. when planned quarters were laid out, such as Zoliborz in the north, Ujazdow in the south and the splendid park of Lazienki.

The citizens of Warsaw took an active part in the political life of the country, especially during the great reforms of the "four years' *sejm*" which on May 3, 1791, voted the parliamentary constitution. In April 1794 the people of Warsaw led by Jan Kilinski, a master shoemaker, helped the Polish troops liberate the town from Russian occupation and subsequently heroically defended it against the joint siege of Russians and Prussians. On Nov. 2, the suburb of Praga was burned and its population massacred by Russian troops under Gen. A. V. Suvorov. During 1796–1806 Warsaw fell under Prussian occupation and the number of inhabitants sank from 116,000 to 65,000. .Liberated by Napoleon it became in 1807 the capital of the duchy of Warsaw and in 1815 the capital of the "Congress" kingdom of central Poland under the emperor of Russia as king of Poland.

The period 1815–30 was one of growth and also of a notable industrial development. Protesting against political oppression, Warsaw gave, on Nov. 29, 1830. the signal for an insurrection against the Russians and became the centre of the movement until its suppression by Field Marshal I. F. Paskevich, after the heroic defense of the city by Gen. Jozef Sowinski in the suburb of Wola (Sept. 6. 1831). The Russians built a fortress (1832–33) on the left bank of the Vistula directed against the city and serving also as the state prison. The ruinous cost of its construction fell upon the inhabitants. The last remains of political self-government were destroyed during this time: the university and the Warsaw Scientific society were closed. Economic improvement began during the mid-19th century when railway connections with Cracow, Vienna, Berlin and St. Petersburg were established. There was also an increase in trade with Russia. During 1860–62, however, Warsaw was again the scene of mass demonstrations against Russia, which were followed on Jan. 22, 1863, by another insurrection. In spite of the intense russification following the crushing of this insurrection, the city's economic and cultural life developed rapidly. In 1872 it had 276,000 inhabitants. It became an important railway junction and intermediary for the trade between Russia and the west. After 1875 the town was encircled by a belt of fortifications, blocks of flats were built and a water supply and drainage system were planned and executed by an Englishman, William Lindley. Its population rose in 1903 to 756,400. In 1905 Warsaw again witnessed a powerful revolutionary movement. Ten years later, on Aug. 5, 1915, during World War I, the Russians left the town taking with them the machinery from the factories. The German occupation that followed was a period of unemployment and misery.

On Nov. 11, 1918, Warsaw became the capital of the restored Polish state and government offices, scientific and cultural institutions were reinstated. In Aug. 1920 Warsaw played an important part in holding back Soviet troops and winning a decisive battle at Radzymin, 10 mi. northeast of the city. According to the 1931 census, 66 8% of Warsaw's 1,158,914 inhabitants were Roman Catholics, and 30.2% of the Jewish faith; 70.5% used Polish as their mother tongue while 28.4% were Yiddish-speaking.

From the very first day of World War II Warsaw was subject to air bombing by the Germans. The damage of the first week increased to an appalling extent during the siege which began on Sept. 8, 1939. A week later Gen. Julian Rommel, the military commander of Warsaw, rejected the demand for capitulation. Stefan Starzynski, the mayor of Warsaw, who had done a great deal for the city in restoring old buildings and erecting new ones, became the soul of the resistance. Warsaw was faithful to the motto of its coat of arms:. *Contemnit procellas* ("Defying the storms"). On Sept. 27, Warsaw—without ammunition, food, water and light—capitulated, The Germans entered the city with Hitler on Oct. 1. During the Nazi occupation of 1939–44 German authorities persecuted the inhabitants and carried tens of thousands of them (mostly the intelligentsia) to their camps of death. mainly to that of Oswiecim (Auschwitz). Thousands of patriots were tortured to death in prisons. A closed ghetto was established (1940) and about 450,000 Jews were crowded there and then carried away to be murdered in extermination camps. On April 19, 1943, an uprising broke out in the ghetto; it was suppressed by the Germans after three weeks' struggle and the ghetto was erased from the earth. In 1940–44 Warsaw was the main centre of the Polish movement of resistance and a great number of clandestine newspapers appeared. In their campaign against Polish culture the Nazis destroyed monuments, closed the theatres, libraries and scientific institutions.

On Aug. 1, 1944, when the Soviet armies were approaching Warsaw, an uprising broke out in the town and street fighting, carried on mostly by young boys and girls. lasted more than two months. About 100,000 persons were killed or murdered by S.S. troops and on Oct. 2 Gen. Tadeusz Bor-Komorowski. the Polish commander, was forced to lay down his arms. A great part of the inhabitants were transported to camps in Germany, the remainder being expelled from the town. The Germans then started the methodical destruction of the city. They blew up the ancient Royal castle, burned the palaces, churches, museums, libraries and blocks of flats. Praga, on the right bank of the river, was saved from complete destruction by being taken on Sept. 14 by Soviet troops. On Jan. 17, 1945, the empty ruins of Warsaw were liberated by the Soviet army under Marshal K. K. Rokossovsky, including some Polish units. The population rapidly flocked back to the ruins to start a new life in primitive conditions, and large-scale reconstruction was begun with the help of the whole country.

From Oct. 19 to 21, 1956, Warsaw was the theatre of yet another, and this time bloodless historic upheaval, namely the return to power of Wladyslaw Gomulka, a Communist and national leader.

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WARSAW TREATY ORGANIZATION, the name usually given to the unified military command established by the U.S.S.R. and its satellite states in eastern Europe through the signing of the Warsaw treaty on May 14, 1955. The treaty was a 20-year mutual-defense pact between the U.S.S.R., Albania, Bulgaria. Czechoslovakia, east Germany, Hungary, Poland and Rumania. Marshal Ivan S. Koniev, deputy defense minister of the U.S.S.R., who had led the 2nd Ukrainian army against Germany in 1943–45, became the commander of the unified forces. The agreement provided not only for a unified military command but also for the maintenance of Soviet army units on the territory of the other participating states. The United States government estimated that the Warsaw pact nations' armies included about 6,000,000 men, made up of between 175 and 225 Soviet divisions and 80 satellite divisions.

The Warsaw treaty was one of the first steps taken by Nikita S. Khrushchev and Nikolai A. Bulganin, after their assumption of power early in 1955, to strengthen the Soviet hold over the satellite area following the limited concessions of the preceding regime of Georgi M. Malenkov. The immediate occasion was the Paris agreement between the western powers to admit west Germany to the North Atlantic Treaty organization (*q.v.*), the formal induction of west Germany as a NATO member having occurred on May 9.

As usual in Soviet propaganda moves, the Warsaw treaty began with a declaration of peaceful motives. The signatory parties agreed, in accordance with the principles of the UN charter, to abstain from violence or the threat of violence in international relations. But the remilitarization of west Germany authorized by the Paris agreements, according to Soviet pronouncements. posed a threat to the national security of peace-loving states and required a defensive counteraction. A further indication of the fact that the Warsaw treaty was also a lever to enhance the bargaining position of the U.S.S.R. in European diplomacy was the concluding article of the treaty, which stipulated that the agreement would lapse when a general east-west collective-security pact should come into force. In July 1955, the U.S.S.R. proposed the dissolution of both NATO and the Warsaw Treaty organization in favour of an all-European security system to include the United States. See GENEVA SUMMIT CONFERENCE (1955).

The rebellions in Poland and Hungary in 1956 both involved nationalist hostility to the terms of the Warsaw treaty. Unrest and popular resentment against extensive Soviet interference in Polish local affairs. together with the presence of many Russian advisers in Polish political and economic administration, came to a head under the leadership of the Polish Communist Wladyslaw Gomulka. As premier he secured the uithdrawal of Soviet troops to the frontier and halted Polish uprisings as well. In Hungary a similar widespread opposition to the presence of Russians flared into open revolt after the successful Polish example. The Hungarian Communist Imre Nagy became premier, and also denounced the Warsaw treaty. Soviet leaders appeared willing to revise the Warsaw treaty with respect to the provision for Soviet garrisons in satellite countries. But Nagy failed to halt continued violent Hungarian attacks on the retiring Soviet troops, which were then reinforced and turned to crush the rebellion, thereafter remaining in Hungary

In Dec. 1957 rumours circulated that the Warsaw pact nations had agreed on increased armaments if west Germany accepted nuclear weapons or bases as a NATO member. The Warsaw Treaty organization, in short. served a double purpose: it became an instrument of Soviet efforts to check the expansion of NATO and to justify the maintenance of garrisons and bases close to NATO territories; at the same time Soviet garrisons were designed to inhibit new outbreaks of "counterrevolutionary" action in the satellites, as Khrushchev intimated in an April 1958 speech in Czechoslovakia. (G. B. C.)

WART is the name for different kinds of benign growths of the skin and adjacent mucous membranes, all having an uneven, rough, cornified "warty" surface. The common warts average the size of a split pea, and usually occur on fingers, backs of hands, palms and soles. They are caused by a filterable virus which after invading the skin may stay latent for several months before the wart develops. The contagion spreads and often. a few months after its onset, dozens of warts are present in the infected area. Common warts spread from person to person by direct contact, possibly also from contact with contaminated objects (*e.g.*, gymnasium floors). Interestingly, in some cases this infectious gron th can be cured by suggestive psychotherapy; hence the success of charms and other superstitious procedures in curing warts. The flat juvenile warts are smaller, flatter, less uneven on the surface and spread more rapidly than common warts. The face and extremities of children are often densely covered with hundreds of these unsightly tiny lesions. This condition, too, is a contagious disease of viral origin. So-called venereal warts develop in the male or female genital region when this region is kept moist by some discharge. Venereal warts are conical pointed elevations shooting up close to each other. By confluence they may form profuse cauliflowerlike vegetations. They are contagious but not necessarily acquired by sexual intercourse. They are caused by the same virus as common warts.

Seborrheic warts occur on the trunk of adults. They are flatly elevated, have a friable greasy top and darken to brown or even black as they grow to the average size of a nickel Their cause is unknown. Neither of these mart varieties is likely to degenerate into cancer, but expert knowledge. and in some cases microscopic examination, is required to differentiate them from the much more serious premalignant lesions. Treatment of warts is different according to type, size and localization, and should never be undertaken by a layman. Many popular methods of treatment cause ugly and unnecessary scarring. (S. RON.)

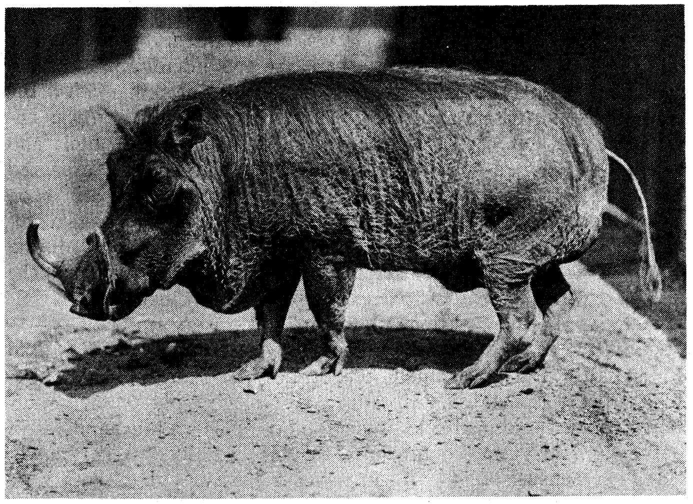
WARTA or WARTHE, a river of Poland and Germany, and the chief affluent of the river Oder. It rises in the Carpathian mountains. Its total length is 473 mi, and it is navigable up to Konin in western Poland, a distance of 265 mi. Its banks are mostly low and flat. its lower course especially running through drained and cultivated marshes. It is connected with the Vistula through its tributary the Notec and the Bydgoszcz canal. The area of its drainage basin is 20,737 sq.mi.

WARTBURG, THE, a castle near Eisenach in the former grand-duchy of Saxe-Weimar. It is magnificently situated on the top of a precipitous hill, and is remarkable not only for its historical associations but as containing one of the few well-preserved Romanesque palaces in existence. The original castle. of which some parts—including a portion of the above-mentioned palace—still exist, mas built by the Landgrave Louis "the Springer" (d. 1123), and from his time until 1440 it remained the seat of the Thuringian landgraves. Under the Landgrave Hermann I, the Wartburg was the home of a boisterous court to which minstrels and "wandering folk" of all descriptions streamed; Walther von der Vogelweide and Wolfram von Eschenbach both refer to the noise and constant crush of crowds passing in and out at the Wartburg "night and day"; and it was there that in 1207 took place the minstrels' contest (Sangerbrieg) immortalized in Wagner's *Tannhäuser.* Some years later it became the home of the saintly Elizabeth of Hungary (see **ELIZABETH.** SAINT) on her marriage to Louis the Saint (d. 1227), to whom she was betrothed in 1211 at the age of four.

Wagner, with a poet's licence, has placed the Sangerkrieg during Elizabeth's residence at the Wartburg. It was to the Wartburg, too, that on May 4, 1521, Luther was brought for safety at the instance of Frederick the Wise, elector of Saxony. and it was during his ten months' residence there that he completed his translation of the New Testament. From this time the castle was allowed gradually to decay. It was restored in the 18th century in the questionable taste of the period; but its subsequent magnificence it owed to the Grand-Duke Charles Alexander of Saxe-Weimar. with whom it was a favourite residence.

WARTHE: see WARTA

WART HOG, the designation of certain hideous African wild swine (see SWINE), characterized by the presence of large warty protuberances on the face and the large size of the tusks in



BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

WART HOG (PHACOCHOERUS AETHIOPICUS)

both sexes. Frequently the adults have no incisors, and nearly bare skins except for a mane along the back which may be long. Two forms are recognized, the southern *Phacochoerus ae aethiopicus,* which formerly ranged as far south as the Cape, and the northern *P. ae africanus,* which extends to the mountains of Abyssinia. In south and east Africa wart hogs frequent open country near water and dwell in holes. In Abyssinia, they spend the day among bushes or in ravines, feeding at night. They are active and wary.

WARTON, JOSEPH (1722–1800), English critic and poet and forerunner of the Romantic poets, was born at Dunsfold, Surrey, in April 1722, the eldest son of Thomas Warton, the elder (*c.* 1688–1745). Educated at Winchester, where he became a friend of William Collins, and Oriel college, Oxford, he took orders and was subsequently rector of Winslade and Tunworth and prebendary of St. Pauls and Westminster. In 17jj he returned to Winchester as a master, becoming headmaster in 1766. In 1793 he retired to Wickham, Hampshire, where he held a living until his death there on Feb. 23. 1800.

Though lacking Collins' genius, Warton shared his impatience with the didactic temper of the poetry of the time, as is shown by *The Enthusiast, or the Lover of Nature* (1744). In the preface to *Odes on Various Subjects* (1746) he declares that "the fashion of moralizing in verse has been carried too far" and that invention and imagination are the chief faculties of the poet. His *Essay on the Genius and Writings of Pope* (vol. 1, 1756 and vol. 2, 1782) which claimed that Pope's poetry is of second rank because moral and ethical verse is essentially inferior, was regarded as revolutionary, especially by Samuel Johnson, a fellow member of the Literary club. whom Warton had the temerity to contradict publicly. In 1797 Warton published Pope's works in nine volumes.

WARTON, THOMAS (1728–1790), English poet laureate, was a son of Thomas Warton, vicar of Basingstoke and professor of poetry at Oxford. He was born on Jan. 9, 1728. In a poem written in 1745 he shows the delight in Gothic churches and ruined castles which inspired so much of his subsequent work in romantic revival. Most of Warton's poetry, humorous and serious—and the humorous mock-heroic was better within his powers than serious verse—mas written before the age of 23, when he took his MA. degree and became a fellow of his college (Trinity, Oxford). He did not altogether abandon verse; his sonnets. especially, which are the best of his poems, were written later. But his main energies were given to omnivorous poetical reading and criticism. He was the first to turn to literary account the mediaeval treasures of the Bodleian library. It was through him, in fact, that the mediaeval spirit which always lingered in Oxford first began to stir after its long inaction and to claim an influence in the modern world.

Warton, like his brother. entered the church, and held, one after another, various livings, but he did not marry. He gave little attention to his clerical duties, and Oxford always remained his home. In 1749 he published a heroic poem in praise of Oxford, *The Triumph of Isis.* He mas a very easy and convivial as well as a very learned don, with a taste for pothouses and crowds as well as dim aisles and romances in manuscript and black letter. The first proof that he gave of his extraordinarily wide scholarship was in his *Observations on the Faerie Queene* (1754). Three years later he was appointed professor of poetry and held the office for ten years, sending round, according to the story, at the beginning of term to inquire whether anybody wished him to lecture. The first volume of his monumental work, *The History of English Poetry* (3 vol., 1774–81), is still indispensable to every student of English literature. A work of such labour could proceed but slonly, and it was no wonder that Warton flagged in the execution of it and stopped to refresh himself with annotating (1785) the minor poems of Milton, pouring out in this delightful work the accumulated suggestions of 40 years.

In 1785 he became Camden professor of history and was made poet laureate in the same year. His busy and convivial life was ended by a paralytic stroke in May 1790.

Warton's poems were collected in 1777, and he was engaged at the time of his death on a corrected edition which appeared in 1791, with a memoir by his friend and admirer, Richard Mant. They were edited in 1822 for the *British Poets* by S. W. Singer. Among his minor works were an edition of Theocritus (1770); a selection of Latin and Greek inscriptions; the humorous Oxford *Companion to the Guide* and *Guide to the Companion* (1762); *The Oxford Sausage* (1764); lives of Sir Thomas Pope and Ralph Bathurst, college benefactors; a *History of the Antiquities of Kiddington Parish,* of which he held the living (1781); and an *Inquiry into the Authenticity of the Poems attributed to Thonzas Rowley* (1782)

The History of English Poetry from the close of the 11th to the Commencement of the 18th Century, to which are prefixed two Dissertations: I. On the Origin of Romantic Fiction in Europe; II. On the Introduction of Learning into England (1774–81) was only brought down to the close of the 16th century. There are later editions, with annotations and corrections, by Richard Price (1824) and again by W. C. Hazlitt (1871). In both these editions other scholars collaborated.

See also W. P. Ker, *Thomas Warton* (1911); E. Gosse, *Two Pioneers of Romanticism; Joseph and Thomas Warton* (London, 1915); C. Rinaker, *Thomas Warton* (Urbana, Ill., 1916); Eric Partridge (ed.), *The Three Wartons; a Choice of Their Verse* (New York, 1928); J. Densin. *The Wartons; Studies in English Literature* (1876).

WARWICK, EARLS OF. The earldom of Warwick was created by William II in 1088 for Henry de Beaumont, who had held Warwick castle since its building by William the Conqueror 20 years before.

The **Beaumonts.**—Henry, younger brother of Robert, count of Meulan. was lord of Neubourg, near Beaumont-le-Roger in Normandy, and Rufus gave him the great midland estate of the English noble, Thurkill of Arden. The new earl was an intimate friend of Henry I, whose succession he did much to promote. He died in 1123, and was buried at Preaux (Normandy). Roger, his eldest son, held the earldom until his death in 1153. As a member of the powerful Beaumont group, headed by Waleran of Meulan and the earl of Salisbury, Roger was deeply involved in the struggle between Stephen and the empress Matilda (Maud). The next earls were two of his sons. William died childless on crusade in Palestine (Nov. 1184). Waleran, his brother, survived until Dec. 1204, and left a son, Henry, still a minor. Henry was first styled earl in June 1213, and died in Oct. 1229. His son, Thomas, had only a brief career, for he was recognized as earl in 1233 and died in June 1242, leaving his sister Margaret (d. 1263) as his heiress. Her two husbands, John Marshall (d. Oct. 1242), and John du Plessis (d. Feb. 1263). a trusted servant of Henry III. were both styled earls of Warwick. Margaret was followed by her cousin, William Mauduit. grandson of earl Waleran, an undistinguished man, who held to the king in the Barons' Wars and died in 1268.

The **Beauchamps.**—The succession to the Beaumont lands and title then passed to Mauduit's sister's son, William de Beauchamp, lord of Elmley and head of the Worcestershire branch of a great Norman family. He was a close friend of Edward I, one of his principal captains in Wales and Scotland, and prominent in politics until his death in June 1298. Guy, his son and successor, fought at Falkirk (1298) and at the siege of Stirling (1303–04). Before Edward I died, Guy was a bitter enemy of Piers Gaveston (*q.v.*), and, in the new reign, he was largely instrumental in compassing the favourite's murder. As an ordainer, Guy, described by a contemporary as a "discreet and well-informed man," was a principal leader of the baronial opposition to Edward II (*q.v.*). He died suddenly (of poison, it was said) in 1315. Thomas I, Guy's son, was married to the daughter of his guardian, Roger Mortimer, earl of March. By inclination a soldier, he made a great name for himself in the early campaigns of the Hundred Years' War. He fought at Crecy and Poitiers, was one of the original knights of the Garter, spent three years with the Teutonic order in the Baltic lands, and died of plague while fighting near Calais in Nov. 1370. His son. Thomas II, grasping, ambitious yet cowardly, spent himself in factious opposition to Richard II. With Thomas of Gloucester and the Arundels, he led the lords appellant, who sponsored the excesses of the Merciless Parliament (1388) against the king's friends (*see* ENGLISH HISTORY: *Richard II*). When Richard's vengeance overtook him in 1397, Thomas cringed abjectly, and escaped with imprisonment and forfeiture. He was restored by Henry IV (1399), and died in April 1401. Richard de Beauchamp, his son and successor, spent most of his career as a soldier and administrator in Lancastrian France, dying there as the king's lieutenant in 1439. His son, Henry (b. March 1425), received extraordinary marks of favour from Henry VI. In virtue of his descent, through his mother, from Edward III, he was made premier earl in April 1444, and created duke of Wanvick three days later. When Henry died (June 1445) the male line of the Warwick Beauchamps became extinct. and the dukedom lapsed, as did the earldom itself on the death of his infant daughter, Anne, in 1449.

The great Beauchamp estates in the midlands and the Welsh marches passed to Anne Neville, daughter of Richard de Beauchamp, earl of Warwick, and wife to Richard Neville. known to posterity as Warwick the Kingmaker. Her marriage, together with that of her brother, Henry de Beauchamp, duke of Wanvick. to her sister-in-law, Cicely Neville. had been planned to unite the power of the Nevilles and the Beauchamps. A few months after the Beauchamp lands came to Anne, the Warwick title was revived for her husband and herself (1450), and he acquired the Neville earldom of Salisbury when his father was beheaded after the defeat of the Yorkists at the battle of Wakefield in 1460. After her husband was killed at Barnet in 1471, Anne's rights in the Beauchamp inheritance were abrogated by statute in favour of her daughter, Isabel, wife of George, duke of Clarence, the brother of Edward IV. He took the Warwick title and held it until his attainder in 1478. It was allowed to pass to his son, Edward Plantagenet, in 1483, but when he was executed in Nov. 1499, for alleged plotting with Perkin Warbeck, the earldom became extinct.

The title was revived in Feb. 1547 for John Dudley, afterward duke of Northumberland (*q.v.*), on the ground of his descent from Richard de Beauchamp, earl of Warwick. Although Dudley was attainted and executed (Aug. 1 j j3) for his attempt to enthrone Lady Jane Grey. the Warwick title was still used by his son John until he died childless in Oct 1 554. Ambrose Dudley, his brother and heir, was confirmed in the title of earl of Warwick by Elizabeth I (Dec. 1561), and held it until his death in Feb. 1590. It then lapsed again, for Ambrose's only male heir, his brother, Robert Dudley, earl of Leicester, had predeceased him.

In 1618 James I revived the earldom once again, this time in favour of Robert, 3rd Baron Rich, whose wife, Lady Penelope Rich (*q.v*), was the Stella of Sir Philip Sidney's *Astrophel* and Stella. He was not descended from the old family of Warwick, nor did he pcssess Warwick castle, let alone any part of the ancestral lands. The earldom continued in this family until the death of Edward Rich (Sept. 1759), when it lapsed again. Two months later it was revived for the fifth time when Francis Greville, who had been created Earl Brooke of Warwick Castle in 1746, became earl of Warwick. The Grevilles were a cadet branch of the Beauchamp family, and the earldom still remains with them.

See Sir William Dugdale, *History and Antiquitzes of Warwickshire* (London, 1656); Joseph Edmondson, *An Historical Account of the Noble Family of Greville* (London, 1766); The Countess of Warwick, *Warwick Castle and its Earls,* 2 vol (London, 1903). (GY. T.)

WARWICK, RICHARD BEAUCHAMP, EARL OF (1382–1439), son of Thomas Beauchamp, was born at Salwarp in Worcestershire on Jan. 28, 1382, and succeeded his father in 1401. He had some service in the Welsh War. fought on the king's side at the battle of Shrewsbury (1403) and at the siege of Xberystn yth (1407).

In 1408 he started on a pilgrimage to the Holy Land, visiting on his way Paris and Rome, and fighting victoriously in a tournament with Pandolfo Malatesta at Verona. From Venice he took ship to Jaffa, whence he went to Jerusalem. and set up his arms in the temple. On his return he travelled through Lithuania, Prussia and Germany, and reached England in 1410. Two years later he was fighting in command at Calais.

Up to this time Warwick's career had been that of the typical knight errant. During the reign of Henry V his chief employment was as a trusted counsellor and diplomatist. He nas an ambassador to France in Sept. 1413, and the chief English envoy to the coronation of Sigismund at Aix-la-Chapelle and to the Council of Constance in the autumn of 1414. During the campaign of Agincourt he was captain of Calais. where in April 1416 he received Sigismund with such courtly magnificence as to earn from him the title of the "father of courtesy."

Warwick's sage experience made it natural that Henry V should on his deathbed appoint him to be his son's governor. For several years thereafter he was engaged chiefly as a member of the council in England. In 1428 he received formal charge of the little king's education. He took Henry to France in 1430, and while at Rouen had the superintendence of the trial of Joan of Arc. In 1431 he defeated Pothon de Xaintrailles at Savignies. Next year he returned to England. The king's minority came nominally to an end in 1437. Warwick was then chosen to succeed Richard of York in the government of Normandy. He died at his post there on April 30, 1439. His body was brought home and buried at Wanvick. His tomb in St. Mary's church is one of the most splendid specimens of English art in the 15th century. (See also WARWICK, EARLS OF.)

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WARWICK, RICHARD NEVILLE, EARL OF (1428–1471), called (since the 16th century) "the Kingmaker." was born Nov. 22, 1428, the eldest son of Richard Neville. earl of Salisbury by Alice, daughter and heiress of Thomas Montacute, earl of Salisbury. He was created earl of Warwick in March 1450, since his wife Anne, to whom he was betrothed by 1436, was sister and coheir of Henry Beauchamp, duke and earl of Warwick. Entering political life in 1452, he and his father became from 1453 supporters of Richard, duke of York, with whom they took up arms in 1455 against Henry VI and the duke of Somerset. At the battle of St. Albans (May 22, 1455) Warwick contributed to the Yorkist victory by penetrating the Lancastrian's defenses. He was appointed captain of Calais in Aug. 1455 and maintained himself in office despite rivals (notably Henry, duke of Somerset, 1459–60) until his death. Much of his influence he owed to his use of the garrison and naval forces there. To pay for the upkeep of Calais he was privateering at the expense of Hansard and Castilian fleets in 1458. He invaded England (Aug. 1459) to help York seize the king; but the desertion of their men at Ludlow on Oct 12, 1459, compelled them to flee, York to Ireland, Warwick with York's son Edward (the future Edward IV) to Calais. In May 1460 he sailed to Ireland to consult York and having returned by sea to Calais, he and Edward invaded Kent and entered London on July 2. Eight days later they defeated and captured Henry VI at Northampton. Warwick's ambition to be the arbiter of the realm under a neak king appeared in the autumn when his influence almost certainly prevented York from assuming the crown and brought about instead a succession award in parliament (Oct. 31) which kept Henry on the throne but made York the heir. While Warwick was guarding Henry in London the earl of Salisbury, his father, and Richard of York were defeated and slain at Wakefield (Dec. 30. 1460). Attempting to bar the Lancastrian advance on London he took out Henry VI with an army but was routed at St. Albans (Feb. 17, 1461) when the Lancastrians recaptured Henry. Warwick was compelled to flee westward to join Edward. son of Richard, duke of York. Together they re-entered London and York's son was proclaimed king as Edward IV on March 4, 1461. Although after the death of Salisbury the earl had become the greatest landlord in England, military events forced him to acquiesce in Edward's occupation of the throne. The battle of Towton (March 29, 1461). in which Edward commanded and Wanvick fought, ended in the destruction of the Lancastrian army and made the Yorkist cause safe in the south. But Henry VI and his mettlesome queen, Margaret of Anjou, had escaped to Scotland and, aided by the French and Scots, kept the north in turmoil until 1464. While exercising a general supervision of Edward IV, Warwick now strove to extend his own immediate authority in the north, where his family interests mainly lay, based on the castles of Middleham and Sheriff Hutton. The victory of the Yorkist cause in the north was really the triumph of the house of Neville at the expense of the Percies. Wanvick's brother George (chancellor since 1460) became archbishop of York in 1465, while another brother, John, Lord Montagu, who was responsible for the final Lancastrian defeat in 1464, became earl of Northumberland, ousting the Percies from their hereditary title. While his relations with Edward IV were nominally amicable Warwick had begun. at least from 1463, to advocate an alliance with France against the king's preference for Burgundy. Edward's marriage (May 1464) to Elizabeth Woodville and the favour accorded to her relatives sowed enmity between the king and Warwick, whose brother was deprived of the chancellorship in 1467. In July 1469 the king's brother. George, duke of Clarence, whom Warwick had been decoying for at least a year, married at Calais the earl's eldest daughter Isabel. Instigated by him, revolts broke out in which many of the king's friends perished, including the earl of Pembroke and Sir Richard Woodville, treasurer and father of the queen. For a short time Edward was held at Middleham; but he was not the man to be used as a puppet and in Oct. 1469 he returned to London. In Feb. 1470 a fresh revolt engineered by Warwick started in Lincolnshire, and on its suppression the king turned against him and Clarence, who both fled to France (April 1470). At Angers (July 1470) under the aegis of Louis XI. king of France. Warwick was reconciled to Margaret of Anjou, queen of Henry VI. and he returned to England at Michaelmas with Clarence, driving Edward IV to escape overseas to Charles duke of Burgundy. Henry VI, confined in the Tower since 1465, was restored to the throne and Warwick was undisputed master; but the situation was highly unstable. Edward IV landed in Yorkshire (March 1471) and, outwitting Warwick, who stood on the defensive at Coventry, reached London. The earl followed him, but was slain at Barnet (April 14, 1471). His younger daughter. Anne, married Richard. duke of Gloucester, the future Richard III, in 1472 and in 1483 his vast estates were merged in the crown.

Most contemporary references are highly favourable to him and he left a deep impression in the country and abroad. As a politician and diplomat he excelled Edward IV; but he was an indifferent soldier, who allowed himself to be surprised at St. Albans (1461) and by the Scots at Alnwick (Jan. 1463). He was outmanoeuvred by Edward IV in 1471. He was more at home on sea and himself took the helm during the voyage to Calais in 1459. He was far from blind to economic factors, witness his interest in mining in the north during the 1460s and the trade pact with France, 1470–71. No other Englishman of the century pursued conciliation with France successfully and without loss of popularity.

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WARWICK, SIR ROBERT RICH, 2ND EARL OF (1587–1658), colonial administrator and admiral, was the eldest son of Robert Rich. earl of Warwick, and his wife, Penelope Rich (*q.v.*), and succeeded to the title in 1619. His interest in colonial ventures involved him in disputes with the East India company (1617) and with the Virginia company, which in 1624 was suppressed through his action. In 1627 he commanded an unsuccessful privateering expedition against the Spaniards. His Puritan connections and sympathies, while estranging him from the court, promoted his association with the New England colonies. In 1628 he indirectly procured the patent for the Massachusetts colony, and in. 1631 he granted the "Saybrook" patent in Connecticut. Compelled the same year to resign the presidency of the New England company, he centinued to manage the Bermudas company and Providence company which. founded in 1630. administered Old Providence on the Mosquito coast. Meanwhile in England Warwick opposed the forced loan of 1626, the payment of ship money and Laud's church policy, and with his brother the first Lord Holland (see HOLLAND, HENRY RICH) was recognized as one of the heads of the Puritans. In March 1642 the commons, in spite of the king's veto, appointed him admiral of the fleet, and in July he gained the whole navy for the parliament. He raised forces in Norfolk and Essex on the outbreak of the war, and as lord high admiral (1643–45) he intercepted the king's ships and relieved threatened ports. In 1643 he was appointed head of a commission for the government of the colonies, which the next year incorporated Providence Plantations, afterward Rhode Island, and in this capacity he exerted himself to secure religious liberty. He died on April 19, 1658.

WARWICK, a municipal borough and the county town of Warwickshire, Eng., on the Avon, 21 mi. S.E. of Birmingham by road. Pop. (1951) 15,349. Area 7.9 sq.mi.

Warwick (*Waerincgwican* in 737, *Warwic* in Domesday) occupies rising ground commanding a crossing of the Avon river. An early settlement was fortified by Aethelflaed against the Danes in 914. At Domesday, Warwick was a royal borough containing 225 houses, 19 of which belonged to burgesses enjoying the privileges they had had in the time of Edward the Confessor. William the Conqueror ordered the castle to be enlarged, and, together with the borough. Henry I granted it to Henry de Newburgh (or Beaumont), who was created earl of Warwick. The motte of this castle ("Ethelfleda's Mount") is at the southwest end of the present castle which was begun about 1330 by Thomas Beauchamp, earl of Warwick. In 1449 the estates and the earldom passed to Richard Neville. the Kingmaker. The Clarence tower was added in the reign of Edward IV and the Bear tower by Richard III. There are only traces of the old town walls. but the east and west gates remain, with chapels above them. Although the borough owed its early importance to the castle and to its position, and received a grant of a fair in 1261, it developed independently. It received no charter until it was incorporated in 154j after it had come into the king's hands in 1499. Other charters were granted in 1554, 1613. 1664, 1683 and 1693, of which that of 1554 allowed the appointment of assistant burgesses (discontinued in 1698). The charter of 1693 conferred the title of "Mayor, Aldermen and Burgesses" on the corporation.

The castle stands on a rock rising sheer out of the river. The battlemented walls and towers are 14th and 15th century but the interior is largely the work of Fulke Greville who was granted the castle in 1604 by James I and who finally converted it from fortress to mansion. The residential part contains famous collections of pictures and armoury. The beautiful park and gardens are open to the public; in a greenhouse is the "Warwick vase" of the 4th century B.C. ($5\frac{1}{2}$ ft. high and 7 ft. in diameter), that came from Hadrian's villa at Tivoli. In spite of a great fire, which did much damage in 1694, Warwick has many mediaeval and Tudor timber-framed buildings as well as 17th-century and Georgian houses. St. Mary's church was largely rebuilt after the fire in a mixture of Perpendicular and Renaissance styles, the Beauchamp chapel (1443–64) remaining untouched. A church had existed on this site before the Conquest and was made collegiate by Roger de Newburgh. the second Norman earl, in 1123. At the dissolution Henry VIII granted the foundation to the burgesses of the town. The Leycester hospital (or Maison Dieu) is a fine half-timbered building with a galleried courtyard (c. 1415). It was originally used as the hall of the united guilds of the Holy Trinity and the Blessed Virgin Mary and St. George the Martyr. The earl of Leicester founded the hospital in 1571 for the reception of 12 disabled men. The market hall (1670) is now used as a museum. There are numerous charities in the town, the principal being those of Henry VIII. Sir Thomas White and Thomas Oken. St. Nicholas park was opened to the public in 1933. The King's school existed in the reign of Edward the Confessor and may have been as early as 914. It was refounded by Henry VIII in 1545. Warwick returned two members to parliament from 1295. but in 188j the number was reduced to one. It has now no independent representation and is in the Warwick and Learnington division of the county. Warwick's industries include the manufacture of gelatin, concrete mixers, bodies for heavy trucks and motorcars and fairground equipment.

WARWICK, a city in Kent county, R.I., U.S., is situated on the western shore of Narragansett bay, 10 mi. S. of Providence. A part of the Providence-Pawtucket standard metropolitan statistical area, its population has grown rapidly from 23,196 in 1930 to 68.504 in 1960. (For comparative population figures see table in RHODE ISLAND: Population.)

The first settlement was at Shawomet in 1643 by Samuel Gorton (*q.v.*) and later was named for Robert, earl of Warwick, who supported Gorton in his quest to gain protection of a royal charter against the Massachusetts Bay colony. Town government was organized in 1647. After the widespread destruction caused by King Philip's War (1675–76), the township was rebuilt and grist-mills and fulling mills were established on the Pawtuxet river. The town was unaffected by the American Revolution, although several of its inhabitants including Gen. Nathanael Greene (*q.v.*) acquired military fame. In the 19th century Warwick became active in textile manufacturing.

Warwick was incorporated as a city in 1931 with a mayor and council, but is basically a group of more than 20 scattered villages, united administratively.

In the early 1960s Warwick had about 70 manufacturing plants, principally textiles, metals and machinery. There are some dairy farms, market gardens, and apple orchards within the city's area but farm land has been increasingly lost with urbanization. The city is predominantly residential and has a wide variety of housing including summer cottages. Many workers commute to Providence. (V. H. WH.)

WARWICKSHIRE, a midland county of England bounded by Leicestershire, Northamptonshire, Oxfordshire, Gloucestershire and Staffordshire. Lillington (on the outskirts of Leamington Spa) and Meriden, northwest of Coventry, each claims to stand in the exact centre of the land. The geographical area is 983 sq.mi. Northwest of the Avon river, watering a rich valley on a line from northeast to southwest, the county drains principally to the Trent through the Tame and its tributaries, the Blythe. Rea, Anker and minor streams. Between these valleys, and dividing the system from that of the Avon, the land rises in gentle undulations. Many canals intersect the county. The land is formed for the most part of Keuper marls and sandstones, the sandstones forming picturesque scarps. The Bunter rocks are represented only between Birmingham and Sutton Coldfield. From this side the Avon receives the Swift, the Sowe and the Alne. An important fault crosses the area from Kenilworth northward to Tamworth, and brings up the coal measures on the eastern side. The Upper coal measures, with the so-called Permian beds, occupy the larger part of the Warwickshire coal field, while the productive Middle coal measures crop out in a narrow fringe along the north and east. The eastern margin of the field is marked by an inlier of Cambrian and Pre-Cambrian rocks, the Hartshill quartzite (Cambrian) being quarried. The district north of the Avon was distinguished by Camden as the Woodland, as opposed to the southern or Feldon, "a plain champain." The Woodland embraced the ancient forest of Arden and the Feldon included the end of the Vale of Evesham and the Vale of the Red Horse, which lies beneath a spur of the Cotswolds and is crossed by the Fosse way. It is not difficult to trace the influence of the scenic characteristics of the county in the writings of its most famous son, William Shakespeare.

History. — Warwickshire, the area once largely occupied by the forest of Arden, is poor in prehistoric antiquities. One Roman road, the Fosse way, cuts across the southeast of the county and another, Watling street, bounds it on the northeast. The earliest English settlers were a tribe of Hwicce who, pushing up the Severn valley early in the 6th century, made their way by the Avon valley and the Fosse way until the vast forest of Arden, from the Avon to modem Birmingham. barred progress northward. The extent of their settlement is indicated by the ancient limits of the diocese of Worcester. In the 7th century the Hwiccan territory became part of the kingdom of Mercia. In 675 Cosford was included in the endowment of Peterborough, and in 757 Aethelbald was slain at Seckington.

The shire of Warwick originated in the 10th century about Aethelflaed's new borough at Wanvick (*q.v.*) and appears in the Saxon Chronicle of 1016. Warwickshire offered little resistance to William the Conqueror, who was at Warwick in 1068 and had the castle enlarged by Turehil, a sheriff. Henry I granted the borough with Aethelflaed's fortress to Henry de Newburgh, son of Roger de Beaumont, whom he created earl of Wanvick. The earldom and castle subsequently passed to William de Beauchamp whose grandson, Thomas, began building the present castle about 1330. Through his wife, Anne Beauchamp, Richard Neville, the Kingmaker, obtained the earldom and estates in 1449. In 1547 they were given to John Dudley in whose family they remained until 1589.

In the wars of the reign of Henry III, Simon de Montfort placed Kenilworth castle in charge of Sir John Giffard, who in 1264 attacked Warwick castle and took prisoner the earl and countess of Wanvick, who had supported the king. During the Wars of the Roses the Nevilles, represented by the earl of Warwick, supported the Yorkist cause, while Coventry was a Lancastrian stronghold. On the outbreak of the Civil War of the 17th century Warwickshire and Staffordshire were associated for the parliament under Lord Brooke. The Battle of Edge Hill was fought in 1642, and in 1643 Birmingham was partly burned by Prince Rupert's forces. Coventry was attacked in 1642, and skirmishes took place at Southam and Warwick. The greatest disaster of all was the bombing of Coventry during World War II, Birmingham also enduring its share.

Warwickshire returned 2 members to the parliament of 1290, and in 1295 Coventry and Warwick were each represented by 2 members. Tamworth returned 2 members in 1584. Under the Reform act of 1832 the county returned 4 members in 2 divisions; Birmingham was represented by 2 members and Tamworth lost its members. Under the act of 1868 the representation of Birmingham was increased to 3 members, and under the act of 1948 the county returns 6 members in 6 divisions (Nuneaton, Rugby, Solihull, Stratford-on-Avon, Sutton Coldfield, Warwick and Leamington), Birmingham 13 members and Coventry 3.

Architecture. — Some traces of pre-Norman architecture appear in the fine church of Wootton Wawen in the Arden (western) district. For ecclesiastical architecture Coventry with its three spires is famous, and among village churches there are many fine examples. Of those retaining Norman portions may be mentioned Wolston, Berkswell, Polesworth, Curdworth, Burton Dassett, a very noteworthy building, and Warmington, where there is a chapel with a priest's chamber above it. There are also fine examples of Decorated work, such as Knowle, Solihull, Temple Balsall and Brailes. Among the numerous religious houses in the county several have left remains, for example the Cistercian foundations of Combe abbey, Merevale and Stoneleigh. The abbey at Stoneleigh (its remains overshadowed by an 18th-century mansion) was a 12th-century foundation, but a majestic gatehouse of the 14th century also stands. Maxstoke priory was a foundation for Augustinian canons of the 14th century; Wroxall abbey was a Benedictine nunnery of the 12th century. Warwick castle and Kenilworth castle, the one still a splendid residence, the other a no less splendid ruin, are described under those towns. Among fortified mansions Maxstoke castle is of the 14th century; Baddesley Clinton hall is of the 15th; Astley castle is a good specimen of various periods. Compton Wynyates is an outstandingly beautiful Elizabethan house. Charlecote park is a modernized Elizabethan hall in an exquisite situation on the Avon above Stratford-on-Avon, the birthplace of William Shakespeare. Many smaller buildings are beautiful examples of half-timbered work. Among larger examples are Coughton court (16th century), near Alcester, and Packwood house (partly 15th century), 11 mi. S.E. of Birmingham.

Agriculture and Industries. — The climate is mild and healthy. The soil is on the whole good and consists of various loams, marls, gravels and clays, well suited for most of the usual crops. The county is rich in pastureland, and dairy farming is extensive. The principal crops are wheat and oats, followed by mangels, and there are excellent orchards and market gardens and also some of the finest woodlands in England. The National trust owned 589 ac. in the county in 1953 and protected 115 ac.

The industrial part of the county is the north. Warwickshire includes Birmingham, the greatest manufacturing centre of the Midlands, though the suburbs of that city extend into Staffordshire and Worcestershire. Metalworking in all branches is prosecuted there, besides numerous other industries. Coventry is noted for aircraft, motorcars and cycles, and, with Bedworth and Nuneaton and the intervening villages, is a seat of the ribbon and tape makers. Rugby is a centre of the electrical industry, with an important radio station. At Sutton Coldfield the then most powerful television transmitter was inaugurated by the British Broadcasting corporation in 1949. A rich coal field occurs in the northeast, extending outside the county northward from Coventry. Clay, limestone and other stone are quarried at various points, and a small amount of iron ore is raised. Coal, lime and cement are the chief mineral products.

Population and Administration.—The area of the administrative county is 873 sq.mi. with a population in 1951 of 490,740. The geographical county (983 sq.mi.) had a population in 1901 of 897.835 and in 1951 of 1,861,670, the chief centres of increase lying naturally in the parts about Birmingham and Coventry. Warwickshire has one court of quarter sessions and is divided into 17 petty sessional divisions and 2 boroughs with their onn commissions of the peace (Leamington Spa and Sutton Coldfield). There are 2 county boroughs (Birmingham and Coventry), 6 municipal boroughs, 3 urban districts, 9 rural districts and 240 civil parishes. Birmingham and Coventry have separate courts of quarter sessions and Warwick is an assize town. The county is mainly in the Birmingham and Coventry dioceses, carved largely out of that of Worcester.

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WASH, THE, a shallow bay of the North sea, 12 by 15 mi., between Lincolnshire and Norfolk. Eng. It formerly extended as far inland as Peterborough and Cambridge but was infilled by silt, mainly brought down by the Witham, Welland, Nene and Great Ouse rivers but partly washed in by coastal currents. Reclamation was inaugurated at several points and sea walls were built to protect the low coastal lands. At low tide the river waters reach the sea through shallow creeks between banks of sand and mud. The two main channels, Boston deep and Lynn deep. provide anchorage for small vessels trading to Boston and King's Lynn respectively. (T. HER.)

WASHBURNE, ELIHU BENJAMIN (1816–1887), **U.S.** congressman. cabinet member and diplomat, was born at Livermore, Me.. Sept. 23, 1816. He graduated from the Harvard law school in 1839 and the next year moved to Galena, Ill. Success in his profession led to politics and election to congress in 1852. There. as a Whig and then as a Republican, he gained a reputation as an advocate of economy by opposing extravagant grants of land to railroads, excessive pensions and other raids on the treasury. He bitterly opposed Stephen Douglas' Kansas-Nebraska act and as ardently supported Lincoln for the senate in 1858 and for the presidency in 1860. When the Civil War broke out he pressed the interests of his fellow townsman, U. S. Grant, for military appointment, and at its close joined the radicals in Reconstruction and in support of Grant for the presidency. His reward was a complimentary place in Grant's cabinet of 12 days' duration and then appointment as minister to France. He died in Chicago, Oct. 23, 1887.

See Gaillard Hunt, *Israel, Elihu, and Cadwallader Washburne* (Sew York, 1925); J. V. Fuller, "Elihu Benjamin Washburne." in S. F. Bemis (ed.), *The American Secretaries of State and Their Diplomacy*, vol. vii (New York and London, 1928). (AY. CN.)

WASHING MACHINES. Although household washing machines, mechanical devices for washing clothes, have been used for many years, they did not come into general popularity until World War I.

An electric motor (occasionally a gasoline engine) combined with a drive shaft, gears. a belt or some combination of these, activates the mashing action by means of an agitator, a revolving cylinder or an agitating basket which moves the clothes through the water or the water through the clothes. This also creates currents in the water which assist the cleansing action.

Agitator Washer.—In this type fins or blades on a cone designed to fit over a central shaft comprise the agitator, which turns back and forth or pulsates up and down. Agitators may be solid or perforated and are made either of metal or plastic. They differ in size. shape, number and arrangement of blades or fins according to the make of washer. Some operate at one speed only and some at more than one. Most agitators operate in an inside tub of rigid metal, usually perforated or in a metal-impregnated rubber tub which is sturdy, flexible and not perforated.

Cylinder Washer.—In this type a perforated cylinder usually made of porcelain enamelled steel holds the load to be washed as it revolves in a tub of water. Projections or baffles within the cylinder cause the clothes to drop back into the water as the cylinder turns. In some washers of this type the cylinder turns in one direction whereas in others it reverses at intervals.

Agitating Basket Washer.—In this type a combination of tub design and movement produce washing action. The inside tub with a partially swirled or corrugated surface and a base that looks like an inverted bowl tips as it moves rapidly up and down to swirl the clothes about through the water.

These washing mechanisms are enclosed in a housing or shell of characteristic design, usually made of synthetic enamel on sheet metal or porcelain enamelled steel. Less frequently it is of aluminum, stainless steel or nickel copper. It also encloses gears, belt, other moving parts and the motor and protects them from water, dust and lint. The motor (usually $\frac{1}{4}$ or $\frac{1}{3}$ h.p.) is grounded and insulated from other metal parts of the washer. Usually it is permanently lubricated with a sealed-in lubricant.

Automatic Washers.—Mechanical washers are automatic, semiautomatic or nonautomatic in their operation. The automatic, which first appeared in 1937, washes, rinses and extracts water with no attention from the operator after the load is placed in the washer. the power turned on and the timing device set. A later development of fully automatic washers went one step further, drying the clothes so they are ready to put away or to iron. The automatics save the most time and labour, but they are also the most expensive.

Semiautomatic Washers.—This type also is power driven and, while the clothes require no handling through the entire wash-rinse-extraction cycle, one or more of the steps are controlled by hand.

Nonautomatic Washers.—This washer, sometimes called the conventional type, is power driven and has a power-driven spinner or wringer which extracts the water. Although they save less of the operator's time, nonautomatic washers are great labour savers and can be used any place power is available. They require some handling of the clothes throughout the process. Clothes must be directed through the wringer or lifted into the spinner basket for water extraction after each step of the process. Often nonautomatic washers are filled through a hose and emptied either by gravity or by a pump. They also may be filled by hand, an advantage in homes without running water.

Water Extraction.—There are three general types of water extractors used with clothes washers. Some are equipped with an electrically driven wringer, two parallel rubber-covered rolls which revolve in opposite directions to squeeze the water from the clothes. Some have two hard rubber rolls. whereas others have one hard and one soft roll or two soft rolls. The soft rubber is used to minimize the danger of damage to buttons, hooks, snaps, zippers or other fastenings and trimmings. Wringers are designed to swing about and lock in convenient positions.

Another type of water extractor is a spinner that removes water by centrifugal action. With this type a perforated cylinder or basket either within the tub or attached to it is driven at a high speed to force out the water by centrifugal action. The third type removes water by squeezing action. In mashers which have a sturdy inside metal-impregnated rubber tub this flexible tub collapses on a vacuum principle to squeeze water from the clothes.

Water Requirements.—The total amount of water required varies widely with the washing machine used. From 6 to 20 gal. of water are required each time the tub is filled. Spray rinses that sometimes are interspersed between deep agitated rinses frequently take less. Automatic washers' requirements range from 25 to 65 gal. for a complete cycle but most automatic machines use only from 35 to 45 gal.; of this the amount of hot water (ideally 135°–160° F.) varies from 15 to 25 gal. per complete cycle. For white linens and cottons the hotter the water used the better the results.

Many washing machines are so constructed that the operator may predetermine both the washing time and the water temperature. With the automatic machines this is done by adjusting the automatic control before the washer starts. This became important as the synthetic fibres and finishes appeared in steadily increasing numbers in the laundry hamper.

Many man-made products give up soil quickly and easily and can be thoroughly washed by machine in a very short time. This is important also with wool fabrics such as blankets, snow suits, etc., which often are sensitive both to high temperatures and agitation.

Soft or softened water is a great asset. If the water is hard the use of a mechanical water softener or the addition of a water softening agent is highly desirable when soap is used. For best results, all the water, including the rinse water, should be softened when soap is used. A practical alternative when water is hard is the use of synthetic detergents made especially for use with hard water.

There are low-sudsing and high-sudsing synthetic detergents. Recommendations for the type that works best in an individual washer are usually made by the manufacturer. The amount of synthetic detergent used varies with the hardness of the water, quantity and degree of soil, the type of washer and the type of detergent. When soap is used, a substantial amount of standing suds on top of the wash water should be maintained. Because of the hard-water problem in the United States, a trend toward an increased use of synthetic detergents developed.

Washers range in size, rated in capacity for pounds of clothes, from 8 to 10 lb. Most are rated at 9 lb. There are, however, some small-capacity washers, usually called portables, designed to wash a maximum of 2, 4 or 6 lb. Some of these extract water with a spinning action, others with hand operated wringers. and some have no provision for water extraction. While they are a convenience under certain conditions, they cannot be considered a substitute for a standard-size washer. They use a small amount of water, occupy little space and often do an acceptable small job.

Washers load from the top or from the front. Some are permanently installed in one spot whereas others are movable and may be rolled into position near the water supply and a drain and later rolled away for storage.

Washing Procedure. — New developments in washing machines greatly altered washing habits. In many homes in the U.S.. for example, there no longer is one general washday each week, washing being done instead one load at a time whenever a load accumulates that suitably may be washed together.

According to accepted procedure each load is sorted according to colour, amount of soil, washing time and water temperature. Extremely soiled or stained articles are pretreated. Heavily soiled clothes may be soaked in the machine for from 10 to 20 minutes only either in cold or lukewarm water; sometimes a small amount of soap or synthetic detergent is added. This usually is an agitated soak.

In some automatic washers this presoak is part of the regular cycle. Often this is a matter of setting the dial that controls the cycling to include the soak or not as the operator chooses. This is followed by a hot (or warm) soapy wash and two or more rinses. Water is extracted from the clothes and fresh water added after each step of this process.

Later developments include improvement in safety devices, more reliable cycling, better bearings and more durable and attractive finishes.

Modern designing of washing machines coupled with the trend in the U.S. toward smaller houses made washing machines acceptable for installation in kitchens, first-floor service rooms, bathrooms, bedrooms, halls and sometimes even in a sewing room that doubles as a guest room.

Experimental models of ultrasonic washers, which rely on high-frequency wave action for cleansing, appeared in the early 1950s, but none was in general use. (E. DA.)

WASHING SODA, the common name for the decahydrate of sodium carbonate ($Na_2CO_3.10H_2O$), also called sal soda and used in household and laundry work.

See ALKALI MANUFACTURE.

WASHINGTON, BOOKER TALIAFERRO (1856–1915), U.S. Negro educator and reformer, for many years a leader of American Negroes, first president of Tuskegee institute, was born on April 5, 1856, in a slave hut on a plantation in Franklin county, Va. At Malden, W.Va., where the family (his mother, himself and two other children) moved after emancipation, dire poverty precluded regular schooling for the boy, and at the age of nine he began working with his foster father in a salt furnace and later in a coal mine.

In 1872 his determination to secure an education carried him to Hampton (Va.) Normal and Agricultural institute, where he worked as a janitor to help defray his school expenses. Upon graduation from Hampton in 1875, Washington returned to Malden to teach children in a day school and adults at night. After two years of teaching and eight months (1878–79) of study at Wayland seminary in Washington, D.C., he joined the staff at Hampton to participate in a successful experiment inaugurating a new educational program for American Indians.

Two years later, in 1881, he was selected to head a newly established Negro normal school at Tuskegee, Ala., an institution with two small, converted buildings, no equipment and very little money. Tuskegee Normal and Industrial institute became the singular achievement of his life's work. At his death, 34 years after its founding, Tuskegee had over 100 well-equipped buildings. more than 1,500 students, a faculty of nearly 200 teaching 38 trades and professions and an endowment of approximately $2,000,000. His success at Tuskegee gained him national acclaim, and he emerged as the most influential spokesman for the American Negro.

Washington believed that the best interests of the Negro were to be realized through education rather than by political agitation for civil rights, and he was opposed by many Negro intellectuals who deplored particularly his emphasis on industrial education. During his lifetime he delivered numerous speeches and established organizations to promote the advancement and welfare of the Negro, among them being the National Negro Business league.

Among the dozen books he wrote are two autobiographies, Up *From Slavery* (1901), translated into at least 18 languages, and My *Larger Life* (1911), which completed the exposition of his philosophy of education and of life. In recognition of his achievement, Harvard university conferred upon him the honorary degree of master of arts (1896), and Dartmouth college, Hanover, N.H., that of doctor of laws (1901).

His death at Tuskegee on Nov. 14, 1915, was attributed to overwork.

See Samuel R. Spencer, Jr., *Booker T. Washington and the Negro's Place in American Life* (1955); Anson Phelps Stokes, *A Brief Biography of Booker Washington (1936).* (J. M. BK.)

WASHINGTON, BUSHROD (1762–1829), **U.S.** jurist, nephew of George Washington, was born in Westmoreland county, Va., on June 5, 1762. His father was John Augustine Washington, brother of George Washington. He graduated in 1778 from the College of William and Mary, Williamsburg, Va., where he was an original member of Phi Beta Kappa. After graduation he served in the colonial army until the end of the American Revolution. He studied law in the office of the noted Philadelphia lawyer, James Wilson, and then took up the practice of law in Alexandria, Va., moving to Richmond in 1790. He served in the Virginia house of delegates in 1787 and in the following year sat in the convention which ratified the federal constitution for Virginia. In 1798 he was appointed associate justice of the U.S. supreme court by Pres. John Adams. He was George Washington's literary executor and supervised the preparation of John Marshall's *Life of Washington* (5 vol., 1804–07); and on Mrs. Washington's death in 1802 he inherited Mount Vernon and a part of the estate. He died in Philadelphia on Nov. 26, 1829, and was buried at Mount Vernon.

WASHINGTON, GEORGE (1732–1799), general, statesman and first president of the United States, was born in Westmoreland county, Va., on Feb. 22 (new style; Feb. 11, old style),

1732. *(See* WAKEFIELD ESTATE.) His father was Augustine Washington, who had gone to school in England, had tasted seafaring life and was then managing his growing Virginia estates. His mother was Mary Ball, whom Augustine, a widower, had married early the previous year. The paternal lineage had some distinction. an early forebear was described as "gentleman"; Henry VIII later gave the family lands; and its members held various offices. But family fortunes fell with the Puritan revolution, and John Washington. grandfather of Augustine, migrated in 1657 to Virginia. The ancestral home at Sulgrave, Northamptonshire *(see* SULGRAVE MANOR), is maintained as a Washington memorial. Little definite information exists on any of the line until Augustine. He was an energetic, ambitious man who acquired much land. built mills, took an interest in opening iron mines and sent his two oldest sons to England for schooling. By his first wife, Jane Butler, he had four children; by his second, six. He died April 12, 1743.

Childhood and **Youth.**—Very little is known of George Washington's early childhood, spent largely on the Ferry Farm on the Rappahannock river opposite Fredericksburg, Va. Mason L. Weems's stories of the hatchet and cherry tree and of young Washington's repugnance to fighting are apocryphal efforts to fill a manifest gap. He attended school irregularly from his 7th to his 15th year, first with the local church sexton and later with a schoolmaster named Williams. Some of his schoolboy papers survive. He was fairly well trained in practical mathematics—gauging, several types of mensuration and such trigonometry as was useful in surveying. He studied geography, possibly had a little Latin and certainly read some of The *Spectator* and other English classics. The copybook in which he transcribed at 14 a set of moral precepts or *Rules* of *Civility* was carefully preserved. His best training. however, was given him by practical men and outdoor occupations, not by books. He rode over the half-dozen family farms or plantations, watched the slaves at work and mastered tobacco growing and stock raising. Early in his teens he was sufficiently familiar with surveying to plot the fields about him.

At his father's death the 11-year-old boy fell under the guardianship of the eldest son. Lawrence, a man of fine character who gave him wise and affectionate care. Lawrence inherited the beautiful estate of Little Hunting Creek that had been granted to the original settler, John Washington, and on which Augustine had done much since 1738 to develop. Lawrence married Anne (Nancy) Fairfax, daughter of Col. William Fairfax, cousin and agent of Lord Fairfax, one of the chief proprietors of the region. He also built a house and named the 2,500-ac. holding Mount Vernon, in honour of the admiral under whom he had served in the siege of Cartagena. Living there chiefly with Lawrence, though he spent spme time with his other half brother. Augustine (called Austin), near Fredericksburg, George entered a more spacious and polite world. Anne Fairfax Washington was a woman of charm, grace and culture; Lawrence had brought from his English school, Appleby, and his naval service much knowledge and experience. A valued neighbour and relative, George William Fairfax. whose large estate, Belvoir, was about 4 mi. distant, and other relatives by marriage, the Carlyles of Alexandria, helped form George's mind and manners. After 1748 Fairfax was husband of the attractive Sally Cary, whose vivacity, good humour and ease made her congenial.

The youth turned first to surveying as a profession. Lord Fairfax. a middle-aged bachelor who owned more than 5.000.000 ac. in northern Virginia and the Shenandoah valley, came to America in 1746 to live with his cousin, George William, at Belvoir, and to look after his properties. Two years later he sent to the Shenandoah valley a party to survey and plat his lands to enable him to make regular tenants of the squatters moving in from Pennsylvania. With the official surveyor of Prince William county in charge, Washington went along as assistant. The 16-year-old lad kept a disjointed diary of the trip which shows skill in observation. He describes the discomfort of sleeping under "one thread Bear blanket with double its Weight of Vermin such as Lice Fleas &c"; an encounter with an Indian war party bearing a scalp; the Pennsylvania-German emigrants, "as ignorant a set of people as the Indians they would never speak English but when spoken to they speak all Dutch"; and the serving of roast wild turkey on "a Large Chip," for "as for dishes we had none." As part of his compensation for the work of the survey, Washington received a patent for 550 ac. in Frederick county which he always referred to as "my Bullskin plantation."

The following year (1749), aided by Lord Fairfax, Washington received an appointment as official surveyor of Culpeper county, and for more than two years he was kept almost constantly busy. Surveying not only in Culpeper but also in Frederick and Augusta counties, he made journeys far beyond the tidewater region into the western wilderness. The experience taught him resourcefulness and endurance and toughened both body and mind. Coupled with his half brother Lawrence's ventures in land it also gave him an interest in western tracts and an appreciation of the importance of western development that endured throughout his life. He was always disposed to speculate in western holdings and to view favourably projects for colonizing the west; and he greatly resented the limitations which the crown in time laid on the westward movement. Lord Fairfax in 1752 determined to take up his final residence in the Shenandoah valley and settled there in a log hunting lodge which he called Greenway Court, after a Kentish manor of his family. There Washington was sometimes entertained and had access to a small library which Fairfax had begun accumulating at Oxford.

Plantation Life.—The years 1751–52 marked a turning point in Washington's life, for they placed him in control of Mount Vernon. His half brother Lawrence, stricken by tuberculosis, went to Barbados in 1751 for his health, taking George along. From this sole journey beyond the present borders of the United States Washington returned with the light scars of an attack of smallpox. In July of the next year Lawrence died, making George executor and residuary heir of his estate in the event of the decease of his daughter, Sarah, without issue. As she died within two months, Washington at the age of 20 became head of one of the best Virginia estates. He always thought farming the "most delectable" of pursuits. "It is honorable." he wrote, "it is amusing, and, with superior judgment, it is profitable." And of all the spots for farming, he thought Mount Vernon the best. "No estate in United America," he assured an English correspondent, "is more pleasantly situated than this." His greatest pride in later days was to be regarded as the first farmer of the land. He gradually increased the estate until it exceeded 8.000 ac. He twice enlarged the house (1760, 1785) and he improved the grounds with greenhouses, a deer paddock. a bowling green, and a "shrubbery." He tried to keep abreast of the latest scientific advances.

For the next 20 years the main background of Washington's life was the work and society of Mount Vernon. He had to manage the 18 slaves that came with the estate and others he bought later; by 1760 he paid tithes on 49 slaves—though he strongly disapproved of the institution and hoped for some mode of abolishing it. He gave assiduous attention to crop rotation, fertilizing and stock management. For diversion he was fond of riding, foxhunting and dancing; of such theatrical performances as he could reach; and of duck-hunting and sturgeon-fishing. He liked billiards and 'cards and not only subscribed to racing associations but ran his own horses in races. In all outdoor pursuits, from wrestling to colt-breaking, he excelled. A friend of the 1750s describes him as "straight as an Indian, measuring six feet two inches in his stockings"; as very muscular and broad-shouldered, but though large-boned, weighing only 175 pounds; and as having long arms and legs. His penetrating blue-gray eyes were overhung by heavy brows; his nose was large and straight; and his mouth was large and firmly closed. "His movements and gestures are graceful, his walk majestic, and he is a splendid horseman." He soon became prominent in community affairs. was an active member and later vestryman of the Episcopal Church and as early as 1755 expressed a desire to stand for the Virginia house of burgesses.

Early Military Career.—Traditions of John Washington's feats as Indian fighter and Lawrence Washington's talk of service days helped imbue George with military ambition. Just after Lawrence's death, Lieut. Gov. Robert Dinwiddie appointed him adjutant for the southern district of Virginia at £100 a year (Nov.

1752). The next year he became adjutant of the Northern Neck and Eastern Shore. Then in 1753 Dinwiddie found it necessary to warn the French to desist from their encroachments on Ohio valley lands claimed by the crown, and after sending one messenger who failed to reach the goal he determined to dispatch Washington. On the day he received his orders, Oct. 31, 1753, Washington set out for the French posts. His party consisted of a Dutchman to serve as interpreter; the expert scout Christopher Gist, for guide; and four others, two of them experienced traders with the Indians. Theoretically, Great Britain and France were at peace, but actually war impended, and Dinwiddie's message was an ultimatum: the French must get out or they would be put out.

The journey proved rough, perilous and futile. Washington's party left what is now Cumberland, Md., the middle of November, and despite wintry weather and wilderness impediments reached Ft. Le Boeuf, at what is now Waterford, Pa., 20 mi. south of Lake Erie, without delay. The French commander was courteous but adamant. As Washington reported, his officers "told me, That it was their absolute Design to take possession of the Ohio, and by God they would do it." Eager to carry this alarming news back, Washington pushed off hurriedly with Gist. He was lucky to get back alive. An Indian fired at them at 15 paces, but missed; when they crossed the Allegheny river on a raft Washington was jerked into the ice-filled stream but saved himself by catching one of the timbers. That night he almost froze in his wet clothing. He reached Williamsburg on Jan. 16, 1754, where he hastily penned a record of the journey. Dinwiddie, who was labouring to convince the crown of the seriousness of the French threat, had it printed, and when he sent it to London it was reprinted in three different forms.

The enterprising governor forthwith planned an expedition to hold the Ohio country. He made Joshua Fry colonel of a provincial regiment, appointed Washington lieutenant colonel and set them to recruiting troops. Two agents of the Ohio company, which Lawrence Washington and others had formed to develop lands on the upper Potomac and Ohio rivers, had begun building a fort at what later became Pittsburgh, Pa. Dinwiddie, ready to launch into his own war, sent Washington with two companies to reinforce this post. In April 1754, the lieutenant colonel set out from Alexandria with about 160 men at his back. He marched to Cumberland only to learn that the French had anticipated the British blow; they had taken possession of the fort of the Ohio company, and had renamed it Ft. Duquesne. Happily, the Indians of the area offered support. Washington therefore struggled cautiously forward to within about 40 mi. of the French position and erected his own post at Great Meadows, near what is now Confluence, Pa. With this as base, he made a surprise attack, May 28, 1754, upon an advance detachment of 30 French, killing the commander, Coulon de Jumonville, and nine others and making the rest prisoners. The French and Indian War (*q.v.*) had begun.

Washington at once received promotion to a full colonelcy and was reinforced, commanding a considerable body of Virginia and North Carolina troops, with Indian auxiliaries. But his attack soon brought the whole French force down upon him. They drove his 350 men into the Great Meadows fort (Ft. Necessity) on July 3, besieged it with 700 men and after an all-day fight compelled him to surrender. The construction of the fort had been a blunder, for it lay in a water-logged creek bottom, was commanded on three sides by forested elevations approaching it closely and was too far from Washington's supports. The French agreed to let the disarmed colonials march back to Virginia with the honours of war, but they compelled Washington to promise that Virginia would not build another fort on the Ohio for a year and to sign a paper acknowledging responsibility for *"l'assassinat"* of M. de Jumonville; a word which Washington later explained he did not rightly understand. He returned to Virginia, chagrined but proud, to receive the thanks of the house of burgesses, to be made a colonel by Dinwiddie and to find his name mentioned in the London gazettes. His remark in a letter to his brother that "I have heard the bullets whistle; and believe me, there is something charming in the sound" was commented on humorously by Horace Walpole and sarcastically by George II.

An Aide to Braddock.— The arrival of Gen. Edward Braddock and his army in Virginia in Feb. 1755, as part of the triple plan of campaign which called for his advance on Ft. Duquesne, Gov. William Shirley's capture of Niagara and William Johnson's capture of Crown Point, brought Washington new opportunities and responsibilities. He had resigned his commission in Oct. 1754 in resentment of the slighting treatment and underpayment of colonial officers and particularly because of an untactful order of the British war office that provincial officers of whatever rank should be subordinate to any officer holding the king's commission. But he ardently desired a part in the war; "my inclinations," he wrote a friend, "are strongly bent to arms." When Braddock showed appreciation of his merits and invited him to join the expedition as personal aide-de-camp, with the courtesy title of colonel, he therefore accepted. His self-reliance, decision and masterful traits soon became apparent.

At table he had frequent disputes with Braddock, who when contractors failed to deliver their supplies attacked the colonials as supine and dishonest, while Washington defended them with warmth. His freedom of utterance is proof of Braddock's esteem. Braddock also accepted from him the unwise advice that he divide his army, leaving half of it to come up with the slow wagons and cattle train and taking the other half forward against Ft. Duquesne at a rapid pace. Washington was ill with fever during June, but joined the advance guard in a covered wagon on July 8, begged to lead the march on Ft. Duquesne with his Virginians and the Indian allies and was by Braddock's side when on July 9 the army was ambushed and bloodily defeated.

In this defeat Washington displayed the combination of coolness and determination, the alliance of unconquerable energy with complete poise, which was the secret of so many of his successes. So ill that he had to use a pillow instead of a saddle and that Braddock ordered his body servant to keep special watch over him, he was everywhere at once. At first he followed Braddock as the general bravely tried to rally his men to push either forward or backward, the wisest course the circumstances permitted. Then he rode back to bring up the Virginians from the rear and rallied them with effect on the flank. To him was largely due the escape of the force. His exposure of his person was as reckless as Braddock's, who was fatally wounded on his fifth horse; Washington had two horses shot under him and his clothes cut by four bullets without being hurt. He was at Braddock's deathbed, helped bring the troops back and was repaid by being appointed, in Aug. 1755, while still only 23 years old, commander of all the Virginia troops. But no part of his later service was conspicuous. Finding that a Maryland captain who held a royal commission would not obey him, he rode north in Feb. 1756 to Boston to have the question settled by the commander in chief in America, Governor Shirley; and bearing a letter from Dinwiddie, had no difficulty in carrying his point. On his return he plunged into a multitude of vexations. He had to protect a weak, thinly settled frontier nearly 400 mi. in length with only some 700 ill-disciplined colonial troops; to cope with a legislature unwilling to support him; to meet attacks on the drunkenness and inefficiency of the soldiers; and to endure constant wilderness hardships. It is not strange that in 1757 his health failed and in the closing weeks of that year he was so ill of a "bloody flux" that his physician ordered him home to Mount Vernon.

Victory Without Promotion.— In the spring of 1758 he recovered sufficiently to return to duty as colonel in command of all Virginia troops. As part of the grand sweep of several British armies organized by Pitt, Gen. John Forbes led a new advance upon Ft. Duquesne. This time Forbes resolved not to use Braddock's road but to cut a new one west from Raystown, Pa. Washington disapproved of the route, but played an important part in the movement. Late in the autumn the French evacuated and burned Ft. Duquesne, and Forbes reared Ft. Pitt on the site. Washington, who had just been elected to the house of burgesses, was able to resign with the honorary rank of brigadier general.

But though his officers expressed regret at the "loss of such an excellent Commander, such a sincere Friend, and so affable a Companion," he quit the service with'a sense of frustration. He had thought the war excessively slow. The Virginia legislature had been niggardly in voting money; the Virginia recruits had come forward reluctantly and had proved of poor quality—he had hanged a few deserters and flogged others heavily. Virginia gave him less pay than other colonies offered their troops. Desiring a regular commission such as his half brother Lawrence had held, he applied in vain to the British commander in North America, Lord Loudoun. to make good a promise that Braddock had given him. Ambitious for both rank and honour, he showed a somewhat strident vigour in asserting his desires and in complaining when they were denied. He returned to Mount Vernon somewhat disillusioned.

Marriage and Stepchildren.—Immediately on resigning his commission he was married, Jan. 6, 1759, to Martha Dandridge, the widow of Daniel Parke Custis. She was a few months older than he, was the mother of two children living and two dead and possessed one of the considerable fortunes of Virginia. Washington had met her the previous March and had asked for her hand before his campaign with Forbes. Though it does not seem to have been a romantic love match, the marriage united two harmonious temperaments and proved happy. Martha was a good housewife, an amiable companion and a dignified hostess.

Some estimates of the property brought him by this marriage have been exaggerated, but it did include a number of slaves and about 15,000 ac., much of it valuable for its proximity to Williamsburg. More important to Washington were the two stepchildren, John Parke ("Jacky") and Martha Parke ("Patsy") Custis, who at the time of the marriage were six and four, respectively. He lavished great affection and care upon them, worried greatly over Jacky's waywardness and was overcome with grief when Patsy died just before the Revolution. Jacky died during the war, leaving four children. Washington adopted two of them, a boy and a girl, and even signed his letters to the boy as "your papa." Himself childless, he thus had a real family.

A Virginia Planter.—From the time of his marriage Washington added to the care of Mount Vernon the supervision of the Custis estate at the White House on the York river. As his holdings expanded they were divided into farms, each under its own overseer; but he minutely inspected operations every day and according to one visitor often pulled off his coat and performed ordinary labour. As he once wrote, "middling land under a man's own eyes, is more profitable than rich land at a distance." To the eve of the Revolution he devoted himself to the duties and pleasures of a great landholder, varied by several weeks' attendance every year in the house of burgesses in Williamsburg. For the years 1760–74 he was also a justice of the peace for Fairfax county, sitting in court in Alexandria.

In no light does Washington appear more characteristically than as one of the richest, largest and most industrious of Virginia planters. For six days a week he rose early and worked hard; on Sundays he irregularly attended Pohick church (16 times in 1760), entertained company, wrote letters, made purchases and sales and sometimes went fox-hunting. In these years he took snuff and smoked a pipe; throughout life he liked Madeira wine and punch. Though wheat and tobacco were his staples, he practised crop rotation on a three-year or five-year plan. He had his own waterpower flour mill, blacksmith shop, brick and charcoal kilns, carpenters and masons. His fishery supplied shad, bass, herring and other catches, salted as food for the Negroes. Coopers, weavers and his own shoemaker turned out barrels; cotton, linen and woolen goods; and brogans for all needs. In short, his estates, in accordance with his orders to overseers to "buy nothing you can make yourselves," were largely self-sufficient communities. But he did send large orders to England for farm implements, tools, paint, fine textiles, hardware and agricultural books, and hence was painfully aware of British commercial restrictions.

He experimented in breeding cattle; acquired at least one buffalo, with the hope of proving its utility as a meat animal; and kept stallions at stud. He also took pride in a peach and apple orchard. His care of slaves was exemplary. He carefully clothed and fed them, engaged a doctor for them by the year, refused to sell them—"I am principled against this kind of traffic in the human species"—and administered correction mildly. They showed so much attachment that few ran away.

In the social life of the tidewater region he meanwhile played a prominent role. The members of the council and house of burgesses, a roster of influential Virginians, were all friends. He visited the Byrds of Westover, the Lees of Stratford, the Carters of Shirley and Sabine Hall and the Lewises of Warner Hall; Mount Vernon often was busy with guests in return. He liked house parties and afternoon tea on the Mount Vernon porch; he was fond of picnics, barbecues and clambakes; and throughout life he enjoyed dancing, frequently going to Alexandria for balls. Cards were a steady diversion, and his accounts record sums lost at them, the largest reaching nearly £10. In bad weather his diary sometimes states, "at home all day, over cards." Billiards was a rival amusement. Not only the theatre, when available, but concerts, cockfights, the circus, puppet shows and exhibitions of animals received his patronage.

He insisted on the best clothes—coats, laced waistcoats, hats, coloured silk hose—bought in London. The Virginia of the Randolph~Corbins, Harrisons, Tylers, Nicholases and other prominent families had an aristocratic quality, and Washington liked to do things in a large way. It has been computed that in the seven years prior to 1775 Mount Vernon had 2,000 guests, most of whom stayed to dinner if not overnight.

Prerevolutionary Politics.—Washington's contented life was interrupted by the rising storm in imperial affairs. The British ministry, facing a heavy postwar debt, high home taxes and continued military costs in America, decided in 1764 to obtain revenue from the colonies. Up to that time Washington, though regarded by associates, in Col. John L. Peyton's words, as "a young man of an extraordinary and exalted character," had shown no signs of personal greatness and few signs of interest in state affairs. The Proclamation of 1763 interdicting settlement beyond the Alleghenies irked him, for he was interested in the Ohio company, the Mississippi company and other speculative western ventures. He nevertheless played a silent part in the house of burgesses and was a thoroughly loyal subject. (See also UNITED STATES: History.)

But he was present when Patrick Henry introduced his resolutions against the Stamp act in May 1765 and shortly thereafter gave token of his adherence to the cause of the colonial Whigs against the Tory ministries of England. In 1768 he told George Mason at Mount Vernon that he would take his musket on his shoulder whenever his country called him. The next spring, April 4, 1769, he sent Mason the Philadelphia nonimportation resolutions with a letter declaring that it was necessary to resist the strokes of "our lordly masters" in England; that courteous remonstrances to parliament having failed, he wholly endorsed the resort to commercial warfare; and that as a last resort no man should scruple to use arms in defense of liberty. When, the following May, the royal governor dissolved the house of burgesses, he shared in the gathering at the Raleigh tavern which drew up nonimportation resolutions, and he went further than most of his neighbours in adhering to them. At that time and later he believed with most Americans that peace need not be broken.

Late in 1770 he paid a land-hunting visit to Ft. Pitt, where George Croghan was maturing his plans for the proposed 14th colony of Vandalia. Washington directed his agent to locate and survey 10,000 ac. adjoining the Vandalia tract, and at one time he wished to share in certain of Croghan's schemes. But the Boston Tea Party of Dec. 1773 and the bursting at about the same time of the Vandalia bubble turned his eyes back to the east and the threatening state of Anglo-American relations. He was not a member of the Virginia committee of correspondence formed in 1773 to communicate with other colonies, but when the Virginia legislators, meeting irregularly again at the Raleigh tavern in May 1774, called for a continental congress, he was present and signed the resolutions. Moreover, he was a leading member of the first provincial convention or revolutionary legislature late that summer, and to that body he made a speech which was much praised for its pithy eloquence, declaring that "I will raise one thousand men, subsist them at my own expense, and march myself at their head for the relief of Boston."

The Virginia provincial convention promptly elected Washington one of the seven delegates to the first continental congress. He was by this time known as a radical rather than a moderate, and in several letters of the time he opposed a continuance of petitions to the British crown, declaring that they would inevitably meet with a humiliating rejection. "Shall we after this whine and cry for relief when we have already tried it in vain?" he wrote. When the congress met in Philadelphia on Sept. 5, 1774, he was in his seat in full uniform, and his participation in its councils marks the beginning of his national career. Later Patrick Henry, being asked who was the greatest man in congress, replied: "If you speak of eloquence, Mr. Rutledge of South Carolina is by far the greatest orator; but if you speak of solid information and sound judgment, Colonel Washington is unquestionably the greatest man on that floor."

His letters of the period show that while still utterly opposed to the idea of independence, he was determined never to submit "to the loss of those valuable rights and privileges, which are essential to the happiness of every free State, and without which life, liberty, and property are rendered totally insecure." If the ministry pushed matters to an extremity, he wrote, "more blood will be spilled on this occasion than ever before in American history." Though he served on none of the committees, he was a useful member, his advice being sought on military matters and weight being attached to his advocacy of a nonexportation as well as nonimportation agreement. He also helped to secure congressional approval of the "Suffolk Resolves," which looked toward armed resistance as a last resort and which did much to harden the king's heart against America.

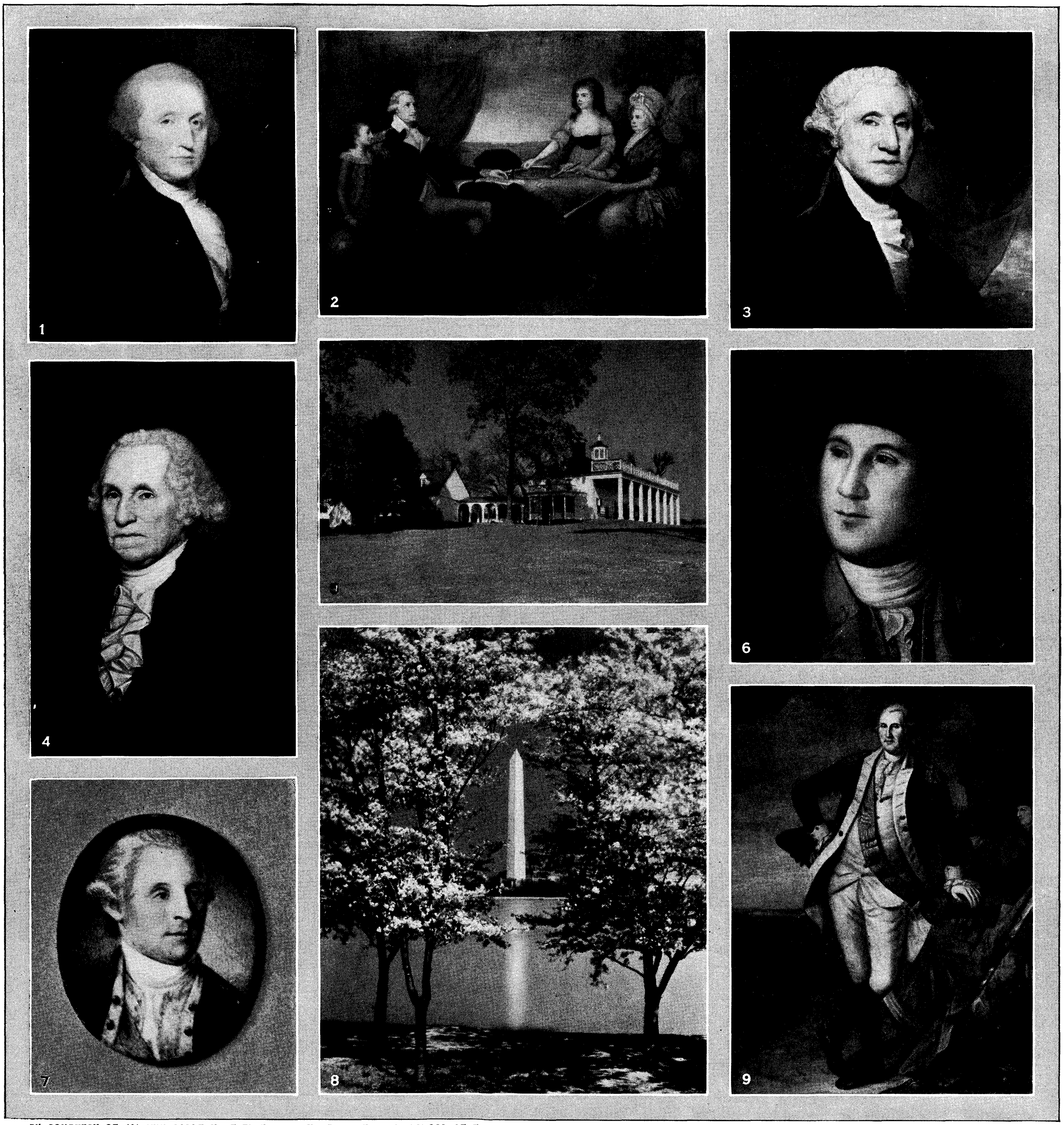
Returning to Virginia in November, he took command of the volunteer companies drilling there and served as chairman of the committee of safety in Fairfax county. The unanimity with which the Virginia troops turned to him, though the province contained many experienced officers and Col. William Byrd of Westover had succeeded Washington as commander in chief, was a tribute to his reputation and personality; it was understood that Virginia expected him to be its general. At the March 1775 session of the legislature he was elected to the second continental congress and again set out for Philadelphia.

Head of the Colonial Forces. — Washington's choice as commander in chief of the military forces of all the colonies followed immediately upon the first fighting, though it was by no means inevitable and was the product of partly artificial forces. The Virginia delegates differed upon his appointment. Washington himself recommended Gen. Andrew Lewis for the post, and Edmund Pendleton was, according to John Adams, "very full and clear against it." It was chiefly the fruit of a political bargain by which New England offered Virginia the chief command as its price for the adoption and support of the New England army. This army had gathered hastily and in force about Boston immediately after the clash of British troops and American minutemen at Lexington and Concord on April 19, 1775. When the second continental congress met in Philadelphia on May 10, one of its first tasks was to find a permanent leadership for this force. On June 15 Washington, whose military counsel had already proved invaluable on two committees, was nominated and chosen by unanimous vote. Beyond the considerations noted, he owed his choice to the fact that Virginia stood with Massachusetts as one of the most powerful colonies; that his appointment would augment the zeal of the southern people; that he had made an enduring reputation in the Braddock campaign; and that his poise, sense and resolution had impressed all the delegates. The scene of his election, with Washington darting modestly into an adjoining room and John Hancock flushing with jealous mortification, will always impress the historical imagination; so also will the scene of July 3, 1775, when wheeling his horse under an elm in front of the troops paraded on Cambridge common he drew his sword and took command of the army investing Boston. News of Bunker Hill had reached him before he was a day's journey from Philadelphia, and he had expressed confidence of victory when told how the militia had fought. In accepting the command he refused any payment beyond his expenses and called upon "every gentleman in the room" to bear witness that he disclaimed fitness for it. At once he showed characteristic decision and energy in organizing the raw volunteers, collecting provisions and munitions and rallying congress and the colonies to his support.

The first phase of Washington's command covered the period from July 1775 to the British evacuation of Boston in March 1776. In those eight months he imparted discipline to the army, which at maximum strength slightly exceeded 20,000; he dealt with subordinates who, as John Adams said, quarreled "like cats and dogs"; and he kept the siege vigorously alive. Having himself planned an invasion of Canada by Lake Champlain, to be entrusted to Gen. Philip Schuyler, he heartily approved of Benedict Arnold's proposal to march north along the Kennebec river and take Montreal and Quebec. Giving Arnold 1,100 men, he instructed him to do everything possible to conciliate the Canadians. He was equally active in encouraging privateers to attack British commerce. As fast as means offered, he strengthened his army with ammunition and siege guns, bringing heavy artillery from Ticonderoga over the frozen roads early in 1776. His position was at first precarious, for the Charles river pierced the centre of his lines investing the town, and if Howe had moved his 20 veteran regiments boldly up the stream he might have pierced Washington's army and rolled either wing back to destruction. But all the generalship was on Washington's side. Seeing that Dorchester heights, just south of Boston, commanded the city and harbour, and that Howe had unaccountably failed to occupy it, he seized it on the night of March 4, 1776, placing his Ticonderoga guns in position. The British naval commander declared that he could not remain if the Americans were not dislodged, and Howe, after a storm disrupted his plans for an assault, evacuated the city on March 17. He left 200 cannon and invaluable stores of small arms and munitions. After stamping out the smallpox in Boston and collecting his booty, Washington hurried south by land to take up the defense of New York.

Sources of Military Strength. — Washington had won the first round, but there remained five years of war, during which the American cause was repeatedly near complete disaster. It is unquestionable that Washington's strength of character, his ability to hold the confidence of army and people and to diffuse his own courage among them, his unremitting activity and his strong common sense constituted the chief factors in achieving American victory. He was not a great tactician: as Jefferson said later, he often "failed in the field"; he was sometimes guilty of grave military blunders, the chief being his assumption of a position on Long Island in 1776 which exposed his entire army to capture the moment it was defeated. At the outset he was painfully inexperienced, the wilderness fighting of the French war having done nothing to teach him the strategy of maneuvering whole armies. One of his chief faults was his tendency to subordinate his own judgment to that of the generals surrounding him; at every critical juncture, before Boston, before New York, before Philadelphia, in New Jersey, he called a council of war, and in almost every instance accepted its decision. Naturally bold and dashing, as he proved at Trenton, Princeton and Germantown, he repeatedly adopted evasive and delaying tactics on the advice of his associates; however, he did succeed in keeping a strong army in existence and maintaining the flame of national spirit, and when the auspicious moment arrived, he planned the rapid movements which ended the war.

One element of Washington's strength was his sternness as a disciplinarian. The army was continually dwindling and refilling; politics largely governed the selection of officers by congress and the states; and the ill-fed, ill-clothed, ill-paid forces were often half prostrated by sickness and ripe for mutiny. Troops from each of the three sections, New England, the middle states and the south, showed a deplorable jealousy of the others. Washington was rigorous in breaking cowardly, inefficient and dishonest men and boasted in front of Boston that he had "made a pretty good sort of slam among such kind of officers." Deserters and plunderers were flogged; and Washington once erected a gallows 40 ft. high, writing that "I am determined if I can be justified in



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GEORGE WASHINGTON (1732–1799)

1. George Washington as president. Painted, **1793,** in Philadelphia by John Trumbull (1756–1843). In the Gallery of Fine Arts, Yale University
2. "The Washington Family," painted from life in New York and Philadelphia between **1789** and **1796** by Edward Savage (1761–1817). Owned by Thomas B. Clarke and in the Pennsylvania Museum, Fairmount Park, Philadelphia, Pa.
3. The Gibbs-Channing-Avery portrait, **1795,** painted in Philadelphia by Gilbert Stuart (1755–1828). In the Metropolitan Museum of Art, New York
4. Portrait, **1795,** painted from life by Rembrandt Peale **(1778-1860).** Owned by Thomas B. Clarke and in the Pennsylvania Museum
5. Mount Vernon, Virginia, the home of Washington on the Potomac River
6. Study for the **1772** portrait by Charles Willson Peale **(1741-1827)**
7. Washington at 25. Miniature, n.d., attributed to John Singleton Copley **(1737-1815).** In the Metropolitan Museum of Art
8. The Washington Monument at the national capital
9. Portrait representing Washington on the College Campus at Princeton by Charles Willson Peale. In the Pennsylvania Academy of the Fine Arts, Philadelphia

the proceeding, to hang two or three on it, as an example to others." At the same time the commander in chief won the devotion of many of his men by his earnestness in demanding better treatment for them from congress. He complained of their short rations, declaring once that they were forced to "eat every kind of horse food but hay."

Campaigns in Middle Colonies.—The darkest chapter in Washington's military leadership was opened when, reaching New York in April 1776, he placed half his army, about 9,000 men, under Israel Putnam, on the perilous position of Brooklyn heights, Long Island, where a British fleet in the East river might cut off their retreat. He spent a fortnight in May with the continental congress in Philadelphia, then discussing the question of independence; and though no record of his utterances exists, there can be no doubt that he advocated complete separation His return to New York preceded but slightly the arrival of the British army under Gen. Sir William Howe, which made its main encampment on Staten Island till its whole strength of nearly 30,000 could be mobilized. On Aug. 22, 1776, Howe moved about 20,000 men across to Gravesend bay on Long Island. Four days later, sending the fleet under command of his brother Adm. Richard Howe to make a feint against New York city, he thrust a crushing force along feebly protected roads against the American flank. The patriots were outmaneuvered, defeated and suffered a total loss of 5,000 men, of whom 2,000 were captured. Their whole position might have been carried by storm, but fortunately for Washington, General Howe delayed. While the enemy lingered, Washington succeeded under cover of a dense fog in ferrying the remaining force across the East river to Manhattan, where he took up a fortified position. The British, suddenly landing on the lower part of the island, drove back the Americans in a clash marked by disgraceful cowardice on the part of Connecticut and other troops. In a series of actions Washington was forced northward, more than once in danger of capture, till the loss of his two Hudson river forts, one of them with 2,600 men, compelled him to retreat from White Plains across the river into New Jersey. There he slowly retired toward the Delaware, and as he went his army melted away, till it seemed that armed resistance to the British was about to expire.

It was at this darkest hour of the Revolution that Washington struck his brilliant blows at Trenton and Princeton, reviving the hopes and energies of the nation, Howe, believing the American army soon would dissolve totally, retired to New York, leaving strong forces in Trenton and Burlington. Washington at his camp west of the Delaware planned a simultaneous attack on both posts, using his whole command of 6,000 men. But his subordinates in charge of both wings failed him, and he was left on the night of Dec. 25, 1776, to march on Trenton with about 2,400 men. He completely surprised the unprepared Hessians and after confused street fighting killed the commander, Rall, and captured 1,000 prisoners, with arms and ammunition. The immediate result was that General Cornwallis hastened with 8,000 men to Trenton, where he found Washington strongly posted behind the Assunpink river, skirmished with him and decided to wait overnight "to bag the old fox."

During the night the wind shifted, the roads froze hard, and Washington was able to steal away from camp, leaving his fires deceptively burning, march around Cornwallis' rear and fall at daybreak upon the three British regiments at Princeton. These were put to flight with a loss of 500 men, and Washington escaped with more captured munitions to a strong position at Morristown, N.J. The effect of these victories was threefold; they heartened all Americans, brought recruits flocking to camp in the spring and encouraged foreign sympathizers with the American cause. (See also TRENTON AND PRINCETON, BATTLES OF.)

Valley Forge.—Thus far the important successes had been won by Washington; then they fell to others, while he was left to face popular apathy, military cabals and the disaffection of congress. The year 1777 was marked by the British capture of Philadelphia and the surrender of Burgoyne's invading army to Gates at Saratoga (*see* SARATOGA, BATTLES OF) followed by intrigues to displace Washington from his command. Howe's main British army of 18,000 left New York by sea on July 23, 1777, and landed on Aug. 25 in Delaware not far below Philadelphia. Washington, despite his inferiority of force, for he had only 11,000 men, mostly militia and in La Fayette's words "badly armed and worse clothed," risked a pitched battle on Sept. 11 at the fords of Brandywine creek, about 13 mi. north of Wilmington. While part of the British force held the Americans engaged, Cornwallis with the rest made a secret 17-mi. detour and fell with crushing effect on the American right and rear, the result being a complete defeat, from which Washington was fortunate to extricate his army in fairly good order. For a time he hoped to hold the Schuylkill fords, but the British passed them and on Sept. 26 triumphantly marched into Philadelphia. Congress fled to the interior of Pennsylvania, and Washington, after an unsuccessful effort to repeat his stroke at Trenton against the British troops posted at Germantown, had to take up winter quarters at Valley Forge. His army, twice-beaten, ill-housed, and ill-fed, with thousands of men "barefoot and otherwise naked," was at the point of exhaustion; it could not keep the field, for inside of a month it would have disappeared. Under these circumstances, there is nothing which better prcves the true fibre of Washington's character and the courage of his soul than the unyielding persistence with which he held his strong position at Valley Forge through a winter of semistarvation, of justified grumbling by his men, of harsh public criticism and of captious meddling by a congress too weak to help him.

Intrigues.—Washington's enemies seized the moment of his greatest weakness to give vent to an antagonism which had been nourished by sectional jealousies of north against south, by the ambition of small rivals and by baseless accusations that he showed favouritism to such foreigners as La Fayette. The intrigues of Thomas Conway, an Irish adventurer who had served in the French army and had become American inspector general, enlisted Thomas Mifflin, Charles Lee, Benjamin Rush and others in an attempt to displace Washington. Gen. Horatio Gates appears to have been a tool of rather than a party to the plot, expecting that the chief command would devolve upon himself. A faction of congress sympathized with the movement and attempted to paralyze Washington by reorganizing the board of war, a body vested with the general superintendence of operations, of which Gates became president; his chief of staff, James Wilkinson, the secretary; and Mifflin and Timothy Pickering, members. Washington was well aware of the hostility in congress, of the slanders spread by Dr. Rush and James Lovell of Massachusetts and of the effect of forgeries published in the American press by adroit British agents. He realized the intense jealousy of many New Englanders, which made even John Adams write his wife that he was thankful Burgoyne had not been captured by Washington, who would then "have been deified. It is bad enough as it is." But Washington decisively crushed the cabal when, the loose tongue of Wilkinson having disclosed Conway's treachery, he sent the latter officer on Nov. 9, 1777, proof of his knowledge of the whole affair.

With the conclusion of the French alliance in the spring of 1778 the aspect of the war was radically altered; and the British army in Philadelphia, fearing that a French fleet would blockade the Delaware while the militia of New Jersey and Pennsylvania invested the city, hastily retreated upon New York city. Washington hoped to cut off part of the enemy, and by a hurried march with six brigades interposed himself at the end of June between Sir Henry Clinton (who had succeeded Howe) and the Jersey coast. The result was the battle of Monmouth on June 28, where a shrewd strategic plan and vigorous assault were brought to naught by the treachery of Charles Lee (*see* MONMOUTH COURT HOUSE, BATTLE OF). When Lee ruined the attack by a sudden order to retreat, Washington hurried forward, fiercely denounced him and restored the line, but the golden opportunity had been lost. The British made good their march to Sandy Hook and Washington took up his quarters at New Brunswick. Lee was arrested, court-martialed and convicted on all three of the charges made against him; but instead of being shot, as he deserved, he was sentenced to a suspension from command for one year. The arrival of the French fleet under D'Estaing in July 1778 completed the isolation of the British and Clinton was thenceforth held to

New York city and the surrounding area. Washington made his headquarters in the highlands of the Hudson, and distributed his troops in cantonments around the city and in New Jersey.

Yorktown.—The final decisive stroke of the war, the capture of Cornwallis at Yorktown, is to be credited chiefly to Washington's vision. With the domestic situation intensely gloomy early in 1781, he was hampered by the feebleness of congress, the popular discouragement and the lack of prompt and strong support by the French fleet. A French army under Rochambeau having arrived to reinforce him in 1780, he pressed Admiral De Grasse to assist in an attack upon either Cornwallis in the south or Clinton in New York. In August the French admiral sent definite word that he preferred the Chesapeake, with its large area and deep water, as the scene of his operations; and within a week, on Aug. 19, 1781, Washington marched south with his army, leaving Heath with 4,000 men to hold West Point. He hurried his troops through New Jersey, embarked them on transports in Delaware bay and landed them at Williamsburg, Va., where he had arrived on Sept. 14. Cornwallis had retreated to Yorktown and entrenched his army of 7,000 British regulars. Their works were completely invested before the end of the month; the siege was pressed with vigour by the allied armies under Washington, consisting of 5,500 Continentals, 3,500 Virginia militia and 5,000 French regulars; and on Oct. 19 Cornwallis surrendered. By this campaign, probably the finest single display of Washington's generalship, the war was brought to a virtual close.

Washington remained during the winter of 1781–82 with the continental congress in Philadelphia, exhorting it to maintain its exertions for liberty and to settle the army's claims for pay. He continued these exhortations after he joined his command at Newburgh on the Hudson in April 1782. He was astounded and angered when some loose camp suggestions found expression in a letter from Col. Lewis Nicola offering a plan by which he should use the army to make himself king. He blasted the proposal with fierce condemnation. When the discontent of his unpaid men came to a head in the circulation of the "Newburgh address" early in 1783, he issued a general order censuring the paper, and at a meeting of officers on March 15 read a speech admonishing the army to obey congress and promising his best efforts for a redress of grievances. He was present at the entrance of the American army into New York on the day of Clinton's evacuation, Nov. 25, 1783, and on Dec. 4 took leave of his closest officers in an affecting scene at Fraunces' tavern. Traveling south, on Dec. 23, in a solemn ceremonial immortalized by the pen of Thackeray, he resigned his commission to the continental congress in the state senate chamber of Maryland in Annapolis and received the thanks of the nation. His accounts of personal expenditures during his service, kept with minute exactness in his own handwriting and totaling £24,700, without charge for salary, had been given the controller of the treasury to be discharged. Washington left Annapolis at sunrise of Dec. 24 and before nightfall was at home in Mount Vernon. (See also AMERICAN REVOLUTION, THE.)

In the next four years Washington found sufficient occupation in his estates, wishing to close his days as a gentleman-farmer and giving to agriculture as much energy and thought as to the army. He enlarged the Mount Vernon house in 1786; he laid out the grounds anew, with sunken walls or ha-has; and he embarked on experiments with mahogany, palmetto, pepper and other foreign trees, English grasses and grains. His farm manager during the Revolution, a distant relative named Lund Washington, retired in 1785 and was succeeded by a nephew, Maj. George Augustine Washington, who resided at Mount Vernon till his death in 1792. Washington's losses during the war had been heavy, caused by neglect of his lands, stoppage of exportation and a depreciation of paper money, which cost him hardly less than $30,000. He then attempted successfully to repair his fortunes, his annual receipts from all his estates being from $10,000 to $15,000 a year. In 1784 he made a tour of nearly 700 miles to view the wild lands he owned to the westward, congress having made him a generous grant. As a national figure, he was constrained to offer hospitality to old army friends, visitors from other states and nations, diplomats and Indian delegations, and he and his household seldom sat down to dinner alone.

A More Perfect Union.—Viewing the chaotic political condition of the United States after 1783 with frank pessimism and declaring (May 18, 1786) that "something must be done, or the fabric must fall, for it is certainly tottering," Washington repeatedly wrote his friends urging steps toward "an indissoluble union." At first he believed that the Articles of Confederation might be amended. Later, especially after the shock of Shays's rebellion, he took the view that a more radical reform was necessary but doubted as late as the end of 1786 that the time was ripe. His progress toward adoption of the idea of a federal convention was, in fact, puzzlingly slow. Though John Jay assured him in March 1786 that breakup of the nation seemed near and opinion for the convention was crystallizing, Washington remained noncommittal. But despite long hesitations, he earnestly supported the proposal for a federal impost, warning the states that their policy must decide "whether the Revolution must ultimately be considered a blessing or a curse." And his numerous letters to the leading men of the country assisted greatly to form a sentiment favourable to a more perfect union. Some understanding being necessary between Virginia and Maryland regarding the navigation of the Potomac, commissioners from the two states met at Mount Vernon in the spring of 1785; from this seed sprang the federal convention. Washington approved in advance the call for a gathering of all the states to meet in Philadelphia in May 1787 to "render the Constitution of the Federal Government adequate to the exigencies of the Union." But he was again hesitant about attending, partly because he felt tired and infirm, partly because of doubts about the outcome. Although he hoped to the last to be excused, he was chosen one of Virginia's five delegates.

Washington arrived in Philadelphia on May 13, the day before the opening of the convention, and as soon as a quorum was obtained was unanimously chosen its president. For four months he presided over the constitutional convention, breaking his silence only once upon a minor question of congressional apportionment. Though he said little in debate no one did more outside the hall to insist on stern measures. "My wish is," he wrote, "that the convention may adopt no temporizing expedients, but probe the defects of the Constitution to the bottom, and provide a radical cure." His weight of character did more than any other single force to bring the convention to an agreement and obtain ratification of the instrument afterward. He did not believe it perfect, though his precise criticisms of it are unknown. But his support gave it victory in Virginia, where he sent copies to Patrick Henry and other leaders with a hint that the alternative to adoption was anarchy; while a letter of his published in a Boston newspaper, declaring that "it or dis-union is before us to chuse from," told powerfully in Massachusetts. He received and personally circulated copies of the Federalist. When once ratification was obtained, he wrote leaders in the various states urging that men stanchly favourable to it be elected to congress. For a time he sincerely believed that, the new framework completed, he would be alloued to retire again to privacy. But all eyes immediately turned to him for the first president. He alone commanded the respect of both the parties engendered by the struggle over ratification, and he alone would be able to give prestige to the republic throughout Europe. In no state was any other name considered. The electors chosen in the first days of 1789 cast a unanimous vote for him, and reluctantly—for his love of peace, his distrust of his own abilities and his fear that his motives in advocating the new government might be misconstrued all made him unwilling—he accepted.

On April 16, after receiving congressional notification of the honour, he set out from Mount Vernon, reaching New York in time to be inaugurated on April 30. The ceremony was performed in Wall street, near the spot now marked by Ward's statue of Washington, and a great crowd broke into cheers as, standing on the balcony of Federal hall, he took the oath administered by Chancellor Livingston and retired indoors to read congress his inaugural address.

President of the United States.—Washington's administration of the government in the next eight years was marked by the caution, the methodical precision and the sober judgment which had always characterized him. He regarded himself as standing aloof from party divisions and emphasized his position as president of the whole country by a tour first through the northern states and later through the southern. A painstaking inquiry into all the problems confronting the new nation laid the basis for a series of judicious recommendations to congress in his first message. In selecting the four members of his first cabinet, Thomas Jefferson as secretary of state, Alexander Hamilton as secretary of treasury, Henry Knox as secretary of war and Edmund Randolph as attorney general, Washington balanced the two parties evenly. But he leaned with especial weight upon Hamilton, supporting his scheme for the assumption of state debts, taking his view that the bill establishing the Bank of the United States was constitutional and in general strengthening the authority of the federal government. Distressed when the inevitable clash between Jefferson and Hamilton arose, he tried to keep harmony, writing frankly to each and refusing to accept their resignations.

But when war was declared between France and England in 1793, he again took Hamilton's view that the United States should completely disregard the treaty of alliance with France and pursue a course of strict neutrality, while he acted decisively to stop the improper operations of the French minister, Genet. He had a firm belief that the United States must insist on its national identity, strength and dignity. His object, he wrote, was to keep the country "free from political connections with *every* other country, to see them independent of all, and under the influence of none. In a word, I want an *American* character that the powers of Europe may be convinced that we act for *ourselves,* and not for others." The sequel was the resignation of Jefferson at the close of 1793, the two men parting on good terms and Washington praising Jefferson's "integrity and talents." The suppression of the Whisky insurrection (*q.v.*) in 1794 by federal troops whom Hamilton led in person and the dispatch of John Jay to conclude a treaty of commerce with Great Britain tended further to align Washington with the Federalist party. Though the general voice of the people compelled him to acquiesce reluctantly to a second term in 1792 and his election that year was again unanimous, during his last four years in office he suffered from a fierce personal and partisan animosity. This culminated when the publication of the terms of the Jay treaty, which Washington signed on June 25, 1795, provoked a bitter discussion, and the house of representatives called upon the president for the instructions and correspondence relating to the treaty. These Washington, who had already clashed with the senate on foreign affairs, refused to deliver, and in the face of an acrimonious debate firmly maintained his position.

Early in his first term Washington, who by education and natural inclination was minutely careful of the proprieties of life, established the rules of a virtual republican court. In both New York and Philadelphia he rented the best houses procurable, refusing to accept the hospitality of George Clinton, for he believed the head of the nation should be no man's guest. He returned no calls and shook hands with no one, acknowledging salutations by a formal bow. He drove in a coach drawn by four or six smart horses and with outriders and lackeys in rich livery. He attended receptions dressed in a black velvet suit with gold buckles, with yellow gloves, powdered hair, a cocked hat with an ostrich plume in one hand and a sword in a white leather scabbard. After being overwhelmed by callers, he announced that except for a weekly levee open to all, persons desiring to see him must make previous engagements. On Friday afternoons Mrs. Washington held more informal receptions, at which the president appeared and chatted gravely with both ladies and gentlemen. Though the presidents of the continental congress had made their tables partly public, Washington, who entertained largely, inviting members of congress in rotation, insisted that his hospitality be entirely private. He served good wines and the menus were elaborate, but such visitors as Senator Maclay complained that the atmosphere was too "solemn." Indeed, his simple ceremony offended many of the more radical antifederalists, who did not share his sense of its fitness and accused the president of conducting himself as a king. But his cold and reserved manner was caused by native diffidence rather than any excessive sense of dignity.

Retirement. — Earnestly desiring leisure, feeling a decline of his physical powers and wincing under opposition abuse, Washington refused to yield to the general pressure for a third term. This refusal was blended with a testament of sagacious advice to his country in the *Farewell Address* of Sept. 19, 1796, written largely by Hamilton but remolded by Washington and expressing his ideas. Retiring in March 1797 to Mount Vernon, he devoted himself for the last two and a half years of his life to his family, farm operations and care of his slaves. In 1798 his seclusion was briefly threatened when the prospect of war with France caused his appointment as commander in chief of the provisional army, and he was much worried by the political quarrels over high commissions; but the war cloud passed away. On Dec. 12, 1799, he exposed himself on horseback for several hours to cold and snow and, returning home exhausted, was attacked late next day with quinsy or acute laryngitis. He was bled heavily four times and given gargles of "molasses, vinegar and butter," and a blister of cantharides (a preparation of dried beetles) was placed on his throat, his strength meanwhile rapidly sinking. He faced the end with characteristic serenity, saying, "I die hard, but I am not afraid to go," and later: "I feel myself going. I thank you for your attentions; but I pray you to take no more trouble about me. Let me go off quietly. I cannot last long." After giving instructions to his secretary, Tobias Lear, about his burial, he died at 10 P.M. on Dec. 14 without pain or struggle. The news of his death placed the entire United States in mourning, and the sentiment of the country permanently endorsed the famous words of Henry Lee, embodied in resolutions which John Marshall introduced in the house of representatives, that he was "first in war, first in peace, and first in the hearts of his countrymen." When the news reached Europe the British channel fleet and the armies of Napoleon paid tribute to his memory; and many of the political and intellectual leaders of the time joined in according him a pre-eminent place among the heroes of history.

BIBLIOGRAPHY.—The earliest known portrait of Washington is that by Charles Willson Peale, painted in 1772. A long line of painters and sculptors followed, and their work may be found criticized in Justin Winsor's *Narrative and Critical History of America,* vol. vii. Washington himself thought highly of the likeness by Joseph Wright, painted in 1782. According to Winsor, the favourite profile is Houdon's, while Gilbert Stuart's canvas had been popularly preferred for the full face and John Trumbull's florid paintings for the whole figure. Stuart's pictures are somewhat idealized, while all the later portraits suffer from the fact that the artificial teeth worn by Washington in later years altered the expression of his face. Houdon's statue hardly does justice to Washington's imposing stature; he was 6 ft. 3 in. tall in his prime and weighed 220 lb., carrying himself with great dignity and poise. But the Houdon bust, modeled from life at Mount Vernon, is excellent. For the iconography see Gustav Eisen, *Portraits of Washington,* in 3 vol. (1932).

The fullest compilation of Washington's *Writings* is the United States bicentennial commission edition, edited by John C. Fitzpatrick in 39 vol. (1931–44). This displaces the older works, Worthington C. Ford, *The Writings of George Washington* in 14 vol (1889–93), and Jared Sparks's edition in 12 vol. (1834–37). John C. Fitzpatrick has separately edited Washington's *Diaries* in 4 vol. (1925). Much the fullest and best biography is that by Douglas Southall Freeman in 6 vol. (1948–54), which is supplemented by a seventh volume written by his associates John A. Carroll and Mary A. Ashworth (1957). Among good earlier biographies now corrected by Freeman are those by John Marshall (including plagiarized material) in 5 vol. (1804–07); Washington Irving, also in 5 vol. (1855–59); Edward Everett Hale (1888); Henry Cabot Lodge (1889); Woodrow Wilson (1897); Worthington C. Ford (1899); and Norman Hapgood (1901). Rupert Hughes published an incomplete 3-vol. biography in 1926–29. The best recent 1-vol works are John C. Fitzpatrick, *George Washington Himself* (1933); Shelby Little, *George Washington* (1931); and Marcus Cunliffe, *George Washington: Man and Monument* (1958).

Valuable studies on special aspects of Washington's career include Charles H. Ambler, *George Washington and the West* (1936); Hugh Cleland, *George Washington in the Ohio Valley* (1956); John Corbin, *The Unknown Washington,* largely on his constitutional ideas (1930); Paul Leland Haworth, *George Washington, Country Gentleman* (1925); Eugene E. Prussing, *The Estate of George Washington, Deceased* (1927); Thomas G. Frothingham, *Washington, Commander in Chief* (1930); H. L. Ritter, *Washington As a Business Man* (1931); and Charles W Stetson, *Washington and his Neighbors* (1956). Paul Leicester Ford's *The True George Washington* (1896) is a classic examination of all sides of Washington's career and personality, while

Charles Moore has examined *The Family Life of George Washington* (1926). For a treatment of the military and political background of the times *see* the large histories by W. E. H. Lecky, George Otto Trevelyan, George Bancroft, Justin Winsor, John Bach McMaster, Edward Channing and L. H. Gipson. The best work on Martha Washington is by Anne Hollingsworth Wharton (1897), supplemented by Paul Wilstach, *Mount Vernon, Washington's Home and the Nation's Shrine* (1916). (*A.* N.)

WASHINGTON, HENRY STEPHENS (1867–1934), U.S. petrologist whose *Manual of the Chemical Analysis of Rocks* (4 ed., 1904 to 1930) became standard for students throughout the world, was born on Jan. 15, 1867, in Newark, N.J. Washington and three associates devised a "Quantitative Classification of Igneous Rocks" published in the *Journal of Geology* in 1902. He used this framework in tabulating 8,600 rock analyses which he collected from world-wide literature for the years 1884 to 1913 inclusive, resulting in his *Chemical Analyses of Igneous Rocks* published in 1917 by the United States geological survey, which continued the work for the years 1914 to 1953. Washington was an organizer, in 1919, of the International Union of Geodesy and Geophysics. He was co-author of a chapter on the constitution of the earth (a National Research council publication in 1951). He died on Jan. 7, 1934, in Washington, D.C. (H. E. ME.)

WASHINGTON, nicknamed the "Evergreen state" for its extensive forests of fir and pine and "Chinook state" for its salmon industry, is a state of the Pacific northwest of the United States. It is bounded on the north by the Canadian province of British Columbia (at the 49th parallel); on the east by Idaho; on the south by Oregon and the Columbia river; and on the west by the Pacific ocean, the Strait of Juan de Fuca and Puget sound. Its extreme length east and west is 341 mi., its extreme width north and south is 238 mi.; and its total area is 68,192 sq.mi., of which 66,709 is land area, including 1,483 sq.mi. of inland water surface, and 530 sq.mi. is boundary water (Puget sound). It is 20th in size among the states, being, with the exception of Hawaii, the smallest state west of Iowa. Washington was proclaimed a state Nov. 11, 1889, becoming the 42nd state in the union; the capital is Olympia. The state bird is the willow goldfinch, the state flower is the coastal rhododendron and the state tree is the western hemlock (*Tsuga heterophylla*). The state flag is dark green bearing in its centre a reproduction of the state seal, a circle bearing the legend "The Seal of the State of Washington 1889" around a bust of George Washington. In 1853 Columbia was suggested as the name of the prospective territory, but because it resembled that of the federal district, Washington was substituted.

PHYSICAL GEOGRAPHY

Physical Features and Soils.—Washington, in fact the entire Pacific northwest, lies within the realm of the western cordillera of the western hemisphere. The state lies between the extremes of approximately latitude 45° 34' and 49" N. and longitude 116° 57' and 124° 48' W. Volcanism and glaciation have been responsible for most of the landscape and soil cover. The region lies within the "Pacific ring of fire," and the highest peaks in the Cascade range are extinct volcanoes. Mt. Rainier (14,410 ft.), Mt. Adams (12,307 ft.), Mt. Baker (10,778 ft.), Glacier peak (10,528 ft.) and Mt. St. Helens (9,677 ft.) were built upon an older mountain system during the Pleistocene period of geologic history.

The Olympic mountains and the Willapa hills come so near to the Pacific shore line that there is only a very narrow coastal lowland. Mt. Olympus (7,954 ft.) is the highest point in the rugged Olympic peninsula. Immediately to the east is the Cowlitz-Puget trough, the northern end of which, Puget sound, is submerged and provides one of two of the largest natural harbours on the Pacific coast of the western hemisphere. Rivers flowing into the sound have silted up their estuaries to form rich farm lands.

The Cascade range, which divides the state into two distinct geographic sections, extends from British Columbia to the Columbia river: Its width at the international boundary is about 100 mi., and it narrows to 50 mi. at the river where its gorge provides the only good break through the Cascade-Sierra Nevada mountain chain in a distance of over 1,000 mi.

East of the Cascades lies a large interior region known as the Inland empire. A merging of the Okanogan highlands and the frontal ranges of the Rockies forms a northern enclosure. To the south and east lies the Columbia plateau, which is one of the largest and deepest lava beds in the world. Parts of it are covered with thick layers of glacial material, other portions have had their topsoil washed away by glacial melt water, so that bedrock protrudes through thin but rich soil. Rivers fed by glacial waters also carved deep trenches called coulees, of which the Grand coulee is the most formidable. It is a depression from 500 to 1,000 ft. in depth and about 50 mi. in length. The upper half of the coulee is used as an equalizing reservoir to store water for the Columbia river basin project. Farther to the south and the east is the Palouse country, a hilly area where winds and snow have deposited thick layers of sediments of volcanic and glacial origin. A unique soil of exceptional depth and fertility has developed from these sediments. In the central part of the state, the Big Bend country and the Columbia basin are semiarid but, by the use of dry-farming methods and irrigation, good crops are produced with consistency. (*See* also COLUMBIA RIVER.)

Climate.—Because of the north-south direction of the mountain ranges which lie athwart the prevailing westerly winds, the climatic zones of the state assume an essentially north-south orientation. Air, thick with moisture, reaching the state from the west has a cooling effect in summer and a warming influence in winter. Whereas this moderating factor extends to the interior, the weather, nevertheless, varies pronouncedly in different parts of the state. Along the coast line, precipitation is excessive—at one point in the south foothills of the Olympic mountains it exceeds 140 in. West of the Cascades the mean annual temperature is very moderate, and the annual range is but 15°–30° F. The interior, on the other hand, is semiarid and desert conditions prevail along the Columbia river at Hanford, which has but 6 in. of precipitation a year. Some places have an extreme annual temperature range of over 120° F. There are areas in western Washington that have 280 days free of killing frost; Walla Walla has 200 such days. Other parts of the interior, however, have only 100.

The Rocky mountains generally shield the state from easterly and northeasterly winds generated on the northern Great Plains. However, when the winds become sufficiently intense, they occasionally surmount or break through the barrier and cause cold spells, called "cow killers" in olden days. A mild fohn wind, known as a chinook (*q.v.*), sometimes brings relief and removes snow.

Due to peculiar circumstances, the weather of the state tends to be dry and stable in late spring and summer and wet and capricious in winter. This is in reverse of the situation in most parts of the United States.

Vegetation and Animal Life.—The Douglas fir, Washington's most important lumber tree, grows on both the east and west slopes of the Cascades, but reaches its greatest dimensions in the west, growing on hills and benches at elevations from near sea level to more than 5,000 ft. Some Douglas firs reach a height of 300 ft., with diameters of 12 to 15 ft. Western red cedar, also important, attains a height of up to 200 ft. and a diameter of up to 10 ft. Ponderosa pine (some of which reach a height of 175 ft. with a diameter of 6 ft.), with an average height of about 100 ft. and diameter of 3 ft., is the most valuable tree of the eastern part of the state. Other important trees include the western hemlock, which grows in all parts of the state, and the Sitka spruce, growing in the coastal fog belt. Grand, silver, noble and alpine firs are common, as is the western larch. More than 3,000 species of wild flowers, shrubs, vines, ferns and mosses are found in the state from the ocean shore and the humid western slopes of the Cascades to the mountain ranges, the Columbia basin and the semiarid plateaus. Among the most spectacular is the state flower, the rhododendron.

The abundant animal life attracted the pioneer hunters and fur traders. Elk, deer and bear may be found in the forests and mountains. Mountain goats have increased in numbers under the protection of conservation laws. Fur-bearing animals include large numbers of beavers, martens, muskrats, skunks, weasels, otter, mink, raccoons, opossums and foxes. Important carnivorous animals are the coyote, bobcat and mountain lion. Because of the extensive forests and wide differences in climate and topography, the state supports a large and varied bird population, including ducks, geese and other migratory waterfowl, pheasants, grouse, sage hens and other upland game birds and numerous species of songbirds. Native fish include the rainbow, steelhead, cutthroat, silver and Dolly Varden trouts; eastern brook, Mackinaw and Loch Leven trouts and bass, perch, crappie, catfish and sunfish have been introduced. Many of the lakes were barren until successfully stocked by the state, which operates 25 hatcheries. Five species of salmon, including the Chinook, or king, salmon, are found there and the rivers, sounds and coastal and offshore waters teem with many varieties of fish, shellfish and other marine life.

State and National Parks.—The state park system includes more than 60 parks, historical, geological and other areas. Deception Pass State park has had the largest total number of visitors, and Twin Harbors State park the largest number of night campers. The Dry falls of the Grand coulee, 400 ft. high and about 3 mi. wide, on the prehistoric Columbia river, are a part of Sun Lakes State park. State game and recreation areas include Banks lake and Potholes and Long lake reservoirs.

National parks in the state include Olympic National park, almost 1,400 sq.mi. of wilderness area on the Olympic peninsula, and Mt. Rainier National park, containing 378 sq.mi., with 26 glaciers on the 14,410-ft, mountain. The national park service also administers the Coulee dam national recreation area, which includes the Franklin D. Roosevelt lake, formed by Grand Coulee dam across the Columbia river. Fort Vancouver National monument, western headquarters of the Hudson's Bay company, 1825–49, and U.S. military reservation for 100 years thereafter, was established in 1954. Whitman National monument, site of the mission set up by Marcus Whitman (see *History: Joint Occupation,* below) and scene of the Whitman massacre in 1847, was established in 1940.

HISTORY

Exploration and Early Settlement.—For most of its history, the Pacific northwest has had the misfortune of being appraised from the standpoint of its geographic position rather than its economic potentialities or its inherent attractiveness for living. Early European mariners sought the region with a view of discovering a passage to the far east, but the first men on record to have seen the region were Juan Pérez, in 1774, and Bruno Heceta, the following year. Sent to determine the status of Russians in Alaska, they described the shore line, and Heceta's men were the first white persons known to have set foot on Washington soil.

Of more enduring significance were the exploits of Capt. James Cook. In 1778, on his third voyage to the Pacific, he discovered the Hawaiian Islands, which he named Sandwich Islands; visited the coast of the Pacific northwest; and put in at Nootka sound for repairs. His crew gathered a lucrative cargo of furs, the sale of which at Canton gave impetus to the maritime fur trade. Notable were the achievements of those who followed. Capt. Charles Barkley, whose wife was the first white woman known to have visited the northwest coast, discovered the Strait of Juan de Fuca in 1787. Capt. John Meares sailed into this passage the following year and bestowed upon it the name of the apocryphal explorer. Capt. George Vancouver, whose mission was both diplomatic and exploratory, surveyed Puget sound and the waters behind Vancouver Island in most expert fashion in 1792. The same year, Robert Gray, a Boston mariner, discovered the Columbia river and thereby gave the United States its first claim to the "Oregon country," as the land drained by the river was called. Later in the year, Vancouver's second in command, William Broughton, also entered the river and made an even more extensive reconnaissance. The maritime fur trade, ruthlessly exploitative, declined rapidly thereafter.

Overland explorations to the Pacific, which previously had proved abortive, succeeded at the turn of the century. Alexander Mackenzie, a Scotsman and partner in the North West company, made the first crossing of North America by a northern route in 1792–93. He did not, however, find "the river of the West." This honour fell to Meriwether Lewis and William Clark, who in 1805–06 reached the main course of that stream. They entered Washington from Idaho by the Snake river which they followed to the Columbia which in turn took them to the sea. They returned by substantially the same route.

David Thompson, a dauntless explorer and superb geographer for the North West company, built posts, called "houses," in the upper courses of the Columbia. One, Spokane house, built in 1810 near the juncture of the Little Spokane and Spokane rivers, became the first building constructed by white men in Washington. John Jacob Astor's Pacific Fur company, a subsidiary of the American Fur company, used Astoria as its regional base of operations. Ft. Okanogan and Ft. Spokane, opposite Spokane house, were interior posts. Misfortunes, chiefly at sea, and the War of 1812 prompted authorities at Astoria in Oct. 1813 to sell out to the North West company, which then had the trade of the region to itself until it was absorbed by the Hudson's Bay company in 1821. Under John McLoughlin, "Father of Oregon" and chief factor of the department of the Columbia, this giant corporation maintained a successful monopoly and warded off the onslaughts of what the company regarded as American interlopers.

Joint Occupation.—The Oregon country did not become the subject of serious diplomatic discussion until after the War of 1812. Spain, in 1819, and Russia, in 1824–25, accepted boundary adjustments on the Pacific slope which eliminated them from the Columbia drainage area. Britain and the United States, the remaining claimants, recognized the ultimate significance of the region but felt themselves too ill-informed to make a final disposition. In 1818 they made a ten-year agreement, erroneously called "joint occupation." The subjects of either government could settle without impairing the claims of the other. In 1827 the arrangement was renewed indefinitely subject to termination by either power upon 12 months' notice. This approach proved workable until the flood of Americans poured over the Oregon trail in the 1840's. It soon became obvious to the Hudson's Bay company that settlement spelled doom to a declining fur trade on the Columbia. Both American and British statesmen also realized that delay in achieving a final boundary solution endangered the peace. Because this and other factors were propitious to the United States position, the treaty of 1846 favoured the U.S. by extending the 49° parallel boundary westward from the Rockies to the Strait of Georgia. The privileges and properties of the Hudson's Bay company were guaranteed but later relinquished for $650,000.

The Indians of the Pacific northwest, on the whole peaceably inclined, had been curious about the white man's religion to which they attributed his extraordinary powers. In 1831 a delegation of Flathead and Nez Perce Indians visited St. Louis to request the "black robes" and the "Book." Methodists and American board missionaries responded. Marcus Whitman, representing the latter, located a station at Wailatpu, near the present city of Walla Walla. Two Catholic secular priests, Fathers Francois Norbert Blanchet and Modeste Demers, went in 1838 to serve the Canadian elements among the fur traders and retired employees. To familiarize the Indians with the history of the church, they devised a chart on a long board called the "Catholic ladder." Jesuits established missions on the upper Columbia. The presence of several denominations, each claiming to represent the only true faith, the influx of immigrants, often carrying disease, and a knowledge of what had happened to Indians in the east produced a confused situation culminating in the Whitman massacre of Nov. 29, 1847. It set back missionary activity in the interior for over a decade.

During the 1830s there were sprinklings of white persons along the Willamette and lower Columbia rivers. In 1842 American pioneers went over the Oregon trail. Congress, probably out of deference to the joint occupation agreement, had done nothing to provide law or civil government for the Oregon country. When the settlers were confronted with this void, they impaneled their own grand and petit juries, designated persons to act as guardians and as executors of estates, instituted bounties on predatory animals and finally, in 1843, established a provisional government which lasted five years. It brought the Oregon country through the crisis of the Whitman massacre and the resulting Cayuse War. In the act of Aug. 14, 1848, creating Oregon territory, Congress gave this extralegal regime retroactive recognition.

Achievement of Statehood. — Under Oregon territory, which embraced all of the present Pacific northwest, the people residing north of the Columbia constituted an ineffective minority. Protests against the effects of distance from the seat of government at Salem and neglect of local needs induced congress to create the new territory of Washington, March 2, 1853. Its boundary ran along the Columbia river to the 46th parallel and thence eastward to the crest of the Rocky mountains. Washington did not assume its present shape until Idaho territory was cut away in 1863.

Isaac I. Stevens, the first territorial governor, had also been designated superintendent of Indian affairs. In 1854–55 he negotiated a series of treaties in nhich the Indians agreed to surrender much of their land. Incongruities in the treaties themselves. delay in ratification, nonfulfillment of some of the government's obligations and trespasses by white men resulted in disturbances and bloodshed during the years 1855 to 1859.

Puget sound, much less disturbed during the years of tension and hostilities in the interior, developed at a rapid rate. Tumwater, the first permanent settlement (1845), was followed by Smithfield, later Olympia (1850); Steilacoom (1851); Port Townsend (1852); and Seattle (1852). Commerce, agriculture and lumbering provided the stimulus to this growth. Soon, attention was again directed to the interior, since gold discoveries in the Selkirk ranges in the middle 1850s caused prospectors to flood the Inland empire, as the area east of the Cascades then became known. Walla Walla, the key outfitting point, was the wholesaling metropolis of the region until the middle 1880s. Miners provided an excellent market for local cattle which found the native bunch grass practically a complete food. When the early mining boom, which had been confined largely to placer operations, subsided, new outlets for livestock appeared. It had, furthermore, been discovered that the rich pastures, particularly in the Palouse country, could be converted to grain fields yielding phenomenal crops. New mineral strikes were made during these years and since the new diggings were largely in the nature of lode mines a more stable industry was assured. The growth in wealth and population led to agitation for statehood, and a constitution was drafted in 1878, but congress declined to pass an enabling act. Stock raising and farming rivaled mining as the basis of prosperity. The Northern Pacific railroad projected in the 1860s was completed in 1883 and brought new hordes of settlers to expand the economy. The resulting population increase from 75,116 in 1880 to 357,222 in 1890 (375%) was the territory's best claim to statehood, which was attained Nov. 11, 1889. Growth continued, with rich strikes of gold in the Klondike in 1897, and later in Alaska, stimulating the trade of cities on Puget sound, and the new prosperity was celebrated at the Alaska-Yukon exposition in 1909.

Perhaps the major development in the state through the first half of the 20th century was the Columbia basin and related projects designed for purposes of hydroelectric power generation, irrigation, flood control, navigation improvement and stream flow regulation, and recreation. The first navigation improvement project on the river was authorized in 1911. Construction of Bonneville and Grand Coulee dams in the Columbia basin project began in 1933; Bonneville was completed in 1937 and the main structure of the Grand Coulee in 1941. Irrigation on the project began in 1948 and irrigation with water from behind Grand Coulee dam began in 1952. The power plant at Grand Coulee was completed in 1951. (For details see COLUMBIA RIVER.)

Washington Politics. — Washington state politics have not observed strict party lines. For more than 40 years, the state leaned toward the G.O.P., except for the elections of 1896 when a fusion of Democrats and Populists had been effected; 1912, when Theodore Roosevelt's Progressives captured the state; and 1916, when Woodrow Wilson triumphed. In 1932 the trend was reversed. Democratic candidates for president carried the state from then on to 1938. Except for holdovers, the Democrats monopolized the state's congressional delegation until 1942 and from 1934 to 1960 there has been but one Republican U.S. senator from the state. Democrats have held most of the state's elective offices from 1932 through 1960 and except for the sessions of 1947 and 1949, have had majorities in both houses of the legislature. Dwight D. Eisenhower. Republican, was favoured for president by Washington voters in 1952 and 1956 and Richard M. Nixon, Republican, in 1960.

GOVERNMENT

Washington is governed under its original constitution, adopted on Oct. 1, 1889, and later frequently amended. Except for the powers of initiative and referendum which the people possess by virtue of a constitutional amendment in 1912, the legislative authority of the state is vested in the legislature, consisting of a senate and a house of representatives. Its regular meetings occur in January of odd-numbered years at Olympia, the capital, and are limited by the constitution to 60 days. Special meetings may be called by the governor at his discretion. Senators are elected for four years (half of the senatorial body retires every two years) and representatives for two years each. In 1935 the state legislature enacted a blanket primary law which provided that at primary elections voters may vote for candidates irrespective of party designation.

The state legislature is limited in three ways: (1) by the constitution, by which it is forbidden to enact special laws with respect to 18 subjects; (2) by the governor, whose veto of any bill or item therein must be overridden by a two-thirds vote of both houses, or the bill dies; and (3) by the people, who have the powers of initiative, referendum and recall. Amendment seven to the state constitution, as approved by the electorate in 1912, required that an initiative petition contain the signatures of 10%, but in no case more than 50,000, of legal voters and that referendum petitions have signatures of "six per centum of legal voters, but in no case more than 30,000 of legal voters." In 1956 a new amendment (30) changed the number of signatures required for initiative petitions to "eight per centum of the number of voters registered and voting for governor at the last preceding regular gubernatorial election" and referendum petitions to 4% of such signatures. Measures enacted by the people became susceptible to legislative alteration when amendment 26, adopted in 1952, permitted the legislature by a two-thirds vote to amend laws enacted through popular vote and made such amended acts immune to referendum. The state supreme court on Dec. 24, 1957, held that the legislature could, therefore, "change the law completely within the realm of the subject matter of the law." The legislature may still, if it wishes, refer any bill it has passed to the people for approval. Any elective officer, with the exception of judges of courts of record, is subject to recall.

The executive department consists of governor, lieutenant governor. secretary of state, treasurer, auditor, attorney general, superintendent of public instruction, commissioner of public lands and insurance commissioner, each chosen for a term of four years. In 1921 the legislature passed an act known as the Administrative code. which abolished about 70 boards and commissions that had come into existence from time to time and distributed their duties among ten ne departments. In view of new functions and reallocations of duties. these were increased in the second half of the 20th century to 16 departments, three commissions and a veterans' council, each having a full-time director and permanent staff.

The judicial department is composed of the supreme court of the state, the superior courts for the counties and courts of justices of the peace for cities, towns or precincts. The last named deal with civil cases involving less than $300 and criminal cases below the rank of felony. Justices of the superior courts are elected for four years. The jurisdiction of the supreme court is almost entirely appellate.

Finance. — Property values, total personal income and taxes increased from 300% to 500% during the three decades prior to 1960. The assessed valuation of property subject to tax was approximately $4,500,000,000 (one-half of actual value).

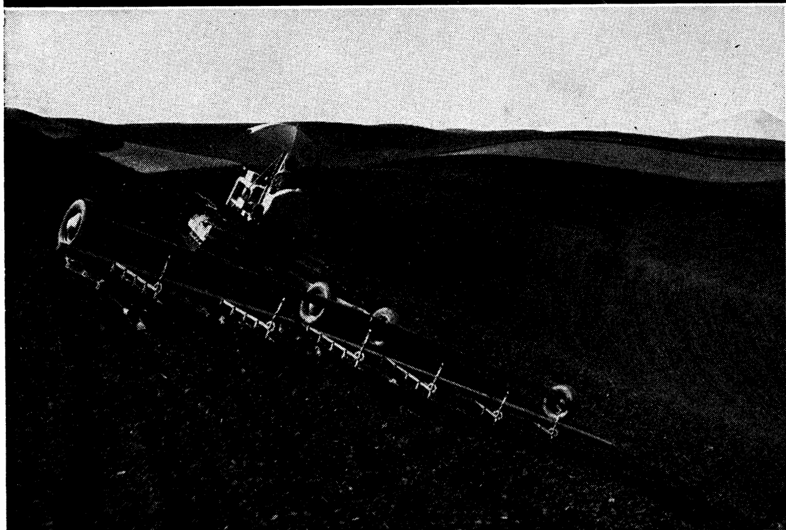
Most important in the history of the state's finances was the tax revolution which during the years 1932 to 1937 effected a change from a property tax base to one of sales and excise taxes.

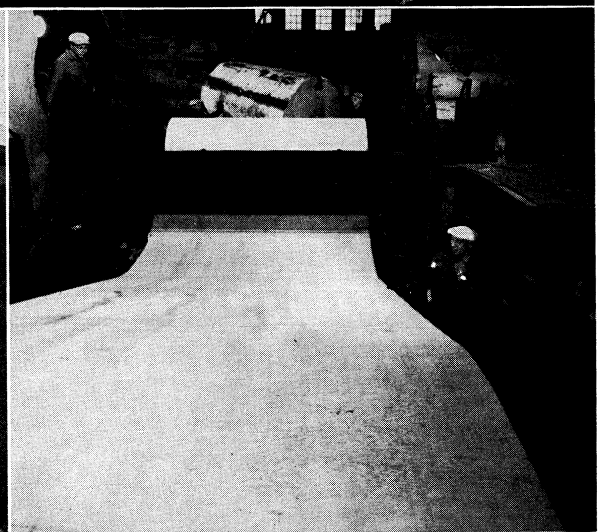
BY COURTESY OF (TOP LEFT, BOTTOM LEFT) JOSEF SCAYLEA FROM SEATTLE CHAMBER OF COMMERCE, (TOP RIGHT) UNION PACIFIC RAILROAD, (CENTRE RIGHT) UNIVERSITY OF WASHINGTON FROM SEATTLE CHAMBER OF COMMERCE; PHOTOGRAPH, (BOTTOM RIGHT) BOB AND IRA SPRING

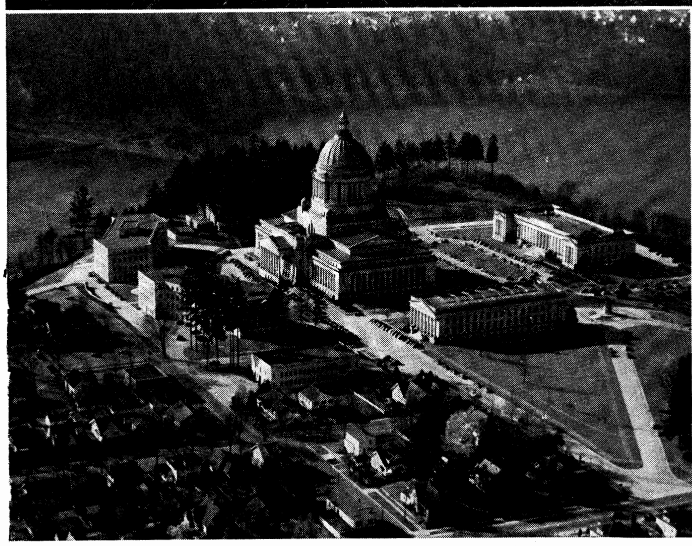
VIEWS OF THE STATE OF WASHINGTON

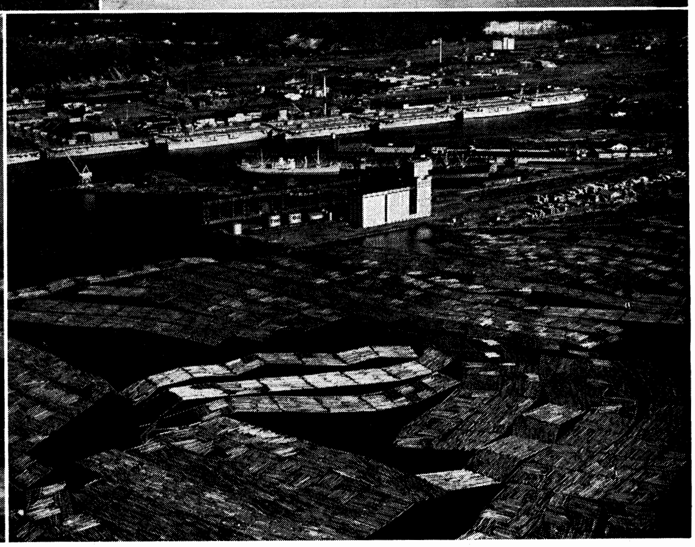
Top left: Lake Washington floating bridge at Seattle, completed in 1940
Top right: Mount St. Helens, 9.671 ft. high, as seen from Spirit lake
Centre right: University of Washington campus at Seattle
Bottom left: Fishermen in the Juan de Fuca straits. In the background is Tatoosh Island
Bottom right: An ice cave under Paradise glacier, Mount Rainier National park

WASHINGTON (STATE)









BY COURTESY OF JOSEF SCAYLEA FROM SEATTLE CHAMBER OF COMMERCE, (CENTRE LEFT) CATERPILLAR TRACTOR CO., (CENTRE RIGHT) DOUGLAS FIR PLYWOOD ASSOCIATION, (BOTTOM LEFT) DEPT. OF CONSERVATION & DEVELOPMENT, DIV. OF PROGRESS AND INDUSTRY, K. S. MELSON, PHOTO (BOTTOM RIGHT) NORTHERN PACIFIC RAILWAY CO.

SCENES IN THE STATE OF WASHINGTON

Top: Seattle, along Elliott bay (right), the largest city of the Pacific northwest. Mount Rainier, 14,408 ft. high, of the Cascade range is in the background

Centre *left:* Harrowing farmland for wheat near Colfax in the eastern part of the state

Centre right: Peeling veneer from Douglas-fir logs for use in making plywood

Bottom left: Group of state buildings, including the capitol at Olympia, on the southern end of Puget sound. The dome on the legislative building is of solid-stone construction, one of two such domes in the U.S.

Bottom right: Port of Tacoma, a well-protected harbour in the western part of Puget sound

In 1927 property taxes amounted to $16,109,673 or 57.22% of the total, whereas in 1937 these amounted to but $3,303,166 or 6.43% of the total. All sales taxes which in 1927 constituted but 16.95% of the total represented 76.76% in 1937. Washington's per capita sales tax collections in the second half of the 20th century were the highest among the states in both amount (more than $75) and proportion to the total (55%) in 1958. Other major revenues in that year were the business and occupation tax, gasoline tax, licenses, motor vehicle excise taxes and liquor board net profits. General property taxes still are the basis for local levies.

Efforts to establish an income tax have been nullified by two adverse decisions of the state supreme court in 1930 and 1933 and the defeat by the electorate of income tax amendments to the state constitution in 1934, 1936, 1938 and 1942. Another obstacle to alteration of the tax base is the 1944 amendment to the state constitution which limits aggregate tax levies upon real and personal properties in excess of "forty mills on a dollar of assessed valuation."

POPULATION

The population of Washington in 1860 was 11,594; in 1890 it was 357,232; in 1910, 1,141,990. By 1950 it had reached 2,378,963, and in 1960 it was 2,853,214.

The 1960 figure represents an increase of 19.9% over the population in 1950. The population per square mile in 1960 was 41.8, as compared with 34.9 in 1950 and with 49.6 for the U.S. in 1960.

Of the 1960 population 1,534,309, or 54.8%, lived in incorporated places of 2,500 or more, as compared with 54.7% in 1950, when these places constituted the urban area. The entire urban population, which included also the thickly settled suburban area, or "urban fringe," adjacent to Seattle, Spokane and Tacoma, and ten unincorporated places of 2,500 or more outside this fringe, in 1960 amounted to 1,948,664 or 68.3% of the state total.

*Washington: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	2,853,214	2,378,963	1,736,191	1,356,621	518,103
Aberdeen	18,741	19,653	18,846	15,337	3,747
Anacortes	8,414	6,919	5,875	5,284	1,476
Auburn	11,933	6,497	4,211	3,163	489
Bellevue	12,809	—	—	—	—
Bellingham	34,688	34,112	29,314	25,585	11,062†
Bremerton	28,922	27,678	15,134	8,918	—
Camas	5,666	4,725	4,433	1,843	—
Centralia	8,586	8,657	7,414	7,549	1,600
Chehalis	5,199	5,639	4,857	4,558	1,775
Clarkston	6,209	5,617	3,116	1,859	—
Edmonds	8,016	2,057	1,288	936	474
Ellensburg	8,625	8,430	5,944	3,967	1,737
Ephrata	6,548	4,589	951	628	—
Everett	40,304	33,849	30,224	27,644	7,838
Hoquiam	10,762	11,123	10,835	10,058	2,608
Kelso	8,379	7,345	6,749	2,228	694
Kennemick	14,244	10,106	1,918	1,684	—
Kent	9,017	3,278	2,586	2,282	755
Kirkland	6,025	4,713	2,084	1,354	—
Lacey	6,630	—	—	—	—
Longview	23,349	20,339	12,385	—	—
Lynwood	7,207	—	—	—	—
Moses Lake	11,299	2,679	326	—	—
Mountlake Terrace	9,122	—	—	—	—
Mount Vernon	7,921	5,230	4,278	3,341	1,120
Olympia	18,273	15,819	13,254	7,795	3,863
Opportunity	12,465	—	—	—	—
Pasco	14,522	10,228	3,913	3,362	254
Port Angeles	12,653	11,233	9,409	5,351	2,321
Port Townsend	5,074	6,888	4,683	2,847	3,443
Pullman	12,957	12,022	4,417	2,440	1,308
Puyallup	12,063	10,010	7,889	6,323	1,884
Renton	18,453	16,039	4,488	3,301	—
Richland	23,548	21,809	247	279	—
Seattle	557,087	467,591	368,302	315,312	80,671
Shelton	5,651	5,045	3,707	984	833
Spokane	181,608	161,721	122,001	104,437	36,848
Sumner	5,874	2,816	2,140	1,499	531
Sunnyside	6,208	4,194	2,368	1,809	—
Tacoma	147,979	143,673	109,408	96,965	37,714
Toppenish	5,667	5,265	3,683	3,120	—
Vancouver	32,464	41,664	18,788	12,637	3,126
Walla Walla	24,536	24,102	18,109	15,503	10,049
Wenatchee	16,726	13,072	11,620	6,324	451
Yakima	43,284	38,486	27,221	18,539	287

*Populations are reported as constituted at date of each census. †Includes Fairhaven and New Whatcom cities consolidated and incorporated as Bellingham City in 1903.

Note: A dash indicates place did not exist during reported census, or data not available.

The number of households in 1950 was 736,988. The average population per household was 3 in 1950.

The population of the state was distributed by colour and nativity in 1950 as follows: 89.3% native white; 8% foreign-born white; and 2.7% nonwhite. Of the foreign-born white population, 24.9% was born in Canada, 10.9% in Sweden and 12.2% in Norway.

Of the population 8.9% was 65 years old or over; and 53.7% of the population 14 years old and over was in the labour force.

Of the total number of employed males, 12.4% was engaged in agriculture; 10.8% in construction; 25.3% in manufacturing; 10.4% in transportation; and 18.1% in wholesale and retail trade.

EDUCATION

During the territorial period, public schools of Washington were sustained by a levy of two mills of territorial tax matched by local levies of like amount. Substantial state support began with the "Barefoot School Boy" law of 1895 which provided each school district with $6 of state funds for each child of school age, subventions which were increased from time to time. In 1933 the basis of support was changed to a grant of 25 cents per day for each pupil in attendance. This stipend likewise later was enlarged.

To enable the public schools to pay salaries of a minimum set by the legislature, state subsidies were voted in 1945. The policy of state aid for school construction was initiated in 1947 when a $20,000,000 bond issue was voted. The electorate approved of a $40,000,000 issue in 1950. Education has become primarily a state responsibility.

The total public school enrollment was 590,000 (including 13th and 14th grades) in the late 1950s as contrasted with 390,000 ten years previously; costs per pupil in attendance were approximately $350 and $230 for the same period. The trend toward the consolidation of school districts continued, the number being reduced to fewer than 500 in 1960 from more than 1,400 in a period of 20 years.

Higher Education. — The state-supported University of Washington, Seattle, was established in 1861 as the Territorial University of Washington; the name was changed to the present when the territory became a state in 1889. Divisions include colleges of architecture and urban planning, arts and sciences, business administration, education, engineering, fisheries. forestry and pharmacy; graduate school; schools of law, medicine, dentistry, nursing and social work; and division of adult education. Some of the university's facilities include Charles Lathrop Pack Demonstration forest, 2,300 ac., at La Grande; Lee Memorial forest, 160 ac., near Maltby; biological laboratories at Friday Harbor on the San Juan (Haro) Islands; West Seattle research laboratory for electronic research, in West Seattle; and a center for graduate study at Hanford, located at Richland, administered under contract with the Atomic Energy commission.

Washington State university, Pullman, university and land-grant college, was chartered in 1890 as Washington State Agricultural College and School of Science; the name was changed to Agricultural College, Experiment Station and School of Science of the State of Washington in 1891, to State College of Washington in 1905 and to Washington State university in 1959. The three state colleges of education are Central Washington College of Education, at Ellensburg, established as Washington State Normal school in 1890, name changed to present in 1937; Eastern Washington College of Education, at Cheney, established as Washington State Normal in 1890, and name changed to present in 1937; and Western Washington College of Education, at Bellingham, chartered as Washington State Normal School at Bellingham in 1893 and name changed to present in 1937. Ten publicly accredited community junior colleges are merged with an extended secondary school program.

Privately endowed universities and colleges include, in Spokane, Gonzaga university (Roman Catholic; 1887) and Whitworth college (affiliated with the United Presbyterian Church in the U.S.A.; 1890); in Tacoma, Pacific Lutheran university (1894), name changed from Pacific Lutheran college in 1960, and College of Puget Sound (related to Methodist Church; 1888); in Seattle, Seattle Pacific college (affiliated with the Free Methodist Church;

1891) and Seattle university (Roman Catholic; 1891); in Walla Walla, Whitman college (nonsectarian; 1859); and in College Place, Walla Walla college (Seventh-day Adventist; 1892).

HEALTH, WELFARE AND CORRECTIONS

Public Health. — The department of public health deals with vital statistics and preventive medicine services and provides supervision of sanitation and local health services. Although no longer in charge of direct medical care to children, the work of the section of maternal and child health and crippled children has been substantially enlarged. In 1959 this department was assigned the establishment of "a state-wide program for the study, treatment and rehabilitation of persons suffering from alcoholism."

Assistance. — The department of assistance determines eligibility and degrees of need of claimants for assistance in the categories of old age, dependent children and foster care, blindness, disability, medical care, general need and burials. Reductions in the state's direct assistance payments, caused by the operation of the Old Age and Survivors insurance and unemployment insurance, have, to a considerable degree, been offset by accentuated health problems of old persons and by prolonged economic recessions which have resulted in unemployed persons' losing eligibility for further benefits.

Special Training for Young Persons. — Notable among several reallocations of functions of state welfare agencies was the law of 1951 which placed a new emphasis upon the needs of young persons. Subordinated to the department of institutions, the division of children and youth services became responsible for mentally, physically, emotionally and socially handicapped children. Although institutional care is provided at special schools, homes, hospitals and youth camps, the policy of the division is to retain, insofar as possible. parental ties and to establish young persons in normal homes and sound social environments.

Rehabilitation and Correction. — The program of the department of institutions has changed pronouncedly from one of custody and correction to one of rehabilitation and treatment. Besides operating three hospitals for mental health, the penitentiary at Walla Walla, the reformatory at Monroe and a system of honour camps, the department administers a bureau of criminal identification, two veterans' homes and a veterans' colony.

THE ECONOMY

Agriculture. — The acreage of farm land increased from approximately 15,200,000 ac. before World War II to more than 17,500,000 ac. in the second half of the 20th century, but the number of farms decreased from more than 80,000 to about 65,000. Crop land harvested amounted to about 4,300,000 ac., the remainder being classified largely as pasture and woodland. The total value of farm land and buildings increased from $593,000,000 before World War II to $2,324,000,000 by 1960. Tenancy has become negligible since many large and prosperous operators rent land, and the small unit farmers generally are full owners. The degree to which motor power has been substituted for animal power in the operation of farm equipment is no better revealed than in the reduction of the number of horses, which in 1915 numbered 311,000 and by the 1960s only 37,000. Also, there were fewer sheep, which in 1920 numbered 725,000 but in 1960 fewer than 250,000. Because the feeding of high-quality stock from grain surpluses has become profitable, the number of cattle has increased from fewer than 500.000 in 1910 to more than 1,000,000 by the second half of the 20th century.

Dry field peas constituted a bonanza crop during the years 1935 to 1949 and reached a peak production of 5,259,000 bags valued at $25,500,000 in 1943. Acreage reductions cut this figure to about 1,000,000 bags in the 1950s, and, whereas there was some recovery by 1960, green peas for processing supplanted the other variety in production and value. With the Columbia basin project lands going under cultivation, sugar beets, tried but virtually abandoned at the turn of the 20th century, went into conspicuous production, as did another comparatively new crop, dry edible beans.

The ten leading farm products by value in the second half of the 20th century were wheat, milk, apples, cattle and calves, eggs, hay, barley, hops, chickens and broilers, and pears. Washington enjoyed first place among states in the production of apples, hops, potatoes (late summer), spearmint and peppermint; and ranked high in the production of dry peas. green peas for processing, Bartlett and other pears, apricots, filberts and sweet cherries.

Mining. — Washington mines had during the century ending in 1960 yielded mineral and mineral aggregates to a total value of more than $1,000,000,000. Production pronouncedly stimulated by World War II expanded with even greater rapidity thereafter, metal production doubling during the ten-year period beginning 1944. All minerals increased in yield from $36,483,000 in 1944 to more than $60,000,000 annually by 1960. Coal, which attained a production of 4,000,000 tons valued at $14.000.000 in 1918, declined because of competition and other factors but large reserves remained if demand should revive. Sand and gravel constituted the largest nonmetal products, and zinc, lead, gold and silver were the leading metals.

Several factors were responsible for the boom in metals production during the period from 1933 to 1955: United States government policies of pegging the price of gold; purchasing silver; the discoveries of remarkably rich veins in Stevens and Ferry counties; and the development in the northeastern part of the state of the largest known body of low-grade lead and zinc ore in the United States. Research in electrometallurgy gave new significance to the magnesite (magnesium carbonate) ores of Stevens county, and the availability of cheap electric power from the Bonneville and Grand Coulee projects prompted the establishment of aluminum reduction plants at Vancouver, Longview, Spokane, Tacoma, Mead and Wenatchee, and an aluminum rolling mill at Trentwood.

The need for fissionable materials and the resulting reconnaissances brought to light in northeastern Washington deposits of uranium and a processing plant was established in 1957. The year 1957 also witnessed the beginning of flow from the first commercially producing oil well in the state near Ocean City, Grays Harbor county. The Holden copper mine of the Howe Sound company, located on Lake Chelan in Chelan county, once the largest single metallic mine operation in the entire Pacific northwest, including Alaska, ceased operation in 1957.

Forests and Lumbering. — Except for 1914, when Louisiana reported the largest production of lumber, Washington led the states from 1905 to 1938, but in that year it yielded first place to Oregon and by 1954 had also fallen to third place behind California. The state retained paramountcy in the production of wood pulp, but lost it in the production of plywood. Of the total land area of the state, over half (23,868,000 ac.) was in forest, of which 19,490,000 ac. were of commercial quality and 1,279,000 ac. productive but reserved. Annual tree growth in commercial stands of the state was about 650,000,000 cu.ft. in the 1950s, less than the cut of almost 800,000,000 cu.ft.

There are seven national forests entirely within the state and parts of two others within its boundaries, and the total area of these lands is 5,674,000 ac. These and Olympic National park with area of 888,558 ac., Mt. Rainier National park of 241.571 ac., as well as 116 state recreation areas with a total area of more than 65,000 ac. are available to the public for recreation.

Fisheries. — Washington relinquished its leadership in Pacific coast fisheries to California in 1922 and suffered further decline in the depression years of the early 1930s. Whereas by 1960 the amount of the annual catch had declined to about 136,000,000 lb., processed value had increased to more than $35,000,000.

The construction of irrigation and power dams placed the entire salmon industry in jeopardy. To offset these injuries, fishways were constructed around some dams. The state expanded its program of operating hatcheries for commercial and game fish and has taken steps to clear streams of obstructions and polluting elements. The Pacific International Salmon Fisheries commission administrated a program to preserve the salmon fisheries of Puget sound and adjacent waters.

Manufacturing and Transportation. — The pattern of growth of the state's manufacturing industry since 1899 has in the main followed that of the nation, although the rate of growth, particularly between 1899 and 1909, has been somewhat greater. Lumbering and lumber products, paper and paper products have been resource-oriented industries, whereas transportation equipment, particularly aircraft since 1916, has been labour-oriented. Most pronounced has been the progress in the processing of primary metals, which depends upon abundant and cheap energy, and of atomic chemicals, which depends upon the substantial water supply from the Columbia river. (For hydroelectric development *see* COLUMBIA RIVER.) These diverse factors redound to the stability and prosperity of the state's industry.

The ten leading industries deal with transportation equipment; lumber and wood products; pulp, paper and paper products; food and kindred products; primary metals; chemicals and chemical products; printing and publishing; machinery (except electrical); fabricated metals; and stone, clay and glass products. Only the first two of these industries and agriculture outranked tourism.

By the middle of the 20th century, the state highway system had recovered from the exceptionally heavy use to which it was put during the World War II period. To meet the demands of postwar tourist traffic, the state legislature in 1947 enacted the Limited Access Highway act, which placed 2,388 mi. of the state's highways under a master plan for conversion to limited access. Two important bridges, the first a concrete pontoon bridge across Lake Washington, the other a suspension bridge across Puget sound at Tacoma, facilitated motor traffic across these waterways. In 1960 there were approximately 56,000 mi. of highways in the state. The state was served by ten airlines, and there was a total of more than 100 airports and a dozen seaplane bases, in addition to privately owned restricted-use airports. There were almost 6,000 mi. of railroad track.

See also references under "Washington" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year,* American edition. (H. J. DE.)

WASHINGTON, **D.C.,** the capital city of the United States, conterminous with the District of Columbia. centre of a metropolitan area extending over adjacent territory in Maryland and Virginia. By the middle of the 20th century Washington had become an important world capital and a news centre equal to or of greater importance than such European capitals as London, Paris and Berlin.

The city lies on the northeast bank of the Potoinac river at the head of tide and navigation, 40 mi. S.W. of Baltimore, 135 mi. S.W. of Philadelphia and 226 mi. S.W. of New York city. Its area is 69 sq.mi. The population in 1960 was 763,956, a decrease of 4.8% from 1950. The standard metropolitan statistical area, as defined by the census bureau, comprises, in addition to the city of Washington, Arlington and Fairfax counties and the independent cities of Alexandria (*q.v.*) and Falls Church in Virginia and Montgomery and Prince Georges counties in Maryland; its 1960 population was 2,001,897, an increase of 36.7% over 1950. Silver Spring, Md., is a large residential suburb.

Washington'has sometimes been called "Uncle Sam's company town." Its first business is service to the federal government and to its 241,000 civilian employees who work and live in the metropolitan area. Military personnel are stationed at Ft. Lesley J. McNair and the navy yard in Washington; at nearby Andrews air force base in Maryland; and in Virginia at Ft. Myer, Ft. Belvoir and the marine corps base in Quantico.

The climate of Washington is characterized by frequent periods of high humidity, occasional periods of oppressive heat in summer and moderately mild winters. The mean winter temperature (December, January and February) is 35° F. and the mean summer temperature (June, July and August) 75°. Extremes range, however, from a maximum of 106° to a minimum of −15°. There is an average annual precipitation of 42.2 in., evenly distributed throughout the year.

HISTORY

Origins of the Capital.—The United States was the first nation in the world to plan a capital exclusively for its seat of government, although in the 20th century Australia, Pakistan and Brazil followed that example. Before 1800 the congress of the young republic sat in eight cities—Philadelphia, Baltimore, Lancaster, York, Princeton, Annapolis, Trenton and New York. In 1783, while convened in Philadelphia, congress was unable to raise money to pay the soldiers who had served to the end of the Revolution. Pennsylvania troops stationed nearby, upon finding themselves furloughed without pay, defied their officers and marched to the statehouse to demand justice from congress and the executive council. Neither the Pennsylvania state government nor the city offered protection. James Madison commented that if the city would not support congress, it was high time to remove to another place. Congress did, in fact, adjourn to meet three days later in Princeton, N.J.

Competition was very keen to secure the seat of government, for it seemed to ensure a bright commercial future for any small town and would increase the prestige and wealth of established centres. Kingston, N.Y., made the first offer and in rapid succession invitations followed from New York; Boston; Philadelphia; Newport, R.I.; Wilmington, Del.; Trenton, N.J.; Reading and Lancaster, Pa.; Annapolis, Md.; Williamsburg, Va.; and Yorktown, Pa. During the debate in congress a question was raised as to the jurisdiction proper for congress to exercise over the place of the permanent government. The constitution of the United States settled the question as far as it touched the relationship of federal to state authority. By that document congress is given power "To exercise exclusive Legislation in all Cases whatsoever, over such District (not exceeding ten Miles square) as may, by Cession of particular States, and the Acceptance of Congress, become the Seat of the Government of the United States . . ." Unfortunately neither the constitution nor the later "residence act" spelled out the relationship of congress to citizens living within the ten-mile square, although James Madison in The *Federalist,* which sought to win converts to ratification of the constitution, declared that local citizens would as a matter of course enjoy the rights of self-government.

The debate on the "residence act" early recognized the wisdom of placing the national capital on a navigable waterway and in a geographically central location between Georgia and New Hampshire. The advantages of relatively easy access to the trans-Allegheny west were also obvious. But sectional conflict ran strong. Madison, Jefferson and Washington all urged a site on the Potomac river, for they believed a southern capital essential to the economic recovery of the war-scarred south; northerners, apart from their aspirations for a locality uithin their region, were opposed to any place within slaveholding territory. According to Jefferson, the deadlock in congress was finally broken by a "deal" between himself and Alexander Hamilton: Jefferson aligned enough votes to ensure federal assumption of state war debts in return for Hamilton's support of a southern site for the capital. The act passed in 1790 specified a district not exceeding ten miles square to be located on the Potomac river "at some place between the mouths of the Eastern Branch and the Connogocheague." The president was authorized to appoint three commissioners who, under the direction of the president, were to survey and define the district, to purchase or accept the necessary lands and to provide suitable buildings for the public offices. To give time to complete these arrangements, the seat of government was to remain in Philadelphia until 1800.

George Washington's first reference to this decision occurs in his diary under date of July 12, 1790: "and about noon had two bills presented to me by the joint committee of Congress. The one, an act for establishing the temporary and permanent seat of the Government of the United States." On Jan. 24, 1791, Washington sent a message to congress stating that he had selected a site and directed commissioners "to survey and limit a part of the territory of the ten miles square on both sides of the river Potomac so as to comprehend Georgetown in Maryland and extend to the Eastern Branch." He suggested that congress choose whether the area should extend lower in Maryland and include the town of Alexandria in Virginia or reach farther north. Without any discussion congress accepted the president's first proposal, placing the southern extremity of the federal district at the mouth of Hunting creek just below Alexandria. Public opinion endorsed the choice.

As commissioners, Washington appointed Thomas Johnson of Frederick, Md.; Daniel Carroll of Rock Creek, Md.; and David Stuart of Hope Park near Fairfax Court House, Va. While Andrew Ellicott of Maryland surveyed the bounds of the ten-mile square, laid obliquely with the compass ($69\frac{1}{4}$ sq.mi. within Maryland, the remainder to the south in Virginia), the president faced two problems: exactly where within the federal district the city should rise and how to induce the planters and farmers who owned the land to sell it at a reasonable price. Washington entrusted the first task to Maj. Pierre Charles L'Enfant (*q.v.*), a young French engineer who had served in the Revolutionary War. As soon as L'Enfant had chosen the site bordering the Eastern branch and the Potomac and encompassing Jenkins hill to the east and most of the valley of Tiber creek, the president began negotiations with the 19 principal proprietors of the land needed. With some difficulty he persuaded them to convey it to him in trust, "in consideration of the great benefit we expect to derive from having the federal city laid off upon our lands," upon condition that "the president shall have the sole power of directing the federal city to be laid off in what manner he pleases." Half the lots were to go to the public and half to the original owners. For the streets the proprietors were to receive no compensation, but for the land taken for public use, they were to be paid at the rate of £25 per acre. On March 31, 1791, Jefferson wrote to Washington, "The acquisition of ground is really noble. . . . I think very liberal reserves should be made for the public."

Plan of the City.—At the president's request, Major L'Enfant undertook to prepare a plan of the city. "After much menutial search for an eligible situation," he wrote, "I could discover no one so advantageously to greet the congressional building as that on the west end of Jenkin's Heights, which stands as a pedestal waiting for a monument." For the "presidential palace" he selected a ridge west of Tiber creek near the' Potomac. The plan placed the executive mansion on a north-south axis intersecting an east-west axis from the congress house to the river. Near the intersection at which L'Enfant proposed to place an equestrian statue, the shaft of the Washington monument rose in the 19th century. A broad thoroughfare, Pennsylvania avenue, was to run from the congress house to the president's palace, about which the executive department office buildings should be grouped. Waterfalls cascading from the terrace of the congress house should descend into a pool at the foot of what came to be called Capitol Hill and thence flow into the Potomac through a mile-long grand canal bordered by gardens. The shore of the Eastern branch with its deep water should serve as the city's commercial centre, while an arcade stretching due east from the congress house should accommodate shops. Upon a gridiron of irregular rectangular blocks L'Enfant's plan superimposed diagonal avenues devised to converge at the capitol and the executive mansion and to form scores of squares, circles and triangles at street intersections, where monuments and fountains should be placed. The Frenchman designated a square on a small hilltop overlooking the Potomac beyond the executive mansion as the site for a national university.

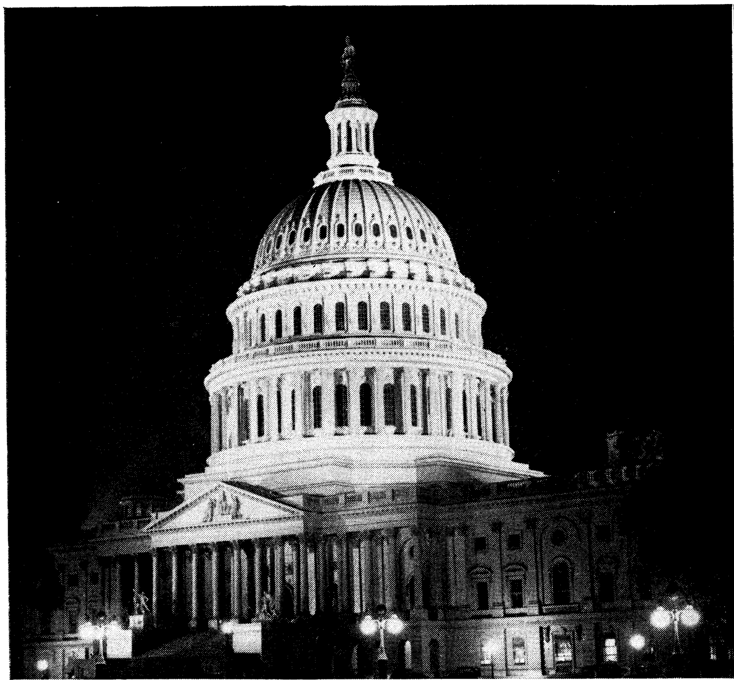
Unhappily, L'Enfant delayed the completion of his map, which had to be engraved in order to have copies to show potential buyers the location of lots available for private purchase. Time became important, since the commissioners in charge of building the public edifices in the city they named Washington had to supplement the $190,000 advanced by Maryland and Virginia and public auction of lots in the city appeared to be the only feasible way of raising the money. Since L'Enfant refused to co-operate with the commissioners, the president reluctantly dismissed him and requested Andrew Ellicott to prepare from L'Enfant's sketch the map for the engraver.

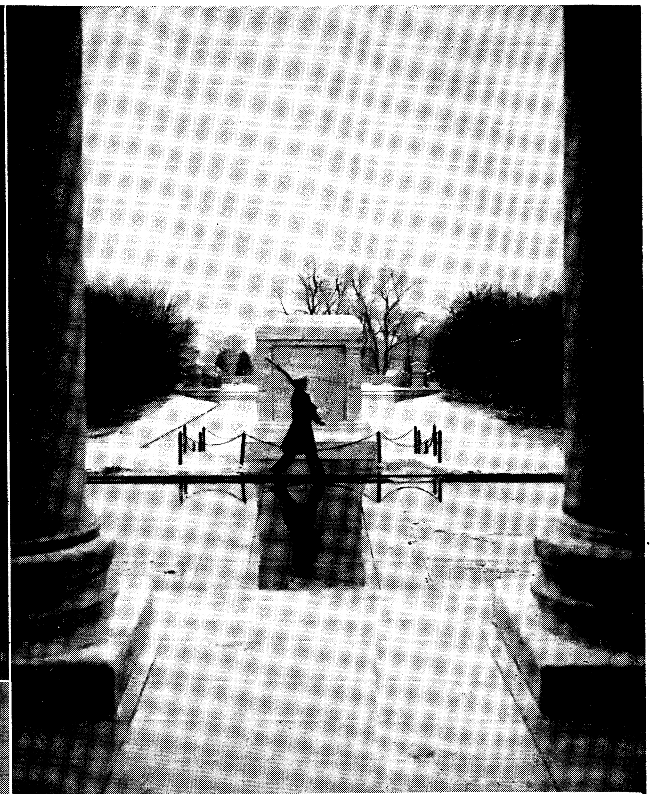
The public auctions brought in disappointingly small sums, but while land for the principal streets was surveyed and cleared and a few private dwellings went up, the commissioners advertised for plans for the halls of congress and the president's house. The plan accepted for the capitol was that of William Thornton, a versatile West Indian doctor who had lived for a time in Philadelphia but had had no previous architectural experience. George Washington laid the cornerstone on Sept. 18, 1793, amid solemn Masonic ceremonies. The most suitable design for the executive mansion was submitted by James Hoban, an Irishman. Built of Virginia freestone so white that as early as 1811 people occasionally spoke of the "White House," the exterior of the dignified two-story house was ornamented with an Ionic portico and balustrade. In spite of shortage of funds, labour troubles and quarrels among the men superintending the work, the commissioners had all three buildings near enough completion to permit the executive departments of the government to move to Washington in the early summer of 1800. In mid-November congress convened in the new capital, by then a community of 2,464 free inhabitants and 623 slaves.

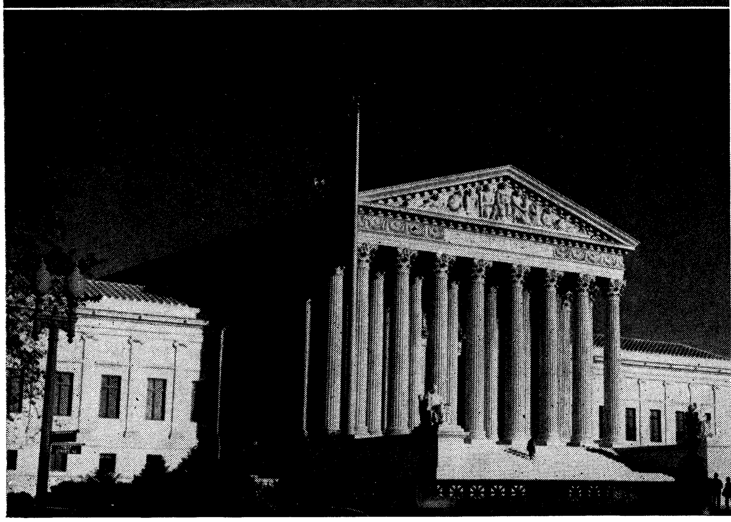
19th Century.—George Washington envisaged a national capital eventually as large as most European cities, while Jefferson thought a century would produce a city of 100,000 and later years possibly a metropolis of 200,000. But until the Civil War, growth was slow. During the first decade in the new capital, members of congress, irked by the discomforts of the raw little city, repeatedly talked of abandoning it and returning to Philadelphia. In 1801 congress created a court system for the district and established two counties, Washington county above the Potomac, where Maryland laws should continue to prevail, and Alexandria county to the south, where Virginia law should operate, unless specific acts of congress superseded the laws of the two states. After granting city charters to Washington, Georgetown and Alexandria, congress left the municipalities largely to fend for themselves. Lack of money left Washington without proper streets or other conveniences beyond those a handful of local taxpayers could provide. In 1814, after British troops had entered the city and burned the Capitol and the president's house, a narrow majority in congress voted to rebuild the capital on the Potomac. Niggardly federal appropriations continued to make difficulties for the city. Visitors, whether from home or abroad, ridiculed the grandiose layout of the "City of Magnificent Distances" which Charles Dickens in the 1840s derisively labeled the "City of Magnificent Intentions." And yet little by little the capital developed. When fire destroyed the treasury in 1833, congress decreed that the new building must stand on the old site, but as treasury officials demanded 114 rooms, the architect, Robert Mills, lengthened the building so that it spread across the approach of Pennsylvania avenue to the White House. The Patent office and a new Post Office building, both in the classical style of architecture, went up on F street. Because congress had never approved the plan of founding a national university, the square L'Enfant had reserved for it stood empty until 1843 when the navy department built a small observatory there as a depot of charts and instruments. Three years later the red brick "Norman castle" designed by James Renwick to house the newly created Smithsonian institution began to rise on the Mall.

In the 1850s construction of two wings and a new 287-ft.-high dome for the Capitol began under the direction of Thomas U. Walter, who drew the plans. At President Lincoln's insistence, work on the dome, symbol of national solidarity, continued during the American Civil War until in Dec. 1863, to the accompanying boom of cannon fired from the Union forts ringing the district, Thomas Crawford's "Statue of Freedom" was lifted to the top of

WASHINGTON, D.C.







PHOTOS (TOP LEFT) STOCK PHOTOS FROM BLACK STAR, (TOP RIGHT) WIDE WORLD, (CENTRE LEFT) A. DEVANEY, INC., (BOTTOM LEFT) TAGER-PIX FROM PUBLIX, (BOTTOM RIGHT) EWING GALLOWAY

Top left: The U.S. capitol

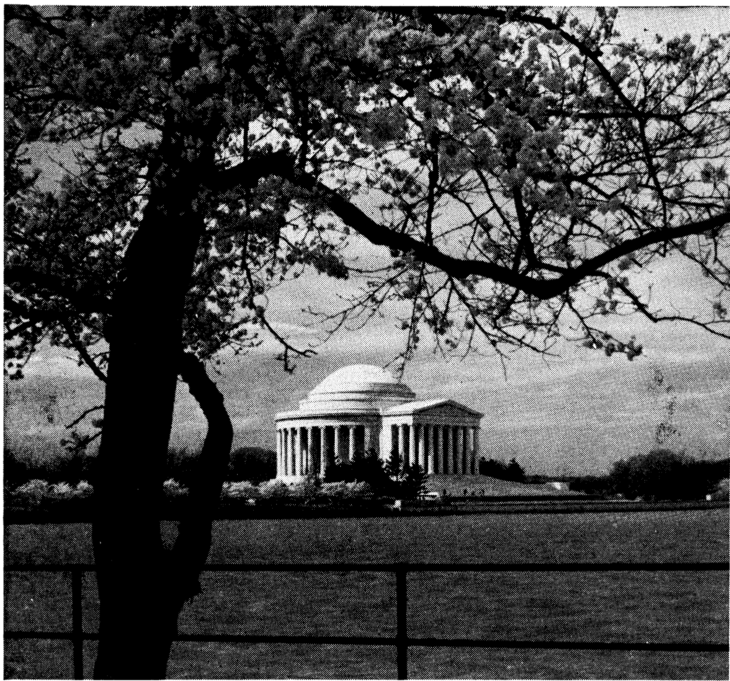
Top right: Sentry at the Tomb of the Unknown Soldier in Arlington National cemetery, Virginia, across the Potomac from Washington

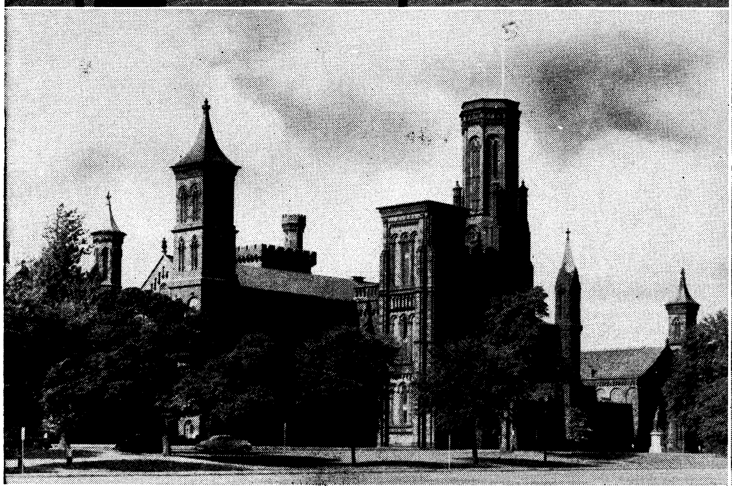
Centre left: The garden front of the executive mansion, better known as the White House

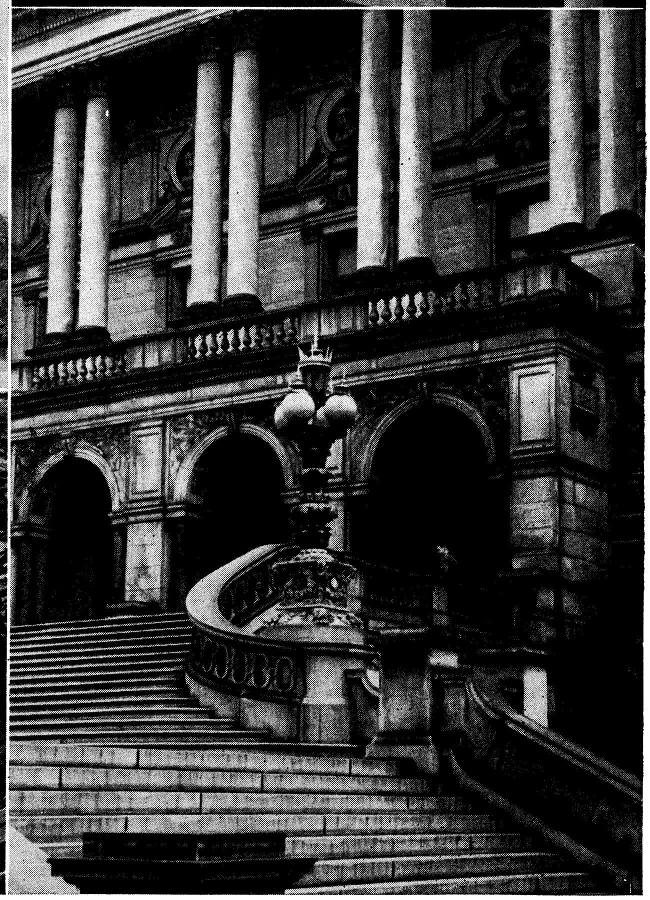
Bottom left: Supreme Court building, opposite the east front of the capitol

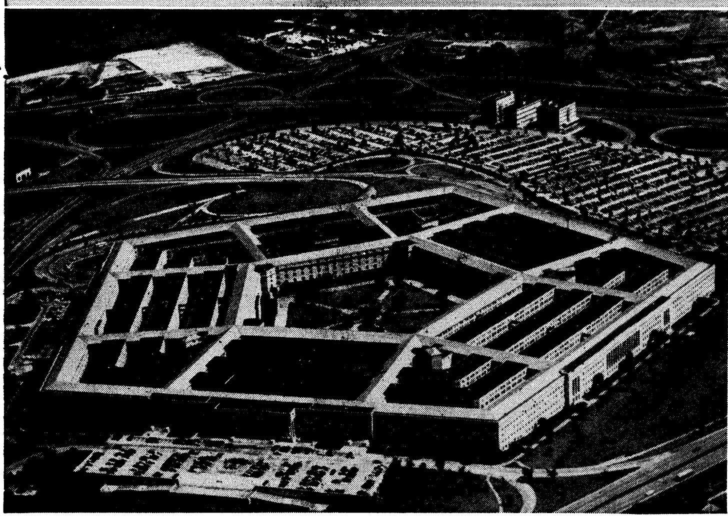
Bottom right: Air view of Capitol Hill which dominates the landscape in the District of Columbia. The two identically shaped buildings at the right house the house office building and annex (below) and the senate office building (above)

WASHINGTON, D.C.









PHOTOS (ALL EXCEPT BOTTOM RIGHT) A. DEVANEY, INC., (BOTTOM RIGHT) CHARLES SIMMONS FROM BLACK STAR

Top left: The Thomas Jefferson memorial and cherry blossoms in bloom
Top right: The Washington monument, viewed from the colonnaded walk of the Lincoln memorial
Centre left: The Smithsonian Institution
Bottom left: Air view of the Pentagon building
Bottom right: Main entrance of the Library of Congress

the dome's crowning cupola. The building of the Washington monument, however, started by a private society in 1848, halted in 1855 when the society ran out of money.

Upon the outbreak of the Civil War, Washington's population suddenly doubled, for the city became the principal supply depot for the army of the Potomac, a great hospital centre and the source of government contracts. Moreover, about 40,000 former slaves from Maryland, Virginia and farther south, freed by President Lincoln's Emancipation Proclamation, poured into Washington, bringing with them difficult social and economic problems for the federal government and the federal city. At the end of the war most of the floating white population disappeared but the former slaves generally remained. Few of them had any education or knew how to adjust to city life. Repair of the streets, cut to ribbons during the war by heavy army wagons and the trampling of cattle driven to abattoirs in the city, offered some jobs for the unskilled. but unemployment was widespread. In the meantime, proposals in congress to move the capital to the midwest alarmed the local community.

In 1871, however, congress authorized construction of a $2,000,000 building west of the White House for the state, war and navy departments; established a board of public works under the new territorial government; and hinted, so Washingtonians believed, that federal appropriations would be forthcoming to ease the tax burden of laying sewers, grading and paving the streets and generally modernizing the city. Alexander Shepherd, who took charge of the board of public works, acted quickly to carry out his "comprehensive plan of improvements." It proved enormously expensive, creating a debt of over $18,000,000, partly because much of the work mas ill-planned and faulty in execution. Yet the results, though bankrupting the district and ending all local self-government, were magnificent stretches of paved, well-lighted streets, lined with carefully tended shade trees and an underground sewage system for most of the city. By 1875 Washington had become a show place of the nation. Monuments to national heroes began to multiply, supplementing Clark Mills' equestrian bronze of Andrew Jackson emplaced in Lafayette square in 1853 and his statue of George Washington unveiled in Washington circle on Feb. 22, 1860. Statues of Generals James McPherson, George Thomas, Winfield Scott, John Logan, Philip Sheridan and of Adm. David Farragut rose in the circles and squares bearing their names, while the figure of the "Great Emancipator," paid for by subscriptions raised among freedmen, was placed in Lincoln park east of the Capitol. The completion of the unadorned 555-ft. shaft of the Washington monument in 1884 seemed to contemporaries to give the city its crowning touch.

But L'Enfant's plan had been largely forgotten. In 1887, after many years of oblivion, the original manuscript of the 1791 "Plan of the City of Washington" was rediscovered and traced in the offices of the geodetic survey. The State, War and Navy building, meanwhile, had broken the stretch of New York avenue beyond the White House, just as the treasury blocked Pennsylvania avenue and the Smithsonian institution and a Gothic stone railroad depot obtruded on the Mall. Later a stone post office, set at an angle to Pennsylvania avenue at 12th street, and in 1897 the ornate Italian Renaissance Library of Congress across Pennsylvania avenue on Capitol Hill did further violence to L'Enfant's design.

L'Enfant's plan had never included the area beyond Boundary street, the Florida avenue of today. There, by the 1890s, suburban sprawl had begun to make orderly development all but impossible, although the district commissioners obtained authority from congress to engage Frederick Law Olmsted, Jr., son of the man who had landscaped the Capitol grounds in the 1870s, to map out a harmonious street and park system to govern the city's future expansion. Less obvious to the casual observer but nonetheless obstructive to wholesome civic growth were the shanties and overcrowded tenements that had sprung up in the alleys in the heart of the city. Scarcely a stone's throw from the Capitol and the White House, hidden alley slums contained thousands of Negroes and impoverished whites living in utmost squalor. In Georgetown also, officially made part of Washington in 1895, deterioration had set in, leaving islands of beautiful 18th-century houses surrounded by a sea of ramshackle dwellings without running water and sanitary facilities. The banks of Rock creek were a rubbish dump. But Chicago's "White City," created in two years' time by a team of distinguished architects, landscape gardeners and sculptors for the World's Columbian exposition, 1893, had made a deep impression throughout the United States and inspired Washingtonians to emulation. The opening in 1898 of a handsome new building on 17th street for the Corcoran Gallery of Art lent encouragement. Yet at the turn of the century the chief triumph of local leaders of the "city beautiful" and "social betterment" movements was the redemption of the tidal swamps of the Potomac flats beyond the Washington monument and the opening of the National Zoological park and Rock Creek park beyond.

20th Century. — Parks, Buildings and Monuments. — Celebration of Washington's centennial in 1900 afforded an opportunity to local members of the American Institute of Architects and other citizens interested in beautification of the capital to promote their tentative plans. Sen. James McMillan, chairman of the senate committee on the District of Columbia, enlisted the services of four experts, Daniel H. Burnham and Charles F. McKim, architects; Augustus Saint-Gaudens, sculptor; and Frederick Law Olmsted, Jr., landscape architect, whose recommendations were embodied in a report presented by Senator McMillan to the senate in Jan. 1902. As a direct result of the McMillan report and of the personal negotiations carried on by Senator McMillan and the commission, the railroad tracks and stone depot were removed from the Mall and, opening out on a wide landscaped plaza, the Union station was erected as a fitting entrance to the capital of the nation. The commission adapted and developed plans for the Mall, recommended sites for new government buildings and designed a complete park system, only part of which congress accepted. In keeping with the commission's proposals, senate and house office buildings, placed to the north and south respectively of the Capitol grounds, were finished by 1910; a building for the district government stood at 14th street below Pennsylvania avenue; a new public library occupied Mount Vernon square; a building for the recently organized National War college rose on the old arsenal grounds at the mouth of the Eastern branch; and a new Department of Agriculture building near the Smithsonian institution and, across the Mall, the United States National museum were opened.

In addition to new monuments in the triangles formed at the intersections of streets and diagonal avenues, the Grant memorial and a statue of Gen. George Meade were placed at the foot of the "Hill" and at the head of the Mall, while at the four corners of Lafayette square statues commemorated heroes of the American Revolution — Lafayette, Rochambeau, Von Steuben and Kosciuszko. Under the direction of the National Cathedral foundation, organized in the 1890s by a group of Episcopalians, the great Cathedral of SS. Peter and Paul began to rise on a commanding site in northwest Washington.

In 1910 Pres. William Howard Taft appointed the first Commission of Fine Arts, including on it three who had been identified with the park commission of 1901: Daniel H. Burnham; Frederick Law Olmsted, Jr.; and Charles Moore. The commission chose the Mall site for the Lincoln memorial beyond the Washington monument but was unable to prevent the location of the Department of Interior building on 18th street near a cluster of non-governmental edifices, the Constitution hall of the Daughters of the American Revolution, the building of the Union of American Republics and the American National Red Cross headquarters. Thanks to Mrs. William Hoaard Taft, however, the Tidal basin, constructed when the Potomac flats were drained, was planted with the Japanese cherry trees presented to her by the mayor of Tokyo in 1912. Disease in some of the trees forced the superintendent of public grounds to replace a number of them, but before the end of the 1920s the circle of healthy blossoming trees every spring drew admiring crowds and launched Washington's annual cherry blossom festival.

Although hampered by the erection of temporary government office buildings during World War I, many of which remained on the Mall for the next 35 years, the Commission of Fine Arts exerted a steady influence to effect the ultimate realization of the Mall plan. Dedication in 1922 of the Lincoln memorial heightened public confidence in the judgment of the commission. It had selected Henry Bacon as architect of the building and Daniel Chester French as the sculptor to design the impressive bronze figure of Lincoln. The commission's advice thereafter was generally accepted on the design and location of public buildings, monuments and fountains. Zoning laws administered by a zoning commission established in 1920, the banning of billboards in residential and other specific areas and the Shipstead act of 1930, which empowered the Commission of Fine Arts to pass upon the character of structures to be built on private property, provided further safeguards for the aesthetic development of the capital. Thus the lines of the Folger Shakespeare library, for which Paul Cret was architect and which faces on East Capitol street, harmonizes with the adjacent Library of Congress annex.

The commission selected the site and design for the Arlington Memorial bridge spanning the Potomac at the end of the Mall and leading to Arlington National cemetery. There, near a beautiful amphitheatre, is the Tomb of the Unknowns (formerly Tomb of the Unknown Soldier). On the brow of the hill looking out over the river toward the Washington monument and the Capitol stands the early 19th-century pillared mansion which, built by George Washington Parke Custis, Martha Washington's grandson, was once the home of Robert E. Lee. In 1909, in belated acknowledgment of the services of Pierre Charles L'Enfant, his remains were placed in a grave marked with a fitting stone on the terrace of the Lee mansion.

The Commission of Fine Arts, intent upon encouraging the development of a monumental city, successfully fought for a generally uniform height and classical style of architecture for public buildings. Commission taste accounted for the façade of the series of departmental buildings that gradually filied most of the "federal triangle" bounded by Pennsylvania avenue, 15th street and north B street, renamed Constitution avenue. The individual buildings were designed by about six different firms of architects but the over-all effect is that of a unit, although an inner plaza invisible from the street gives variety to the group placed about the Post Office building. Across Constitution avenue on the Mall where the Pennsylvania railroad depot once stood, the National Gallery of Art, made possible by the gift of Andrew W. Mellon, was built in the late 1930s. John Russell Pope, the architect for the gallery, also designed the National Archives and the Public Health Service buildings located at the far end of Constitution avenue where another group of handsome public and semipublic edifices was built—the National Academy of Sciences and National Research Council building in Alexandrian Greek architectural style, and nearby the Pan American annex, Constitution hall and an administration building for the Daughters of the American Revolution, and a second building for the American National Red Cross. As the department of state outgrew the building it had shared with the war and navy departments. that structure turned into an overflow for the White House offices and a new State Department building began to rise in "Foggy Bottom" off Constitution avenue near the river. On the hill the imposing Corinthian-columned Supreme Court building built by Cass Gilbert faced the Capitol grounds and a second house office building adjoining the first went up on south B street, renamed Independence avenue. In the square to the rear of the Library of Congress the Library annex was placed. Only the Pentagon, in 1941 the still unfinished headquarters for the war department, located across the Potomac, displayed any architectural deviations from the classical form the Commission of Fine Arts prescribed. Thomas Jefferson indirectly determined the architecture for the Jefferson memorial near the Tidal basin, for the domed rotunda was an adaptation of his design for the University of Virginia library.

Expansion of the city's parks, which the McMillan commission had originally urged, moved forward more slowly than did the federal building program. For years the acquisition of land for nen parks and playgrounds was limited to purchase of two or three small plots in Georgetown and northeast Washington and a narrow strip of parkway connecting Potomac park and the Mall with the "Zoo." In 1924, however, congress set up a park-purchase commission and by an amendment to that act in 1926 established a National Capital Park and Planning commission charged with formulating and directing on a regional basis plans for thoroughfares, city parks, playgrounds and recreation centres, improved transport facilities and the eradication of slums. The result in the course of the next 15 years was a park system that embraced about 6,900 of the 11,287 ac. in the District of Columbia and, through collaboration with a Maryland National Capital Park and Planning commission and later a Northern Virginia Regional commission, many thousands of acres in the emerging metropolitan area. Rock Creek park was extended into Maryland; reclamation of the swampland along the Eastern branch made possible the Anacostia parkway; while the Mount Vernon Memorial highway along the Potomac in Virginia linked George Washington's home with the city named in his honour. Magnificent beeches, elms, magnolias, dogwoods, oaks, sycamores and maples cover much of the parkland, just as shade trees line many of the city's streets and avenues. The district's parks were administered by the national park service in the department of the interior, the playgrounds by a unit of the district government and the school grounds and recreation facilities by the board of education. In 1935 a recreation board took charge of the recreation facilities of all three agencies.

Housing.—Meanwhile, attempts to wipe out alley slums in Washington and Georgetown proved abortive. Congressional acts passed as early as 1892 and enlarged in scope in 1906 authorized the demolition of unsanitary dwellings, but the strong recommendations of a housing commission appointed by Pres. Theodore Roosevelt were unable to resolve legal complications which arose over private property rights. Before 1914 the one successful public project was the razing of the shanties in the notorious Willow Tree alley and the making of a playground in the block where the building of the department of health, education and welfare would later stand. An act of 1914 forbidding all alley dwelling after Oct. 1, 1918. was in turn rendered inoperative by the housing shortage that developed during and lasted long after World War I. Neither private philanthropy, which through organizations such as the Sanitary Housing company undertook to get families out of the alley dwellings into decent low-rental houses, nor the district public welfare department, nor the National Capital Park and Planning commission was able to handle the problem. Not until 1934 did a new Alley Dwelling authority secure the necessary powers to launch an effective slum-clearance program, beginning with the alleys in "Foggy Bottom." But further projects were soon crippled by insufficient funds and then by World War II.

The decade of the 1930s nevertheless saw Washington become a centre of social and economic reform directed by new federal agencies. The New Deal brought to the capital men and women to staff the Works Progress administration, the Securities and Exchange commission, the Social Security board, the functioning of the National Labor Relations board and a dozen other new planning and administrative units. Washington thus assumed a position of importance in national affairs far exceeding that of earlier years. Before World War I an English writer described the city as the principal "foundry" of government and the headquarters of scientific research but observed in cultural areas a pronounced provincialism. By 1940 Washington had launched a National Symphony orchestra and acquired by gift a National Gallery of Art containing the Mellon, Kress and Widener collections.

Effects of World War *II*.—When the United States entered World War II, Washington became the headquarters of planning operations for supply of all the Allied forces, as well as the administrative centre for a long array of new agencies aimed at regulating the wartime economy. The newly organized Office of Scientific Research and Development directed the programs that produced new types of military weapons and paved the way for government sponsorship in the postwar era of applied and basic research on a hitherto unheard-of scale. As leadership in diplomatic negotiations to hasten the end of the war fell to the United States, Washington became the political capital of the free world. Every added responsibility of the government increased the number of people crowding into the city. The district's swelling population spilled over into nearby Maryland and Virginia, in spite of gasoline restrictions which made commuting difficult.

Building postponed during the war was resumed in 1947. The White House, remodeled in Theodore Roosevelt's day to provide offices outside but adjacent to the residence, in 1949–51 underwent complete rebuilding, although careful architectural planning preserved the exterior of the original Hoban design A second senate office building to the east of the first was finished in 1959, while work began on a third house office building southwest of the Capitol grounds. At the same time an extension of the east front of the Capitol got under way, an operation involving removal of the huge pillars of the east portico. A second National museum under construction on Constitution avenue adjacent to the 1910 building resulted in demolition of several of the temporary structures erected in World War I. An additional Department of State building in "Foggy Bottom" began to alter the looks of the shabby section of the city adjoining the Rock Creek parkway. Nearby, George Washington university acquired several blocks of land and embarked upon a large expansion of its campus and buildings. Private enterprise built dozens of new office and apartment buildings, and labour unions grown powerful during the war chose to erect headquarters in Washington. Of these the most conspicuous were the International Brotherhood of Teamsters building near Union station and the American Federation of Labor headquarters on 16th street next to St. John's Episcopal church. Farther north on 16th street the National Education association erected its headquarters, a large glass and marble structure, while on the hill at Maryland avenue the Veterans of Foreign Wars opened a new building of similarly modern design. A bell tower commemorating Sen. Robert Taft was completed in 1959 on a square below the old senate office building. Renovations in Georgetown (*q.v.*) brought about a reversal of the usual American norm whereby white families move out of a neighbourhood when Negroes move in, for the lingering charm of the little 18th-century city and its convenience to government offices in "Foggy Bottom" hastened a movement begun during the war which transformed Georgetown within a decade from a run-down village heavily populated with impoverished Negroes into a fashionable residential section occupied almost exclusively by white people. In order to preserve the town's historic character, congress then forbade architectural changes unless approved by the Commission of Fine Arts.

In the interim, urban blight in the United States led congress to pass the Housing act of 1949, granting federal aid to states and cities for urban renewal. In Washington, while criticisms sounded at the slavishness with which two generations of architects had adhered to the McMillan scheme of 1901, said to have been "obsolete" when it was adopted, the National Capital Planning commission, the Redevelopment Land agency, the National Capital Housing authority and several departments of the district government collaborated in determining which sections of the city should be completely razed, which partially cleared and where the residents of the blighted areas should be relocated. Most of southwest Washington was entirely cleared, new multiple-family dwellings were erected there and an elaborate plan for a civic centre and an inner loop of a new circumferential highway system was accepted. Work began also on redeeming sections in northeast and the central area in north est Washington.

POPULATION CHARACTERISTICS

The centrifugal trend of Washington's white population to the suburbs increased after World War II. Government policies of decentralization abetted the movement, reducing the former concentration of research facilities in Washington and heightening the importance of locations in the outlying areas. Thus the Naval Medical Research institute and the National Institutes of Health at Bethesda; the U.S. Naval Ordnance laboratory at White Oak; the Army's Office of Operations Research and the Army Chemical Corps research centre at Ft. George Meade were all established in the Maryland suburbs, and agencies such as the Johns Hopkins university applied physics laboratory under contract with the government rarely remained in Washington. The decision to move the central intelligence agency to new quarters in McLean, Va., underscored the government's policy. In 1950 the District of Columbia, which 30 years before had contained 76.5% of the persons living in the metropolitan area, had only 61.6%.

Negroes drawn to the capital during World War II and after by the government's nondiscriminatory employment policies generally remained in Washington. A decision of the supreme court in 1953 which upheld the validity of laws passed in the district between 1869 and 1873 forbade racial discrimination in restaurants and places of public entertainment and, together with the court decree of 1954 declaring segregated schools unconstitutional, further encouraged an influx of Negro citizens. Difficulty in obtaining desirable housing in the Maryland and Virginia suburbs kept well-to-do Negro families in the district.

GOVERNMENT

Administration and Finance. — Throughout most of its history, Washington has not enjoyed self-rule but has been governed by the federal congress. The city was chartered in 1802, with a mayor appointed annually by the president and an elective council of two chambers. At about the same time, congress renewed the municipal charters of Georgetown and Alexandria, the two cities that existed within the federal district before Washington came into being. Modifications of Washington's charter in 1812 vested in the city council the right to elect the mayor; in 1820 a new charter permitted white resident property-owners to elect him, and a third charter in 1848 removed the property qualification for municipal voting. Three years later a similarly broadened elective franchise went into effect in Georgetown. Meanwhile. in 1846, retrocession to Virginia of the trans-Potomac part of the original ten-mile federal square took Alexandria out of direct congressional control. In 1867 congress, adhering to the principle later accepted by the states upon ratification of the 14th amendment to the constitution, enfranchised male Negroes in Washington and Georgetown. By 1869 one Negro sat on Washington's 14-man board of aldermen and out of 21 councilmen 7 were Negroes, a proportion in keeping with the racial distribution of the city's population. But white opposition to Negro voting and confusion arising from the overlapping jurisdictions of the two city governments, county officials and a metropolitan police force led congress in 1871 to repeal the municipal charters and create the Territory of the District of Columbia with a new unified government for the entire district. The president, with the concurrence of the senate, appointed a governor, secretary, board of public works, board of health and a governor's council, while 22 members of a lower house and a delegate to the national house of representatives were elected by adult males irrespective of their colour. During the three years of the territory's existence, never more than three Negroes sat on the governor's council nor more than five in the house of delegates. Extravagant spending by the board of public works in its efforts to modernize the city brought the District of Columbia to bankruptcy in 1874 and, coupled with continuing white hostility to Negro suffrage, caused congress to abrogate the territorial government and substitute a commission of three presidential appointees.

Four years later the Organic act of 1878 established a permanent commission form of government. By the terms of that act the executives of the district government consist of two civilian residents of the district and an officer of the corps of engineers of the U.S. army appointed by the president with senate concurrence. The president, the three commissioners and the judges of the district courts appoint most of the administrative officers and boards, although in 1952 authority to make some appointments was vested in the commissioners alone. Lesser posts are filled by civil service examination.

The president appoints the judges of the district courts. The municipal court includes a civil and a criminal division, a juvenile court and a domestic relations court. One judge sits on local tax cases in the tax court. At a higher level are the municipal court of appeals; the U.S district court for the District of Columbia, until 1938 known as the supreme court of the District of Columbia; the U.S. circuit court of appeals for the District of Columbia circuit; and the supreme court of the United States. A District of Columbia code of laws was first completed in 1929.

Congress, acting usually upon the recommendations of the house and senate committees on the District of Columbia and of the subcommittees on district appropriations, legislates for the district, sets its tax rate and fixes its annual budget. All local revenue—derived from real estate and income taxes, a 2% sales tax and license fees—is paid into the U.S. treasury and all accounts are audited by treasury officials. Between 1878 and 1922 the United States matched local tax revenues with annual appropriations and thereafter reduced the federal contribution to a figure that for 40 years thereafter averaged about 10% of the total budget.

Adoption of the 23rd amendment to the federal constitution in 1961 gave Washington residents the right to vote in elections for president and vice-president of the United States. The amendment, supported by advocates of "home rule" for Washington, allotted three electoral votes to the District of Columbia but did not othernise change the area's governmental status.

Metropolitan Area.—The results of a population of increasing density spreading over a constantly expanding geographical area introduced serious and unfamiliar problems, for political control is divided between two state governments and congress, and yet decisions on many matters must affect all parts of the whole. Problems concerning intelligently planned land use; the location of highways, factories, residential subdivisions, shopping centres and parks; how to halt pollution of the Potomac and tributary streams and yet develop adequate sewage systems; and, above all, how best to conserve for the future the region's water supply were to be met only by prompt unified action. As the co-ordinating role of a new National Capital Regional Planning council proved too limited to resolve these difficulties, in 1957 a joint congressional committee on Washington metropolitan problems undertook a thorough study. Its recommendations included the establishment of a regional development agency, a regional sanitary board, a co-ordinator for national capital affairs in the executive office of the president and a metropolitan fiscal agency. For, as the committee's final report noted: "Washington's ideal, which 50 years ago was thought presumptuous in aspiring to become 'a capital worthy of the Nation,' is now obliged to aim still higher and become a great world city, an epitome of urban ideals of the Western World and a model for growing cities throughout the free world." (Senate Report No. 38, 86th Congress, first session, *Meeting the Problems of Metropolitan Growth in the National Capital Region*, p. 12, 1959.)

THE ECONOMY

Commerce and Industry.—Real estate transactions rank after government in the city's economy, with the tourist and convention trade a close third. Approximately 6,500,000 tourists visit the city every year, making Washington second only to New York as an American sight-seeing centre. Headquarters for a large number of national organizations, the capital also serves as host to about 350 conventions each year.

For 145 years the city's industry was of little importance The bulk of manufactures consisted of goods for local consumption and items made for the federal government at the navy yard and later at the naval gun factory and other government installations. Only about 21,000 people are employed in the fewer than 500 privately owned manufacturing concerns The character of some of these concerns, however, placed the city in a special category, for after World War II companies engaged in scientific research services and production of scientific equipment began to multiply rapidly. From 7 in 1940. the number of these firms, popularly called research and development companies, grew to about 50 by the 1960s. Proximity to government contracting offices and the number of scientists and highly trained technicians that war brought to Washington explain this growth. In the suburban area. where space for industrial plants was more readily available, the expansion was still greater, from 8 research and development establishments in 1940 to more than 75 in the 1960s. exclusive of nonprofit organizations. Employment does not run large compared with that of heavy industry; according to the economic development committee of the Washington board of trade, in the late 1950s four companies nith fewer than 9.000 employees accounted for over half the total employed in "r & d" industries in the entire metropolitan region Nevertheless, after 1950 greater Washington ranked first among U.S. metropolitan areas in the number of scientific persons employed per 1.000 of the population: these included scientists in the government service. Much of the work of the private companies is directed toward problems of national defense and deals with data processing, electronic devices, applications of nuclear energy and the like.

Transportation and Communications.—Five railways enter the city and the several airlines yearly fly nearly 500,000 passengers into and out of the Washington National airport. Construction of a second national airport 30 mi. to the south at Chantilly, Va., was begun in 1959. Interstate buses offer alternate means of travel. Potomac river steamboats, once popular, no longer offer passenger service except for summer excursions to Mount Vernon and an amusement park downstream. Within the city the D.C. Transit company operates buses, electric street railways and special sightseeing buses; a number of local and interstate companies conduct bus tours to points of interest in and about the capital. Washington has several radio and television stations.

EDUCATION, SCIENCE AND CULTURE

Public and Private Schools.—Washington is an educational centre of considerable importance. The public-school system, under the control of a board of education appointed by the district court judges of the District of Columbia, embraces kindergartens; elementary and secondary schools; a business high school; and manual training, normal and night schools. From 1862 to 1954 racial segregation obtained in the public schools, although in the 20th century a white superintendent was the administrative head of both white and Negro school systems. In 1954, after the supreme court decreed that racially segregated schools were unconstitutional the board of education and school officials moved quickly to establish an integrated system, the first to go into effect in any large city nhere a dual system had formerly operated. In addition to the public schools there were established several Roman Catholic schools, tno Episcopal preparatory schools attached to the Cathedral of SS. Peter and Paul, the nonsectarian Friends school started by Quakers, and other private schools, as well as seminaries, small colleges and the Episcopal College of Preachers, providing refresher courses for Episcopal ministers.

Higher Education.—At mid-20th century, of all the metropolitan areas in the United States, Washington had the highest educational level of adults 25 years of age and over Whereas in the San Francisco-Oakland area, ranking second, about 10% of the adult population had four years or more of college training, in the Washington area the proportion was more than 15%. Five universities in Washington offer graduate work. a great deal of it in evening classes to enable students who earn their living at daytime jobs to win advanced degrees. Georgetown university, located on the heights above the Potomac in Georgetown, is the oldest of these institutions. Founded by Bishop John Carroll in 1789 as Georgetown seminary to train young men for the Roman Catholic priesthood and later chartered by congress as a university, it comprises a liberal arts college, school of medicine, graduate school, law school, dental school and a school of foreign service.

In 1821 Baptists in Washington obtained from congress a charter for a nonsectarian institution, the Columbian College in the District of Columbia, from which grew Columbian university in 1873 and, by a change of name in 1904. George Washington university. Benefiting from a small congressional endowment in 1831, a gift of $1,000,000 from W. W. Corcoran in 1872 and later gifts from other men. the university acquired a campus to the west of the White House in the vicinity of the department of state buildings. Besides a junior college and the Columbian college of arts and sciences, primarily for undergraduates, the university includes a graduate council which gives the Ph.D. degree, a school of medicine, a law school. school of pharmacy, school of engineering. school of education. school of government, a division of special students and several research units under contract with the federal government The Catholic University of America was incorporated in 1887 to serve as the head of Roman Catholic schools in the United States. It opened in 1889 in a building near the Soldiers' home. Although designed especially for advanced theological studies, the university later comprised schools of the sacred sciences, philosophy, letters, physical sciences, biological sciences, social sciences, jurisprudence, law and technological sciences. Affiliated are a Franciscan convent; Dominican, Paulist and Marist houses; and Trinity college for girls.

The American university under Methodist auspices was chartered in 1893 and acquired a 90-ac. wooded campus in the northwest section of the city but did not enroll students until shortly before World War I. A downtown centre, purchased much later, accommodates a graduate school, the Washington college of law, a school of business administration and a school of government and public administration; the college of arts and sciences, mainly undergraduate, and a newer school of international service occupy the uptown campus. Adjacent, on land donated by the university, stands Wesley seminary, which opened in 1958.

Howard university, chartered in 1867 for the higher education of Negroes, is situated southwest of the Soldiers' home. It was named in honour of Gen. Oliver O. Howard, one of its founders and its president from 1869 to 1873. Howard, one-time head of the Bureau of Freedmen, and his associates had intended to make the new university biracial; their own sons were enrolled in the first classes, and most of the faculty members also were white men. But by the mid-1880s the student body had become virtually all Negro and remained so until after World War II, when a few white students again sought admission, particularly to the graduate school of social work. The faculty, predominantly Negro after 1890, often included some white scholars. The university comprises a college of liberal arts, a law school, school of medicine, school of dentistry, school of pharmacy, school of engineering and architecture, school of music, school of religion and a school of social work. The university has a small endowment but is supported chiefly by annual congressional appropriations administered through the federal department of health, education and welfare.

Gallaudet college at Kendall Green in northeast Washington is an outgrowth of a school for deaf mutes founded in 1857 on the farm given for the purpose by Amos Kendall, postmaster general in President Jackson's cabinet. The school was incorporated as the Columbia Institution for the Instruction of the Deaf and the Dumb and the Blind and, though a private foundation, from its beginning received congressional appropriations. Its first head was the son of Thomas H. Gallaudet (*q.v.*) who introduced into America the use of sign language for teaching deaf mutes and for whom the college was later named. Sign language instead of lip reading is still the standard method of teaching employed at both Kendall school (the secondary school) and Gallaudet college. For a few years in the 1860s the Columbia institution also accepted blind students but later, as special schools for the blind developed elsewhere, limited enrollment to the deaf. Its name was changed to Gallaudet college in 1954 and it was the first in the United States to provide higher education for the deaf.

At Ft. McNair, on the grounds of the former Washington arsenal, the National War college and the Industrial College of the Armed Forces occupy an imposing building designed by Stanford White. At the National War college officers selected from the armed services and civilians chosen from the department of state spend a year in intensive study of international problems. The work of the Industrial college is directed at problems of military procurement and supply. A large specialized library serves both colleges. The U.S. army medical department maintains a research and graduate school in Washington.

Scientific and Cultural Institutions and Activities.— Among the institutions, both public and private, which have increased Washington's stature as a centre of learning and scientific research, the national archives and the Library of Congress are outstandingly important. When in 1936 the national archives opened in a new building near the apex of the "federal triangle" between Pennsylvania and Constitution avenues, the government's manuscript records and official correspondence, formerly scattered in scores of federal installations in and out of Washington, were brought together in carefully indexed, well-ordered collections covering virtually every phase of national development. The Library of Congress is much older. It contains more than 36,900,000 books, pamphlets, bound newspaper volumes, manuscripts, maps, prints, photographs, recordings and movie films, as well as a collection of microfilmed copies of doctoral dissertations and studies located in other libraries. Founded in 1800, the congressional library was wiped out in 1814 when British troops burned the Capitol; it was re-established by purchase of Thomas Jefferson's library and again largely destroyed by fire in 1853. Rebuilt by purchase and by gift, the collections occupied part of the Capitol itself until a separate building on the square to the east was completed in 1897. An annex, to the rear of the main building, was finished in 1939. The reading rooms are open to the general public and special facilities for study are available to scholars. A legislative reference service supplies congress with information, while a copyright office and a card catalogue division, which sells catalogue cards to other libraries and maintains a national union catalogue, are more than self-supporting. Another unit of the library loans books in braille and Moon type and recordings, called talking books, to the blind. The law library is the largest of its kind in the world. Ever since 1866 when the Smithsonian institution's collections of publications of learned societies and of scientific periodicals were transferred to the Library of Congress, it has formed, together with the library of the department of agriculture and after 1956 the National Library of Medicine in Cleveland, a vast national repository of scientific materials.

The Smithsonian institution (*q.v.*), founded in 1846 with money bequeathed to the United States by the Englishman James Smithson for the express purpose of enlarging and disseminating "knowledge among men," was the first organization to give the capital a unique position in the world of science. Joseph Henry, the Smithsonian's first secretary, and John Quincy Adams, who as a member of the house of representatives in 1846 helped determine the policy, believed that the increase of human knowledge was as important as its dissemination; Henry laid the groundwork for fundamental scientific research under government sponsorship. After the Library of Congress took charge of the earlier collection, the institution continued to publish scientific articles and, through the studies prepared by the Bureau of American Ethnology and the materials assembled and put on exhibit at the U.S. National museum, became a leading source of data on cultural anthropology, primarily of the American Indian. The original National museum building, located east of the Smithsonian, opened in 1881 in time to be the scene of President Garfield's inaugural ball. But when in 1910 the squat-towered red brick edifice proved too small, a much larger building was erected across the Mall where not only the scientific exhibits but the national collection of paintings were housed. Shortly after World War I, the Freer Gallery of Art was opened as part of the Smithsonian institution. The gallery stands to the west, near the department of agriculture buildings, and contains the collection of oriental art and American paintings presented to the United States between 1906 and 1916 by Charles L. Freer of Detroit, Mich.

Besides the Smithsonian institution, the geological survey, organized in 1879, and the Naval observatory, which in 1893 moved from its one-time location beyond the White House to Observatory hill of Massachusetts avenue, carried on some fundamental research under government auspices in the late 19th century, but after 1901 the federal government gradually relegated basic research to universities and private foundations. Applied research, aimed at the solution of specific problems, expanded in Washington, however, before World War I, chiefly under the aegis of the national bureau of standards, organized in 1901; the National Advisory Committee for Aeronautics, formed in 1915; and the National Research council, established in 1916, itself an offshoot of the then 53-year-old advisory National Academy of Sciences. During the 1920s and 1930s additional installations appeared, notably the Naval Research laboratory (1923); the National Institutes of Health (1930) under the public health service, which in 1938 established its research center in Bethesda, Md.; the National Cancer institute (1937); and, at Beltsville, Md., an agricultural research station (1934). After World War II renewed attention to basic research brought into being the National Science foundation (1950) with its headquarters in the capital.

In the field of basic research in the physical sciences the Carnegie Institution of Washington is of major importance. It was endowed by Andrew Carnegie in 1902 "to encourage in the broadest and most liberal manner, investigation, research and discovery, and the application of knowledge to the improvement of mankind; and in particular to conduct, endow and assist investigation in any department of science, literature or art." Archaeological research, mostly in the Mayan region of Mexico, after replacing the historical research the institution once supported, in turn largely yielded to the programs carried on by the departments of terrestrial magnetism, astronomy and geophysics. The geophysical laboratory and the laboratory of terrestrial magnetism in Washington are world-renowned.

In the realm of the social sciences, the Brookings institution, founded and endowed in 1928 by Robert Brookings, a St. Louis merchant and industrialist, sponsors studies in government, public administration and economics, including labour relations. After 30 years on Jackson place facing Lafayette square, its headquarters were moved to a new building on Massachusetts avenue.

The American Association for the Advancement of Science and a long list of other national scientific and scholarly organizations maintain headquarters in Washington. The Washington Academy of Sciences, formed in 1898 as a federation of local societies with and without national affiliations, originally included the Philosophical Society of Washington which dated from 1871 and was dedicated to mathematical and physical sciences; the Anthropological Society of Washington, founded in 1879, which published *Transactions* (1879 *et seq.*, with the co-operation of the Smithsonian institution) and *The American Anthropologist* (1888–98; from 1898 published by the American Anthropological association); the Biological Society of Washington (1880); the Chemical Society of Washington (1884); the Entomological Society of Washington (1884); the National Geographic society (1888), which has sponsored scientific explorations in Alaska and South America and publishes the *National Geographic Magazine* (1888, *et seq.*), special maps and in 1895 issued *National Geographic Monographs;* and the Geological Society of Washington (1893). Several newer societies later became members of the academy and published reports and articles in the Academy's *Proceedings* and *Journal.* Most of the other local scientific societies formed in the late 19th and early 20th centuries gradually disappeared. Among the best-known nonscientific learned societies which have national headquarters in Washington are the American Historical association (1884), which publishes the *American Historical Review* (1886, *et seq.*); the American Planning and Civic association, which publishes an annual (1929, *et seq.);* the American Political Science association (1903), which publishes the *American Political Science Review;* and the American Institute of Architects. The last-named was founded in 1857 and through its publications early became a national clearinghouse of architectural ideas. In 1902 it saved from demolition the century-old Octagon house and turned that fine example of William Thornton's architectural skill into the institute's headquarters.

Members of all these societies are eligible for election to the Cosmos club. Founded in 1878 to provide a common meeting ground for scientists, scholars and men of letters, the club long occupied the house looking out over Lafayette square in which Dolly Madison spent the last years of her life. The wish of the federal government to use the space flanking the square for federal buildings led the club in the 1950s to move to larger quarters on Massachusetts avenue. There the club maintains a considerable library for its members.

Exclusive of such private collections, libraries in Washington number about 250, ranging in character from that of the Franciscan monastery to that of the Washington public library with its branches and its main building, the gift of Andrew Carnegie, on Mount Vernon square, Virtually every embassy, every school and university and every labour union with national headquarters in Washington maintains a library. The Daughters of the American Revolution have a large genealogical collection housed in Constitution hall at D and 18th streets; at Dumbarton Oaks in Georgetown, Harvard university has its volumes and manuscripts dealing with Byzantine art and church history; the Folger Shakespeare library, which stands next to the Library of Congress annex on Capitol Hill, contains the largest collection of Shakespearean materials in the world and also has valuable data on 17th and 18th century British America. Only the New York metropolitan area makes available to the U.S. public more extensive collections of books and manuscripts than are to be found in Washington.

See also Index references under "Washington, D.C." in the Index volume.

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WASHINGTON, a city in southwestern Pennsylvania, U.S., the seat of Washington county, is approximately 22 mi. S.W. of Pittsburgh's golden triangle. Formed in 1910 by a consolidation of the boroughs of Washington, South Washington and North Washington, it was chartered as a city in 1924 and is the centre of an agricultural, industrial and coal-mining territory which extends into several neighbouring townships and hamlets. In general, the eastern part of the city's sphere of influence has been coal mining in nature, while the western and southern parts have been agricultural. The principal industries of the region have been steel and glass making. The city is included by the census bureau in the Pittsburgh standard metropolitan statistical area (*see* PITTSBURGH); the area between Pittsburgh and Washington tended to develop into various suburban residential communities.

In the period before the American Revolution, Washington and its region was more properly an extension of Virginia rather than of Pennsylvania. In Aug. 1776 the first court west of the Monongahela river was held under Virginia jurisdiction about three miles from the city's present site. At the same time, the region was included in Virginia's district of West Augusta and was the cause of much dissension between the Virginians and the Penns. The latter group's claim was finally validated by the Virginia constitution of June 1776.

Laid out by David Hoge in 1781, Washington was first known as Catfish's Camp after a Delaware chief who had a camp there about 1750. Known also as Dandridge Town and Bassett-town for short periods, it received its present name about 1781. It was a centre of rebel activity during the Whisky insurrection (*q.v.*) of 1794; the home of David Bradford, one of the rebel leaders, still stands on South Main street. The National road was completed to the town in 1817.

Washington and Jefferson college, a private college for men and the oldest institution of higher learning west of the Alleghenies, was formed by the consolidation of two colleges in 1865. Both had resulted from academies developed by Presbyterian ministers in the last 15 years of the 18th century. The first crematory in the United States was built in Washington in 1876 by Francis Julius LeMoyne (1798–1879), who had to contend with an aroused public opinion, which forced the construction of the building at night. He was also an ardent abolitionist of the pre-Civil War period.

For comparative population figures see table in PENNSYLVASIA: Population. (P. R. J.)

WASHINGTON, MOUNT, highest (6,288 ft.) peak of the White mountains in New Hampshire, U.S., noted for its extreme weather conditions at all seasons. The treeless summit is accessible by an eight-mile road from the Glen house in Pinkham notch, by the three-mile cog railway from the Base station near Crawford notch and by marked trails maintained by the U.S. forest service and the Appalachian Mountain club. Summit buildings, which must be anchored against high winds, include Tip-Top house and Summit house. open to the public in summer, Mt. Washington observatory and the Mt. Washington television transmitter. Weather at the summit has often been called the worst in the world and the highest free air movement ever recorded—231 m.p.h.—was measured at the observatory in 1934. The summit tract and the cog railway, owned by Dartmouth college, are surrounded by the far-flung White Mountain National forest. From this ridgepole of New England flow three of the region's major rivers, the Connecticut, the Androscoggin and the Saco. (R. S. Mo.)

WASHINGTON, TREATIES OF. Among various important international agreements signed at Washington, D.C., were the Webster-Ashburton treaty of Aug. 9, 1842, which settled the northeastern boundary of the United States and provided for Anglo-U.S. naval co-operation in the suppression of the international slave trade; and the North Atlantic treaty of April 4, 1949, a mutual security pact signed by Belgium, Canada, Denmark, France, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom and the United States and later signed by various other powers (see NORTH ATLANTIC TREATY ORGANIZATION). More properly known by the designation treaties of Washington, however, were certain treaties of 1871 and 1921–22.

Treaty of 1871.—The treaty of Washington, May 8, 1871, was the achievement of an eminent Anglo-American joint high commission which was convened to settle a number of disputed issues. Chief among these were the "Alabama" claims of the United States against Great Britain, arising out of the U.S. Civil War. But Canada had certain important questions bearing on its relations with the U.S., viz., the settlement of the perennial Northeast Atlantic fisheries dispute, the renewal of commercial reciprocity with the U.S., which had lapsed in 1866, and the payment of an indemnity for damages inflicted on Canada by Irish Fenian raiders from the U.S. (see FENIANS). To cope with these Canadian questions Sir John A. MacDonald, the Canadian prime minister, was made a member of the British commission, but he served nevertheless under the authority of the British government rather than as a Canadian. The joint high commission wrote into the treaty three rules of due diligence pertaining to the duty of a neutral and made them retroactive so as to form the explicit basis for the "Alabama" claims arbitration that ensued at Geneva (see "ALABAMA" ARBITRATION). The Canadian desire for reciprocity was refused as were the Fenian claims, and the inshore fisheries were reopened to U.S. fishermen, subject to payment of an indemnity by the U.S., the amount to be decided subsequently by a mixed commission. Over and above its actual provisions, the treaty proved to be of decisive and permanent value in harmonizing the relations of Britain, Canada and the U.S.

TREATIES OF 1921–22

The Washington conference (*q.v.*) of 1921–22 resulted in seven treaties and agreements. These were, in the order in which they were signed: (1) the treaty (four-power pact) relating to insular possessions and insular dominions in the Pacific ocean signed Dec. 13, 1921, by the U.S., the British empire, France and Japan; (2) a declaration accompanying the four-power pact stating that it was the understanding of the signatory powers that the pact applied to the mandated islands of the Pacific; (3) the treaty for the limitation of naval armament signed Feb. 6, 1922, by the above four powers and Italy; (4) the treaty relating to the use of submarines and noxious gases between the same five powers; (5) an agreement supplementary to the four-power pact, defining the application of the terms "insular possessions" and "insular dominions" as relating to Japan, signed Feb. 6; (6) the treaty (nine-power treaty) relating to principles and policies to be followed in matters concerning China, signed Feb. 6 by the above five powers and Belgium. the Netherlands, Portugal and China; (7) the treaty between the nine powers relating to the Chinese customs tariff.

Four-Power Pact.—The four-power pact was an ambiguously worded agreement by the signatories "as between themselves to respect their rights in relation to their insular possessions and insular dominions in the region of the Pacific Ocean." The treaty went on to provide that, should a controversy arise between any of the parties over "any Pacific question" which they could not settle between themselves, they were to summon the other parties to a joint conference "for consideration and adjustment." Furthermore, "if the said rights are threatened by the aggressive action of any other power," the parties "shall communicate with one another fully and frankly in order to arrive at an understanding as to the most efficient measures to be taken, jointly or separately, to meet the exigencies of the particular situation." The treaty was to remain in force for 10 years and thereafter was subject to the right of any one of the parties to terminate upon 12 months' notice.

On its face this treaty was a consultative agreement on the part of the four powers, but especially on the part of the three, the U.S., Great Britain and Japan, whose interests in the Pacific were most in danger of a clash. This was especially true of the U.S. and Japan, which, upon at least three previous occasions (the Taft-Katsura memorandum of 1905, Root-Takahira agreement of 1908 and the Lansing-Ishii agreement of 1917), had endeavoured to arrive at an understanding. Anglo-Japanese relations were concurrently regulated by the alliance of 1902, which had been renewed and strengthened in 1911. This alliance was up for renewal again in 1921 at the time of the Washington conference. British diplomacy preferred to continue the alliance and have the U.S. join it, a viewpoint shared by Sen. Henry Cabot Lodge of the U.S. delegation. But for political reasons this course was not practicable, and the four-power pact became the alternative. The pact declared the Anglo-Japanese alliance terminated, but as an instrument itself for consultation among the powers the pact was never invoked thereafter. The U.S. senate, as a condition for its acceptance of the pact. wrote in a reservation to the effect that "under the terms of this treaty there is no commitment to armed force, no alliance, no obligation to join in any defense."

The declaration concerning the mandates was designed merely to cover a legal technicality arising out of the failure of the U.S. to join the League of Nations. The supplementary agreement, noted under (5) above. specified the "insular possessions and dominions" of Japan as the southern portion of Sakhalin Island, Formosa and the Pescadores, and the islands under mandate to Japan.

Naval Limitation Treaty.—The five-power naval limitation treaty was a detailed agreement respecting capital ships and aircraft carriers. The treaty designated by name the capital ships (defined as vessels of war exceeding 10,000 tons standard displacement or carrying guns with a calibre exceeding 8 in.) which each nation might retain. The aggregate tonnage thus to be retained was 525,850 for the U.S.; 558,950 for the British empire; 221,170 for France; 182.800 for Italy; 301,320 for Japan. All other capital ships, built or building, not so named, were to be scrapped, except that France and Italy were authorized to replace existing tonnage to be retired in 1927, 1929 and 1931. The U.S. was to scrap 15 pre-Jutland ships (ships built prior to the battle of Jutland in 1916) and 11 uncompleted ships; the British empire was to scrap 20 pre-Jutland ships and 4 uncompleted ships; and Japan was to scrap 10 pre-Jutland ships and 6 uncompleted ships and to abandon its program for 8 ships not yet being built. The number of capital ships of the U.S. and British empire was to be stabilized in 1936 at 15 each, and the number of Japanese ships was to be stabilized in 1935 at 9. In the case of France and Italy the number of vessels was not fixed, but no vessel was to exceed 35,000 tons displacement. Subject to certain specified exceptions and replacement provisions, the contracting powers agreed to abandon their capital-ship building programs. The total capital-ship replacement tonnage was not to exceed 525,000 each for the U.S. and the British empire, 315,000 for Japan and 175,000 each for France and Italy, resulting in a final ratio of 5–5–3–1.67–1.67. No capital ship was to exceed 35,000 tons or to carry a gun with a calibre in excess of 16 in.

Restrictions were likewise placed upon aircraft carriers as follows: total tonnage was not to exceed 135,000 for the U.S. and the British empire respectively, 60,000 for France and Italy respectively and 81,000 for Japan. No aircraft carrier was to exceed 27,000 tons displacement or to carry a gun with a calibre in excess of 8 in.

An essential corollary to these ship limitations was art. xix of the treaty, under which the U.S., the British empire and Japan agreed to the *status quo* with regard to fortifications and naval bases in their respective territories and possessions located inside an area bounded on the east by the 180th meridian, on the north by the 30th degree of latitude, on the west by the 110th meridian and on the south by the equator. In addition, Japan agreed to maintain the *status quo* in the Kurile Islands. The significance of this nonmilitarization agreement meant that no two of the powers could launch an offensive attack on each other, and thus the naval ratio of 5–5–3 was made palatable to Japan.

The treaty also laid down precise rules for scrapping and replacement and stipulated the periods in which scrapping was to be effected. Finally it contained certain miscellaneous provisions, viz., (1) Should any contracting power consider the requirements of its national security materially affected by any change of circumstances, it might request a conference with the other contracting powers with a view to reconsidering and amending the treaty. (2) After eight years from the coming into force of the treaty, the U.S. was to arrange a conference to consider changes rendered necessary by possible technical and scientific developments. (3) Should any contracting power become engaged in a war affecting its naval defense, upon due notice it might suspend for the period of hostilities its treaty obligations. (4) The treaty was to remain in force until Dec. 31, 1936, subject to the right of any contracting power to give notice two years before that date of its intention to terminate the treaty. Upon such notice taking effect, the treaty was to terminate as regards all the contracting powers. Restive under the limitations of the treaty. Japan subsequently demanded parity with Britain and the U.S.; its demand being rejected, Japan gave notice of termination and the treaty expired at the end of 1936.

At the Washington conference the British, who had suffered grievously from German submarines, strongly advanced the argument for the abolition of this type of vessel, but they encountered opposition from all the other participants, especially the French. The U.S. delegation was prepared to advocate limitation, though not abolition, of the submarine and the extension of the ratio principle to this and other types of auxiliary war craft. But even this proved impossible, and in lieu thereof the five powers signed an innocuous treaty reiterating the traditional rules of visit and search (*q.v.*) at sea and pledging themselves not to use the submarine as the Germans had used it in 1914–18. They also agreed to outlaw the use of poisonous gases in warfare. When it came to placing restrictions on military aviation, including the use of bombing planes against surface craft. none of the powers was prepared to enter into treaty engagements on the subject.

Nine-Power Treaty.— The nine-power treaty was a kind of international bill of rights for China. The other eight powers convenanted together (1) to respect China's sovereignty, independence and territorial and administrative integrity; (2) to aid China in developing and maintaining an effective and stable government; (3) to use their influence in promoting the principle of equal opportunity for the commerce and industry of all nations throughout China; and (4) to refrain from taking advantage of conditions in China to seek special rights or privileges in that country. Among the many unsatisfied demands put forward by the Chinese at the conference was the demand for tariff autonomy. By the customs tariff treaty the powers promised to establish an international commission to study the question.

See WASHINGTON CONFERENCE; DISARMAMENT; FAR EAST: RELATIONS WITH THE WEST.

See Goldwin Smith, *The Treaty of Washington, 1871: a Study in Imperial History* (1941). For the Washington treaties *see* WASHINGTON CONFERENCE. (R. W. V. A.)

WASHINGTON CONFERENCE. The genesis of this unusual international conference, held in Washington, D.C., from Nov. 12, 1921, to Feb. 6, 1922, lay in the widespread fear of an arms race between the powers victorious in World War I. Particularly acute was the fear of unrestrained competition in naval armaments between Great Britain, the United States and Japan, a prospect that arose out of the expanding naval power of these three nations during the war. Britain was alarmed lest the United States seize control of the seas; Japan feared that overwhelming U.S. sea power would threaten its independence in the far east; the U.S. government's naval building programs (under both Pres. Woodrow Wilson and Pres. Warren G. Harding) lent support to these fears, but a strong revulsion of feeling on the part of the U.S. public, given direction especially by Sen. William E. Borah, forced the abandonment of these plans in favour of a conference. In addition, information supplied confidentially by the British government that it would accept parity with the U.S. persuaded the Harding administration to take the initiative and call a conference.

Organization of Conference.— It is important to note the countries participating. The navies of France and Italy being a primary consideration in British strategic thinking, the presence of those countries was required. Furthermore, ill feeling between France and Britain and also between France and Italy raised political questions which were important factors in relation to any disarmament arrangement.

Issues concerned with the political situation of the far east and bearing on the new power position won by Japan and on the status of China called for the presence of a Chinese delegation. Finally, three other powers with interests in the far east, viz., Belgium, the Netherlands, Portugal, were invited, apparently for the sake of appearances. This made a total membership of nine powers. Conspicuous by its absence was the U.S.S.R., historically a far eastern power but brusquely excluded despite its protests and expressed desire to be present.

Among the leading personalities at the conference were Charles Evans Hughes, the U.S. secretary of state and chairman of the conference, Elihu Root and Sen. Henry Cabot Lodge; Arthur James Balfour, prime minister of Great Britain and head of the British delegation, and Lord Lee of Fareham, first lord of the admiralty, who had been instrumental in smoothing the way for the conference; Aristide Briand, the French premier; Baron Taka-Akira Kato, most influential among the Japanese delegation; and V. K. Wellington Koo, who had previously made his voice heard at the Paris peace conference in behalf of China.

Problems Considered.— At the outset Hughes created a public sensation by proposing that the U.S. scrap 15 capital ships then under construction and 15 older predreadnought battleships, that Great Britain scrap 4 new capital ships and 19 older ones and that Japan abandon its program of building 8 capital ships and scrap 7 under construction and 10 predreadnoughts. The effect of carrying out the plan would be approximate parity between the U.S. and Britain, with Japanese tonnage constituting three-fifths of either of the other two. This was the famous 5–5–3 ratio (500,000 tons for the U.S.; 600,000 for Britain, the discrepancy being accounted for in the greater age of the British vessels; 300,000 for Japan). France and Italy were requested to reduce their capital ship tonnage to the ratio of 1.75 each, a proposition that met with objections, but which was eventually accepted, with minor changes in the U.S., British and Japanese tonnages and consequently in the French and Italian ratios. (*See* also WASHINGTON, TREATIES OF: *Naval Limitation Treaty.*) Thus the conference resulted in limiting the number of capital ships and, to that extent, in restricting naval rivalries among the five powers. But that was all that it accomplished in this respect. Submarines, which had proved so effective during World War I and which the French now especially wanted, other auxiliary vessels and aircraft were omitted from the naval limitation treaty.

Related to the problem of naval limitation were the political problems of the far east. These can be classified under two main headings: (1) the ominous rivalry between the U.S. and Japan, which can be traced back to 1905, but which was accelerated by the ambitions which Japan revealed and the gains which it made during World War I; (2) the pressure from the Chinese to rid themselves of the "unequal treaties" and gain a position of strength *vis-à-vis* the western powers and Japan. American-Japanese ill will had broken out into the open at the Paris peace conference (see PARIS, CONFERENCE OF), exacerbated in dehates over Japan's right to dominate the Chinese province of Shantung. In 1920 a quarrel arose over the island of Yap, the issue being the question of control over the international cables. Other issues, by no means minor, also existed.

From the conference emerged the four-power pact, an agreement of the British empire, France, Japan and the United States, each to respect the insular possessions and dominions of the others in the Pacific and to consult together in the event of a controversy arising over "any Pacific question." This, coupled with an agreement in the naval limitation treaty to maintain the military status quo in the respective territories and possessions of the powers in the North Pacific between Singapore and Pearl Harbor satisfied their mutual security requirements. As a result of this treaty Japanese-American relations entered a ten-year period of comparative friendship. China's position was theoretically improved by a treaty signed by all nine powers recognizing its administrative independence and reaffirming the open door.

See DISARMAMENT; FAR EAST: RELATIONS WITH THE WEST.

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WASHINGTONIA, a genus of the palm family (Palmae), named in honour of George Washington. comprising two handsome species, natives of southern California, Arizona and adjacent Mexico.

WASHINGTON UNIVERSITY, a privately endowed, coeducational, nonsectarian institution of higher learning, chartered in 1853 at St. Louis, Mo. See ST. LOUIS.

WASHITA RIVER, a Great Plains stream rising in the Texas Panhandle in Hemphill county, near the Oklahoma border. The river. 500 mi. long, flows southeast in Oklahoma past Cheyenne, Clinton, Mountain View, Anadarko, Chickasha, Pauls Valley and Davis and empties into Lake Texoma, formed by Denison dam in the Red river downstream from the former mouth of the Washita at Woodville.

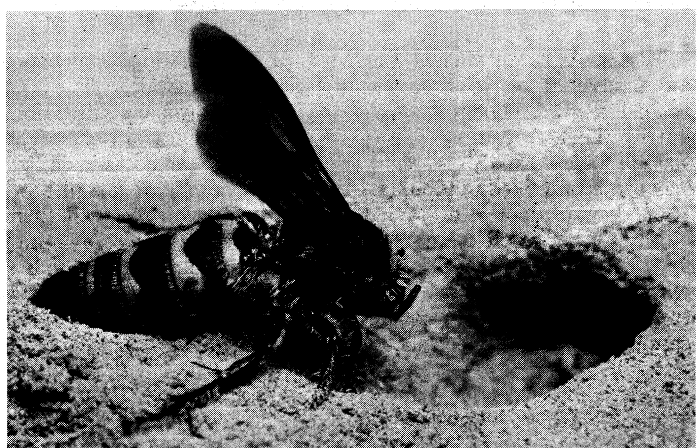
A broad, shallow valley cut into a vast expanse of flat land marks the upper course of the river. Most of the year, save for the periods of maximum rainfall in spring and early summer, the stream bed is dry and sand-choked. From Anadarko to Lake Texoma, increased rainfall has created a permanent winding stream that is sluggish and subject to severe floods. In Murray county, southeast of Davis, the Washita has cut a gorge into the Arbuckle upland 350 ft. deep in which it flows for 20 mi. emerging at the southern boundary of the county.

On Nov. 23. 1868, in the battle of Washita, General Custer's men killed Cheyenne Indian Chief Black Kettle and many of his warriors; the result was severely weakened Indian resistance to the white man (see CUSTER, GEORGE ARMSTRONG). (M. J. L.)

WASP, a general name applied to any of those insects of the order Hymenoptera that have biting mouth parts and 12- or 13-segmented antennae, are normally winged, have the abdomen attached to the thorax by a slender petiole and. in the female and worker, are provided with a formidable sting. In habits they differ from the bees in being carnivorous or parasitic. There are more than 20.000 known species, the vast majority of which are solitary wasps. The comparatively few social species comprise certain subfamilies of the family Vespidae, which differ from other wasp families in having the wings folded longitudinally when at rest. Included are the hornets, builders of the familiar large paper nests in trees or shrubs, on buildings or elsewhere above ground. and the yellow-jackets, which also build large paper nests but out of sight in the ground. For a discussion of the social wasps see SOCIAL INSECTS.

The majority of the solitary wasps construct nests or cells, which they provision with permanently paralyzed insects or spiders. An egg is deposited in each cell and the wasp larva hatching from that egg feeds to maturity upon the food with which its cell has been provisioned. The nest builders belong to several different families. Certain sections of the Vespidae, including the large subfamily Eumeninae, have varied nesting habits: some nest in wood or pithy plant stems; others dig tunnels in the soil; and still others, known as mason or potter wasps, construct nests of mud, which are sometimes vaselike or juglike and may be found attached to twigs or other objects. All of these wasps provision their nests with caterpillars, which they have paralyzed by stinging.

The Pompilidae or spider wasps usually construct single cells in the ground, in rotten wood or in rock crevices and provision them with spiders. The Sphecidae or thread-waisted wasps con-

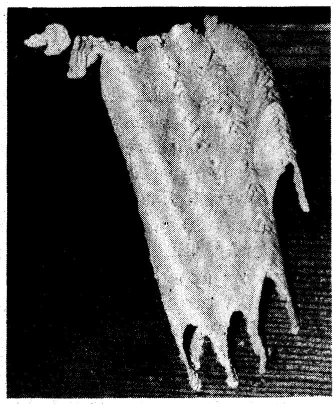


ROSS E. HUTCHINS

FIG. 1.—DIGGER WASP (SPHECIDAE) AT ITS BURROW IN THE GROUND

tain forms of diverse habits. Most of them nest in the ground and use leafhoppers, treehoppers, cicadas. stink bugs, bees, winged ants, beetles or caterpillars as food for their young, each species or group confining itself to one type of prey. Some build series of cells in rose canes or other pithy stems or twigs and provision with aphids or leafhoppers; and still others, known as mud daubers, construct small nests of mud. often in attics or outbuildings and store them with paralyzed spiders.

Three major groups of solitary wasps do not construct nests but are parasitic. These wasps are the superfamilies Chrysidoidea. Scolioidea and Bethyloidea. The Chrysidoidea are the cuckoo wasps. They are mostly brilliant metallic green or blue in colour and have the abdomen strongly convex with only three or four exposed segments. Most of them lay their eggs in the nests of solitary bees or wasps and the larvae hatching from those eggs feed on the bee or wasp larvae or on the food with which the parent bee or wasp has provisioned the nest. The Scolioidea include the families Mutillidae, Tiphiidae and Scoliidae. The Mutillidae are the so-called velvet ants. Their bodies are clothed with long thick hair of contrasting colours, often black and red, and the females are wingless and antlike in appearance. Most Mutillidae are parasitic on the larvae and pupae of solitary bees and wasps, but a European species develops parasitically in the nests of bumblebees and certain African species are parasites of tsetse flies. The Mutillidae occur principally in the warmer areas. The species of Tiphiidae and Scoliidae are mostly parasites of beetle grubs that live in the soil. The female wasp digs into the soil to locate the grub, paralyzes it by stinging and deposits an egg on it; the wasp larva feeds externally on the beetle grub. One Asiatic species of Tiphiidae (*Tiphia* polilliavora) was introduced into the United States as a natural enemy of the destructive Japanese beetle (Po-*pillia* japonica) and became well established there. The Bethyloidea comprise small to very small wasps (some of them less than 2 mm. in length) that develop as external parasites of other insects, especially the larvae of various beetles and moths.



JOHN H. GERARD

FIG. 2.— NEST OF PIPEORGAN MUD DAUBER (TRYPOXYLON ALBITARSIS) The long tubes are composed of several cells, each of which encloses an egg and a store of paralyzed insects

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(C. F. W. M.)

WASSAIL, an ancient English form of "toasting" and hence any convivial occasion, especially at Christmastide. The Old English wes *hál* ("be in good health") was an ordinary salutation, but by the 12th century it was used as a drinking formula. The wassail bowl usually contained spiced ale or wine. Wassailing was often practiced outdoors by villagers who took a wassail bowl from door to door and drank health to those who received them kindly. Even apple trees were wassailed; a toast was thrown into a tree to propitiate the spirits; cider was drunk from the bowl, with the song: "Old apple tree, We've come to wassail thee, Every twig, apples big, Every bough, apples enow!" The large wassail candle at feasts is mentioned by Shakespeare. See also TOASTS.

(A. McQ.)

WASSERMANN, AUGUST VON (1866–1925), German bacteriologist and discoverer of serodiagnosis in syphilis (the Wassermann reaction) was born on Feb. 21, 1866, at Bamberg in Bavaria. He studied in Erlangen, Munich, Strassburg (Aus.) and Vienna, and in 1888 began to practise as a physician in Strassburg. He was then engaged as an assistant at the Robert Koch Institute for Infectious Diseases, Berlin, where, from 1906, he directed the department of experimental therapy and serum research. In 1913 he became director of the Kaiser Wilhelm institute in Berlin-Dahlem. Wassermann died in Berlin on March 15, 1925.

He was a prolific contributor to medical literature. His best-known works are contained in the Handbook of Pathological *Microorganisms* (1902–09), which he published in collaboration with Wilhelm Kolle. The blood serologic test for syphilis that Wassermann announced in 1906 is highly specific and sensitive, though technical error in its interpretation is not uncommon and factors other than syphilis can cause a false positive reaction.

WAST, HUGO (pseudonym of GUSTAVO MARTÍNEZ ZUVIRÍA) (1883–), Argentinean novelist, the most prolific and popular novelist of his country, was born in Córdoba on Oct. 23, 1883. A lawyer by profession, he was active in public life as a national deputy (1916–20), newspaper editor, publisher, university professor and, after 1931, director of the National library in Buenos Aires.

Wast's most characteristic novels, Flor de *Durazno* (1911), *Valle* negro (1918) and Desierto de *piedra* (1925), treat of rural customs. In them he depicts the people of the countryside, emphasizing their struggle against nature and adversity and their ability to endure hardships. Some—La *casa* de *los cuervos* (1916), El *jinete* de fuego (1926) and *Tierra* de *jaguares* (1927)--deal with historical subjects, while others—Los ojos vendados (1921) and Ciudad turbulenta, *ciudad alegre* (1919)—treat of socioeconomic urban problems. Many of. his novels have been translated into foreign languages.

Wast is also an adept short-story writer, *Sangre* en el *umbral* (1927) being his most important collection.

See Ruth Sedgwick, "Hugo Wast, Argentina's Most Popular Novelist." *Hispanic* American Historical Review, 9:116–126 (1929); H. H. Hespelt,' "Hugo Wast—Argentine Novelist," *Hispania,* 7:360–367 (1924).

(L. LL.)

WASTE, a term used in English law in several senses, of which four are the most important: (1) "Waste of a manor" is that part of a manor subject to rights of common, as distinguished from the lord's demesne (see COMMONS; MANOR). (2) "Year, day and waste" was a part of the royal prerogative. acknowledged by a statute of Edward II, De Praerogativa Regis. The king had the profits of freehold lands of those attainted of felony and petit treason, and of fugitives for a year and a day with a right of committing waste in sense (3) thereon. After the expiration of a year and a day the lands returned to the lord of the fee. This species of waste was abolished by the Corruption of Blood act, 1814 (see FELONY). (3) The most usual signification of the word is "any unauthorized act of a tenant. for a freehold estate not of inheritance, or for any lesser interest, which substantially alters the permanent character of the thing demised (a) by diminishing its value, (b) by increasing the burden on it, (c) by impairing the evidence of title and thereby injuring the 'inheritance' " (West Ham Charity Board v. *East* London *W.W.*, 1900. 1 Ch. 624, 637; cf. Pollock on Torts, 357).

Waste in sense (3) is either voluntary or permissive. Voluntary waste is by act of commission, as by pulling down a house, wrongfully removing fixtures (*q.v.*), cutting down timber trees, *i.e.*, oak, ash, elm, 20 years old, and such other trees, *e.g.*, beech, as by special custom are counted timber in the district, opening new quarries or mines (but not continuing the working of existing ones) or doing anything which may—for this is the modern test—alter the nature of the thing demised, such as conversion of arable into meadow land.

Although an act may technically be waste, it will not as a rule constitute actionable waste or be restrained by injunction in the absence of some prohibitive stipulation if it is "ameliorating"; *i.e.*, if it improves the value of the land demised. In the case of timber estates upon which trees of various kinds are cultivated solely for their produce and the profit gained from their periodical felling and cutting, the timber is not considered as part of the inheritance but as the annual fruits of the estate, and an exception arises in favour of the tenant for life. Under the Settled Land act, 1925, a tenant for life may grant building, mining, forestry and other leases for the prescribed terms "for any purpose whatever, whether involving waste or not" and is also protected as regards waste in the execution and repair of improvements. Permissive waste is by act of omission, such as allowing buildings to fall out of repair. A "fermor"—a term which here includes "all who held by lease for life or lives, or for years by deed or uithout deed" by the statute of Marlborough, (1267)—may not commit waste without licence in writing from the reversioner.

Acts of equitable waste were, before 1875, not cognizable in courts of common law. However, by the provisions of the Law of Property act, 1925 (s. 135), an equitable interest for life without impeachment of waste does not confer upon the tenant for life any right to commit equitable waste, unless an intention to confer such right expressly appears in the instrument creating the equitable interest.

A copyholder may not commit waste unless allowed to do so by the custom of the manor. The penalty for waste is forfeiture of the copyhold (see COPYHOLD). The Agricultural Holdings act, 1923, by provisions giving compensation for improvement as regards the holdings to uhich it applies, overrides some of the old common law doctrines as to waste.

(4) "Waste of assets" or "devastavit" is a squandering and

misapplication of the estate and effects of a deceased person by his executors or administrators (see ESTATES, ADMINISTRATION OF and Administration of Estates act, 1925, s. 29). Executors and administrators may now be sued in the county court for waste of assets (County Courts act, 1888, s. 95).

Remedies for Waste.—The landlord is entitled to compensation for deterioration in the value of a holding by the failure of the tenant to cultivate according to the rules of good husbandry or the contract of tenancy.

Proceedings may be taken either by action for damages or by application for an injunction or by both combined. and either in the king's bench or in the chancery divisions.

The law of waste as it affects ecclesiastical benefices will be found under DILAPIDATION.

Scotland.—In Scots law "waste" is not used as a technical term, but the respective rights of fiar and liferenter are much the same as in England. As a general rule. a liferenter has no right to cut timber, even though planted by himself. An exception is admitted in the case of coppice wood, which is cut at regular intervals and allowed to grow again from the roots. Grown timber is also available to the liferenter for the purpose of keeping up the estate or repairing buildings.

Before making use of mature timber for estate purposes, the liferenter should give notice to the fiar. He is also entitled to the benefit of ordinary windfalls. Extraordinary windfalls are treated as grown timber. Liferenters by constitution (*i.e.*, by grant from the proprietor) as opposed to liferenters by reservation (where the proprietor has reserved the liferent to himself in conveying the fee to another) have, as a rule, no right to coals or minerals underground if they are not expressed in the grant or appear to have been intended by a testator to pass by his settlement. Where coals or minerals are expressed in the grant, and also in cases of liferent by reservation, the liferenter may work any mine which had been opened before the beginning of his right, provided he does not employ a greater number of miners or bring up a greater quantity of minerals than the unburdened proprietor did. All liferenters are entitled to such minerals as are required for domestic consumption and estate purposes.

United **States.**—U.S courts adapted the common law doctrine of waste to the requirements of a continuously expanding country. The application of the English law of waste was thus restricted to stimulate the development of the land by the tenant in possession. Good husbandry upon his part was the criterion by which the character of his acts as waste was determined. The conversion of meadow and wood land into arable land mas thus permissible.

With the disappearance of pioneer conditions, a tendency toward greater stringency in the application of the doctrine of waste became apparent, particularly in such highly industrialized states as those of the northern Atlantic seaboard. The difference, however. lies largely in a change in the character of what good husbandry demands rather than a change in the legal principle. The remedy for waste lies either by an action at lam for damages caused by waste or by an injunction to restrain further waste and to compel an accounting for the waste done. (A W R ; X)

WATCH, a portable mechanical timepiece. When matches were first made is uncertain, but there can be little doubt that the first appeared shortly after the invention of the mainspring by Peter Henlein of Niirnberg. Clocks had originally been weight driven. but after the invention of the mainspring they could be made portable. The escapement used in the early watches was the same as that used in the early clocks, the verge or vertical escapement. Early watches were made in Germany and at Blois in France. By the middle of the 20th century it was being contended that they originated in Italy.

MECHANISM

The rate of going of a watch (*i.e.,* its timekeeping) is governed by a controlling element in the form of an oscillating system. Since the latter part of the 17th century, this has taken the form of the balance and spring. The energy required to maintain the balance in oscillation is stored in the mainspring and replenished when the watch is wound.

The energy stored in the mainspring is transmitted to the balance by the wheel train and escapement, the motion of the balance itself controlling the release of the escapement and consequently the phase of the maintaining impulse. A friction drive to the hands is provided from a wheel rotating at a convenient rate, usually once per hour. The hands may thus be set to time without deranging the remainder of the watch.

The Mainspring.—The mainspring consists of a fiat steel band stressed in bending; when the watch is wound, its curvature is increased and energy thus stored.

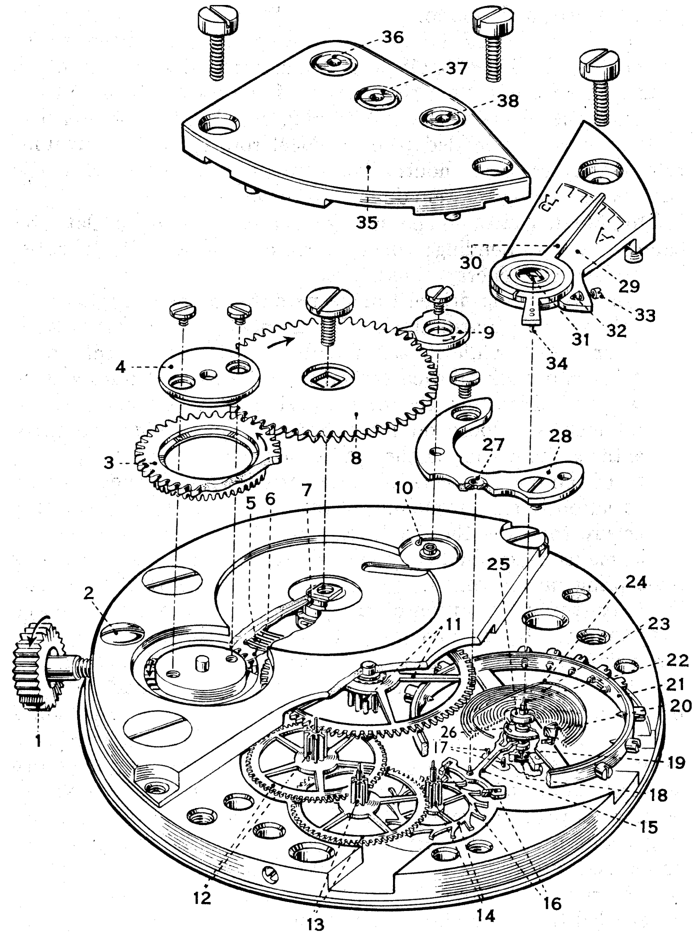
In the first spring-driven timekeepers the mainspring was open, as in the modern alarm clock. It was hooked to an arbor at its centre or "eye," while its outer end was attached to the frame. A ratchet and click allowed the arbor to be rotated during winding without disturbing the first wheel or "great wheel" of the train, which was loose on the arbor. During going, the spring drove the great wheel via the ratchet and click.

One of the main defects of these early portable timepieces was the variation in the torque output of the mainspring. An attempt to remedy this was the stackfreed. which acted against the pull of the mainspring when fully wound, exerting less restraint as the mainspring ran down. It was, in effect, little more than a crude auxiliary spring. Solution of the problem was advanced between 1515 and 1540 by the invention of the fusee. In this arrangement the mainspring is made to rotate a barrel, in which it is housed; a length of catgut, later replaced by a chain, was wound on it, the other end being coiled around the fusee. This is a drum cut in the form of a curved-sided volute or a hollow-sided threaded cone. When the mainspring is fully wound, the gut or chain pulls on the smallest radius of the fusee; as the mainspring runs down. the leverage is progressively increased as the gut or chain pulls on a larger radius. With correct proportioning of mainspring and fusee radii. an almost constant torque may be obtained throughout the run. The going barrel, fitted to all modern watches. has superseded the fusee and obviated the need for maintaining work to keep the watch going during winding. By careful proportioning of barrel arbor and barrel diameters to mainspring thickness, torque variations have been reduced to a minimum. The use of Geneva stopwork in high-class precision watches eliminates the most serious variation in torque, which occurs when the spring is fully wound.

The Controlling System.—In the earliest timekeepers, a weighted crossbar or foliot or a wheel with a heavy rim known as the balance was used to control the rate of going of the mechanism. It was subjected to no systematic constraint, and it would not be possible to define its period of oscillation mathematically. Consequently, its period of oscillation and hence the rate of the timekeeper were dependent on the driving force; this explains the great importance of the fusee.

Robert Hooke claimed to be the first to control the oscillations of a balance by a hairspring or balance spring, c. 1660; it was applied to watches for him by Thomas Tompion. Early illustrations show a balance with two pins on either side of a straight biade spring; this, when deflected by the balance, provided the restoring couple. The amplitude of the balance must. in this case, have only been small. Christiaan Huygens (*q.v.*) devised the spiral balance spring in 1675 and had watches made by Thuret to prove his theories. Besides Hooke, another who claimed priority was the *abbe'* Jean de Hautefeuille.

The balance spring is a delicate ribbon of steel or other suitable material, generally wound into a spiral form. The inner end is pinned into a collet, which fits friction-tight on the balance staff, while the outer end is held in a stud fixed to the movement. This spring acts on the balance as gravity does on the pendulum—it provides the restoring couple. If the balance is displaced to one side the spring is wound and energy stored in it; this energy is then restored to the balance, causing it to swing nearly the same distance to the other side if the balance is released. If there were no frictional losses (caused by air friction, internal friction in the spring material and friction at the pivots), the balance would swing precisely the same distance to the other side and continue



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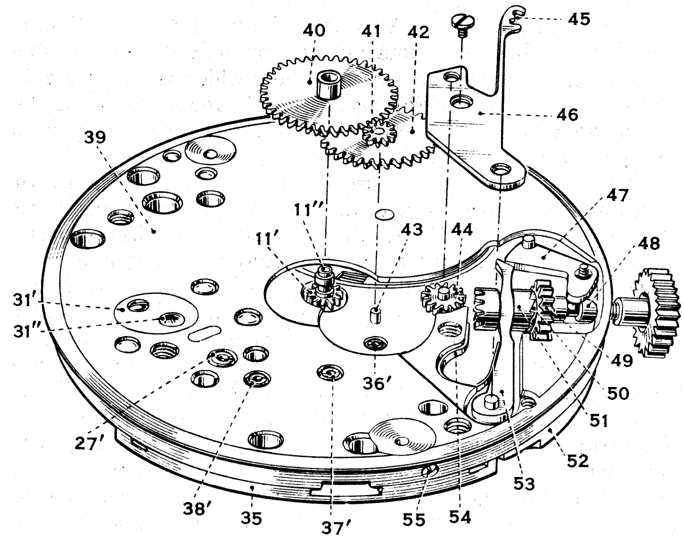


B

BY COURTESY OF MAJOR R. A FELL AND THE INSTITUTION OF MECHANICAL ENGINEERS, LONDON

A. Train side of movement

1. Winding button
2. Setting-lever screw
3. Crown wheel
4. Crown-wheel centre
5. Mainspring
6. Barrel
7. Barrel arbor
8. Ratchet wheel
9. Click
10. Click spring
11. Centre wheel and pinion
12. Third wheel and pinion
13. Fourth wheel and pinion
14. Escape wheel and pinion
15. Lever
16. Pallet stones
17. Banking pins
18. Lower end stone
19. Lower balance jewel
20. Stud
21. Baiance
22. Balance staff
23. Balance spring
24. Overcoil
25. Collet
26. Roller
27. Upper pallet staff jewel
28. Pallet bridge
29. Balance cock
30. Regulator index
31. Upper end stone
32. Stud hole
33. Stud screw
34. Curb pins
35. Train bridge
36. Upper third-wheel jewel
37. Upper fourth-wheel jewel
38. Upper escape-wheel jewel

B. Dial side of movement

- 11′. Cannon pinion
- 11″. Centre-pinion extension
- 27′. Lower pallet-staff jewel
- 31′. Lower endpiece
- 31″. Lower end stone.
- 36′. Lower third-wheel jewel
- 37′. Lower fourth-wheel jewel
- 38′. Lower escape-wheel jewel
- 39. Pillar plate
- 40. Hour wheel
- 41. Minute pinion
- 42. Minute wheel
- 43. Minute wheel stud
- 44. Transmission wheel
- 45. Jumper
- 46. Keyless cover
- 47. Setting lever
- 48. Winding stem
- 49. Winding pinion
- 50. Clutch teeth
- 51. Sliding pinion
- 52. Barrel bridge
- 53. Return arm
- 54. Return arm spring
- 55. Dial screw

FIG. 1.—WATCH MOVEMENT

to oscillate indefinitely; because of these losses, however, the oscillations would, in practice, die away. It is the energy stored in the mainspring and fed to the balance through the wheel train and escapement which maintains the oscillations. The frequency is generally $2\frac{1}{2}$ c.p.s. or 18,000 half cycles per hour.

Invention, as applied to timekeepers, was greatly stimulated during the 18th century by the need for a good timekeeper for determining longitude at sea. The problem was finally solved by John Harrison (*q.v.*), originally a Yorkshire carpenter, with his no. 4 marine timekeeper. This timekeeper, however, was difficult to construct, and of all the devices embodied in it only his maintaining power (which drives the balance during winding in fusee timepieces) was later adopted by others. The marine chronometer as developed by John Arnold and improved by Thomas Earnshaw is closely akin to the modern form of this instrument. Perhaps the only improvements on the Earnshaw form (c. 1790) are in the balance and spring.

Errors in the Balance and Spring.—A watch's performance depends on the uniformity of the period of oscillation of the balance and spring. The balance takes the form of a wheel with a heavy rim, while the spring coupled to it provides the restoring torque. The balance possesses moment of inertia, and this is dependent on its mass and configuration. The spring should. ideally. provide a restoring couple directly proportional to the displacement from its unstressed or zero position. A system of this kind will have a periodic time $T = 2\pi\sqrt{\frac{I}{G}}$ where **I** is the moment of inertia of the balance and G the restoring couple of the spring per unit displacement. If these factors do not change. or remain in constant ratio, the periodic time will evidently remain constant and the watch will have a uniform rate. Any departure from uniformity of rate should be examined in relation to variations in the above expression. The balance is mounted on pivots and, in watches of good quality, these run in jewels. Two jewels are used at each end of the balance staff, one pierced to provide a bearing, the other a flat end stone providing axial location by bearing against the domed end of the pivot. Frictional effects at the pivots influence the performance of the watch in various positions; for example, lying and hanging.

The balance and spring can be brought to time or "regulated" by varying either the restoring couple provided by the spring or the moment of inertia of the balance. In the first case (by far the more common) this is generally effected by providing a pair of curb pins mounted on a movable regulator index. The spring constant G is given by the expression $G = \frac{Eht^3}{12l}$ where E is

Young's modulus of elasticity (see ELASTICITY) and h, t and l represent the height, thickness and length of the spring. Evidently the only factor that may be changed in use is l, and the spring therefore passes between a pair of curb pins mounted on the index; movement of the curb pins will effectively lengthen or shorten the spring, thus making the requisite change in the spring constant. In the second instance, screws are provided at one or two pairs of opposite points on the rim of the balance; these screws are friction-tight in their holes and thus can be moved in or out so as to adjust the moment of inertia of the balance. In "free-sprung" watches no regulator index is provided, and the only adjustment available is the screws on the balance rim.

Errors of *Isochronism.*—Errors of isochronism are recognized when the periodic time of the balance varies with the amplitude of oscillation. The following occur with the watch in the lying position (*i.e.*, with the balance staff vertical): (1) curb pin errors; (2) centrifugal error (with cut compensation balance only); (3) departures from Hooke's law in the spring material; (4) "point of attachment" effect; (5) escapement error.

Curb pin errors occur when the regulator curb pins do not positively clamp the spring, which will thus be out of contact with them during part of the oscillation. its effective length being then measured from the stud instead, so that any change in the amplitude of oscillation will change the length of time for which the spring is in contact with the pins and cause an error of isochronism.

Centrifugal error is of decreasing importance (except in the older types of marine chronometer), as the cut compensation balance is seldom used today. However, with a cut balance the moment of inertia mill vary with angular velocity, since the rim will be sprung outward because of centrifugal loading. This will cause the effective value of the moment of inertia to vary with the amplitude of oscillation, tending to cause the timekeeper to lose at high amplitudes.

Departures from Hooke's law (see ELASTICITY; MATERIALS, STRENGTH OF) depend on the particular spring material involved and can cause errors of isochronism of the order of 20 seconds per day.

"Point of attachment" effect occurs because the balance spring cannot in practice be anchored at zero radius (ie., on the true axis of the balance) but has to be pinned to the collet, which anchorage is at an appreciable radius. Hence, particularly if a flat spiral spring is used. elastic side-thrust couples will be set up through the eccentric development of the spring as it coils and uncoils. These couples will give rise to disturbances to the periodic time, and these will vary with amplitude.

A theoretical analysis of escapement error was developed by Sir George Airy. The function of the escapement is to supply the balance and spring with energy obtained from the mainspring. via the wheel train. to maintain the balance in oscillation. If an oscillating system receives a forward impulse when approaching the zero position it will be caused to gain. while under the same condition a backward impulse would cause a loss; after the zero position, the effects are reversed. With the lever watch escapement, the net effect of the action of the escapement is to cause a loss. This amounts to approximately two to five seconds per day over the normal working range of amplitudes, that is, between 180 and 270 degrees.

Positional Errors.—Because of the type of pivot on which the balance and spring is mounted. a change of position from lying to hanging will cause an increase in the frictional losses; in the hanging position the amplitude will be reduced by about 40°–60° as compared with the amplitude in the lying position. All the five types of isochronal error will therefore take effect when the watch is moved from the lying to the hanging position.

A general idea of effects caused by eccentric movement of the centre of gravity may be formed if one considers the centre of gravity of the balance to lie below the axis in the zero position. At all amplitudes up to 180° the restoring couple caused by the spring will be augmented by a restoring couple caused by gravity, so that the watch would tend to gain. If the amplitude is increased, the spring couple will be opposed by the gravity couple at the extremes of displacement, and in fact the effect on periodic time becomes zero at an amplitude of about 220°. Beyond this amplitude the effect reverses, and the gravity couple would cause a loss.

In practice, it is most difficultto make a balance spring in which the centre of gravity remains on the axis for all displacements of the balance. In general, the centre of gravity will move in a complex manner depending on the exact configuration of the spring and its inner and outer terminations. This movement can be greatly reduced by raising an overcoil at the outer end of the spring and terminating this at the stud in a plane above that of the body of the spring. This invention was made by Abraham Louis Breguet (c. 1800), and overcoil springs are named after him. The theoretical conditions governing the form of overcoil to ensure a stationary centre of gravity and to eliminate lateral pressure at the balance spring collet were established by E. Philips, an Englishman working in France (c. 1860).

Temperature Errors.—The full expression for the periodic time of the balance and spring is $T = 2\pi\sqrt{\frac{12mk^2l}{Eht^3}}$, where m is the mass of the balance; k, its radius of gyration; E, Young's modulus of elasticity; and h, t and 1, the height, thickness and length of the spring respectively. A change of temperature may evidently affect all these factors except m. If the temperature rises, the moment of inertia of the balance will increase, because of an increase in k caused by the expansion of the balance. As regards the spring, variations in h and 1 will cancel one another, while with a rise of temperature the increase in t will tend to make the spring stiffer. Changes in E are of the greatest importance: with steel springs, E decreases by 240 parts in 10^6 per degree centigrade of temperature rise.

The net change in timekeeping, in seconds per day, is given by the expression $At = -86400\,\alpha_1 + 129600\,\alpha_2 + 43200\,C$, where α_1 is the coefficient of expansion of the balance, α_2 the coefficient of expansion of the spring material and C the temperature coefficient of Young's modulus or thermoelastic coefficient.

The first of these effects causes a loss, the second a gain, and the third either a gain or a loss with rise of temperature, according to the particular spring material. For a steel spring and brass balance, the first effect causes a loss of 1.6sec. per day per degree centigrade, the second a gain of 1.4sec. per day per degree centigrade, and the third a loss of 10.5 sec. per day per degree centigrade. Thus the timekeeper would lose nearly 11 sec. per day for every degree centigrade of temperature rise.

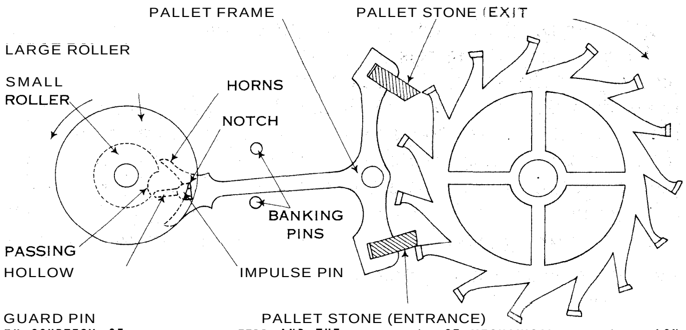
For marine timekeepers, which have to encounter a wide range of temperatures, the problem was solved by John Harrison, who used a pair of curb pins mounted on a brass and steel bimetallic strip; with changes of temperature, the curb pins moved along the spring, thus changing its effective length and compensating for the errors of the system as a whole, largely for changes in Young's modulus.

This arrangement was superseded by a balance which changed its moment of inertia with the temperature. Pierre Leroy's balance was of the fluid compensation type, with alcohol thermometers causing the displacement of mercury threads in glass tubes. Later, the bimetallic compensation balance was developed by Arnold and Earnshaw.

Earnshaw's form, in which brass was fused onto the outside of the steel balance rim, is identical in principle with the bimetallic balances still used in some very high-grade watches. The unequal expansion of the brass and steel caused the rim, which was attached to the balance arm at one end and free at the other, to curl inward or outward with changed temperature. This effected changes in the moment of inertia of the balance. The rate of change of moment of inertia with temperature could be adjusted by moving compensation weights or screws toward or away from the free ends of the rim. In this way the rates of the timekeeper could be made exactly equal at two temperatures.

However. if these temperatures differed by about 30° C., an error of approximately $2\frac{1}{2}$ sec. per day would remain at a temperature midway between the extremes. If the metals of the rim have constant coefficients of expansion this "middle temperature error" is bound to occur, and many ingenious "auxiliary compensations" were developed during the 19th century, principally in marine chronometers.

About 1900 certain nickel-iron alloys were developed by C. E. Guillaume. In these, the coefficient of expansion is not constant: it varies nith temperature. One of the series, containing about 40% nickel. when used with a brass outer rim gives virtually



BY COURTESY OF MAJOR R A FELL AND THE INSTITUTION OF MECHANICAL ENGINEERS LONDON

FIG. 2.— LEVER ESCAPEMENT

continuous temperature compensation for a steel balance spring, over the range from 0° to 30° C. Temperature errors of less than $\frac{1}{20}$ sec. per day per degree centigrade can readily be achieved with a carefully adjusted Guillaume balance.

Guillaume also developed an alloy known as Elinvar (c. 1912). This has a low value of temperature coefficient of Young's modulus. Further development of this alloy enabled the compensation balance to be dispensed with, except for the very highest grade of timekeeper intended for observatory trials. Moreover, it is rustless and much less affected by magnetism than steel.

Subsequently improved alloys of low temperature coefficient were developed. In these, the mechanical properties are greatly superior to the original Elinvar, elastic limits as high as 50 tons per square inch being achieved. Temperature errors with these springs when used with a monometallic balance are often less than 1 sec. per day per degree centigrade. The alloy developed by the Hamilton Watch company in the Cnited States is also highly stable in its elastic properties.

Effect of Adjustment.—After adjustment against all these types of error, a man's wrist watch of moderate quality will perform to within about 70 sec. per day between the lying position and two edgewise positions differing by 90° in orientation. High-grade commercial watches can be adjusted to within approximately 20 sec. per day in five positions. while watches intended for observatory competition work, if of pocket size, may have differences of rate in positions amounting to 3 sec. per day. or even far less.

Escapements. — Of the great number of escapements invented. only five came into general use: the verge or vertical; the cylinder or horizontal; the duplex; the lever (either jeweled or pin palletj; and the chronometer or detent.

The verge escapement consisted of two pallets projecting from the balance staff, working with an escape wheel of contrate form, sometimes known as the crown wheel. The teeth of this wheel impelled the two pallets alternately. The balance was coupled to the escape wheel during its entire vibration and not only while receiving impulse; because of the geometry of the wheel and pallets, the balance caused the escape wheel to turn backward against the driving torque of the wheel train during its supplementary arc. Consequently, the balance was subject to constraint during its entire swing. and the timekeeping was much affected by the torque available at the escape wheel, the condition of the oil and the state of the working surfaces in the escapement.

The cylinder escapement was introduced by George Graham in 1726. It was a considerable improvement over the verge. in that the escape wheel did not turn backward during the supplementary arc of the balance. Thus, the constraint on the balance was caused only by the frictional couple set up by the locking pressure of the escape-wheel teeth on the circular surfaces of the cylinder, either inside or out. Originally, cylinder watches had a steel cylinder and brass escape wheel, which cut the steel cylinder when the oil began to dry up; then ruby cylinders were used in some fine watches (Thomas Mudge's cylinder watches, *c.* 1750, were the first really satisfactory pocket watches).

Eventually it was found that a hardened steel wheel working with a hardened steel cylinder caused far less wear. The escapement was long used in this form for the majority of cheap watches, but it is now relatively uncommon.

The duplex escapement came into use toward' the end of the 18th century; it aimed at further reducing constraint on the balance by separating the functions of locking and impulse. The escape wheel had two sets of teeth (whence "duplex"); the long teeth served for locking in conjunction with the ruby roller on the balance staff, while the raised triangular teeth delivered impulse to the impulse finger or "hook," also mounted on the staff. It was a single-beat escapement, delivering impulse in alternate swings only (*i.e.*, once per cycle), and so, if the balance received an adverse shock in wear, reducing its amplitude below a critical value, it would "set" and the watch stop. A well-made duplex watch was an accurate timekeeper, and this escapement was used in fine English matches as late as 1880. The American Waterbury "dollar" watch used a simplified form of duplex escapement.

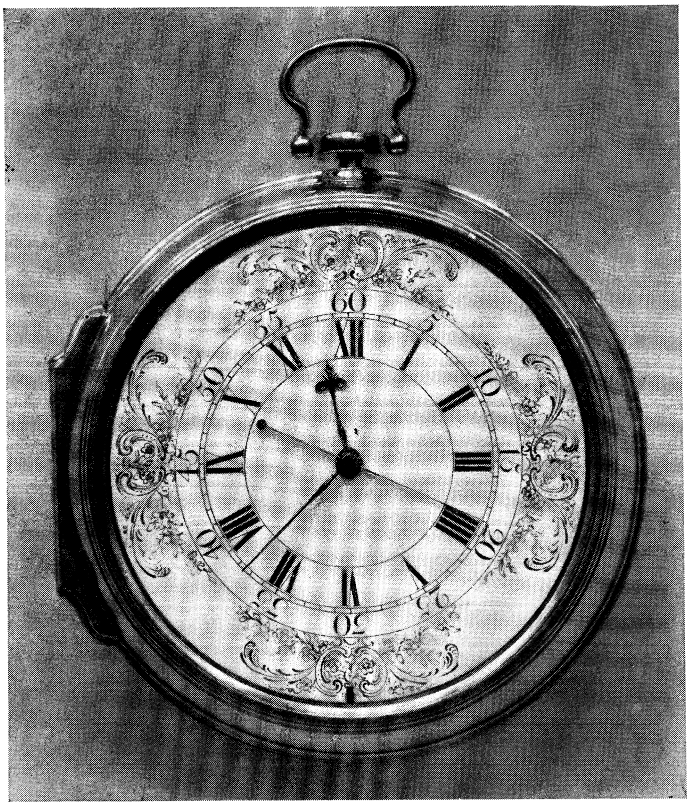
The lever escapement was invented by Thomas Mudge in 1765. In this escapement, the balance is free to execute its supplementary arc, being coupled to the escapement only while effecting unlocking and receiving impulse. This resulted in a marked improvement in timekeeping. The escapement was developed into its modern form, with a club-tooth escape wheel and double-roller safety action, by Josiah Emery and A. L. Breguet. Although this form (fig. 2) had been reached by the beginning of the 19th century it was not universally adopted until c. 1915.

The club-toothed wheel is, in good-quality watches, made of hardened steel. with the acting surfaces ground and polished. It is much less subject to wear than the ratchet-tooth variety. and its geometry reduces loss of motion between wheel and pallets. In the double-roller safety action the intersection between guard pin and roller is much deeper than in the single-roller. and any friction caused by jolts encountered in wear takes place at a smaller radius and causes less constraint on the balance. The safety action should only operate on relatively severe jolts, since the locking faces of the pallet stones are so inclined as to "draw" the lever over to the appropriate banking pen when locking occurs. This escapement, by far the most important watch escapement today. is used in its jeweled form in watches of moderate to excellent quality and with steel pallet pins and a simplified fork and roller action in cheap watches.

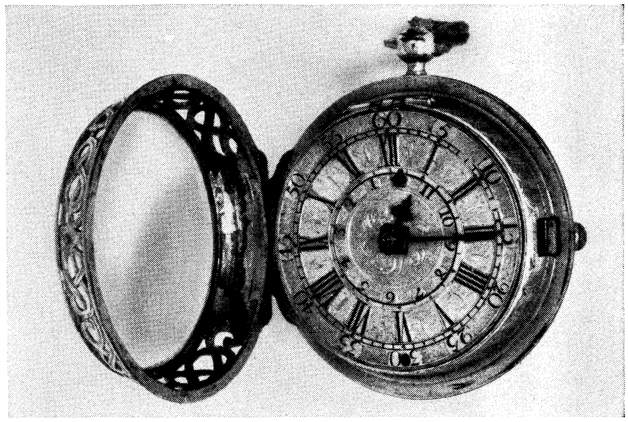
The chronometer escapement was originated by Pierre Leroy, but much development was required. Arnold and Earnshaw, working in rivalry, brought it into its modern form, Earnsham's version of the escapement being unaltered in principle even today. It is a single-beat escapement, and the balance is free to execute its supplementary arc unconstrained. Unlike the lever escapement, the escape wheel delivers impulse directly to the balance, locking being effected on a separate unit, the detent. Perhaps the most important feature favouring long-term stability of rate is that the escapement functions without oil (in the lever escapement oil on the pallet stones is bound eventually to dry up or thicken and so reduce the balance amplitude). The chronometer escapement is not very suitable for a watch. being liable to "set"; but for marine chronometers its supremacy has not yet been seriously challenged.

The Wheel Train. — In a watch it is necessary to achieve a step-up ratio of approximately 4.000 : 1 between barrel and escape pinion. This involves four pairs of gears, the ratio per pair commonly being between 6 : 1 and 10 : 1. Because of considerations of space, the pinions must have a low number'of leaves — commonly from 6 to 12. This entails a number of special gearing problems. aggravated by the fineness of their pitch. Any error in centre distance, form or concentricity is therefore proportionately more important than in larger types of gearing.

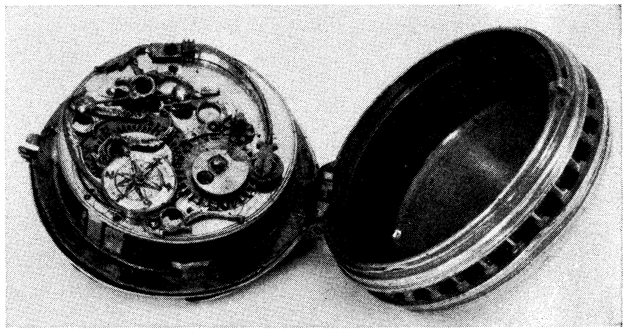
A special form of cycloidal gearing is used, in which the pinion has hypocycloidal dedenda, and the wheel epicycloidal addenda.



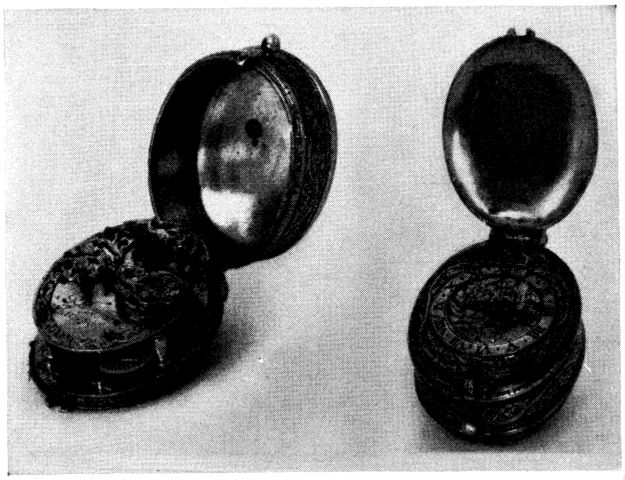
The No. 4 chronometer of John Harrison, English; 1759



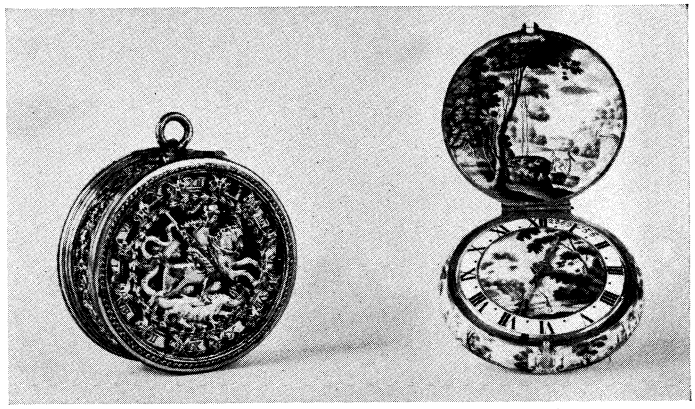
Watch by Thomas Tompion, most famous of the English clockmakers, 1675



German stackfreed clock-watch with dumbbell foliot (escapement control mechanism) ; late 16th century

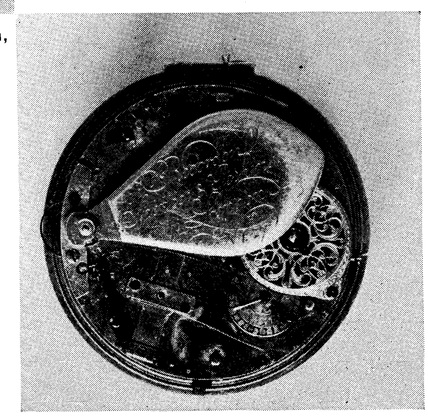


Two views of an oval verge watch made about 1630 by Richard Jackson, English



(Left) German watch of the middle of the 16th century; (right) enameled French watch of the middle of the 17th century

Oval alarm watch of the 17th century by André Pichon, French



Self-winding watch by (Louis) Recordon, Spencer & Perkins of London; 18th century

Enameled watch by Isack Pluvier of London; c. 1650

EARLY EXAMPLES OF EUROPEAN WATCHMAKING

BY COURTESY OF (ALL EXCEPT CENTRE ROW RIGHT) THE SCIENCE MUSEUM, LONDON, (CENTRE ROW RIGHT) VICTORIA AND ALBERT MUSEUM

The generating circle, which is common to both wheel and pinion, has a diameter equal to the pitch circle radius of the pinion. This special case of hypocycloid is a straight radial line, and watch pinion leaves are of this form below the pitch circle. The range of modules encountered is from about 0.25 mm. in a large pocket watch to 0.07 mm. in a lady's very small wrist watch. A six-leaf pinion of 0.07-mm. module has an over-all diameter of about 0.5 mm. only. In practice, the cycloidal form is approximated.

Jewels.—A patent was taken out by Nicholas Facio in 1704. which covered the use of jewels in watches. Diamonds and sapphires were used. The sapphires were pierced with diamond splints and steel wires charged with diamond ponder; this was practised only in England until about 1790. Synthetic jewels made from powdered alumina fused in the oxyhydrogen blowpipe later came into use. Colourless unless certain materials are added, they are usually coloured to a ruby red, although the clear stones are considered slightly harder.

R'atch jewels are worked up from the raw material to exceedingly close limits and with a very high polish. A uniform outside diameter is highly important, since jewels are fitted by the friction jeweling method, being pressed into accurately sized holes smaller than the jewels themselves and held there by the interference and consequent elasticity of the surrounding metal. The hole diameter of a typical balance jewel is about 0.1 mm , with a unilateral tolerance of 2.5 microns. The holes are drilled undersize nith diamond charged wires, and opened to their final dimensions with a stepped lapping mire. Finally, they are "olived" with a bowed lapping wire to reduce friction.

TYPES OF WATCH

Wrist Watches.––Until the beginning of the 20th century. watches were almost invariably made to be carried in the pocket However, the wrist watch rapidly gained popularity and after 30 years more than 50 wrist watches were made to 1 pocket watch. The diameters of the movements of men's wrist watches range from roughly 23 to 30 mm., while ladies' round movements are commonly betneen 14 and 20 mm. in diameter. Shaped movements are made both in men's and in ladies' sizes. Second hands are commonly fitted on movements down to about 18-mm. diameter, and the centre seconds ("sweep" second hand) arrangement is frequently preferred. The modern watch runs for about 40 hours.

Chronographs.—The chronograph was developed by E D. Johnson in 1855 to measure time intervals (in sporting events. for example). In these watches, an additional second hand is engaged with the wheel train by pressing the pendant, disengaged by a second pressure and returned to zero by a third. Split-second chronographs have two chronograph second hands; these begin to move together and one can be stopped to take a reading and then made to catch up with the other. It is thus possible to take the times of more than one competitor in a race.

The stop watch is made for purposes that do not warrant the more expensive chronograph. In a stop watch, the balance is actually started and stopped, whereas in the chronograph it oscillates continually. Minute and sometimes hour recorders are added to chronographs and to stop watches. All the hands are returned to zero when required by the action of strikers pressing against heart cams. In certain cases the balance vibrates more rapidly than the usual 18,000 half-cycles per hour; it is thus possible to record tenths or hundredths of a second.

Self-Winding Watches.—The first patent on the self-winding pocket watch was taken out by Louis Recordon in London in 1780. The early self-winding watches operated on the pedometer principle. The development of the self-winding wrist watch dates from the invention of an Englishman, John Harmood, who secured a patent in 1924. His system consisted of a swinging weight pivoted at the centre of the movement, coupled to the barrel arbour through reduction wheels and clicks; the weight swung between buffer stops; no winding stem was fitted and the hands were set from the bezel. Between 1930 and 1945 much development work was carried out in Switzerland, and a wide range of self-winding watches was being made there and elsewhere by the 1960s. As their mainspring is kept more uniformly wound, these watches are generally better timekeepers. (R. M. J. L.; R. A FL.)

Electric Powered Watches.—Electric powered watches use either of tuo drive systems. (1) the galvanometer drive, consisting of the conventional balance-hairspring oscillator kept in motion by the magnetic interaction of a coil and a permanent magnet; or (2) the induction drive, in which an electromagnet attracts a balance containing soft magnetic material. Both types use a mechanical contact. actuated by the balance motion, to provide properly timed electric drive pulses. Each oscillation of the balance operates a time-indicating gear train by advancing a toothed wheel one tooth. Miniature high-energy-density batteries are used as power sources (C. N. CH)

Accessory Mechanisms.—Additional mechanisms are often fitted to watches The repeating watch will strike the time on pulling a slide or pressing the pendant—sometimes to the nearest minute. The clock watch strikes the time in passing like a clock and can generally also be made to repeat The alarm watch can be set to operate a small bell or case-clapper at a predetermined time Calendar mechanisms have been added; the perpetual calendar automatically corrects for the varying lengths of month including leap year; the simple calendar gives the date and often the day of the week, the month and even the phases of the moon.

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WATER. This chemical compound. having the formula H_2O, is one of the most abundant, aidely distributed and essential substances on the surface of the earth. It occurs in nature in the solid, liquid and gaseous states as ice or snow. water, and steam or water vapour, respectively. Water is a necessary constituent in the cells of all animal and vegetable tissues and in the crystals of many minerals.

Sea water contains on the average about 3.5% by weight of dissolved substances, principally sodium chloride ($NaCl$) 2.7%, magnesium chloride ($MgCl_2$) 0 4%, magnesium sulfate ($MgSO_4$) 0.2%, calcium sulfate ($CaSO_4$) 0.15% and potassium chloride (KCl) 0.05%; but traces, at least. of all the naturally occurring chemical elements are present.

Snow is probably the purest natural source of water and rain the next purest, although the latter contains dissolved gases of the air as well as traces of carbon dioxide, chlorides, sulfates, nitrates and ammonia, with organic and inorganic dust held in suspension.

Water from streams and lakes in mountainous districts is relatively free from organic impurities but may contain dissolved inorganic salts, ahile that from lowland rivers and lakes may 'be highly polluted. Water from springs and wells has filtered through the ground and has been more or less purified of organic contamination but may contain inorganic salts.

Water is essential in all animal and plant nutrition. It finds extensive use in science and industry as a solvent, a catalyst, a standard for the concrete representation of certain physical units (*e.g.,* litre, calorie), a standard of comparison for certain physical properties (*e.g.,* specific gravity, relative viscosity), a conveying medium for the transport of materials and disposal of wastes, a diluent or dispersive medium, a cooling agent, a cleansing medium and in the production and distribution of heat and power. Industrial hydrogen is obtained from water by electrolysis or hy passing steam through a bed of hot coal.

Inorganic salts in small amounts are not objectionable in potable waters but harmful bacteria thrive on the organic content. Drinking water is subjected to microscopic, bacteriological and chemical examination. In the interpretation of the chemical analysis the source and history of the water must be taken into account. Abnormally high chloride content usually means sex-age pollution. The amount and condition of nitrogenous solutes is an indication of the extent and present state of the contamination.

Certain bacteria in water convert albuminoid ammonia to free ammonia, which is then oxidized to nitrites and later to nitrates.

A high albuminoid or free ammonia content indicates recent contamination while a high nitrate content is evidence of past contamination from which the water may have been purified.

For purification of potable water see WATER SUPPLY AND PURIFICATION.

Hard Water.— Hard waters contain soluble salts of calcium and magnesium, principally as bicarbonates, chlorides and sulfates. Ferrous iron may also be present. Hardness caused by calcium bicarbonate is known as temporary since boiling converts the bicarbonate to the insoluble carbonate; hardness from the other salts is called permanent. Calcium and magnesium ions react with the higher fatty acids of soap (*q.v.*) to form an insoluble gelatinous curd difficult to remove from the material being washed and thereby cause a waste of soap, since a lather will not form until these ions have been removed from solution. This does not happen with the newer detergents, which are sulfonates of long-chain molecules; *e.g.*, alcohols. The iron is oxidized to the ferric form and appears as a reddish-brown stain on the material. The hardness of water is determined by the amount of a standard soap solution (made by dissolving castile soap in an alcohol solution) required to produce a lather that remains unbroken for five minutes in a definite volume of the water.

Water is softened on a small scale by the addition of ammonia, borax or trisodium phosphate together with sodium carbonate (washing soda). The latter precipitates the calcium as carbonate and the magnesium as hydroxide. Water is softened on a large scale by the addition of just sufficient lime to precipitate the calcium bicarbonate as carbonate and the magnesium as hydroxide followed by the addition of sufficient sodium carbonate to remove the remaining calcium salts. In the "permutite" process the water is filtered through a natural or artificial zeolite (*q.v.*), which replaces the calcium, magnesium and ferrous ions by sodium ions. The zeolite is regenerated by treatment with a strong brine solution.

In the boilers of power plants, the calcium and magnesium salts in hard waters form a hard, adherent scale on the plates. As a result of the poor heat conductivity of the scale, fuel consumption is increased and the boiler deteriorates rapidly through overheating of the plates. Sodium carbonate if present in the water hydrolyzes to give free alkali that causes caustic embrittlement and failure of the boiler plates. In some localities sulfuric acid is added to boiler feed water after softening to increase the ratio of sulfate to carbonate.

Ion-free water comparable in saline content with ordinary laboratory distilled water is produced by percolating the water through a granular bed of a polyhydric phenol formaldehyde resin, then through an amine formaldehyde resin. The phenol groups of the former replace the positive ions in solution by hydrogen ions and the amino groups of the latter absorb the acids so formed.

Water as a Standard.— Water exhibits the anomaly of having a greater density at 3.98° C. than at any temperature above or below. The litre is the volume of 1 kg. of air-free water at this temperature and 1 atm. pressure. The prototype kilogram was designed to have the mass of 1,000 c.c. of water under these conditions but because of a slight error one litre actually contains 1,000.028 c.c. The specific gravity of a substance at a temperature t is the ratio of the mass of a certain volume to the mass of an equal volume of water at the same temperature (S_t^t) or at the temperature of maximum density (S_4^t). Zero degrees centigrade (32° F.) is defined as the temperature of equilibrium between ice and air-saturated water under a pressure of 1 normal atmosphere; 100° C. (212° F.) is the temperature of equilibrium between water and steam at the same pressure. The 15° calorie is the quantity of heat required to raise the temperature of 1 g. of liquid water from 14.5° to 15.5° C. under an air pressure of 1 atm.; the 20° calorie, from 19.5° to 20.5° C.; and the main calorie is $\frac{1}{100}$ of the quantity of heat required to increase the temperature from 0° to 100° C. These calories are equivalent to 4.185, 4.181 and 4.188 joules, respectively. Water is used as a standard in the calibration of viscosimeters (see VISCOSITY).

Physical Properties of Water.—The water molecule is in the form of an isosceles triangle with an apex angle of 105° and a

TABLE I.—Some Physical Constants for Water
(calories are 15° calories)

Item	At melting point (0° C.)	At boiling point (100° C.)
Heat of fusion	79.7 cal./g.	
Heat of vaporization	597.2 cal./g.	539.0 cal./g.
Specific volume of ice	1.091 ml./g.	
Specific volume of water	1.000132 ml./g.	1.0434 ml./g.
Specific volume of steam	. . .	1673 ml./g.

Critical constants: temperature 374.1° C.; pressure 218.4 atm.; density 3.1 ml./g.

Properties of Liquid Water at 25° C. and 1 atm.

Specific volume	1.002934 ml./g.	Electrical conductance	5.51×10^{-8} (ohm-cm.)$^{-1}$
Coefficient of thermal expansion	2.57×10^{-4} ° C.$^{-1}$	Heat of formation* (ΔH)	−68,320 cal.
Coefficient of compressibility	4.51×10^{-5} atm.$^{-1}$	Free energy of formation* ($\Delta F°$)	−56,690 cal.
		Entropy	16.72 e.u./mol.
Constant pressure heat capacity	4.179 joules/g.	Heat of ionization†	13,360 cal.
Heat of vaporization	583.2 cal./g.	Ion product	1.0×10^{-14}
		Viscosity	8.95 millipoise
Dielectric constant	78.5 c.g.s.e.	Surface tension	72.0 dyne/cm.

*For H_2 (gas, 1 atm.) + ½ O_2 (gas, 1 atm.) = H_2O (liquid, 1 atm.) at 25° C.
†For H_2O (liquid) = H^+ (aq.) + OH^- (aq.) at 25° C., 1 atm.

dipole moment of 1.83×10^{-18} c.g.s.e. (centimetre-gram-second electrostatic units) (in the gas), the oxygen atom being negatively and the hydrogen atoms positively charged. Other properties are given in the tables. Abnormalities in the properties of water are the high dielectric constant which accounts for its solvent action and ionizing power, high melting and boiling points for its low molecular weight, high critical temperature and pressure, large heat capacity, expansion below 3.98° C. and expansion (rather than contraction) on freezing. Since ordinary ice (ice I) is less dense than water, increasing pressure decreases the temperature of melting; the other crystalline forms of ice given in table II are all denser than water so that pressure increases their melting points. P. W. Bridgman followed the melting curve of ice VII to 192° C. and 39,000 atm. The normal freezing point of water (0° C.) is 273.15° on the Kelvin or thermodynamic scale (by international agreement).

TABLE II.—Triple Points Along the Melting Curve

Phases at equilibrium	Temperature (° C.)	Pressure (atm.)
Steam, ice I, water	+0.0100	0.00603
Ice I, ice III, water	−22.0	2,000
Ice III, ice V, water	−17.0	3,400
Ice V, ice VI, water	+ 0.2	6,200
Ice VI, ice VII, water	+81.6	21,700

When water freezes near 0° C. it forms α-ice, which is hexagonal; when supercooled at least a few degrees before freezing it produces β-ice, which is rhombohedral. (See also ICE.)

Chemical Properties of Water.— Water is a relatively stable compound dissociating into hydrogen and oxygen only to the extent of 2% at 2,000° C. and 1 atm. Metals and some nonmetals are oxidized by water or steam to the oxides with the liberation of hydrogen ($3Fe + 4H_2O = Fe_3O_4 + 4H_2$, $C + 2H_2O = CO_2 + 2H_2$). Steam reduces the halogens with the liberation of oxygen ($2Cl_2 + 2H_2O = 4HCl + O_2$). With some elements disproportionation takes place ($3S + 2H_2O = SO_2 + 2H_2S$). Oxides or hydrated oxides react with water to form hydroxides which are basic, acidic or amphoteric depending on the position of the positive element in the periodic table (see PERIODIC LAW) ($CaO + H_2O = Ca^{++} + 2OH^-$; $P_2O_5 + 3H_2O = 2H_3PO_4$, $H_3PO_4 = H^+ + H_2PO_4^-$; $Al_2O_3.H_2O + 2H_2O = 2Al[OH]_3.Al[OH]_3 = Al[OH]_2^+ + OH^-$ and $Al[OH]_3 = H^+ + H_2AlO_3^-$). Neutralization is the reaction of base with an acid to form a salt and water ($Na^+OH^- + H^+Cl^- = Na^+Cl^- + H_2O$). Since water itself ionizes to a small extent into H^+ (or H_3O^+) and OH^-, hydrolysis takes place when the salt of a weak base or a weak acid or both is dissolved in water. The chlorides and sulfides of many of the elements that are not strongly metallic are often completely hydrolyzed ($PCl_3 + 3H_2O = H_3PO_3 + 3HCl$, $Al_2S_3 + 6H_2O = 2Al[OH]_3 + 3H_2S$). Metallic nitrides and hydrides are decomposed by water to give NH_3 and H_2 respectively and the hydroxide of the metal. Metallic carbides yield hydrocarbons ($CaC_2 + 2H_2O = Ca[OH]_2 +$

C_2H_2). Organic esters, *e.g.* fats, are hydrolyzed by water to yield the alcohol and the acid. Because of its small size the water molecule can fit into many ionic crystal lattices, yielding hydrates ($Na_2HPO_4.2H_2O$, $Na_2HPO_4.7H_2O$, $Na_2HPO_4.12H_2O$).

Heavy Water.—Ordinary water as obtained from fresh-water lakes contains isotopes of hydrogen in the ratio of 1 atom deuterium, D or H^2 to 6,900 of hydrogen H^1. The oxygen isotope ratio is $O^{16}:O^{18} = 506:1$ with perhaps one-fifth as much O^{17} as O^{18}. When water is electrolyzed the gas produced at the cathode is poorer in deuterium than the water, which is thus enriched in deuterium content. Practically pure heavy water (D_2O) has been obtained by the electrical decomposition of hundreds of gallons of water until only a few millilitres remain. The oxygen isotope ratio in the water seems to remain substantially unchanged during the electrolysis. Heavy water has a density at 25° C. of 1.1079 times that of ordinary water It freezes at 3.82° C, boils at 101.42° C. and has a maximum density at 11.9° C. D_2O solid phases corresponding to ices I, III, V and VI have been found; all triple points are at higher temperatures and pressures than for ordinary water. The dielectric constant of the liquid is 80 7, viscosity 10 99 and surface tension same as that of ordinary water. The ion product is about $0\ 2 \times 10^{-14}$. In general, salts are less soluble in D_2O than in H_2O and the rates of chemical reactions in solution are less. Heavy water is used to slow the speed of neutrons in nuclear investigations. When deuterium is used as a tracer in physiological studies, the amount present in tissue is usually determined by oxidation to water and measurement of the density. Snow, rain and surface waters of lakes and oceans contain tritium, H^3, in the ratio of about 1 atom of tritium to 10^{18} atoms of hydrogen. Glacial waters contain smaller quantities of tritium (see DEUTERIUM AND TRITIUM).

See N E Dorsey, Properties of Ordinary *Water-Substance* (1948); H. C. Urey and G. K. Teal, "Hydrogen Isotope of Weight Two," Reviews of Modern Physics, vol. 7, pp. 56–58 (1935). (J. A B)

WATER BOATMAN, an aquatic hemipterous insect belonging either to the family Notonectidae or to the family Corixidae. In England it is a notonectid of which the best-known species (Notonecta *glauca*) is common in the ponds. This insect feeds upon other aquatic insects and can inflict a severe sting with its beak. In the United States the Notonectidae are called hack swimmers because they suim on their backs, while water boatman refers to the Corixidae which often occur in large numbers and include more species than any other family of aquatic Hemiptera. They live on the pool bottom where they feed on organic ooze containing both plants and minute animals or consume quantities of filamentous algae or the chlorophyll therefrom. (H B. HD.)

WATERBUCK, a large south African antelope (*Kobus ellipsiprymnus*) of the tribe Reduncini. characterized by the white elliptical ring on the buttocks and the general reddish-gray colour of the long coarse hair. They have heavily fringed necks and tufted tails; long sublyrate, ringed horns are carried by the bucks. The name is extended to include the sing-sing (K. defassa), a species without the white ring. See ANTELOPE.

WATERBURY, a city of western Connecticut, U.S., on the Naugatuck river. The chief centre of the U.S. brass industry, Waterbury is the core of a metropolitan area in the Naugatuck valley which is distinguished for its diversified industrial output that also includes rubber goods, clocks and watches, chemicals, electronic parts, textiles, plastics, machine tools and Clothing. It is the financial and commercial hub of the western part of the state

The population of Waterbury was 107,130 in 1960, an increase of 2.5% since 1950; the Waterbury standard metropolitan statistical area, comprising parts of New Haven and Litchfield counties, had a population of 181,638, an increase of 17 4%. The greatest expansion occurred in 1870–1920, when the population grew from 13,106 to 91,175. Foreign-born whites compose roughly 20% of the population; the largest groups, in order, are Italian, Lithuanian, French Canadian, Polish and Irish. About 65% are Roman Catholic, 25% Protestant and 5% Jewish Only 4% are Negro The principal suburbs are: Naugatuck, a rubber manufacturing centre; Watertown, a residential and textile centre, site of Taft school; and Cheshire, site of Cheshire academy and Connecticut State reformatory.

Thirty-one families established Mattatuck plantation in 1677 which was incorporated as a town in 1686 and named Waterbury because of the abundant drainage of the steep granite hills and slopes by the Naugatuck river and its tributaries. The unsuitability of the soil for agriculture, the "great flood" of 1691, the "great sickness" of 1712, and the lure of western lands retarded the town's growth. Tall handmade wooden clocks were a notable product of late 18th-century Waterbury craftsmen. The history of Waterbury thereafter was industrialization, based mainly on brass, and population growth. Brass buttons were first made in 1802, and by the 1830s the city was the largest U.S producer of brass kettles, pins, buttons and clocks. Manufacture of dollar watches, frequently called Waterbury watches, was begun in 1879, and from 1892 they were manufactured and marketed with great success by Robert H. Ingersoll (1859–1928). A fire in 1902 and a flood in 1955 were costly natural disasters.

Waterbury was incorporated as a borough in 1825 and chartered as a city in 1853. The town and city were consolidated in 1902. From 1895 until the abolishment in 1960 of county government in Connecticut, Waterbury was co-seat (with New Haven) of New Haven county. The Democrats achieved large pluralities in most state and national elections; however, the Republicans have had frequent success at the local level since World War II.

Waterbury's educational facilities include an extension centre of the state university, a business college and two nursing schools. There are 50 public parks with an aggregate of 760 ac. The largest, Hamilton park, contains the city zoo. Numerous outdoor recreational facilities and three state parks and forests are in the area. (M. J. TE.)

WATER CHINQUAPIN (*Nelumbuim pentapetalum*), a beautiful North American aquatic plant of the water lily family (Nymphaeaceae), called also American nelumbo or lotus (*q.v.*), rare and local in ponds and slow streams from Connecticut to Michigan and southward to Florida and Louisiana. It is a stout plant, rising from a horizontal tuber-bearing rootstock, with large shield-shaped leaves, one to two feet across, some floating but mostly rising high out of the water, and solitary pale-yellow flowers, four to ten inches broad, borne on long stalks usually higher than the leaves The edible tubers and farinaceous seeds were used for food by the Indians, who probably introduced it into the eastern states It is sometimes grown in water gardens for its ornate foliage. See WATER LILY.

WATER-COLOUR PAINTING. Water colour is a pigment ground in gum, usually gum arabic, and applied with brush and water to a painting surface, usually paper. The pigment is generally spread thinly and transparently, but it can be made opaque by being mixed with a white of some covering power, and in this form is known as body colour or gouache (*q.v*). Works of art, whether executed wholly in water colour, wholly in gouache, or in a combination, are known as water-colour paintings, water-colour drawings or simply water colours.

HISTORY

EUROPE

The forms of painting which preceded the introduction of oil painting—that is, fresco painting and tempera (*qq.v.*)—are akin to water colour in the preparation of the pigment and in the absence of plastic brush texture from the completed work. Drawing with the brush with inks in varying dilutions or with coloured washes upon paper or silk is the basis of oriental painting (see CHINESE PAINTING; JAPANESE PAINTING AND PRINTS). Illuminated manuscripts (*q.v.*) and portrait miniatures have commonly been executed in water colour and body colour, though normally with a hatching, point-of-the-brush technique different from that of water colour in its modern development; yet these arts contributed to water-colour technique as it is more narrowly defined (see DRAWING (TECHNIQUES OF); MINIATURE PAINTING). What is given here is the history of European water-colour painting from the beginning of the 16th century.

Water colour has bng been an adjunct of drawing. Once the brush had been added to the pen and chalk as a standard instrument it was natural to add washes of ink or bistre to an outline drawing; and but a further short step to use coloured washes over, or in place of, the monochrome ones. The history of water-colour painting therefore overlaps on one side the history of drawing, just as on the other it overlaps the history of painting.

Indeed to make a selection, in the case of the continental schools of art, between water colourists and other draftsmen is generally to impose an arbitrary distinction between contemporaries of quite similar aims, some of whom may sporadically have tinted their drawings while the others only used a monochrome wash. But in England in the 18th and 19th centuries the name does stand for a quite recognizable distinction of craft, dividing artists such as J. R. Cozens, J. S. Cotman, David Cox and Peter de Wint who, if they worked at all in oil, did so purely as a side line, from those who were preponderantly painters in oil. This article, then, while it does not ignore the continental schools, must be devoted in most detail to the English water colourists.

16th **and** 17th Centuries.—Albrecht Dürer (1471–1528) learned to paint landscapes in water colour and gouache while still an apprentice, and the use to which he put this accomplishment in his maturity marks the beginning of the modern water colour. His landscapes and natural history drawings combine, in a way entirely characteristic of the Renaissance, his reverence for observed fact with his wonder at the works of nature. Accordingly many of them have become classics of the visual arts—the "Young Hare," the view of Innsbruck and the "Great Piece of Turf" in the Albertina at Vienna; the "Alpine Landscape" in the Ashmolean museum, Oxford. His natural history drawings are almost incredibly detailed, but their literalness does not submerge the artist's delight in the complexity of the animal or the blade of grass. The landscape drawings are equally factual, but express a feeling for the arrangement and construction of mountains and for the subtleties of aerial perspective which anticipates the painting of the 17th and 18th centuries.

Lucas Cranach the younger (1515–86) and Hans Holbein the younger (1497–1543) tinted some of their designs and water-colour portraits, but the next main outcropping of water-colour drawing occurred in the Netherlands. There, echoing an established convention in landscape painting, drawings of landscapes were made in contrasting hues of brown and blue washes by such artists as Paul Bril (1554–1626) and Tobias Verhaegt (1561–1631). It was but a short step to introduce a greater variety of colour and to aim at truth of local tone, and we find this extension undertaken by, among others, Roelandt Savery (1576–1639), Hendrik van Avercamp (1585–1663), Adriaen van Ostade (1610–85) and Cornelis Dusart (1660–1704). These drawings were produced for sale as completed water-colour drawings rather than as steps toward the construction of other works of art.

The 18th Century: England. — Whereas the water colours of Diirer and Ostade form only a section of their drawings and a comparatively small portion of their whole artistic output, the chief figures in water-colour painting in England in the 18th and 19th centuries were specialists in this medium. From the first the English landscape water colourists were differentiated into two groups according as their interests were predominantly in the scenery of their own country or that of Italy. The former. led by Paul Sandby, were generally more matter-of-fact in their approach; the latter often infused with their topography a greater imaginative intensity and a composition more closely derived from the ideal landscape of the 17th century. But both groups were versed in the methods of oil painting of Claude Lorrain, Nicolas and Gaspard Poussin and Salvator Rosa, from whom they derived the ideas of picturesque scenery which flavoured their English or Italian views. Already in the 17th century Sir Anthony Van Dyck (1599–1641) had painted water-colour landscapes in England which anticipated the later school in their treatment of atmospheric effect. The predominant characteristics of the forthcoming *floraison* were to be seen in the work of William Taverner (1703–72), an amateur whose landscapes reflect clearly enough the study of Poussin in their balance and their classical *staffage*.

After other early workers in water colour, such as Samuel Scott (*c.* 1710–72), George Lambert (1700?–6j) and John Skelton (d. 1758), came Paul Sandby (1725–1809). Through the length of his career and by the extent to which he concentrated on water-colour painting he was the first English artist in the medium to attain real prominence. His training was a strictly professional one, since he was engaged by the military authorities as a draftsman on the survey of the Highlands which followed upon the suppression of the Jacobite rebellion of 1745. But he soon settled in London and began a busy career as draftsman and as teacher. One of his favourite sketching grounds was the countryside round Windsor castle, and he drew these scenes of unspectacular pastoral charm with a style so natural that it seems more like the pictorial equivalent of conversation than like art. In his travels in Wales he struck upon more conventional picturesque scenery, and he wove motifs drawn from the mountains into more elaborate, Italianate compositions which owe a clear debt to Claude and Poussin. Like his brother Thomas Sandby (1721–98), an architect and a water colourist of less accomplishment, Paul Sandby was one of the original members of the Royal Academy, which was founded in 1768.

The artists who fall into a natural grouping with Sandby are those who were mainly concerned with the landscape and townscape of Great Britain. Michael Angelo Rooker (1743–1801) invested his meticulous study of brick and stone buildings and leafy lanes with a pleasant sympathy for antiquity. Thomas Malton, Jr. (1748–1804), instructed J. M. W. Turner in perspective drawing, and his water colours of London and Bath display elegant groups of fashionable people against a background of Georgian architecture. Edward Dayes (1763–1804) carried on the same urbane treatment of city life against its architectural background, and is notable also because Thomas Girtin, who followed a very different course, was his pupil. Also in this group were Thomas Hearne (1744–1817), who paid a visit to the Leeward Islands as draftsman to the governor; Samuel Hieronymus Grimm (1733–94), a Swiss artist who settled in England; and James Miller, who exhibited views of London from 1773 to 1791.

The artists who traveled to Italy were open to wider experiences: the grandeur of the Alpine scenery through which they passed, the paintings they saw and the cosmopolitan group of artists they met in Rome. They are preluded by Alexander Cozens (1717?–86), who, though he rarely coloured his drawings, evolved the system which his son John Robert Cozens was to infuse with such haunting appeal. John Robert Cozens (c. 1752–97) made two visits to Switzerland and Italy, the second in the train of William Beckford (*q.v.*), the author of *Vathek*. He was perfectly endowed to fulfill the requirements in landscape painting of this romantically minded patron. His technical means were of the simplest; his palette rarely went beyond tones of blue-gray, but was fully adequate to express his feelings of melancholy awe in the presence of the mountains and their mist-filled valleys. Mountains, sublime in their magnitude and unapproachableness, picturesque in their ruggedness, made a powerful assault on the enhanced sensibilities of the age. By entering into these feelings Cozens universalized the sensations of the romantic traveler of the late 18th century. His career was cut short by mental disease and he died insane in 1797; but his influence lived on, for Girtin and Turner were given his sketches to copy and took the key of their sentiments from his.

Francis Towne (1740–1816) was also spurred to his best achievements by his visits to the mountains—to the Welsh hills in 1777, to Italy and Switzerland in 1780 and 1781 and to the English lake district in 1786. His response to the scenic grandeur of these districts found expression in a uniquely personal style. Where Cozens was all evanescence, Towne was all precision of outline; he used a firm pen line to isolate areas of contrasting colour and presented the view in a subtly calculated and carefully balanced pattern. William Pars (1742–82) visited Greece as as draftsman for the Society of Dilettanti and was later sent by that body to study at Rome. His works give an individual interpretation of the Italian scene which is in somewhat the same key of romanticism as those of Cozens and Towne; but William Marlow (1740–1813), and John "Warwick" Smith (1749–1831) are more prosaic interpreters of the same subjects.

A link between the greatest achievements by the 18th-century water colourists and the new generation was provided by Thomas Monro, who displayed a remarkable flair for choosing young men of talent to copy drawings by J. R. Cozens and other water colourists. Among those who attended his house were Thomas Girtin, J. M. W. Turner, John Sell Cotman, John Varley and Peter de Wint. Of these the career of Thomas Girtin (1775–1802) alone falls almost entirely within the 18th century; the others are considered later as part of the 19th-century development of the English school of water colour. Girtin died young, but not before he had achieved maturity in his art. Apart from subjects, largely architectural ones, suggested by his visit to Paris, his material was derived from the landscapes of England and Scotland, notably the Yorkshire dales. There he had none of the usual romantic symbols—mountain peaks and chasms—to assist his effect; but he communicated serenity and a sense of the unlimited through his extraordinary command of space and ability to draw wide rolling vistas. Like Cozens he aimed at variegation of tone rather than truth of local colour; but his prevailing colour key of brownish-gray reflects his more sanguine temperament.

Of the draftsmen who inherited the tradition of English humour exemplified by William Hogarth and James Gillray, Thomas Rowlandson (1757–1827) was the most prolific. He compromised his reputation by producing a mass of inferior drawings in his later years, but the works of his prime are outstanding in the vitality of their outline and the gusto of their comment on human foibles.

William Blake (1757–1827) is a remote and lonely figure amid the landscape painters and figure draftsmen of his time. Painting was his most articulate means of expressing his mystic intuitions of the grandeur of the universe, the strength of rebellion, the innocence of childhood. He bounded his figures with long flowing lines and adjusted the colours to the peacefulness or terror of the action. The opportunity given him late in life to illustrate Dante's Inferno resulted in one of the few completely satisfying transmutations of literary into pictorial art.

The 18th Century: the Continent. — The monochrome drawings of Claude have a range of warm tone which almost places them in the same category as the drawings of Cozens and Girtin; they had a far-reaching effect on the development of the English school. But though the rococo artists of France were far from feeling any aversion to colour, they satisfied this taste in their drawings largely by the use of sanguine and coloured chalks.

The French vignettists often tinted their exquisite illustrations of contemporary fashionable life; for example, Jean Michel Moreau (Moreau le Jeune) (1741–1814), Charles Eisen (1720–78) and Charles Nicolas Cochin (1715–90). Gabriel de St. Aubin (1724–80) had an especial ability in rendering crowds and fashionable interiors by the simplest means; and the Swedish-born Nils Lafrensen or Nicolas Lavreince (1737–1807) used gouache for his minute paintings of *galant* scenes. An impetus toward landscape drawing was given by the growth of neoclassical feeling in France in the second half of the 18th century and the consequent encouragement to artists to visit Rome. Charles Joseph Natoire (1700–77), who became director of the French academy at Rome, made both figure drawings and landscapes with water-colour embellishments. Among the artists who studied in Italy were Hubert Robert (1733–1808), who was fascinated by the crumbling architecture of antiquity. and Jean Louis Desprez (1743–1804). Desprez prepared many drawings for the abbé de St. Non's works on his Italian travels. These drawings have a delicacy of outline and liveliness of colour which made them admirable models for rendering in hand-coloured etchings; they show the lighter touch of the French admiration for the picturesque.

In obedience to a widespread movement of taste the Swiss were awakening to the romantic beauties of their scenery. Johann Ludwig Aberli (1723–86) made tastefully composed drawings with delicate atmospheric effect and had as pupils Johann Biedermann (1763–1830) and Heinrich Rieter (1751–1818). Sigmund Freudenberger (1745–1801) won great popularity with his idyllic scenes from peasant life. Louis Ducros (1748–1810) took his place in Rome among the cosmopolitan group of landscape artists, including the German Philipp Hackert (1737–1807), who were well patronized by the international visitors to Italy; not least by English travelers. However, the Germans practised a more minute and detailed approach to landscape painting than was favoured by the English artists in Rome.

Meanwhile the Dutch were pursuing their own course in a direct line from their great days in the 17th century. Cornelis Troost (1697–1750) has been compared with Hogarth, and his humorous genre is carried out in a variety of methods. including water colour. The topographical draftsmen, such as Jacob Cats (1741–99) and Johannes Huibert Prins (1758–1805), took Dutch town life as their subject and treated it with a quiet meticulousness which brings it close to the work of Michael Angelo Rooker and Thomas Hearne.

The 19th Century: England. — Patronage for water colours increased greatly in the 19th century. This development was not entirely beneficial to the art, since the wealthy new class of patrons required highly finished pictures which could hold their own with oil paintings and which represented places of obvious picturesque appeal. A symptom of the changing field of patronage was the foundation of the Old Water-Colour society in 1804 by a group of artists who were dissatisfied with their treatment at the hands of the Royal Academy.

John Varley (1778–1842), a foundation member of the society, is a characteristic figure. He was a deliberate exponent of a formula for picturesque composition abstracted from the practice of Claude and Poussin. He was an extremely fast worker, and though his drawings are neat and individual in style they are somewhat arid and lacking in fire. Other successful men of his generation are Joshua Cristall (c. 1767–1847), George Barret, Jr. (*c.* 1767–1842), and John Glover (1767–1849).

Soon after its foundation the Old Water-Colour society received its most important recruits in David Cox and Peter de Wint. David Cox (1783–1859) matured into an artist with a preference for passing atmospheric effects — the wind across the heath or storm clouds above the sea — which he treated with an energetic breadth of brushwork and a rich palette of transparent colour. Peter de Wint (1784–1849) had a temperament which felt more kinship with the underlying structure of the landscape and its enduring substratum. He chose for his subject matter what would have seemed the most unpromising material — the flats of the English midlands, seldom varied except by a prominent building or clump of trees. Yet to these pastoral scenes he brought a sense of construction and space akin to Girtin's (whose work he had studied in Monro's house) and a fondness for rich deep colour, predominantly a strawberry roan; and with these simple materials he gives a tranquil and satisfying transcription of the workaday agricultural English countryside.

The reputations of John Sell Cotman and Samuel Palmer did not stand so high in their lifetimes, but have increased ever since, with better knowledge of the independence and originality of their early work. John Sell Cotman (1782–1842), a Norwich artist, saw in nature the classic and monumental effect of precise, austere pattern. He expressed this effect in perfectly controlled flat washes of cool colour, eliminating inessentials and leaving only what is balanced and universal in the scene. His halcyon days followed early visits to Yorkshire; but he had an unstable temperament and was not able to recapture indefinitely, in the face of lack of encouragement, the masterly control of his early years.

Samuel Palmer (1805–81) was one of a group of young men who met Blake in his old age and were influenced by his dedicated character. The moment of vision came to Palmer with his early visits to the Kentish village of Shoreham. Out of the experiences he had in that valley he constructed a world of his own, echoed by rich inventiveness in technique and variety of colour.

Richard Parkes Bonington (1802–28) succeeded in summing up all the tendencies of his time in his short working life span, most of which was passed in France. His water colours are marked by facility and a certain fragile brilliance. Particularly deft in the rendering of architecture, he had many followers in France and England, the most notable of the latter being Thomas Shotter Boys (1803–74), James Holland (1799–1870) and William Callow (1812–1908). A heavier but even more popular exponent of picturesque views of foreign cities — artistic souvenirs for the widening circle of travelers abroad — was Samuel Prout (1783–1852).

Meanwhile Joseph Mallord William Turner (1775–1851) was pursuing his brilliant, chameleonlike career through manifold phases and experimental advances. His drawings up to about 1800, with their harmonious tones of green, blue and gray and their skillfully exact drawing of architecture, are in the 18th-century style, the style of Rooker and Dayes, carried to its quintessence. In the most characteristic drawings of his middle period he aimed to give a generalized impression of the city or the scene he was rendering, rather than adhere to topographical exactitude. The immense range of his subjects reflects his aim for complete comprehensiveness in the types of picturesque scenery. These drawings glow with brilliant colour, their brightness being achieved by minute stipplings in which the white paper peers through the dots of colour. No doubt this discarding of broad washes for a closely modulated surface was suggested to Turner by the greater ductility of oil paint. This development was not all gain in the hands of Turner's successors, for it led to finicky neatness and lack of amplitude in Anthony Vandyke Copley Fielding (1787–1855) and Myles Birket Foster (1825–99); but Turner's virtuosity enabled him to wrest some of his most striking achievements from this method. In his last phase of water colour, as in his oil painting. he passed beyond details into an abstraction of colour and light. "Turner," said Constable—himself an accomplished water colourist—"seems to paint with tinted steam, so evanescent and so airy."

Water-colour painting does not play so large a part in the full history of English painting in the second half of the 19th century. James Duffield Harding (1797–1863) and his pupils produced drawings of foreign beauty spots with some liveliness of handling; but generally speaking the most popular specialists in the medium were unadventurous and given to overelaboration. The more interesting work was produced by men who were primarily oil painters. For instance the Pre-Raphaelites brought their medievalism of approach to drawing with the result that the water colours of Dante Gabriel Rossetti (1828–82) and Sir Edward Burne-Jones (1833–98) glow with the colour of stained glass and owe their poetry to their conscious archaism. Again, James Whistler (1834–1903) opposed the literary element and reverted to simplicity in place of overstatement; his water colours are broad in treatment, reticent in detail and delicate in colour.

The 19th Century: the Continent.—The leaders of the romantic movement in France were filled with the resolve to seek material in the most unlikely places; and this intention no doubt accounts for the unwonted popularity of English art and a corresponding curiosity about water colour, a medium the English had made peculiarly their own. Eugkne Delacroix (1798–1863) had as friends in Paris both Bonington and Thales Fielding (1793–1837), a brother of A. V. Copley Fielding; the interest he felt in their methods is reflected in his sketchbooks of north African scenes, some of the pages of which are carried out in water-colour washes of the freest kind. The influence of Bonington was not confined here. Camille Corot was so attracted by seeing one of his water colours in a Parisian dealer's window when running an errand that he decided to become a painter himself. Camille Roqueplan (1800–55) painted shore scenes and romantic groups in historical costume in just Bonington's manner and the seascapes of Eugkne Isabey (1803–86) are equally of Bonington's circle. In his turn Isabey influenced Louis Eugène Boudin's lively water-colour groups. so something of English art entered directly into the stream of French Impressionism.

Among the figure draftsmen, Louis Eugkne Lami (1800–90) enjoyed success both in Paris and in London with his pictures of fashionable life, which give an accomplished and tasteful picture of the glittering externals of society. A more mordant observer, Honoré Daumier (1808–79) turned from his lithographs to treat in coloured draaings, as in oil paintings, the sombre scenes which possessed his mind. Paul Gavarni (1804–66) and Constantin Guys (1802–92) produced poignant renderings in wash of Parisian life.

Toward the end of the century Gustave Moreau (1826–98) found water colours an adaptable medium for the expression of the jeweled decadence with which he interpreted such subjects as "Sappho" and "Salome." In complete contrast to the enameled colour and ingrown morbidity of these works are the contemporary landscapes of Henri Harpignies (1819–1916), in which the broad controlled washes and selective sense of colour are the final working out of the manner taken over by Isabey and Boudin.

Meanwhile in the Netherlands Josef Israels (1824–1911) was an exponent of social realism in his sombre studies of peasant life. Other well-known Dutch painters of the second half of the 19th century to practise in water colours were Johannes Bosboom (1817–91), Johan Jongkind (1819–91), Jacob Maris (1837–99) and Anton Mauve (1838–88). In Germany Adolph von Menzel (1815–1905) applied his immense graphic gifts to water colour as well as to lithography and pencil drawing; and Eduard Hildebrandt (1818–67) traveled round the world for exotic landscapes. In Austria Rudolf von Alt (1812–1905) used the medium with effortless accomplishment.

The 20th Century.—The artistic history of the first half of the 20th century was enlivened by the battle between traditionalists and revolutionaries. New ideas of form derived from an increased knowledge of primitive art prompted a re-examination of the fundamental principles behind painting. But into this revolution water colour only entered incidentally. Already in the 19th century Paul Cézanne (1839–1906) had worked out his extremist abstraction from landscape in his late water colours. Paul Signac (1863–1935) applied Pontillist theories in his water colours. Raoul Dufy (1877–1953) painted scenes with bright bold expanses of local colour. The German Expressionists, such as Christian Rohlfs and Emil Nolde, found the fluidity of the medium well adapted to their emphatic methods. Water colour was an essential element in the world of whimsical fantasy invented by Paul Klee (1879–1940). In England Paul Nash (1889–1946) combined romantic feeling for landscape with an austere analysis of form, and in so doing showed himself to be in the main tradition of English water colour.

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THE UNITED STATES

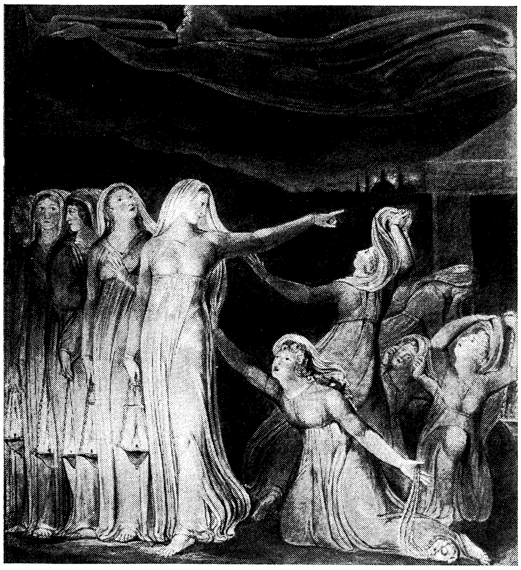
Early History.—In the new world water colour was used by those of the 16th-century explorers who could draw and wished to add colour to their observations of the aborigines, their dwellings, and the landscape; but a continuous tradition can hardly be traced to anything earlier than the heraldic painters who traveled up and down the American colonies in the 18th century, drawing and tinting achievements of arms to hang in the entrance halls of houses whose owners claimed gentility. The likeliest stimulus to real artistic activity in the medium was the military engineer or the chart maker who delineated coast lines; these men and the surveyor had some training in a journalistic sort of drawing, and they commonly used colour, if only as a local tone within pen outlines. Pierre Charles l'Enfant (1754–1825), designer of the Washington, D.C., city plan, was one such competent performer, though a late one.

By the time when there began to be a small leisure class, British drawing books were available which told young ladies how to sketch, giving neat formulas for foliage and clouds. Carington Bowles' *The Artists Assistant,* which had run to five editions in London by 1788, had a sixth in Philadelphia in 1794. David Cox's book of 1813 and Samuel Prout's of 1819 had a ready market. An early example of original U.S. publication is Fielding Lucas' *Progressive Drawing Book*, published in Baltimore in 1827, which has some explanatory colour plates; it was followed in 1835 by Rembrandt Peale's *Graphics.*

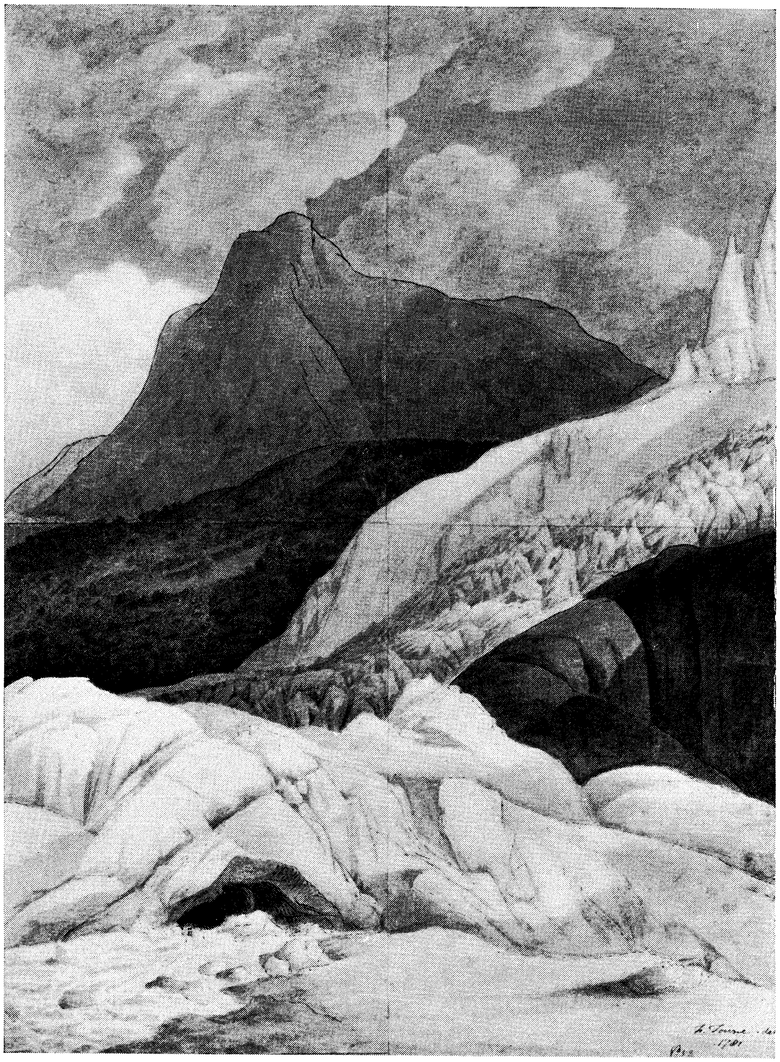
Further, the itinerants of the 18th and the early 19th centuries who painted the American, his family, his ox and his ass, his house and his barn, often used water colours for their less ambitious portraits. These were likely to be outline drawings filled in with tints, but many exist into which some inkling of the floodings and shadings of the professional technique crept, so that tones are often saturated toward the edges of their areas, and diluted within.

John Trumbull (1756–1843) and William Dunlap (1766–1839), early biographer of U.S. art and artists, were among the first native professionals. Both used water colour on a small scale. but largely as a pastime on their portrait-painting travels; yet, unlike the engineers, they drew with the brush. The Wiirttemberg immigrant, John Lewis Krimmel (1787–1821), made many records of U.S. city life, notably in Philadelphia; his work, often on a line-drawing base, did however exploit the wetness and translucency of water colour. The Russian diplomat Pavel Svinin made many large documentary water colours of similar subjects from 1811 to 1813. Around Charleston, the miniaturist Charles Fraser (1782–1860) made charming, small colour sketches of the houses he visited between 1796 and 1806. Henry Inman (1801–46) occasionally painted small portraits in water colour.

It is hard to tell how much immediate influence upon U.S. practice came from the superb records of western Indians and landscape made by such a man as the Swiss painter Karl Bodmer (1809–93) whose hundreds of dra ings were taken by his patron to Germany where a small part of the bulk was published as illustrations.



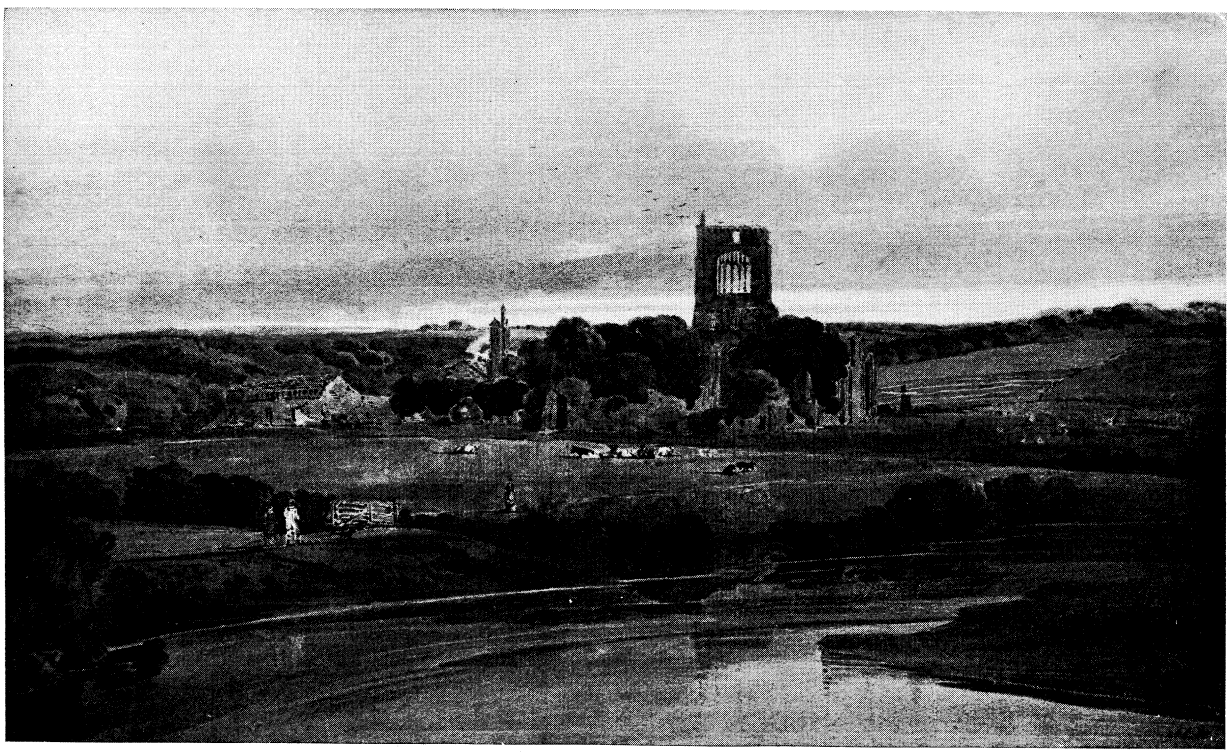
"The Wise and Foolish Virgins" by William Blake (1757–1827). Water-colour with pen and ink. In the Metropolitan Museum of Art, New York city



"The Source of the Arveiron" by Francis Towne (1740–1816). In the Victoria and Albert museum, London

ENGLISH WATER-COLOURISTS OF THE 18TH CENTURY

"Kirkstall Abbey" by Thomas Girtin (1775–1802). In the Victoria and Albert museum, London



BY COURTESY OF (TOP LEFT) METROPOLITAN MUSEUM OF ART, NEW YORK, (TOP RIGHT, BOTTOM) VICTORIA AND ALBERT MUSEUM

WATER-COLOUR PAINTING

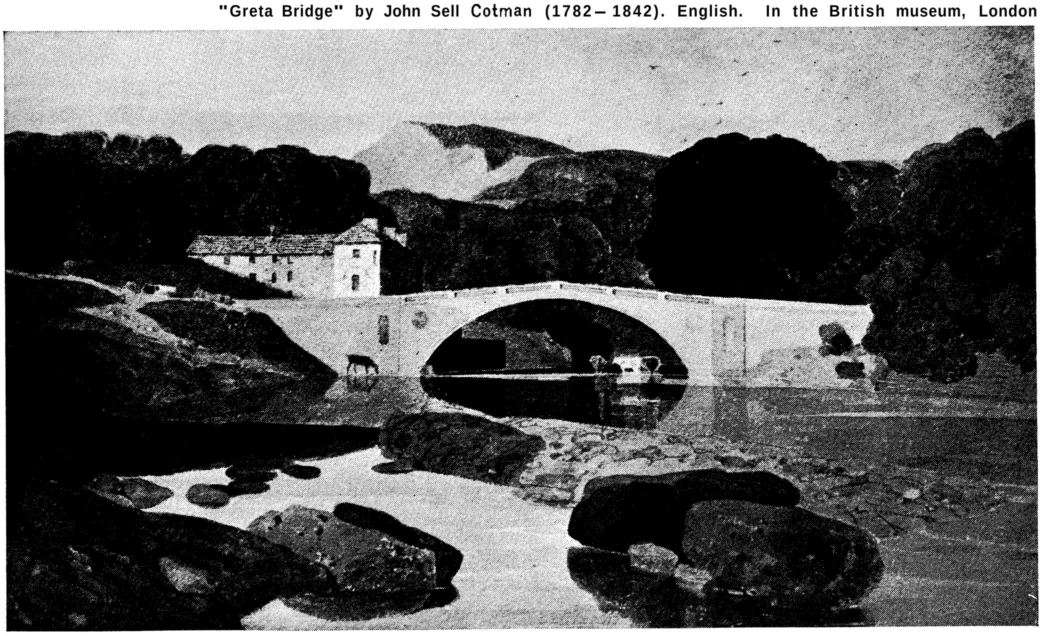
"Sun, Wind and Rain" by David Cox (1783–1859), English. In the Birmingham, Eng., museum and art gallery

"Don Quixote and Sancho Panza" by Honore Daumier (1808–79), French. In the Metropolitan Museum of Art, New York city

"In a Shoreham Garden" by Samuel Palmer (1805–81), English. In the Victoria and Albert museum, London

ENGLISH AND FRENCH WATER-COLOURS OF THE 19TH CENTURY

"Greta Bridge" by John Sell Cotman (1782–1842). English. In the British museum, London



"View In the island of Elba" by John R. Cozens (1752–97), English. In the Victoria and Albert museum, London

COZENS AND TURNER

"Warkworth Castle, Northumberland" by Joseph M. W. Turner (1775–1851), English. In the South Kensington museum, London

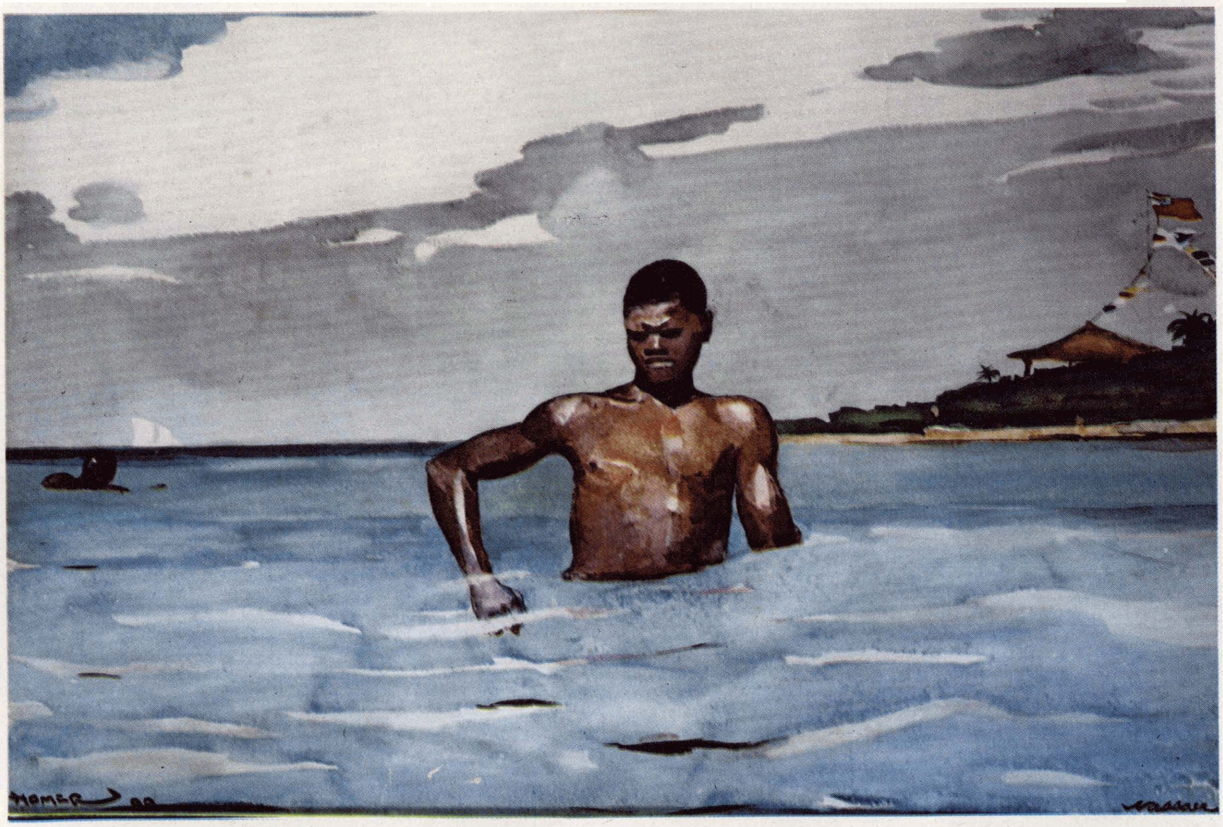
BY COURTESY OF THE OWNER

"Houses in Provence" by Paul Cézanne (1839–1906), French. In a private collection, Hartford, Conn.

CÉZANNE AND HOMER

"The Bather" by Winslow Homer (1836–1910), U.S. In the Metropolitan Museum of Art, New York city

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, LAZARUS FUND, 1910



BY COURTESY OF THE BROOKLYN MUSEUM, PHOTO BY CHARLES UHT

"Mountain Fire" by John Singer Sargent (1856–1925), Anglo-U.S. In the Brooklyn (N.Y.) museum

SARGENT AND MARIN

"Sunset, Casco Bay" by John Marin (1872–1953), U.S. In the Roland P. Murdock collection, Wichita (Kan.) Art museum

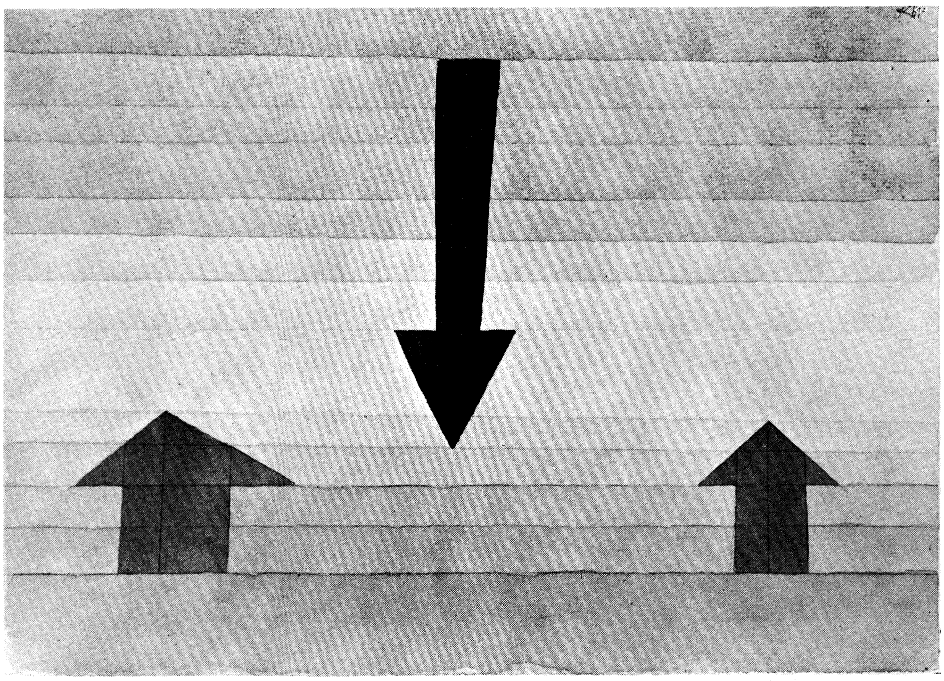
BY COURTESY OF WICHITA ART MUSEUM, PHOTO BY WAYNE D. SOURBEER

WATER-COLOUR PAINTING

"Goyescas" by Ben Shahn (1898–), U.S. In the Paul Roebling collection, Downtown gallery, New York city. Painted in 1956

"Blind Bird" by Morris Graves (1910–), U.S. In the Museum of Modern Art, New York city. A gouache, painted in 1940

THREE WATER-COLOURISTS OF THE 20TH CENTURY



"Begrüssung" (Greetings) by Paul Klee (1879–1940), Swiss. In the Wadsworth Atheneum, Hartford, Conn. Painted in 1922

BY COURTESY OF (TOP LEFT) COLLECTION OF PAUL ROEBLING DOWNTOWN GALLERY N Y (TOP RIGHT) MUSEUM OF MODERN ART, N Y PHOTO BY SOICHI SUNAMI (BOTTOM) WADSWORTH ATHENEUM HARTFORD CONN

George Catlin (1796–1872) and Alfred J. Miller (1810–74), Americans, did much the same sort of work; Catlin at least saw to his own publication. The great man of the time was. however, John James Audubon (1785–1851), born in Haiti and brought up in France and Pennsylvania, whose grand work *The Birds* of *America* (Lohdon, 1827–38) results from a combination of French style (in the tradition of Louis Gabriel Moreau (l'aine), Jean Pillement, Louis Debucourt and Louis Boilly) with American frontier aggressiveness and British capital and aquatinting skill The original water colours (mostly at the New-York Historical society) possess the necessary ornithological precision and an enchanting fertility in composition, along with a succession of backgrounds which portray the American landscape in many regions and moods.

Thus, up to the middle of the 19th century, most United States water colours were by-products, or amateurs' work, or were intended for reproduction. Certain of the best painters of the mid-century used water colour occasionally: William S. Mount (1807–68) sometimes recorded landscapes or invented compositions, and George Caleb Bingham (1811–79) made many figure studies with the brush and diluted ink, but seldom in colour.

Late 19th Century and After. — In the second half of the 19th century, there was a vast activity in emulation of Girtin, Cotman, Turner, Cox and de Wint. In half a dozen eastern cities there were water-colour societies; one, founded in 1866, was attracting by 1873 many British as well as U.S. painters to its annual exhibition. It is against this routine background that the truly distinguished men should be seen.

The uncompromising naturalist Thomas Eakins (1844–1916), though he restricted himself almost wholly to oil painting after about 1890, was a master of the water-colour medium, in which he presented sport and urban genre. His technique was one of rather small strokes which seldom overlapped very much, so that the tone is blond and the surface rather uniform. Winslow Homer (1836–1910) might be called a counterblast to Turner, who often used oil as if it were water colour; Homer was such a virtuoso of water colour as to raise it to the stature of oil painting. His early lithographic training and his practise in drawing as a Civil War correspondent gave him, when he turned to water colour in the 1870s, the base for an extraordinary graphic language. His eye for nature and for the outdoor life of man combined with his manual skill and sense of scale and drama in a long series of "essences," seized from children's games, sailing and hunting, the Caribbean shore and mountain picnics, in which he created almost the whole later conduct of representational U.S. water colour. Though his work. in contrast to that of the societies' neat practitioners, was labeled "unfinished" or "of mistaken eccentricity," his muscular grace, feeling of articulation and monumentality, his soaking wets and dragged drys, his eloquent blank areas and his accents of *gouache,* all triumphed over the tasteful dappling of his contemporaries.

Among the more conservative, George Inness did a good many *gouaches.* J. F. Cropsey. Alexander Wyant, Thomas Moran and the Barbizonlike Homer Martin (1836–97) sometimes painted in water colours, but their chief work was to acquaint Americans with their landscape. Their expatriate contemporary Whistler (1834–1903), already mentioned above, was far from "professional" in handling: he used water colour in flecks and patches, sometimes with pastel in combination, or on toned paper, and these works were not so wet looking or translucent as some of his Japanesque oil paintings in close harmonies. John La Farge (1835–1910), best of eclectics, was brought up in the arts; he made hundreds of water colours in Japan and the south seas as well as at home and in Europe before his great success in decorative undertakings (from 1876) plunged him into other work. His method was thorough without being stuffily academic.

French Impressionism made an entry into the United States not only by the importation of Monets but also through Theodore Robinson, John Twachtman and Childe Hassam (1859–1935). Of these only Hassam was a prolific water colourist, and he was so deep in good taste as to have more charm than power. The man who gave Impressionism real stature and a different accent was Maurice B. Prendergast (1859–1924). He developed a personal language of figures in landscape, in which half-floating ovals and squarish areas of colour. hats and trees, balloons, carriage wheels, and clouds. became elements of both a decorative pattern and a lighthearted picture. Prendergast kept a feeling of youth and romance all his life. Arthur B. Davies (1862–1928) was a poetic eclectic who derived from Whistler. Puvis de Chavannes, and the orient a dancelike. trancelike style often executed in blond (*gouache* lightened) areas on toned papers. Both these men were temporarily associated with the Ashcan school of New York, 1908, but the central men of that group used a fairly dark palette and thus tended away from water colour. Everett Shinn (1876–1953) and John Sloan (1871–1951) did come to it, the latter for some of his humorous scenes from stylish and unstylish life, the former for luminous: often nocturnal, cityscapes in mixed techniques with *gouache* and pastel. George ("Pop") Hart (1868–1933), self-taught and a great traveler, exercised the genre tradition upon Mexican villages, U.S. small towns, cockfights and a thousand things, using water colour almost exclusively.

As a relaxation from his labours at fashionable portraits and. later, monumental murals. John Singer Sargent (1856–1925) carried water-colour materials with him and painted impromptu when he had spare time; on paper his virtuosity is almost free of the pretentiousness which troubled his canvases. With stenographic brilliance he pursued transparency and fluidity beyond Turner and Homer, sometimes becoming prophetically or accidentally expressionistic, as in his rapid notes of forest fires. An interesting Boston group rose in the following of Homer and Sargent: the seascapist Charles Woodbury (1864–1940), Dodge MacKnight (1860–1950), influenced by Chinese brush drawing to create an open, not quite calligraphic but rather bristly economical landscape style; and Charles Hopkinson (1869–1935), like Sargent a portrait painter, who pursued the blinding sun-struck appearance of rocks and sea in abrupt close-ups not so emphatically structural as Marin's work. Marsden Hartley's (1877–1943) emotional response to landscape produced massive simplifications, a tilting up of the ground plane. and sometimes glutted colour; Arthur Dove (1880–1946) moved to almost fully abstract geometrical forms having something of the passion of Frans Marc. Through them the way from Impressionism of the Hassam-Sarpent-Hopkinson manner led to Expressionism, and was recapitulated in Max Weber (1881–1961), who worked his way in water colour and oil through Cubism to abstraction and Expressionism, all of which he adorned with emotional gesture and a racial reference different from the sometimes coy whimsicality of Marc Chagall (1887–).

The giant Expressionist in water colour was John Marin (1872–1953), whose early architectural training and technical labour at etching provided strength and sensitivity. His work was a rugged, concentrated structure of strong paper (seldom large), flatness of detail which managed to allow depth in composition; economical broad blunt strokes. often isolated; somewhat neutralized colour with one or two sharp accents. The compositions are often "self-framed" with jagged strokes using the same language as the subjects, which are the essence of sea, rock, sky, sun, sailing ship and pine tree. Marin's personality, akin to Winslow Homer's and to Frank Lloyd Wright's, kept the romantic part of traditional American romantic realism without the realism.

Lyonel Feininger (1871–1956) was a sort of sharp-edged diminuendo of Marin; his areas of colour seldom coincided with his criss-crossing structural pen lines. A technically similar combination with very different effect was the delicate pencil outlines and deeply suffused washes of Charles Demuth (1883–1935), whose delicious still lifes and half-Cubist half-Futurist interpretations of U.S. buildings brought him the nickname of "immaculate." Personal views of the U.S. scene were also the country of Edward Hopper (1882–) and Charles Burchfield (1893–). Hopper's gaunt buildings, somehow nobler if ugly than if meretriciously pretty, seem at first as if painted in their denotation. but then people or atmospheres about them begin to be noticed: it is Eakins with a psychological undertone. Burchfield's more patently subjective animated buildings. railway cars and trees have musical and even ideographic suggestions. Giving background to these inventive men is a body of highly skillful landscapists. Ogden Pleissner, Eliot O'Hara, Millard Sheets, John Whorf, Paul Sample, all born near the turn of the century, all incomparable craftsmen who sometimes rose above journalism. Dong Kingman (1911–), usually working in *gouache,* is a witty variant. Adolf Dehn (1895–), a sound nater colourist, fell foul of the public's pleasure in some limited fields of satire. Reginald Marsh (1898–1954) used a water-colour technique, but largely in tempera on panel, for his monumentally made but half-satirical half-sympathetic urban pictures.

An explosive group of showmen, using large paper, strong colour dropped on already wet areas and sometimes casein, *gouache* and negative techniques, includes the German-born social commentator George Grosz (1893–1959), William Gropper (1897–), who has known some oriental influence, the decorative Expressionist Lanrence Kupferman (1909–) and the German-born Hans Hoffmann (1880–), who as a teacher has influenced many abstract painters. A calmer, rather mystic group in the northwest includes Mark Tobey (1890–) of the white-line calligraphy and anxious detail. Morris Graves (1910–) of the secretly sorrowing birds and Kenneth Callahan (1907–) of the whirling or floating Blakelike figures. Reuben Tam from Hawaii (1916–) paints ideographlike trees and rocks.

Georgia O'Keeffe (1887–) stood alone with her semiabstract and often greatly enlarged details of natural objects (flowers or desert jetsam), poignant and feminine but not womanish, and sliced from life and enclosed as if in the range finder. Ben Shahn (1898–) is more likely to use tempera or casein, as Marsh did, but with the humanist's eye rather than the decorator's bravura.

(W. A.)

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(A. W. C.-J.)

TECHNIQUE

Water-colour paint, which includes not only transparent water colour but the opaque methods commonly known as *gouache* and casein, has a range and variety comparable with any other painting method.

Transparent water colour allows for a freshness and luminosity in its washes and for a deft calligraphic brushwork which makes it a most alluring medium. Too often artists, dazzled by the ease of attaining atmospheric effects, degenerated into creating slight and pretty transcriptions of nature. Consequently water colour mas condescendingly thought of as the anemic and gaudy little sister of oil painting.

During the 20th century, especially after 1940, a revitalization in water-colour painting came about. The painters liberated themselves of tight purists' notions and started adding ink, pencil, pastel, crayon and opaque white to gain new effects. Henry Moore was one of the leading innovators. The biggest change came in the general use of *gouache* and casein colours. As a result the average water-colour exhibition probably contained more opaque than transparent water colours and acquired the same serious respect which oil painting had always had.

There is one basic difference between transparent water colour and all other heavy painting mediums—its transparency. The oil painter can paint one opaque colour over another until he has achieved his desired result. The whites are created with opaque white.

The water colourists' approach is the opposite. Instead of building up he leaves out. The white paper creates the whites. The darkest accents may be placed on the paper with the pigment as it comes out of the tube or with very little water mixed with it. Otherwise the colours are diluted with water. The more water in the wash, the more the paper affects the colour; for example, vermilion, a warm red will gradually turn into a cool pink as it is thinned with more water.

The knowledge which comes through much experience, of how all colours change through dilution and the awareness that the wet wash is fresher and brighter than the dried-in wash, is necessary to successful painting. Timing—knowing when to place a wash of one colour next to a wash of another colour or over it—requires experience. If the original wash is very wet a complete merging of the two will occur: if it is still damp the edges will become fuzzy; if it is dry the newly laid wash or line will be sharp and clear.

Laying an even wash over a large area, as in a sky, should be done rapidly with a big flat brush so that one stroke is placed against the preceding one before it will have dried into the paper. If the whole area is dampened with water beforehand it can be covered with greater ease. If a graduated wash from light to dark is desired, the wash can be spread upward by starting with the lighter colour and gradually intensifying it to the darkest tone. Then by tilting the drawing board at a 45° angle, an even merging of colour will occur.

Although the most unique and beautiful attribute of water colour is the luminosity of the washes and the skillful calligraphy of the brush strokes, some painters deliberately glaze over certain colour areas with thin washes, thereby destroying some of the luminosity of such areas. The resulting heavier and more mat surface in the ground area of a landscape sets off the luminosity of the sky.

Scrubbing out colours partially or completely with a dampened sponge creates fuzzy atmospheric effects which may be desirable. The hard surface of the paper is lost, however, and transparency is lessened.

The dry-brush technique—the use of the brush containing pigment but little water, dragged over the rough surface of the paper—creates various granular effects similar to a crayon drawing. Whole compositions can be made in this way. This technique also may be used over dull washes to enliven them.

A razor blade is a valuable tool. The blade dug into a wet wash will create different textures as in foliage. Absorbent tissues can be used effectively to create shapes, as in clouds, by pressing the tissue onto the wet wash and lifting the colour.

It is often said that transparent water-colour painting is the most difficult medium of painting. Great knowledge and experience plus a nimbleness of hand and brain are required for success. The water-colourist may start with a well-conceived plan of action but should always be ready to shift his approach if, and most probably when, the washes run away from him. He must then be able to use the new possibilities which the unforeseen makes possible, thus remaining master of a situation which might otherwise cause failure.

Gouache Painting.—In contrast to transparent water colour, *gouache* (*q.v.*) painting is considered an easier medium to manipulate; though the painting can be developed with the same directness and speed. However, the use of opaque colour will allow for several layers of paint until the results are satisfactory. The *gouache* pigment has a soft pastel quality which makes for ingratiating colour relations. The painting of diluted washes over existing colours merges the two layers into unexpected passages of colour. *Gouache* and transparent colour can be used successfully in the same composition.

Casein painting came into general use about 1940. Casein is an opaque medium; when it is thoroughly dry it is not soluble in water and the chroma is at full intensity (no white loading as in *gouache).* Casein may be used with less water than *gouache,* creating a heavy impasto if one thick layer is laid over another. A palette knife or bristle brushes may be used to attain effects similar to those of oil painting. Such casein pictures, if varnished or waxed, are difficult to distinguish from oils. The quick drying of casein is sometimes considered a disadvantage, in that it is difficult to attain details and nuances of shading. Many painters develop their pictures in casein and then, after varnishing, finish the picture with oil. *(See* also TEMPERA: *Casein Painting.)*

Paper.—Water colour can be applied to almost any paper, but for most purposes the rag papers made especially for water colour give the best results. These papers are of different weights. generally running from 70 to 300 lb. to the ream. All papers of 140 lb. and less should be stretched, otherwise they will buckle, which makes for uncontrollable washes.

A good quality illustration board faced with heavy water-colour paper is generally used for gouache. Casein can be used on heavy illustration board as well as gesso panels.

Brushes. — The best sable brushes are expensive but durable and should always be used if possible. A large no. 10 or 12 round brush and two or three smaller ones are sufficient. A large flat one-inch brush for laying large washes and getting straight edges is important. The same brushes are used in *gouache* painting. Bristle brushes also can be used and in casein painting they are used almost entirely.

Water-Colour Paints. — The paints come in tubes and cakes. Cake colours in a box are handy and can be used for small outdoor sketches; otherwise the tube colours are quicker and easier to handle and are recommended.

The colours are generally listed as permanent, durable and fugitive. The fugitive colours may fade quickly and should be avoided as much as possible.

Limiting the palette to the fewest colours is wise. A surprising range can be obtained with five or six. Such a palette might consist of cadmium yellow, Hooker's green, prussian blue, burnt sienna, alizarin crimson and ivory black.

A comprehensive palette for all purposes might contain a dozen colours. The following make up one possible list: yellow ochre, cadmium yellow, Hooker's green dark, chromium oxide dull, vermilion, alizarin crimson, cobalt blue, prussian blue, burnt sienna, warm sepia, Payne's gray and black.

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WATER CRESS (Nasturtium *officinale*), an aquatic plant of the mustard family (Cruciferae; *q.v.*), native to Europe and Asia, common in Great Britain, widely naturalized in the Cnited States and Canada and introduced also into the West Indies and South America. It is a creeping or floating perennial, rooting in clear. cold running water. with leaves composed of a few to several small rounded leaflets and elongated clusters of small white flowers. Its slightly pungent flavour is caused by an oil containing sulfur. Water cress is cultivated for the market in shallow streams or in prepared shallow pools of running water. These pools, called beds, have carefully graded bottoms and provision for controlling the depth of water up to about two feet. Water cress is propagated by both seeds and stem cuttings. It is widely used as a garnish and green salad, but relatively small quantities are grown for sale. (V. R. B.)

WATER DEER, Hydropotes *inermis*, a small, harsh-haired deer from eastern China and Korea. differing from all other Cervidae except the musk deer (with which it has no special affinity) by the absence of antlers in both sexes. Instead the males are armed with long, daggerlike upper tusks (see DEER). Four to seven young are born at a time, a unique condition for the hoofed, herbivorous order Ungulata.

Water deer frequent the neighbourhood of the large Chinese 'rivers, where they crouch amid the reeds and grass. When running, they arch their backs and scurry away in a series of short leaps. The water deer is one of the few deer in which there are glands neither on the hock nor on the skin covering the cannon bone. These glands probably enable deer to ascertain the whereabouts of their fellows by the scent they leave; but the subaquatic habits of the water deer render such a function impossible. The tail is a mere stump. (J. E. HL.; X.)

WATERFALL, the precipitous descent of a stream over a very marked steepening of its bed. The declivity may be so steep that the stream leaps from the waterfall brink and drops freely in air, making contact with a rock bottom again only after passing the site. If the descent is less steep and the stream maintains contact with rock bottom, the term cascade is commonly applied, even if the stream at that place is largely a series of little falls. Rapids are produced where still less marked declivities interrupt the stream's gentler gradient. They are characterized by increased velocity, great turbulence and a broken surface of the stream. The term cataract is generally limited to waterfalls of large volume. Scenic value of a waterfall lies more largely in its height, however. than in voluine of water descending over the declivity.

The energy of a waterfall causes vigorous erosion in whatever kind of rock may constitute the stream bed. At the foot of a free fall there may develop a plunge pool type of pothole unless, perchance, the fall is so high and the volume so small that the water becomes largely dissipated as spray or mist. Niagara, discharging from four of the five Great Lakes of North America, has a plunge pool reported to be deeper than the cataract is high. Bridalveil falls in Yosemite, Calif., is typical of many small mountain stream falls in losing most of the ability to erode by scattering of the water in the 620 ft. of air it traverses on the way down.

Any cataract, cascade or rapid interrupting the even slope of a river's gradient is the consequence of special conditions at its site. The most common condition is that of a resistant rock stratum

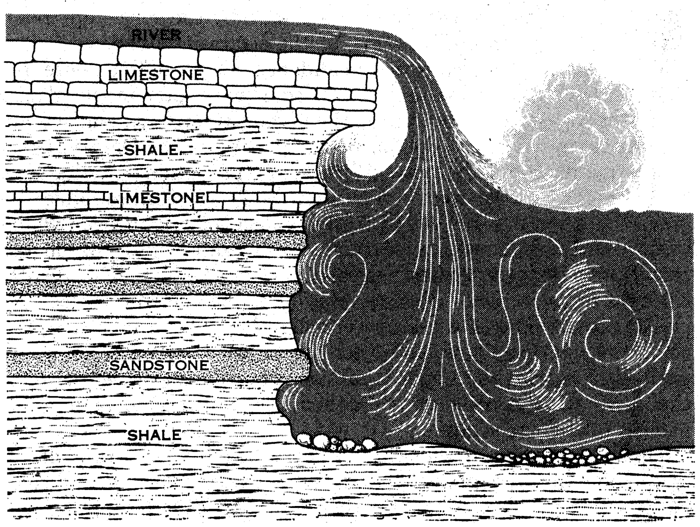

DIAGRAM ILLUSTRATING GEOLOGIC CONDITIONS AT NIAGARA FALLS

overlying a weak stratum, the edges of both being exposed in the declivity over which the stream descends. More rapid wastage of the subjacent weak rock. both by direct erosion by the tumbling water and by enlargement of the plunge pool, causes a constant undermining of the resistant stratum above until such recession of the exposed edge of the weak rock removes it far enough back under an overhang to bring the erosion on both rocks to a common rate.

Niagara Falls. — Destructive attack on the underlying weaker rock of such a cliff, over which a vertical fall plunges, may be severe even though the water so overleaps it that visitors may clamber back of the fall as in Niagara's Cave of the Winds. Spray constantly wets the cliff face and wintertime freezing in crevices disrupts the rock into loose pieces that are swept away. This causes a constant enlargement of the space behind the fall, particularly in the exposed face of the weaker rock. The more resistant lip of the waterfall, thus undermined, breaks off from time to time and the site of the waterfall actually recedes upstream. The American falls, the smaller of the two into which Goat Island divides Niagara falls, lost a mass of lip rock 150 ft. long in one fall. Horseshoe (Canadian) falls carries a greater voluine of water and thus its greater average rate of recession is responsible for its shape. Its continued rate of recession should sometime leave the American falls dry. They are now on the side, not at the end, of the lengthening gorge.

The Horseshoe falls recede in this fashion at an average rate of about four feet a year and therefore annually lengthen the gorge downstream from the great cataract by that amount. The gorge is about 73 mi. long. This length would afford a rough measure of the age of the falls if the rate of recession had been the same since the Niagara river, on the retreat of the great Canadian ice sheet, first spilled over the escarpment at Lewiston and Queenston. Volume of water, however, has been much less at times because the upper three Great Lakes have discharged by other routes to the St. Lawrence, only Lake Erie water then going over the falls.

Details of the complicated history of Niagara falls have been the subject of many studies made by both Canadian and United States geologists, and that history is not yet completely known. The falls took origin when the retreating front of the ice sheet exposed the pre-existing cliff (the Niagara escarpment) and also provided a lower discharge route for melt water dammed back of the ice front in the Michigan, Huron and Erie basins. In earlier retreatal stages, the discharge of these glacial Great Lakes had been to the Mississippi, by way of the Wabash river (Erie basin), the Illinois river (Michigan and Huron basins) and the St. Croix river (Superior basin).

Furthermore, the height of the initial Niagara, at Lewiston and Queenston, was perhaps twice that of the modern falls. The lowering of Niagara's height which took place during its recession and the production of the gorge was caused by the gentle upstream dip or decline from horizontality of the strata involved.

But the early Niagara was abandoned as an outlet route for Michigan and Huron basin overflow somewhat later in the glacial retreat because a lower route, the Trent river, was uncovered, leading eastward out of the Huron basin to enter the Ontario basin downstream from the falls. With only the volume of the Erie basin discharge, the rate of recession at Niagara must have decreased. Then began a widespread uplift in the region from which the great ice sheet was retreating, a differential uplift which became progressively greater toward the northeast. This gentle tilting is universally ascribed to relief of the ice load on the earth's elastic crust. The lake basins were slightly tilted or canted to the southwest, and the new outlet across Ontario rose with the uplift until discharge of the upper lakes again flowed into Erie and over the falls. Rate of recession must then have returned to an approximation of the early rate.

Detailed studies of the warped shore lines of the early glacial lakes show that this procedure was later repeated, the Ottawa river then becoming the outlet. By this time, the Lake Superior basin had become ice-free; indeed, the three upper lakes were high enough to flood across the low land where they now are connected by a strait and a river, making one huge water body, Lake Nipissing. Niagara, during this episode, had its second low-volume discharge. Only the continued glacial retreat, and consequent rise of the unloaded land of Ontario and Quebec, can account for the second return of the upper lakes' overflow to Erie and Niagara, a return that has persisted to the present time.

For a problem like this, full of quantities that cannot be precisely measured, only a rather tentative estimate of the time involved can be made. A Canadian geologist, E. M. Kindle, and a U.S. geologist, F. B. Taylor, collaborated in an elaborate study of the problem and their conclusion was widely accepted. Taking all variables into account, they estimated Niagara falls to be between 25,000 and 30,000 years old. Nobody conversant with the problem, however, was confident that later studies would not change that estimate. (See also NIAGARA RIVER AND FALLS.)

Falls of the Yellowstone. — In the national park of that name, these falls are caused by a structure of the underlying rock quite different from that at Niagara. The park is largely a plateau of extrusive igneous rock, up through earlier accumulations of which volcanic energy has repeatedly forced later discharges of lava, volcanic gases, steam and hot water. Some conduits or fissures thus used are today nearly vertical masses of harder rock embedded in the plateau deposits. Yellowstone river crosses two such wall-like masses. each marked by a fall. The upper fall is about 109 ft. high, the lower one about 319 ft. Waterfalls of this character cannot migrate upstream as Niagara does. They can only become lower by reason of stream notching on the brink and down the face, and presumably are fated to degenerate eventually into cascades.

Victoria Falls. — A third type of waterfall is exemplified by Victoria falls on the Zambezi river in Rhodesia. The underlying rock is a series of basalt lava flows. Like the Niagara and Yellowstone rivers, the Zambezi has made almost no valley above the cataract but plunges abruptly from a plain into this gorge. Unlike Niagara and Yellowstone, however, this gorge is exceedingly narrow and its course below the cataract is strikingly zigzag. Furthermore, the river does not enter at the head of the gorge but spills down over the side. Geologists believe that the river is only using and enlarging great fracture and fault planes that were made in the basalt plateau by earth movements. Victoria is 355 ft. high, more than twice the height of Niagara (Horseshoe falls, 158 ft.) but the full spectacle is impossible to see because of the narrowness of the gorge and the perpetual cloud of mist in its depths.

Hanging Tributaries. — Many tributary streams of larger mountain valleys of the world are hanging upon the valley walls at the point of confluence and descend to the major stream by falls or cascades. Erosive deepening of their valleys has not kept pace with that of the trunk valley. Commonly, this hanging relationship, with resulting waterfalls, has been caused by glacial deepening of the main valley, later disappearance of the glacier allowing the major stream to use a valley it did not excavate. Yosemite has five tributary creeks making this spectacular entrance, at Bridalveil, Illilouette, Ribbon and Upper and Lower Yosemite falls.

Another cause for hanging tributaries and consequently a sheer or cascading plunge of the creeks on entering the master valley is simply more rapid deepening of that valley by its river. The gorge of the Columbia across the Cascade range in Oregon and Washington has several such waterfalls. Multnomah falls has a 620-ft. drop.

U.S. Atlantic Fall Line.--The fall line of the Atlantic seaboard of the U.S. extends from New Jersey to Georgia along the boundary between the coastal plain and the Piedmont plateau, roughly parallel to the continental shore line. Every stream of the higher Piedmont that flows to the Atlantic has falls, cascades, rapids or at least quickened current where it enters the coastal plain. The Great falls of the Potomac, near Washington, D.C. (40-ft. drop in three miles), are probably the best-known example, but the Delaware, Susquehanna, Rappahannock, James, Appomattox, Roanoke, Yadkin, Broad, Savannah and other rivers are also marked by steep interruptions of the streams' gradients as they cross the fall line.

The Piedmont plateau is underlaid by relatively resistant crystalline rocks, such as granite and gneiss, while the coastal plain consists of much weaker sedimentary rocks. The streams thus pass from a more resistant to a less resistant substratum as they cross the boundary. Yet the weaker rock of the plain does not underlie the Piedmont rock, so these falls, cascades and rapids are not of the receding or Niagara type. It appears that there is a zone of consistent steepening of the surface of the Piedmont hard rocks where they go under the softer rocks of the coastal plain, the existence of which almost entirely accounts for the fall line.

Trick Falls. — The creek supplying Trick falls, in Glacier National park, Montana, has found partial passage for its water down a fissure in its channel bottom a little upstream from the falls' brink and a horizontal escape route back to the channel at the foot of the falls. In low-water stages, the falls go dry, the stream being entirely swallowed by the underground bypass and appearing like a huge spring at the base of the waterfall cliff. Enlargement of this subterranean route will sometime take even floodtime discharge. Eventually, only a natural bridge spanning the creek will remain to record the original Trick.

Celilo Falls. — Formerly on the Columbia river near The Dalles, Ore., Celilo falls was a waterfall about 20 ft. high at low water. Because the Columbia in flood rose nearly 90 ft. in the vicinity of The Dalles, Celilo falls would disappear. Rivers, however, do most erosional work in their channels during floodtime and Celilo falls, therefore, must have had its maximum alteration at times when it had no surface expression but was more than 60 ft. beneath the surface when the Columbia was carrying its floodtime discharge of 700,000 to more than 1,000,000 cu.ft. per second.

The concept of G. H. Matthes seemed to explain this anomalous subfluvial cataract. It dealt with an intense quasi-vertical vortex suction in the lee of submerged downstream-facing, vertical rock faces. It was essentially a subfluvial tornado in structure and velocity and, quoting Matthes, was "the most powerful form of concentrated energy at work on stream beds." Vertical jointing of the rock at the Celilo falls favoured this plucking action and lifting mechanism under the floodtime Columbia for the making and maintenance of the falls.

With the building of The Dalles dam below Celilo falls in the mid-1950s and the filling of its storage area the falls were permanently inundated.

Dry Falls.—Dry falls in Grand coulee, east-central Washington, is a compound abandoned cataract, totaling three miles across and 400 ft. in maximum height of the waterfall cliff. It is a product of the last occupation of Grand coulee by a greatly swollen Columbia river which, detoured by glacial ice. was forced to cross the basalt plateau of eastern Washington. Many other coulees of this region are likewise products of such detouring of large glacial rivers, and they similarly contain abandoned cataract cliffs with plunge pool basins at the foot. The U.S. bureau of reclamation. test drilling for an accessory dam in the Columbia Basin Irrigation project, found such a pothole basin excavated 300 ft. deep in the basalt and later filled with gravel. The favouring structure for most of these dry falls was the close-set, vertical. columnar jointing of the basalt. Plucking of columns in these glacial stream beds where the gradient was adequate made several such falls and accompanying downstream gorges as large as at Niagara today.

Grand Canyon.—When Maj. J. W. Powell, the first man to take a party by boat down the Grand canyon of the Colorado, was developing his plan, he was cautioned that he might encounter many receding-type waterfalls because the canyon was known to be eroded in nearly flat-lying beds of varying resistance to erosion. His reply was that the Colorado river is one of the dirtiest rivers in the world, that its load of sand, gravel and boulders had been a great longitudinal saw which must have long since cut through the hard rock lips of any such falls. He did encounter many dangerous rapids but no cataracts, despite the favouring structure of the rock. In contrast with the turbid Colorado are the Niagara, Yellowstone and Zambezi rivers. clear-water streams which consequently have done little cutting down into their bedrock floors upstream from their cataracts.

Leading Falls in Height and Volume.—The highest perennial fall known is Angel in Venezuela. It makes little contact with the sheer mountainside as it drops more than 3.280 ft. Other very high falls are Tugela, Natal. Republic of South Africa. 3.000 ft.; Kukenaam. Venezuela. 2,000 ft.; Sutherland. South Island, N.Z., 1,904 ft.; Ribbon. Yosemite, Calif., 1,612 ft ; Upper Yosemite. 1.430 ft.; Gavarnie, France, 1.384 ft.; Takkakaw, B.C., 1,248 ft.; Silverstrand Falls. Uosemite. 1.170 ft.

Niagara is doubtless the world's best-known cataract. It also has the steadiest flow of all large-volume waterfalls, discharging around 200.000 cu.ft. per second throughout the year.

Perhaps the largest mean discharge of any waterfall in the world is that of Guaíra or Sete Quedas on the Paraná river between Brazil and Paraguay. It is estimated at 470,000 cu.ft. per second and the falls' height is only 30 ft. less than that of Niagara. Another cataract of very large volume is Khon on the Mekong river, Indochina. Its estimated mean annual flow is between 400.000 and 420.000 cu.ft. per second. In descending order of volume are Paulo Affonso. on the São Francisco river. Braz.. 100.000 cu ft. per second; Urubu-Pungá, on the Paraná river, Braz., 97.000 cu.ft. per second; Iguaqu, on the Iguaqu river, on the boundary between Brazil and Argentina. 61,660 cu.ft. per second; Victoria. on the Zambezi river. Rhodesia. 38,430 cu ft. per second; Grand, on the Hamilton river. Labrador, 30.000 to 40 000 cu ft per second: and Kaieteur on the Potaro river, British Guiana, 23.400 cu.ft. per second.

Economic **Aspects.**—Waterfalls are an important economic asset if they are not too remote from industrial areas. Some falls have had their entire low-water flow detoured through hydroelectric power installations and now are spectacles only in floodtime.

Offsetting this asset, as at Niagara, has been the need for constructing navigation canals to by-pass the falls. To save Niagara's unexcelled natural scenic value: treaty regulations between the U.S. and Canada allow only 56,000 cu.ft. per second to be taken into canals and penstocks above the falls for power purposes. In the lowest stages of the river, it still discharges about 100.000 cu.ft. per second over the falls. But a strong east wind for a day or two will so lower the eastern end of Lake Erie that the smaller American falls will temporarily go dry.

The fall line has been an important controlling factor in the development of the Atlantic seaboard region since early colonial days. The individual falls were the upstream limit of early navigation. also a source of water power. The locations of Trenton. S. J. Philadelphia. Pa.. Wilmington, Del., Baltimore. Md.. Washington. D.C.. Fredericksburg and Richmond, Va., Columbia, S.C.. Augusta, Ga., and other cities mere determined, in part, by the fall line interruptions in the larger rivers entering the coastal plain:

Rivers which have not encountered fall-making conditions in the rock of their channel beds but which have adequate gradient for water-power development have been "harnessed" by construction of dams (*q.v.*), essentially artificial waterfalls with the added advantage in some cases of affording storage basins above the "falls." Man has constructed concrete and earthen barriers across some of the earth's great rivers (Mississippi, Missouri, Ohio, Columbia, Nile. Dnieper, etc.) to serve as navigation correctives, flood-control works, irrigation reservoirs, etc. The Tennessee Valley authority built 27 such "falls" on one river alone. Needless to say, the engineers have balked the falling water's tendency to dig plunge basins at the foot of the dams. The overflow is not allowed to fall freely; it slides down the sloping dam face and encounters a properly curved concrete apron at the foot which shoots the water horizontally downstream away from the structure. But these dams invariably upset the river's normal regimen both above and below the dam. In the slackened current of the reservoir, the stream unavoidably deposits its load of silt sand and gravel, gradually decreasing storage capacity. Downstream, the river has added erosional ability simply because it has been relieved of that load on its energy and can devote more attention to deepening its channel. Keither result is economically desirable. (J. H. Bz)

WATER FLEA, a popular term for certain minute Crustacea (q v.) which make flea-like jumps through the nater. Modern usage restricts the term to the Cladocera, a suborder of the Branchiopoda (q *v*). Cladocera are abundant in fresh water and a few species are marine. They are rarely over 4 mm long. The characteristic jumps result from oarlike strokes of large, biramous antennae. In some species, however, these appendages beat so rapidly that swimming is continuous. Up to six pairs of trunk limbs are present. usually enclosed within a bivalve shell. The well-known genus Daphnia is transparent. Thus. in it one can see with a microscope such activities as the beating of the heart, intestinal movements circulation of the nhite blood cells (in which phagocytosis of bacteria was first discovered), movements of the fused compound eye and the rapid beating of the trunk limbs. This last action produces a current for filter-feeding and respiration. Usually one finds only females, which reproduce parthenogenetically. the unfertilized eggs entering a dorsal brood chamber where they develop rapidly into fully formed young released at the next molt. At certain times small males appear, and fertilized resting eggs are then produced, able to withstand freezing and drying.

Cladocera are closely related to the suborder Conchostraca, from which they apparently arose by neoteny, becoming sexually mature at what was formerly a juvenile stage. By adaptive radiation Cladocera have evolved into a variety of forms, living in the mud. on aquatic plants, under the surface film, as a parasite of Hydra, as filter-feeders in the plankton and as active predators. (J. H Lo.)

WATERFORD, a county of Ireland in the province of Munster. The land area of Waterford is 454,128 ac., or 709.5 sq.mi. Pop. (1961), exclusive of Waterford city, 43,205 (total 71,343). The coast line is in some parts rocky and is indented by many bays and inlets, the principal being Waterford harbour; Tramore bay, with picturesque cliffs and extensive caves. and noted for its shipwrecks on account of the rocky character of its bed; Dungarvan harbour, much frequented for refuge in stormy weather; and Youghal harbour, partly separating County Waterford from County Cork. The surface of the county is to a large extent mountainous, providing beautiful inland scenery, especially toward the west and northwest. The Knockmealdown mountains, which attain a height of 2,609 ft., form the northern boundary with Tipperary. A wide extent of country between Clonmel and Dungarvan is occupied by the two ranges of the Comeragh and Monavallagh mountains. reaching a height of 2,504 ft.

To the south of Dungarvan there is a lower but very rugged range, called the Drum hills. The southeastern division of the county is for the most part level. Though Waterford benefits in its communications by the important rivers in its vicinity, the only large river it can properly claim as belonging to it is the Blackwater. This river is famous for salmon fishing and, particularly in the stretch between Cappoquin and Lismore, flows between high, well-wooded banks, contrasting beautifully with the background of the mountains. It enters the county east of Fermoy, and flows eastward to Cappoquin, the head of navigation, where it turns abruptly southward to enter the sea at Youghal harbour.

Waterford harbour may be called the estuary of three important rivers, the Suir. the Nore and the Barrow. but neither of the last two touches the county. The Suir reaches it about 8 mi. from Clonmel and thence forms its northern boundary with Tipperary and Kilkenny. It is navigable to Clonmel, but the traffic lies mainly on the left bank, outside the county.

Geology. — The Knockmealdown mountains are an anticline of Old Red Sandstone, cut away at the eastern end to expose Silurian strata, which are associated with an extensive series of volcanic and intrusive rocks, often crushed by earth movement. The impressive scarp formed by the Old Red Sandstone conglomerate above this lower ground is called the Comeragh mountains. The moraine-dammed cirque of Lough Coumshingaun lies in these, with a precipice 1,000 ft. in height. The unconformity of the Old Red Sandstone on the greenish and yellowish Silurian shales is excellently seen on the north bank of the Suir at Waterford. Carboniferous limestone is found in the floor of the synclinals on either side of the great anticline, that is, in the Suir valley on the north and in the green and richly wooded hollow of the Blackwater on the south. Rapidly repeated anticlinal and synclinal folds continue this structure across the country between Dungarvan and Youghal.

Rich copper mines were worked, mainly in the 19th century, in the Silurian area near Bunmahon, and the region remains full of mineral promise.

History. — In the 9th century the Danes landed. and afterward made a permanent settlement. W'aterford was one of the 12 counties into uhich King John is stated to have divided that part of Ireland uhich he nominally annexed to the English crown. On account of the convenience of the city as a landing place, many subsequent expeditions passed through the county. It suffered severely during the Desmond rebellion in the reign of Elizabeth I, as well as in the rebellion of 1641 and during the Cromnellian period.

At Ardmore, overlooking the sea from Ram head. there is a round tower 95 ft. in height, and near it a huge rath and a large number of circular entrenchments. Lismore castle, originally erected in 1185, is in great part comparatively modern. The chief ecclesiastical remains are those of the chancel and nave of the cathedral of Ardmore, where a monastery and oratory mere founded by St. Declan in the 7th century. The see of Ardmore was abolished in the 12th century. The existing monastery of Mount Melleray, a convent of Cistercians, was founded near Cappoquin in 1830, on the expulsion of the foreign members of this order from France. A large expanse of barren and rocky mountainside has been reclaimed by the monks, who have converted it into an extensive model farm, conducted on scientific lines. They maintain schools and guest houses for visitors. and have built with their own labour the large abbey church which was. dedicated in 1952. The stone used for building the church was bought from the modern ruin of Mitchelstown castle. Three other Cistercian abbeys, at Roscrea (Tipperary), Mellifont (Louth) and Portglenone (Antrim), have been founded directly from Mount Melleray and are known as its daughter houses. The abbeys of Mount St. Bernard (Leicestershire) and New Melleray (Dubuque, Ia.) are also its offshoots.

Agriculture and Industries. — The land is generally better for pasturage than for tillage. although there are considerable tracts of rich soil in the southeastern districts. In 1951 there were 52,656 ac. in crops, 27,676 ac. in hay and 222.046 ac. in pasture. Of the crop acreage more than half was planted to corn crops, mostly oats (19,763 ac.) and less than half to root and green crops. Of the latter, potatoes, turnips and mangels were the most important.

The size of farmholdings in the county averages larger than for Ireland in general. In the number of its cattle Waterford's position has fallen considerably. The woollen manufacture, except for home use, is practically extinct, but the cotton manufacture is still of some importance. There are a number of breweries and distilleries and also a large number of flour mills. The deep sea and coastal fisheries have their headquarters at Waterford, and the salmon fisheries of the Suir and Blackwater have theirs at Waterford and Lismore respectively. Waterford returns four members to *dáil eireann.*

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WATERFORD, a city and port and the chief town of County Waterford, Ireland. Pop. (1961) 28,138. It is situated on the south bank of the River Suir 4 mi. above its junction with the Barrow at the head of the tidal estuary called Waterford harbour. The Suir is crossed by a concrete bridge with a lifting centre bay. It was built in 1913 to replace a wooden one and connects Waterford with the suburb of Ferrybank. Waterford is governed by an elected council and a manager who is appointed by the national government. The manager's extensive powers were limited by the council's authority over rates, bylaws and loans.

Anciently Waterford was called Cuan-na-groith, the haven of the sun. By early writers it mas named Menapia. It first acquired importance under the Danes, of whom it remained one of the principal strongholds until its capture by Strongbow (Richard le Clare, 2nd earl of Pembroke) in 1171. In 1172 Henry II landed near Waterford. and received there the hostages of the people of Munster. It became a cathedral city in 1096. The Protestant dioceses of Cashel, Emly, Waterford and Lismore were united in 1833 The Roman Catholic diocese of Waterford and Lismore includes County Waterford and parts of Tipperary and Cork. John landed at Waterford in 1185 and after ascending the English throne he granted it a charter of incorporation in 1206. He landed at R'aterford in 1210 in order to establish within his nominal territories in Ireland a more distinct form of government. Richard II landed at Waterford in Oct. 1394 and again in 1399. In 1447 it was granted by Henry VI to John Talbot, earl of Shrewsbury. who was created earl of Waterford.

In 1603, after the accession of James I to the English crown, the city, along with Cork, took a prominent part in opposition to the government and to the Protestant religion, but on the aproach of Mountjoy it formally submitted. In 1619 an unsuccessful attempt was made to induce Bristol merchants to settle in the city and undertake its government. It resisted Cromwell in 1649 but surrendered to Henry Ireton in 1650. After the battle of the Boyne James II embarked at Waterford for France (July 1690). Shortly afterward it surrendered to William, who sailed from there to England. The city sent two members to parliament from 1374 to 1885, when the number was reduced to one. In 1898 it was constituted one of the six county boroughs having separate county councils.

The city is built chiefly along the banks of the river, occupying for the most part low and level ground except at its western extremity. The modern Protestant cathedral of the Holy Trinity (begun 1773, altered 1891) occupies the site of the church built by the Danes in 1096 in the Mall. There is a Roman Catholic cathedral, and St. John's college, a seminary for priests. The principal secular buildings are the town hall, the county and city courts and prisons, the customhouse and the barracks. At the extremity of the quay is a large circular tower, called Reginald's tower, forming at one time a portion of the city walls and occupying the site of the tower built by Reginald the Dane in 1003. Other remains of the fortifications, consisting of towers and bastions, are to be seen as in the Tramore railway sidings and in Castle street. The town possesses breweries, salthouses, foundries and flour and paper mills; there is a large export trade in cattle, sheep and pigs, and in agricultural produce; the traditional manufacture of Waterford glass has been recently revived. It is the headquarters of extensive salmon and sea fisheries. Waterford is second in importance to Cork among the ports of the south coast of Ireland. There is regular communication by motor and steam ships with Cork, with Dublin and Belfast, with Fishguard and with many English ports.

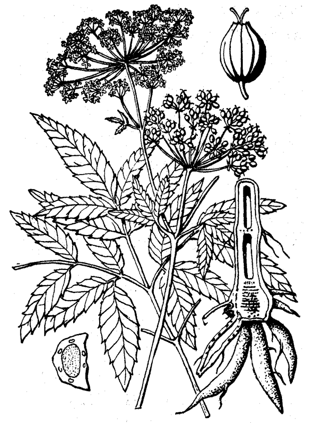
Waterford harbour is a winding and well-sheltered bay formed by the estuary of the Suir river, and afterward by the joint estuary of the Nore and Barrow. Its length to the sea is about 1 j mi. Its entrance is 3 mi. wide and is lighted by a fixed light on the ancient donjon of Hook tower (139 ft. in height) and three others. The Suir is navigable to Waterford for vessels drawing 22 ft. The shores of the harbour are studded with country residences and waterside villages. A large housing estate was built on the southern outskirts of the city toward Tramore, a seaside holiday resort 8 mi. S.

WATER GAS. When steam is passed over red-hot anthracite or coke it is decomposed, and the resultant gas. consisting of a mixture of hydrogen and carbon monoxide, is termed water gas. Enriched with gas from cracked oil. it is termed carbureted nater gas and is largely employed in industrial operations. It is also used mixed with coal gas for town purposes; when so employed it increases the poisonous character of the gas supply because of the peculiarly dangerous qualities of carbon monoxide. See GAS INDUSTRY and FUELS.

WATER GLASS. A common name for sodium silicate, made by fusing together soda ash and clean sand in a furnace. The name water glass (or soluble glass) is derived from the fact that while the substance resembles glass it can be dissolved in water by prolonged exposure. The proportions of soda and silica in water glass may be considerably varied, according to the purpose for which it is required. See ALKALI MANUFACTURE.

WATER HEMLOCK, also known as cowbane, is botanically Cicuta *virosa,* of the parsley family, Umbelliferae, a poisonous weed growing at the edges of ponds, ditches and rivers in Great Britain. It is a perennial with clusters of fleshy roots, and has large compound leaves and small white flowers appearing from July to August. It has been mistaken by human beings for celery, with fatal results. and is responsible for the death of cattle. In North America there are several native species of *Cicuta* common in marshes and wet meadows, all similarly poisonous. especially the spotted cowbane or musquashroot (C. *maculata*) of the eastern states and Canada, and the western water hemlock (C. *douglasi*) of the Pacific coast. Before its virulence became known to cattle raisers the western species caused serious losses of livestock in the Pacific northwest. Humans are sometimes fatally poisoned by mistaking the roots for other plants.

The closely allied poison hemlock (Conium *maculatum*) is a biennial plant of the family Umbelliferae, found wild in many parts of Europe, where it occurs in waste places on hedge banks, and by the borders of fields. It is also widely spread over temperate Asia and is naturalized in the cultivated districts of North and South America. It is an erect branching plant, growing from three to six feet high, from a large taproot. The stems are hollow, smooth, somewhat glaucous green, spotted with dull dark purple. The root leaves have long furrowed footstalks, sheathing the stem at the base, and are large, triangular in outline, and repeatedly divided or compound, the ultimate and very numerous segments being small, ovate and deeply incised at the edge. These leaves generally perish after the growth of the flowering stem, which takes place in the second year, while the leaves produced on the stem become gradually smaller upward. The branches are all terminated by compound, many rayed umbels of small white flowers. which are succeeded by broadly ovate fruit. Humans have been poisoned by mistaking the roots for parsnips or the seeds for caraway. See also POISON HEMLOCK; POISONOUS PLANTS. (W. C. M.)



THE WATER HEMLOCK (CICUTA MACULATA), A HERB FOUND IN SWAMPS AND LOWLANDS

WATERHOUSE, ALFRED (1830–1905), English architect of many educational and civic buildings, was born at Liverpool on July 19, 1830, and died on Aug. 22, 1905. He was a pupil of Richard Lane in Manchester. His position as a designer of public buildings was assured as early as 1859 when he won the open competition for the Manchester assize courts. This work marked him as a champion of the Gothic style. In 1868 he won the competition for the Manchester town hall, where he showed a firmer and perhaps more original handling of the Gothic manner. The same year brought him the rebuilding of part of Caius college, Cambridge, not his first university work, for Balliol, Oxford, had been put into his hands in 1867. At Caius the Gothic element was intentionally mingled with classic detail, while Balliol and Pembroke, Cambridge, which followed in (1871), were of the style of his mid-career—European Gothic tradition tempered by individual taste and by adaptation to modern needs.

Among his other educational buildings were Girton college, Cambridge; Owens college. Manchester; and Liverpool university college. He designed the Jenner Institute of Preventive Medicine, Chelsea, and the Liverpool infirmary, his largest hospital. His Natural History museum. South Kensington, marked a new epoch in the use of terra cotta. Waterhouse was a member of the Royal Institute of British architects and many other professional societies.

WATERHOUSE, GEORGE ROBERT (1810–1888), English zoologist, an expert on the classification of beetles and mammals, was born at Somers Town. London, on March 6, 1810. Educated at Koekelberg, near Brussels, he returned to England to be trained as an architect, and practised this profession from 1831 to 1835. His real taste, however, was for entomology, and in 1833 he was appointed curator of books, memoirs and insects to the Entomological society, London. In 1836 he became curator of the Zoological society of London. His catalogue of the mammals in the society's museum was not published until 1838, because of strong opposition to his adopting a more modern arrangement. Waterhouse proposed a new scheme for the classification of Heteromera Coleoptera, but this was never published, as he lost the paper that he was to have read before the new Entomological society and had not the heart to rewrite it. The dissections made for this study were eventually placed in the Natural History department of the British museum. In 1843 Waterhouse was appointed assistant in the mineralogical and geological branch of the museum, becoming keeper in 1851. When in 1857 this branch was split into the two departments of mineralogy and geology. Waterhouse continued as keeper of the department of geology. He never published anything in geology. but did a good deal of administrative work, particularly in preparation for the transfer of the department to South Kensington While there, Waterhouse spent all available spare time in aorking on beetles and mammals and in writing about them. He retired in 1880 and died at Putney on Jan. 21, 1888.

During his earlier years, Waterhouse wrote many articles on mammals. fishes and insects for Charles Knight's *Penny Cyclopaedza.* He began a *Natural Hzstory of the Mammals* in 1844, but only two volumes, on the Marsupialia and Rodentia, had been brought out (1846–48) when the work was discontinued. Waterhouse published also a *Catalogue of British Coleoptera* (1858).

(J. Rm.)

WATERHOUSE, JOHN WILLIAM (1847–1917) English painter, was the son of an artist, by uhom he nas mainly trained. As a figure painter he shows in his uork much imaginative power and a very personal style. and his pictures are mostly illustrations of classic myths treated with attractive fantasy; *e g*, "Consulting the Oracle" He was an able draftsman and a fine colourist. He was elected an associate of the Royal Academy in 1885 and academician in 189j.

He died in London on Feb 10. 1917.

WATER HYACINTH (*Eichhornia crassipes),* an aquatic herb of the pickerel weed family (Pontederiaceae), native to tropical America and widely naturalized in warm regions. It is an

JOHN H. GERARD
WATER HYACINTH (EICHHORNIA CRASSIPES) IN BLOOM. THE BLADDER-LIKE FLOATS ARE VISIBLE AT THE BASE OF THE LEAF STALKS

emersed or floating, somewhat fleshy plant. bearing smooth, nearly round. erect leaves, one-half inch to six inches broad, and loose clusters of pale-violet, orchidlike flowers, marked with blue and yellow. The bladderlike bases of the leafstalks serve as floats which keep the plant high in the water. Escaping from cultivation, it has become a troublesome weed, impeding navigation in the inland waters of the Gulf states of the U.S. and in other tropical and subtropical areas. Large expenditures of labour and money on mechanical and chemical control result in only temporary relief. On the subcontinent of India water hyacinth plants have been utilized for making paper and pressed boards.

See M. A. Azam, "Utilization of Water Hyacinth in the Manufacture of Paper and Pressed Boards, *Sci & Cult.*, vol. 6, pp 656–661 (1941).

WATERLAND, DANIEL (1683–1740), English theologian, was born at Walesby on Feb. 14. 1683. He was educated at Magdalene college. Cambridge. On Nov. 14, 1715, he became vice-chancellor of the university and in the following year mas appointed chaplain in ordinary to the king. In 1720 he published *Eight Sermons in Defence of the Dzvinity of our Lord Jesus Christ,* preached by him in St. Paul's cathedral. In 1722 he was appointed chancellor of the diocese of York. and in 1723 appeared his *Critical History of the Athanasian Creed* In 1730 he became archdeacon of Middlesex and vicar of Twickenham.

His other major works were *Scripture Vindicated* (1730–32); *The Importance of the Doctrine of the Holy Trinity Asserted* (1734); and *Review of the Doctrine of the Eucharist* (1737). His nork did much to check the increase of latitudinarian ideas within the Church of England at the time.

Waterland died on Dec. 23, 1740.

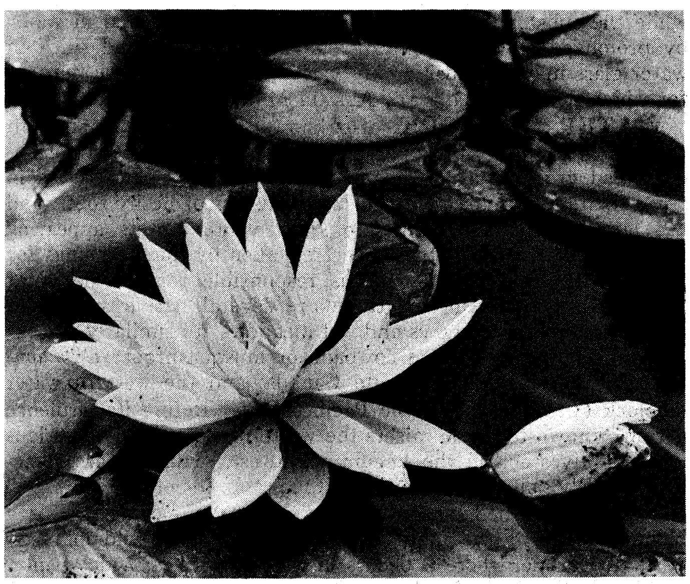
WATER LETTUCE *(Pistia stratiotes),* an aquatic plant of the arum family (Araceae. *q.v.*), very widely distributed in tropical and subtropical regions; in the United States it is native to slow streams from Florida to Texas. It is a tender, floating perennial, rarely becoming anchored by its long feathery roots. The wedge-shaped, light-green leaves form a rosette. about six inches broad. which is somewhat similar to a half-grown lettuce plant before the head is formed. In the cuplike centre of the rosette are borne the small white flowers. Water lettuce is often groun in water gardens and as an aquarium plant.

WATER LILY, a name loosely given to almost any floating plant with conspicuous flowers. but applying especially to the species of *Nymphaea*, *Nuphar* and other members of the water lily family (Nymphaeaceae). These are aquatic plants with thick fleshy rootstocks or tubers embedded in the mud and sending up to the surface circular shieldlike leaves and leafless flower stalks, each terminated by a single flower, often of great beauty, and consisting of four or five sepals and numerous stamens without any definite line of demarcation between them.

The ovary consists of many carpels united together and free, or more or less embedded in the top of the flower stalk. The ovary has many cavities and is surmounted by a flat stigma of many radiating rows as in a poppy. The fruit is berrylike, and the seeds are remarkable for having their embryo surrounded by an endosperm as well as by a perisperm. The leaf stalks and flower stalks are traversed by longitudinal air passages, whose arrangement varies in different species.

The species of *Nymphaea* are world-wide in distribution. Their flowers range from white to rose coloured, yellow and blue. Some expand in the evening only, others close soon after noon.

Nymphaea odorata, fragrant water lily, and N. *tuberosa,* tuberous water lily, are the conspicuous white water lilies of eastern North America. *Nuphar advenum* is the common yellow water lily or spatter dock of the eastern United States and Canada, and *Nuphar polysepalum,* Indian pond lily, is its counterpart on the Pacific coast. *Brasenia schreberi,* the water shield, with small yellow flowers occurs across the continent. *Nelumbium sentapetalum,* of the eastern United States, is the American lotus or water chinquapin (*q.v.*). The gigantic *Victoria regia* (*q.v.*), with leaves 4 to 7 ft. in diameter and flowers 6 to 18 in. across. also belongs to this group. It grows in the backwaters of the Amazon. often covering the surface for miles; the seeds are eaten under the name water maize. *Nymphaea alba* is common in some parts of Great Britain, as is also the yellow *Nuphar luteum* (*Nymphaea luteus*).



WILLIS PETERSON
HYBRID WATER LILY (NYMPHAEA MARLIACEA CHROMATELLA)

The seeds and the rhizomes contain an abundance of starch and are used in some places for food.

Under the general head of water lily are included the lotus of Egypt, *Nymphaea lotus*, and the sacred lotus of India and China, *Nelumbium nelumbo*, formerly a native of the Nile, as shown by Egyptian sculptures and other evidence, but no longer found in that river. *See* also LOTUS.

WATERLOO, a city of northeastern Iowa, U.S., about 50 mi. N.W. of Cedar Rapids, on the Cedar river, is the seat of Black Hawk county. Population of the city was 71,755 in 1960, an increase of 10.1% since 1950; the Waterloo standard metropolitan statistical area, comprising Black Hawk county, had a population of 122,482, an increase of 21.9%. (For comparative population figures *see* table in IOWA: *Population*.)

Settlers arriving in 1845 recognized that the river provided excellent mill sites; they called the place Prairie Rapids. The name Waterloo, adopted in 1851, is said to have been taken from a postal directory by Charles Mullan and inserted into a petition to the Cedar Falls postmaster for a post office at the settlement. After Waterloo became the county seat in 1855, it grew slowly as a railroad division point and as a centre of regional trade. It was chartered in 1868. Efforts to found local industries generally failed until the 1890s, when the practice adopted by local businessmen of making donations to attract industry met success. Subsequent industrial growth was extremely rapid. Early settlers in the county came mainly from New York, Pennsylvania, Ohio and Illinois. Many Germans, Danes and British immigrants also arrived; foreign-born and their children comprised about 42% of the population in 1900. The population in the second half of the 20th century was mainly derived from those stocks.

Major industries include meat products, farm tractors, construction machinery, metal products, textile and leather goods, corrugated boxes and soy products. Four major railroads serve Waterloo, and there is a municipal airfield.

Lying within the northeastern dairy area of Iowa, Waterloo sponsors the annual National Dairy Cattle congress, an internationally famous cattle exhibition. The city has a historical museum, and a municipal band and a symphony orchestra. The State College of Iowa (1876) lies 3 mi. W., at Cedar Falls.

(A. G. Bo.)

WATERLOO CAMPAIGN, 1815. On Feb. 27, 1815, Napoleon set sail from Elba with a force of 1,000 men and 4 guns, determined to reconquer the throne of France. On March 1 he landed near Cannes, and proceeded at once to march on Paris. He deliberately chose the difficult route over the French Alps because he recognized that his opponents would neither expect him by this route nor be able to exert combined operations in time to thwart him. Events proved the wisdom of his choice. His advance was a series of triumphs, his power waxing with every league he covered, and when he reached Paris the Bourbons had fled. But he had soon to turn his attention to war. His sudden return far from widening the breaches between the allies had fused them indissolubly together, and the four powers bound themselves to put 150,000 men apiece under arms and to maintain them in the field until Napoleon had been utterly crushed. To oppose their vast armies, Napoleon only had in March the 150,000 men he had taken over when Louis XVIII. hurriedly quitted the throne. Within ten days the emperor could have concentrated 50,000 men and struck straight at the small allied forces then in Belgium. But he wisely refrained from taking the immediate offensive. Such action could lead to no decisive result; and Napoleon therefore hastened forward the organization of an army with which to confront the Seventh Coalition. Meanwhile he sought by various means to detach Great Britain and Austria from the alliance.

Napoleon's Preparations and Plans.—By June 1 Napoleon had got together an army of 360,000 for the defence of France, one half of which was available for field service. In this army was comprised his whole means of defence; for he had no allies. On his return from Elba it is true Murat, the king of Naples, took his side; but recklessly opening an offensive campaign, Murat was beaten at Tolentino (May 2–3), and he found himself compelled to fly in disguise to France, where the emperor refused to give him an audience or employment. Napoleon thus deprived himself of the most brilliant cavalry soldier of the period. Murat's disaster had left the whole eastern frontier of France open to invasion. The country, too, was weakened by internal dissensions at the very moment when it was necessary to put every man in line to meet the rising tide of invasion.

In Belgium lay an ever-increasing force of Anglo-Dutch and Prussian trbops under Wellington and Blucher. The eastern frontier was threatened by Austrian armies, and the Russians were slowly coming up. The allies determined to avoid any risk of defeat in detail. It was arranged that Wellington and Blücher should await in Belgium the arrival of the Austrians and Russians on the Rhine. Then about July 1 the general invasion of France would be begun. Affording each other mutual support, the allies would press forward on Paris, and, after defeating Napoleon, drive him within its works. This menacing danger forced Napoleon to strike prematurely, for he determined to crush Wellington and Bliicher, whose forces lay dispersed in Belgium, before the Austrians and Russians poured across the eastern frontier.

In the early days of June Wellington and Blucher were disposed as follows. (*See* map.) The Anglo-Dutch Army, 93,000, headquarters at Brussels, were cantoned: I. Corps (Prince of Orange), 30,200, in the area Enghien-Genappe-Mons; II. Corps (Lord Hill), 27,300, in the area Ath-Audenarde-Ghent; reserve cavalry (Lord Uxbridge), 9,900, in the Dendre valley; whilst the reserve (Wellington), 25,500, lay around Brussels. The front was watched by Dutch-Belgian light cavalry.

Blücher's Prussian Army, 116,000, headquarters at Namur, were quartered: I. Corps (Zieten), 30,800, along the Sambre covering Fontaine l'Evêque-Fleurus-Moustier; II. Corps (Pirch), 31,800, in the area Namur-Hannut-Huy; III. Corps (Thielemann), 23,900, in the bend of the Meuse from Dinant to Huy; IV. Corps (Bulow), 30,300, around Liége. The front was watched by the Prussian outposts.

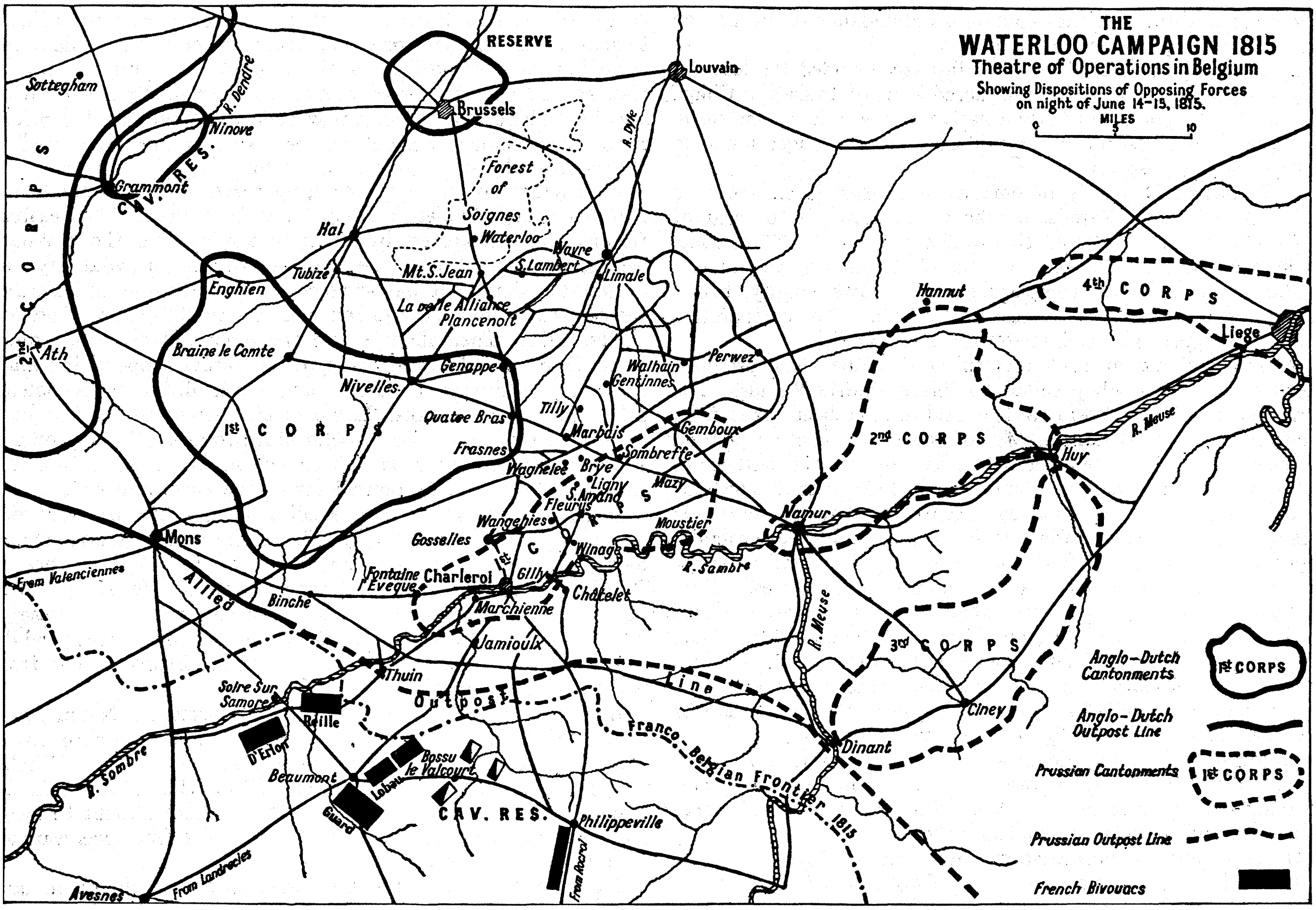
Thus the allied cantonments extended for nearly 90 m. and their mean depth was 30 m. To concentrate on either flank would take six days, and on the common centre, Charleroi, three days.

The allies had foreseen the very manoeuvre that Napoleon decided to adopt, and if an attempt was made to break their centre they intended to concentrate forwards and on their inner flanks, the Anglo-Dutch at Gosselies and the Prussians at Fleurus. They could then act united against Napoleon with a numerical superiority of two to one. They felt certain they would obtain the necessary three days' warning of the French concentration, as Napoleon's troops were then distributed between Lille, Metz and Paris (175 m. by 100 m.). To concentrate the French army, within striking distance of Charleroi, before the allies had moved a man to meet it was unthinkable. But it was the unthinkable that happened.

Whereas Bliicher had covered Fleurus by Zieten's Corps, which by a yielding fight would secure the time for the Prussian concentration, yet Wellington had only covered Gosselies by a cavalry screen which was too weak to gain the time requisite for the Duke to mass there. Hence to enable him to concentrate as arranged Wellington relied on obtaining timely information of Napoleon's plans, which in fact he failed to obtain.

The French Concentration.—The emperor made his final preparations with the utmost secrecy. The "Armée du Nord" was to concentrate in three columns—around Solre, Beaumont and Philippeville—as close to Charleroi as was practicable. On June 6 the IV. Corps (Gérard) started and soon the whole army was in motion, every effort being made to hide the movements of the troops, for there was no great natural screen to cover the strategical concentration. On June 11 Napoleon left Paris for the front, and by June 14 he had achieved almost the impossible itself. There around Solre, Beaumont, and Philippeville lay his mass of men, 124,000, concentrated under his hand and ready to march across the frontier at dawn against the unsuspicious enemy. The allies still lay in widely distant cantonments and they had not moved a man to meet the foe.

The opposing armies were of very different quality. Welling-



ton's was a collection of many nationalities, and the kernel of British and King's German Legion troops numbered only 42,000. Blucher's army was undoubtedly more homogeneous and included no specially weak elements. Napoleon led out a veteran army of Frenchmen who worshipped their leader. But there were lines of weakness in his force. For various reasons, neither Davout, Murat, Suchet, nor Clausel were employed in the "Armée du Nord." Marshal Soult, appointed chief of the staff, possessed few qualifications for this post; and neither Ney nor Grouchy who, when the campaign began were given command of the left and right wings, possessed the ability or strategic skill necessary for such positions. Again the army was morally weakened by a haunting dread of treason; and, finally, it was too small for its purpose. Locked up in secondary theatres Napoleon had left 56,500 men, of whom he might have collected over 30,000 for the decisive campaign in Belgium. Had he concentrated 155,000 of his available force opposite to Charleroi on June 14, then the issue would hardly have been in doubt. As it was he left too much to Fortune.

For his advance into Belgium in 1815 Napoleon divided his army into two wings and a reserve. As the foe would lie away to his right and left front after he had passed the Sambre, one wing would be pushed up towards Wellington and another towards Blucher; whilst the mass of the reserve would be centrally placed so as to strike on either side, as soon as a force of the enemy worth destroying was encountered and gripped. To this end he had, on the 14th, massed his left wing (Reille and D'Erlon) around Solre, and his right wing (Gerard) at Philippeville; whilst the central mass (Vandamme, Lobau, the Guard and the Cavalry Reserve) lay around Beaumont. The orders for the French advance next day, among the finest ever issued, directed that the army should march at dawn and move to the Sambre at Marchienne and Charleroi. By evening it was expected that the whole would have crossed the Sambre, and would bivouac between the sundered allies.

The Passage of the **Sambre.**—At the very outset delays occurred. Vandamme, who was to lead the advance on Charleroi, was delayed by an accident that befell the single orderly who carried the orders to the III. Corps. Gerard, too, was late as his concentration had not been completed on the 14th. Zieten's outposts fought stubbornly to delay the French advance for 24 hours and give time for Blucher's concentration. As soon as the emperor reached the front he took vigorous action, nevertheless it was after noon before the Charleroi bridge was stormed. At the same time Reille crossed at Marchienne. The emperor at once began the advance up both the Fleurus and Quatre Bras roads. It was 3 P.M. when Marshal Ney joined the army and was at once given command of the left wing. Napoleon then proceeded with Grouchy to reconnoitre the Prussian position at Gilly, and, handing over the command of the right wing to the marshal, the emperor immediately returned to Charleroi and ordered Vandamme to go to the assistance of Grouchy.

The allies had been caught unprepared. But as soon as Blücher got the first real warning of imminent danger he ordered the immediate concentration of his army at Sombreffe. Unfortunately, the orders sent to Bülow were so hazy that Bülow did not realize the need for any special haste. Thus the IV. Corps was neutralized until after the 16th. But Pirch I. and Thielemann acted with satisfactory promptness and their corps reached Mazy and Namur by nightfall. Blücher in pursuance with his plan moved to Sombreffe.

Wellington's position at night was hardly safe or even satisfactory. It was not until 3 P.M. that definite news of the French advance reached Brussels, and even then the duke was not certain of the direction of Napoleon's main stroke. Consequently he ordered his divisions to concentrate at their alarm-posts and await further orders. The danger of Blucher's position was thus enormously increased. The allies do not appear to have decided upon the course to be taken in case they were surprised, and their system of inter-communication was most imperfect. Luckily

Wellington's subordinates at the critical point acted with admirable boldness. Prince Bernard, commanding the brigade at Quatre Bras, retained his position there to check the French advance instead of drawing off to mass with his division at Nivelles. His immediate superiors approved his action. Owing to these officers Wellington retained possession of the important strategical point of Quatre Bras. Consequently Ney's advance struck into Prince Bernard's advanced troops who were forced back. But Prince Bernard firmly held his main position at the cross-roads; and, as the day was drawing on, Ney wisely decided not to push on any farther and so risk isolating the left wing. He halted and reported to the emperor.

Meanwhile Grouchy and Vandamme wasted two hours deliberating in front of the Prussian brigade at Gilly. Then at j:30 P.M. Napoleon again reached the front and vigour replaced indecision. After a brief cannonade Vandamme advanced with the bayonet and the Prussians gave way. Grouchy then moved on Fleurus and halted for the night.

Owing to Zieten's skill Blucher had secured his concentration area, one corps was in position, and two others were at hand. Thanks to his subordinates Wellington still retained a grip on Quatre Bras. His corps were assembling: I, Nivelles, Braine le Comte, Enghien; II., Ath, Grammont, Sotteghem; Cavalry, Ninove; Reserve, at Brussels. During the night the divisions were ordered to move to Nivelles, and at dawn the Reserve marched for Mt. St. Jean.

The duke had relied on information that did not come to hand. His intelligence officer, Colonel Colquhoun Grant, who was in France, was ordered to send back his reports to the duke through General Dornberg at Mons. On June I j Grant reported that the French Army was advancing, but Dornberg refused to believe the report and returned it. Owing to this officer's presumptuous folly Grant's report only reached Wellington on June 18.

On the night of the I jth the "Armée du Nord" was disposed as follows: — Left Wing, Frasnes to Marchienne; Right Wing, in front of Fleurus and astride the Sambre at Chdtelet; Centre (or Reserve), Guard, between Gilly and Charleroi; but Milhaud's Cuirassiers and Lobau's (VI.) Corps were still south of the Sambre. Thus, despite the delays, Napoleon had secured a dominant strategical position. The allies were still encouraged to attempt a risky forward concentration, whilst Napoleon's covering forces were sufficiently far forward to be able to grip whichever ally adventured his army first. The "Armée du Nord" lay concentrated "in a square whose sides measured 12 m. each; and it could with equal facility swing against the Prussians or the Anglo-Dutch, and was already placed between them."

16th June. — Early in the morning Prince Bernard was reinforced at Quatre Bras by the rest of his division (Perponcher's); and Wellington's other troops were now all on the march eastward except the reserve, who were heading southwards and halted at the cross-roads of Mt. S. Jean until the duke had resolved that their objective should be Quatre Bras. They then marched in that direction. Blucher meanwhile was making his arrangements to hold a position to the south of the Namur-Nivelles road and thus maintain uninterrupted communication with Wellington at Quatre Bras.

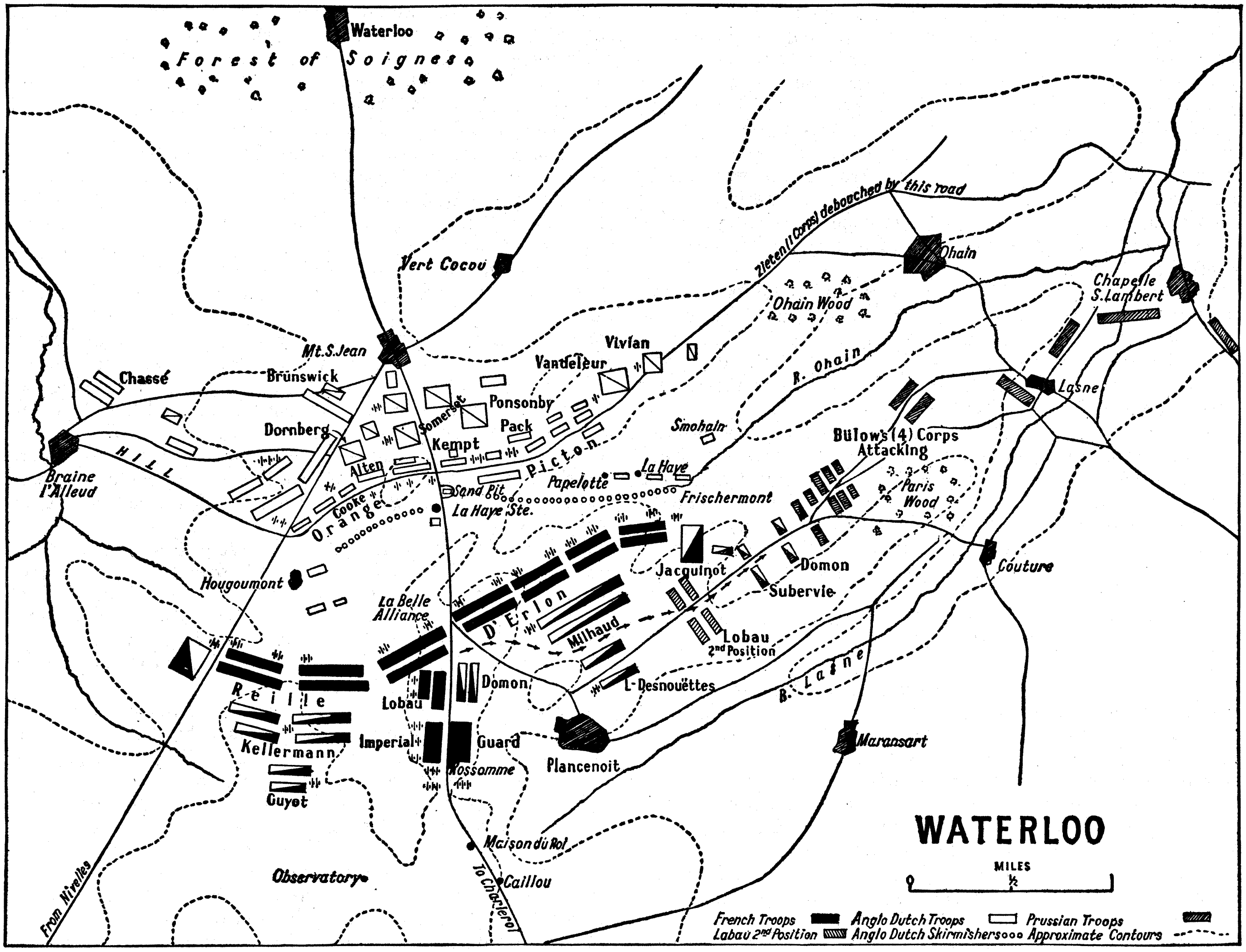
Napoleon spent the early morning in closing up his army, and writing what proved to be the most important letter of the campaign to Ney (Charleroi, about 8 A.M.): "I have adopted as the general principle for this campaign to divide my army into two wings and a reserve. . . . The Guard will form the reserve, and I shall bring it into action on either wing just as circumstances dictate. . . . According to circumstances I shall weaken one wing to strengthen my reserve. . . ." Here, in its simplest form, is the principle that underlies Napoleon's strategy in 1815. Only on the wing on which the reserve is brought into action will a decisive result be aimed at. The other is to be used exclusively to neutralize the other enemy, by holding him at bay.

Napoleon's plan for this day assumed that the surprised allies would not risk a forward concentration. The emperor intended to push an advanced guard to Gembloux to ward off Blucher, and move up the Guard to Fleurus. But once in possession of Sombreffe, the emperor would swing the reserve westward to join Key, who should then have mastered Quatre Bras and have pushed out a force to link with Grouchy, as well as another body 6 m. to the northward. The centre and left wing would then march by night to Brussels. The allies would thus be irremediably sundered. Meanwhile Napoleon and the VI. Corps waited at Charleroi for further information. Up till noon Ney took no serious step to capture Quatre Bras, which still lay at his mercy. Grouchy reported that Prussian masses were coming up from Namur, but Napoleon ignored this. Before 10 A.M. Ney reported considerable hostile forces at Quatre Bras. The marshal was ordered to crush what was in front of him and report to Fleurus. Here Napoleon arrived at 11 A M., still leaving Lobau at Charleroi. Napoleon at once reconnoitred the situation. Only one Prussian corps was showing, but it was disposed parallel to the Namur road, as if to cover a forward concentration. Had the decisive day arrived? If so, by 2 P.M. Vandamme, Gérard, Pajol and Exelmans would be available for the assault, and the Guard and Milhaud would act as a reserve. At 2 P M. Napoleon ordered Ney to secure Quatre Bras, as the emperor was attacking the Prussian corps. Whichever wing succeeded first would then wheel inwards and help the other. The decisive flank had not yet become clear.

Blucher had determined to fight. Wellington, on arrival at Quatre Bras, finding all was quiet, rode over to meet Blucher at Brye. Considering no serious force was in front of Quatre Bras, Wellington ended the interview with the conditional promise that he would bring his army to Blucher's assistance at Ligny, if he was not attacked himself. But on his return to Quatre Bras he found the situation already critical.

Quatre **Bras.**—Ney had let slip the chance when he could have mastered Quatre Bras with ease, and thereby ensured co-operation with Napoleon. He waited to mass Reille's Corps before he advanced, though the Prince of Orange had only 7,500 troops at Quatre Bras. The Prince had boldly scattered his force, made wise use of cover and showed a firm front to Key. It was 2 P M. when the French attacked. East of the road the Dutch-Belgians were forced back and the line wavered. But at 3 P.M. Merlen's cavalry rode in from Nivelles, Picton and the jth division marched up from Brussels, and Wellington himself returned. Pictonstopped the French advance, but Reille's last division was thrown in on the French left, and a hot fight broke out. The Brunswick contingent now reached Wellington and at once attacked. It was 4:1j P.M. Ney had just received Kapoleon's 2 P M. order, and he promptly pressed his attack and almost cleared the Bossu wood. However, at 5 P.M. Alten's division arrived from Nivelles, and Ney realized that he needed D'Erlon's corps to gain the cross-roads.

About 5:15 P.M. Key learned that D'Erlon, without his knowledge, had moved eastwards to co-operate at Ligny. Then at 5:30 P.M. he received Napoleon's order to seize Quatre Bras and swing in against Blucher nho was pinned at Ligny. Napoleon added, "the fate of France is in your hands." Ney's duty was clear. He must hold Wellington at Quatre Bras and allow D'Erlon to ensure that a decisive success was gained that day at Ligny. In no case could D'Erlon return in time to be of any use at Quatre Bras. Ney, beside himself with rage, sent imperative orders to D'Erlon to return and ordered Kellermann's cuirassier brigade to break through Wellington's line. The charge was admirably executed. A British regiment, caught in line, was overthrown and lost a colour. But unsupported, the horsemen were then beaten back. At that moment Ney received a verbal message from Napoleon ordering him, whatever happened at Quatre Bras, to allow D'Erlon to carry out the move to Ligny. Despite remonstrance, Ney refused to reconsider D'Erlon's recall and plunged into the fight. Then about 7 P.M. the British Guards reached Wellington and at last gave him the numerical superiority. Promptly the duke attacked all along the line, and by nightfall the French had been driven back to Frasnes. The losses were, Anglo-Dutch 4,700, French 4,300. At 9 P.M., when the battle was over, D'Erlon arrived. The corps had reached the edge of the Ligny battlefield when it received the counter-order. Thinking he was still under



Ney, D'Erlon decided to leave one division at Wagnelée and to return to the left wing. The incident was immeasurably unfortunate for the French. Had D'Erlon been used betimes at Quatre Bras, Wellington would have been crushed; had he only engaged at Ligny, D'Erlon would have ensured Blucher's annihilation. But oscillating between the two fields the Corps took part in neither. At 10 P.M. Ney wrote a short and somewhat one-sided report to Soult.

Ligny.—On the other flank there had meanwhile been waged the very bitterly fought battle of Ligny. As Blucher's dispositions gradually became clearer the emperor realized that the first decisive day of the campaign had actually come and promptly made arrangements for defeating the Prussian army in his front. Blucher, to cover the Namur road, held with the I. Corps the villages of Brye, St. Amand, and Ligny, whilst behind his centre was massed the II. Corps, and on his left was placed the III. Corps. Wellington and Bulow on arrival would act as general reserve. Blücher's army was quite visible to Napoleon on the bare open slopes, the II. Corps being especially exposed. The emperor decided to bear down Blücher's centre and right with the corps of Vandamme and Gérard and with Girard's division which he had drawn into his operations, containing the Prussian left meanwhile with the squadrons of Pajol and Exelmans, assisted by a few infantry. The Guard and Milhaud were in hand at Fleurus. Further, he could order up Lobau, and direct Ney to move his rearward corps across and form it up behind Blucher's right. When the battle was ripe, he would crush the Prussian centre and right between the Guard and D'Erlon's corps. It was a somewhat complicated manoeuvre; for he was attempting to outflank his enemy with a corps that he had subordinated to Marshal Ney. Much depended on whether Ney would grasp the full purport of his orders. The usual Napoleonic simplicity was wanting at Ligny, and he paid in full for the want.

The Prussians numbered about 83,000 to Napoleon's 71,000 (including Lobau). About 2:30 P.M. the sound of Ney's guns to the westward proved that Wellington was attacked and Napoleon then opened the battle. A fierce fight soon raged for the villages of Ligny and St. Amand. By 3:15 P.M. the battle was in full swing and Napoleon wrote to Ney, saying, "The fate of France is in your hands," and ordering the marshal to master Quatre Bras and move eastwards to assist at Ligny. Directly afterwards, hearing that Ney had 20,000 men in front of him, he sent the "pencil-note" by General La Bédoyère, directing Ney to detach D'Erlon's corps to Ligny. This the A.D.C., in a fit of mistaken zeal, took upon himself to do. Hence the corps appeared too soon and in the wrong direction. It is clear that Ney's essential duty was to co-operate at Ligny, provided that Wellington was held fast at Quatre Bras. Unfortunately, in the heat of action, Ney misread his instructions. Meanwhile the emperor had ordered Lobau to move up to Fleurus. The fight for the villages raged fiercely and incessantly, and the places were captured and recaptured. Generally the French had the better of the fighting, and Blucher was compelled to use up more and more of his reserves. The fighting grew so furious that the troops literally melted away. Even the emperor had to call on his reserves. Just as the Young and Middle Guard moved to reinforce Gérard and Vandamme, the latter reported that a hostile column, 30,000 strong, was threatening his left (in reality it was D'Erlon). This sight unnerved Vandamme's exhausted troops, and guns had to be turned on them to quell a panic. It was nearing 6 P.M. Napoleon concluded that this could not be D'Erlon, as he had arrived too soon and was marching in the wrong direction.

Napoleon sent an officer to reconnoitre. As the French attacks slackened the Prussians rallied and counter-attacked, but they were beaten back by the Young Guard. By 6:30 P.M. Napoleon learned that the force was D'Erlon's, and that it had withdrawn westwards. Thus there was no direct co-operation from the Left Wing on this decisive day. The emperor had perforce to finish the battle single-handed.

Blucher now launched a general counter-stroke against Vandamme, but the chasseurs of the Guard drove back the Prussians in disorder and Napoleon's chance had come at last. As Lobau formed up near Fleurus, the guns of the Guard opened on Ligny to prepare Bliicher's centre for assault. At 7:45 P.M. a crashing salvo from 60 guns heralded a combined onslaught by Gérard, the Guard, and Milhaud. This tremendous impact of picked troops pierced and broke the Prussian centre. Blucher promptly launched his cavalry reserve to stem the French advance. Leading a charge in person he was dismounted and ridden over, before he was rescued and borne from the field. Blucher had taken an unjustifiable personal risk, for at this crisis it was essential for the Prussians to be commanded by a chief who would keep loyally in touch and act in concert with his colleague. By 9 P.M. the battle was over and the French pressed resistlessly onwards. The beaten Prussians retired to the north of the Namur road. But in the failing light and in the uncertainty as to events on the left wing, immediate pursuit was out of the question.

The execution had again fallen short of the conception; Blucher though beaten was not destroyed, nor was his line with Wellington cut. If the Prussians now retired northwards, parallel to the direction which Wellington would follow perforce on the morrow, the chance of co-operating in a decisive battle would still remain to the allies; and Gneisenau's order issued by moonlight, directing the retreat on Tilly and Wavre, went far to ensuring the possibility of such combined action. However, Gneisenau was very remiss in not immediately reporting this vital move and the necessity for it to the duke, as it left the Anglo-Dutch inner flank quite exposed. Gneisenau apparently selected Wavre, not with the intention of assisting his ally, but rather to re-establish his own line of communication, and the presence of the Prussians on the field of battle of Waterloo must be put down to the immortal credit of Blucher and Grolmann, his quartermaster-general.

Gneisenau allowed the re-establishment of his communications to overweigh the paramount necessity of arranging concerted action with his ally. Probably Wellington's failure to co-operate at Ligny had heightened the Prussian chief-of-staff's unworthy suspicions of the duke's good faith. It was well for the allies that Blucher was able to resume command before Napoleon had time to profit from the dissensions that would probably have arisen had Gneisenau remained in control. The casualties at Ligny were very heavy. The Prussians lost 12,000 men and 21 guns, and the French 8,500 men. So close was the fighting that most of the 20,000 casualties lay on 2 sq. m. of ground.

Napoleon's plan of campaign had succeeded. Despite D'Erlon's misadventure, Key's failure had placed the Anglo-Dutch army in a precarious position. Napoleon having beaten Blucher, the latter must fall back to rally and re-form. On the other flank Key lay in front of Wellington, and the marshal could fasten upon the Anglo-Dutch army and hold it fast on June 17, sufficiently long to allow the emperor to close round its open left flank and deal it a death-blow. It was essential to deal with Wellington before Blucher could re-appear on the scene. Wellington was but imperfectly informed of the details of the result of Ligny. Certainly Blucher had despatched an aide-de-camp to warn Wellington that he was forced to retire. But the officer was shot and the message remained undelivered. Nor did Gneisenau repeat this important message directly he assumed temporary command. Gneisenau's neglect involved the allies in an unnecessary and very grave risk.

June 17.—Napoleon was unwell, and was not in the saddle as early as he would otherwise have been; and neither Soult nor Ney made any serious arrangements for an advance when every minute was golden. By early morning the duke had most of his army about Quatre Bras. But Blucher's defeat had rendered Wellington's position untenable. Still ignorant of Blücher's exact position, Wellington sent out a well-escorted officer to establish touch with the Prussians. He reported that the Prussians were drawing off to rally at Wavre. Then, about g A.M., a Prussian officer arrived to explain the situation and learn Wellington's plans. The duke replied that he should fall back and accept battle near Mt. S. Jean, provided he was assured of the support of one of Blucher's corps. He now subordinated everything to remaining in communication with Blucher. It was 2 A.M., June 18, before Wellington received an answer.

Covered by Thielemann the Prussians had drawn off towards Gembloux to join Bulow. Meanwhile, soon after dawn, the French cavalry rounded up some stragglers on the Namur road, and for a time confirmed the idea that Blucher was retiring on his base. The situation was still obscure, details about what had happened to Ney were wanting, and the direction of the Prussian retreat was uncertain. At 8 A.M. Key was ordered to take up his position at Quatre Bras, or if he reported that it was impossible the emperor would co-operate. Napoleon meant that if only a rear-guard opposed Key it was to be driven off and Quatre Bras occupied. But if Wellington was still there, the marshal was to hold him fast, and Napoleon would hasten up with the reserve and crush his enemy. Wellington in fact was there; but Ney did nothing to retain him, and at 10 A.M. the duke began to retire northwards. The last chance of bringing about a decisive French success was thus allowed to slip away.

Grouchy's Operations.—About 11 A.M. Napoleon came to a decision. He determined to send two cavalry corps, and Vandamme's and Gérard's corps, and Teste's division (33,000 and 110 guns) to follow the Prussians and discover if they intended uniting with Wellington in front of Brussels. As touch had been gained with Thielemann at Gembloux, Marshal Grouchy, who had been given command of the force, was ordered by the emperor to "proceed to Gembloux." This order the marshal obeyed literally. After an inconceivably slow march, in one badly arranged column moving on one road, Grouchy only reached Gembloux on June 17, and halted there for the night. Grouchy's cavalry who had been in touch with Thielemann's corps, at Gembloux, allowed it to slip away, and contact was lost for want of a serious effort to keep it. Grouchy did not proceed to the front and entirely failed to appreciate the situation. Pressing danger could only exist if Blucher had gone northwards, and northwards in the Dyle valley Grouchy should have sought for the Prussians. But on June 17 the marshal pushed no reconnaissances to the northward and westward of Gentinnes. (Actually Milhaud, when marching with Napoleon towards Quatre Bras, did see some Prussian infantry retiring northwards and reported this about 9 P.M. to Napoleon, but he attached little importance to it.) Had Blucher gone eastwards, then no danger threatened, for Grouchy could easily have held back any future Prussian advance on the line of the Dyle. Grouchy merely obeyed his orders literally and went to Gembloux. At nightfall the situation was in favour of the allies. The four Prussian corps were concentrated astride the Dyle at Wavre and Grouchy was actually outside them. After an unmolested retreat the Prussians were ready to take the field once more, and 24 hours before Napoleon had deemed it possible after their defeat at Ligny.

Napoleon's Pursuit of Wellington.—On the other flank, too, things had gone all in favour of Wellington. At noon Napoleon wrote to Ney that troops had been placed at Marbais to second the marshal's attack on Quatre Bras, yet Ney remained quiescent, and Wellington began his retreat unmolested. Thus on Napoleon's arrival only the duke's cavalry screen and some horse artillery remained on the position. As the emperor justly said, Ney had ruined France. This was the fatal mistake of the campaign. Although Napoleon opened a rapid pursuit as the cavalry screen crumpled up and decamped, yet he failed to entangle the rear guard so deeply as to force the duke to return to its assistance. Also a tropical thunderstorm considerably retarded the French pursuit. Only as the light failed did Napoleon arrive opposite to Wellington's position, and then by a masterly reconnaissance in force he compelled the duke to disclose the presence of virtually the whole army. The French halted between Rossomme and Genappe, bivouacking in the sodden fields.

June 18.—During the night Wellington heard that Blucher would bring two corps certainly, and possibly four, to Waterloo, and the duke determined to accept battle. Yet so far was Wellington from divining Napoleon's plan that he stationed 17,000 men (including Colville's British division) about Hal, 8 m. to his right, to repel a turning movement that he groundlessly anticipated and to form a rallying point for his right in case his centre was broken. By making this detachment the duke ran a very grave risk. But with the 67,600 men and 1j6 guns which he had in hand, he took up a truly admirable "Wellingtonian position" in front of Mt. S. Jean. He used a low ridge to screen his main position, exposing comparatively few troops in front of the crest. He occupied Hougoumont with detachments of the British Guards and placed a King's German Legion garrison in La Haye Sainte, the key of his position. The duke also took care to distribute the troops so that the indifferent and immature were closely supported by those who were "better disciplined and more accustomed to war." Full arrangements for Blucher's co-operation were made through General Muffling, the Prussian attaché on the duke's staff. The duke was to stand fast and receive the attack, whilst Blucher closed round Napoleon's exposed right. Thus the Prussians were the real general reserve on this day.

Blücher kept his promise loyally, but the execution was faulty. The Prussians did not start marching at dawn, and the rear corps (Bulow) was selected to lead the column. A fire that broke out in Wavre further delayed the march. But, despite his hurts, the old marshal was in the saddle.

Luckily the wet state of the ground (largely cornfields) and the scattered bivouacs of the French caused Napoleon's attack to be put off until 11.30 A.M. Grouchy had reported at 10 P.M., 17th, from Gembloux that the Prussians were retiring towards Wavre and Perwez. He stated that he meant to follow the Wavre column, if it was the stronger, and separate it from Wellington. But this was impossible. Grouchy was outside the Prussian left and, by following it, he must inevitably drive the allies together. The emperor answered the letter at 10 A.M., and directed the marshal to march for Wavre. Napoleon's original plan must be kept in mind when considering this letter. It will then be seen to mean that Grouchy was to place his force on Blucher's inner flank and hold him back from Waterloo. But this is just what the letter does not state precisely; accordingly Grouchy (as Ney had done previously) misread it.

Meanwhile the French army formed up some 1,300 yards from Wellington's position. Although some misgivings filled the minds of such Peninsular veterans as Soult, Reille, and Foy, none assailed Napoleon. But the late hour at which the battle opened, and Napoleon's determination to break Wellington's centre instead of outflanking his left and farther separating the allies, deprived him of any chance of beating Wellington before Blücher could intervene. Napoleon drew up his army of 74,000 and 246 guns in three lines in full view of the Anglo-Dutch army. It was an imposing array of veteran troops backed by the dark masses of the Imperial Guard. As their emperor rode along the lines the troops acclaimed him with extraordinary enthusiasm.

WATERLOO

First Phase.—About 11.30 A.M. the battle was opened with an attack by one of Reille's divisions on Hougoumont. This was merely to draw Wellington's attention to his right, and in this it failed. Half-an-hour later a battery of 80 guns unlimbered on the long spur to the S.E. of La Haye Sainte to prepare the duke's centre for the main attack. But the crest of the "Wellingtonian position" sheltered the defence from the tempest of iron. After 1 P.M., and just before he gave orders for Ney to lead the main attack, the emperor scanned the battlefield, and on his right front he saw a dense dark cloud emerging from the woods at Chapelle Saint Lambert. It was soon discovered that this was Bulow's corps marching to Wellington's assistance. A letter was now awaiting despatch to Grouchy, and to it was added a postscript that the battle was raging with Wellington, that Bülow's corps had been sighted by the emperor, and that the marshal was to hasten to the field and crush Bülow. This order at least was clear, but it was sent 12 hours too late, and when Grouchy received it he was unable to carry it out. To neutralize Bulow when necessity arose, the emperor now detached Lobau together with the squadrons of Domon and Subervie. The general, however, hardly drew out far enough from the French right; otherwise the magnificent resolution he displayed and the admirable obstinacy with which his troops fought against ever-increasing odds are worthy of all praise. Thus as early as 1.30 P.M. the Prussian intervention deranged the symmetry of Napoleon's battle-array. The emperor never considered breaking off the fight and seeking a more favourable opportunity of beating the allies in detail. He was still determined to involve both Wellington and Bulow in a common ruin.

Second Phase.—Ney was therefore ordered to attack Wellington's centre with D'Erlon's corps. Owing to a misconception the columns used for advance were over-heavy and unwieldy, and the corps failed to achieve anything of importance. As D'Erlon's troops advanced the Dutch-Belgian brigade in front of the ridge, which had been subjected to an overwhelming fire from the 80 French guns at close range, turned about and retired in disorder through the main position. This, however, was the solitary success secured by the I. corps; for the left division failed to storm La Haye Sainte and Picton's division met the remainder of D'Erlon's corps face to face, engaging them in a murderous infantry duel in which Picton fell. During this struggle Lord Uxbridge launched two of his cavalry brigades on the enemy; and the "Union brigade" catching the French infantry unawares rode over them, broke them up, and drove them to the bottom of the slope with the loss of two eagles, but the British cavalry were driven back with great loss by fresh French horsemen hurled on them by the emperor. So far no success against Wellington had been achieved, and Bulow was still an onlooker.

Third Phase.—Ney was now ordered to attack La Haye Sainte again, but the attack failed. A furious cannonade raged, and the Anglo-Dutch line withdrew slightly to gain more cover from the ridge. Ney misinterpreted this manoeuvre and led out, about 4 P.M., Milhaud's and Lefebvre-Desnouettes' horsemen (43 squadrons) to charge the allied centre between the two farms. For several reasons, the cavalry could only advance at a trot. As the horsemen closed they were received with volleys of case from the guns, and the infantry formed into squares. Against the squares the horsemen were powerless, and failing to break a single square, they were finally swept off the plateau by fresh allied horsemen. Kellermann's cuirassiers and the heavy horse of the Guard (37 fresh squadrons) now advanced to support the baffled cavalry, the latter falling in as supports. The whole 80 squadrons resumed the attack, but with no better result The cavalry gradually became hopelessly entangled among the squares they were unable to break, and at last they were driven down the face of the ridge and the most dramatic part of the battle came to an end. Had these great cavalry attacks been closely supported by infantry, there can be little doubt that they must have achieved their object. But they were not. In his handling of the three arms together, Napoleon on this day failed to do justice to his reputation.

About 4.30 P.M. Bulow at last engaged. Lobru's men were gradually overpowered and forced back into Plancenoit, the village was stormed, and the Prussian round shot reached the main road. To set his right flank free the emperor called further on his reserve, and sent Duhesme with the Young Guard to Lobau's support. Together, these troops drove Bulow out of Plancenoit, and forced him back towards the Paris wood. But the Prussians had not yet changed the fate of the day.

Fourth Phase.—Napoleon now ordered Ney to carry La Haye Sainte at whatever cost, and this the marshal accomplished with the wrecks of D'Erlon's corps soon after 6 P.M. The garrison (King's German Legion) had run out of rifle ammunition and the French bursting in seized the post. This was the first decided advantage that Napoleon had gained during the day. The key of the duke's position was now in Napoleon's hands, Wellington's centre was dangerously shaken, the troops were exhausted, and the reserves inadequate. But the Iron Duke faced the situation unmoved. Calmly he readjusted his line and strengthened the torn centre. Happily for him, Pirch I. and Zieten's corps were now at hand. Pirch I. moved to support Bulow; together they regained possession of Plancenoit, and once more the Charleroi road was swept by Prussian round shot. Napoleon, therefore, had to free his right flank before he could make use of Key's capture. To this end he sent two battalions of the Old Guard to storm Plancenoit. The veterans did the work magnificently with the bayonet, ousted the Prussians from the place, and drove them back 600 yards beyond it. But Napoleon could not turn now on Wellington. Zieten was fast coming up on the duke's left, and the crisis was past. Zieten's advent permitted the two fresh cavalry brigades of Vivian and Vandeleur on the duke's extreme left to be moved and posted behind the depleted centre. The value of this reinforcement at this particular moment can hardly be overestimated.

Fifth Phase.—The French now fiercely attacked Wellington all along the line; and the culminating point of this was reached when Napoleon sent forward the Guard, less 5 battalions, to attack Wellington's centre. Delivered in three échelons, these final attacks were repulsed, the first échelon by Colin Halkett's British Brigade, a Dutch-Belgian battery, and a brigade of Chassé's Dutch-Belgian division; the second and third échelons by the Guards, the 52nd, and the Royal Artillery. Thus ended the fifth phase.

Rout of the French.—As the Guard recoiled (about 8 P.M.) Zieten pierced the north-east corner of the French front. and their whole line gave way as the allies rushed forward on their now defenceless prey. Three battalions of the Guard indeed stood their ground for some time, but they were finally overwhelmed. Afterwards, amidst the ruins of their army, two battalions of the 1st Grenadiers of the Guard defied all efforts to break them. But, with the exception of these two battalions, the French army was quickly transformed into a flying rabble. Bdlow and Pirch I. now finally overpowered Lobau, once more recaptured Plancenoit, and sealed the doom of the French army. But Lobau's heroic efforts had not been in vain; they had given his master time to make his last effort against Wellington; and when the Guard was beaten back the French troops holding Plancenoit kept free the Charleroi road, and prevented the Prussians from seizing Napoleon's line of retreat.

When Wellington and Blucher met about 9.15 P.M. at "La Belle Alliance," the victorious chiefs arranged that the Prussians should take up the pursuit, and they faithfully carried out the agreement. Pushing on through the night, they drove the French out of seven successive bivouacs and at length drove them over the Sambre. The campaign was virtually at an end, and the price paid was great. The French had lost over 40.000 men and almost all their artillery on June 18: the Prussians lost 7,000, and Wellington over 15,000 men. So desperate was the fighting that some 45,000 killed and wounded lay on an area of roughly 3 sq m. At one point on the plateau "the 27th (Inniskillings) were lying literally dead in square"; and the position that the British infantry held was plainly marked by the red line of dead and wounded they left behind them.

Grouchy's Operations **June** 18–19.—A few words may now be bestowed on Marshal Grouchy, commanding the right wing. The marshal wrongly determined on the 18th to continue his march to Wavre in a single column, and he determined, still more wrongly, to move by the right bank of the Dyle. Breaking up from bivouac long after dawn, he marched forward, via Walhain. Here he stopped to report to the emperor some intelligence which turned out to be false, and he remained for breakfast. Hardly had he finished when the opening roar of the cannonade at Waterloo was heard. Grouchy was now urged by his generals, especially by Gérard, to march to the sound of the firing, but he refused to take their advice, and pushed on to Wavre, where he found the Prussians (Thielemann's corps of 16,000 men) holding the passages across the Dyle. A fierce fight (called the Action of Wavre) began about 4 P.M., in which the Prussians were for long victorious. Instead of concentrating his force upon one bridge over the swampy and unfordable Dyle, Grouchy scattered it in attacks upon several; and when the emperor's despatch arrived, saying Bulow was in sight, the marshal was powerless to move westward. Towards the end of the day Colonel Vallin's Hussars stormed the Limale bridge, and a large part of Grouchy's force then promptly gained the left bank. The action continued till about 11 P.M., when it died out, to recommence shortly after dawn. Thielemann was at length overborne by sheer weight of numbers, and towards 11 A.M. he was forced to retire towards Louvain. The losses were considerable, about 2,400 men on each side.

Grouchy's victory was barren. In the far higher duty of co-operation he had failed miserably. His tactical achievement could avail the emperor nothing, and it exposed his own force to considerable danger. Whilst pondering on the course he should follow, the marshal received the news of the awful disaster that had overtaken the emperor at Waterloo. In a flash he realized his danger and made prompt arrangements to begin his retreat on Namur, the only line to France that was then available. This retreat he carded out resolutely, skilfully and rapidly, slipping past Blucher and finally bringing his force to Paris But the rapid advance of the allies gave France no time to rally. Napoleon was forced to abdicate, and finding escape was impossible, he surrendered (on July 14) to the British—"the most powerful, the most unwavering and the most generous of his foes."

The causes of Napoleon's failure in the Waterloo campaign were as follows:—The French army was numerically too weak for the gigantic task it undertook. Napoleon himself was no longer the Napoleon of Marengo or Austerlitz, and though he was not broken down, his physical strength was certainly impaired. Ney failed to grasp and hold Wellington on the critical 17th of June; and on the 17th and 18th Grouchy's feeble manoeuvres enabled Bldcher to march and join Wellington at Waterloo. Napoleon's chance of success was dangerously diminished, if not utterly destroyed, by the incompetence of the two marshals whom in an evil hour he selected for high commands.

Another dominant influence in shaping the course of events was the loyalty of Blucher to his ally, and the consequent appearance of the Prussian army at Waterloo. Nor must we overlook Wellington's unswerving determination to co-operate with Blucher at all costs, and his firmness on June 18; or the invincible steadiness shown by the British troops and those of the King's German Legion.

Reviewing this campaign at St. Helena, Napoleon laid the responsibility for the disaster of Waterloo on the inaction of Marshal Grouchy who, after he had lost touch with the Prussian army (which had crossed the Dyle at Wavre in order to work round to the north in the direction of Soignes), ignored the urgent representations of his officers, and in particular of General Gérard, and refused to unite his forces with the bulk of Napoleon's army, although he could hear the sound of the guns. However grave may have been Grouchy's error, it would be unjust to characterize his failure as treason. In any case, Marshal Grouchy, in spite of the miscarriage of his first mission, fearing to depart from the orders of the emperor, showed himself deficient not only in military insight but also in character.

In this article the writer has been greatly assisted by the advice and suggestions of Lt.Col. H. W. L. Hime, R.A. (A. F. Be.)

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WATERLOW, SIR ERNEST ALBERT (1850–1919), English landscape painter, was born in London on May 24, 1850. He studied at the Royal Academy schools, where, in 1873, he was awarded the Turner gold medal for landscape painting.

Elected associate of the Royal Society of Painters in Water Colours in 1880, he became a member in 1894 and was president of the society, 1897–1914. He was named an associate of the Royal academy in 1890 and academician in 1903. Waterlow was knighted in 1902.

From the early 1870s he produced a number of landscapes, with and without figures, in oil and water colour. One of his pictures, "Galway Gossips," was hung in the Tate gallery in London.

Waterlow died at Hampstead, London, on Oct. 25, 1919.

WATERMARKS, the emblems or designs in paper used originally in Italy in the latter part of the 13th century. The orientals, who were the first to make paper, did not employ watermarks, although their method of fabricating sheets of paper was almost identical with that introduced into Europe during the middle 12th century.

The original Italian watermarks consisted of devices such as crosses, circles, triangles and forms of the simplest kind that could readily be twisted in wire. Until the middle of the 19th century all watermarks were formed in outline and were produced by the use of metal wires bent to the shape of the required design. These wire objects were then sewed to the mould on which the paper was to be formed, the wire leaving its impression in the wet sheet of paper by causing the fibres to lie thinner along its course. The ordinary watermarks in hand-made paper of the present day are made in the same manner as those from the inception of the art, the only difference being in the employment of finer wire and greater skill in their formation. Plate, fig. 3, shows the wire device on the covering of a laid paper mould from the 16th century; fig. 5 gives a section of an 18th century Dutch mould with the watermarking wires in place.

About the middle of the 19th century a more complicated and artistic form of watermarking was devised and instead of being limited to simple outline forms, it was possible to cause the paper to be made in any degree of thickness or tone desired. Fig. 1 shows a mould for the watermarking of a portrait. This mould has been made by first modelling the profile in a sheet of wax so that the various degrees of light and shade may be had and then making intaglio and cameo dies from the wax model by electrotyping. Closely-woven brass wire gauze is then subjected to great pressure between the two electrotype plates, the wire cloth or gauze taking the same contour as the original wax relief.

In forming sheets of paper on a hand mould the water drains through the woven wire, leaving the moist pulp in precisely the same thicknesses as those sculptured in the wax original. The watermarking of paper in colour was invented by Sir William Congreve in 1818 (English patent, Dec. 4, 1819, No. 4419) and consisted in placing coloured paper stock (pulp) in various layers to form a homogeneous sheet of paper.

The foregoing treats only of watermarks that are produced in hand-made paper where the moist pulp lies on the wire lettering or pressed wire design during the whole process of forming the sheet.

This naturally gives a brilliant and clear-cut watermark. In machine-made paper a wire cylinder known as a "dandy-roll" or a circular rubber form is used to impart the lettering or symbol to the moist paper by rolling over its surface after the web of paper has been formed. It is therefore not possible to produce as clear or distinct a watermark on a machine as it is by the use of a finely constructed mould in the hands of a skilled craftsman.

(D. Hu.)

WATERMELON (Citrullus vulgaris), a succulent fruit of the gourd family, native to tropical Africa, under cultivation on every continent with suitable climate and soil. The word for watermelon is included in Sanskrit, and fruits are depicted by early Egyptian artists, indicating an antiquity in agriculture along with other old-world species under cultivation for more than 4,000 years. Its vines grow prostrate, with branched tendrils, deeply cut leaves and flowers borne singly in the axil of a leaf. Each flower produces either pollen or fruit. The flesh may be red, white or yellow. Weight varies from 3 or 4 lb. to 50 lb. or more. The number of fruits per vine varies from 2 or 3 to 15.

Citron melon (Citrullus vulgaris), not to be confused with true citron of the citrus family, is prized for preserves and jellies. Another species (C. colocynthis) contains a bitter constituent to which some individuals show "taste blindness." The bitter and sweet melons are found in the same habitats. Scientific discoveries applied to watermelon breeding make possible another commercial variety, a seedless hybrid that is chromosomally unbalanced and sterile but vegetatively vigorous and productive. Its immature fruit flowers can be artificially pollinated in such a way that the hybrid fruit sets and becomes a seedless fruit preferred by consumers. For the next season's production, seed must be obtained by hybridizing parental strains.

Common diseases afflicting watermelon are Fusarium wilt, anthracnose, downy mildew, stem-end rot and root knot. Cucumber beetles, cutworms, wireworms, melon aphids and mites are the important insects reducing melon production.

See also CUCURBITACEAE ; VEGETABLE. (O. J. Ei.)

WATER OPOSSUM or YAPOCK (Chironectes minimus), distinguished from other opossums by its aquatic habits. webbed hind feet, and peculiar colouration. Its ground colour is light gray. nith four or five sharply contrasted blackish bands passing across its head and back giving it a very peculiar mottled appearance; the head and body together are about 14 in. long, and the tail a little more. It feeds on small fish, crustaceans and other water animals; its range extends from Guatemala to southern Brazil.

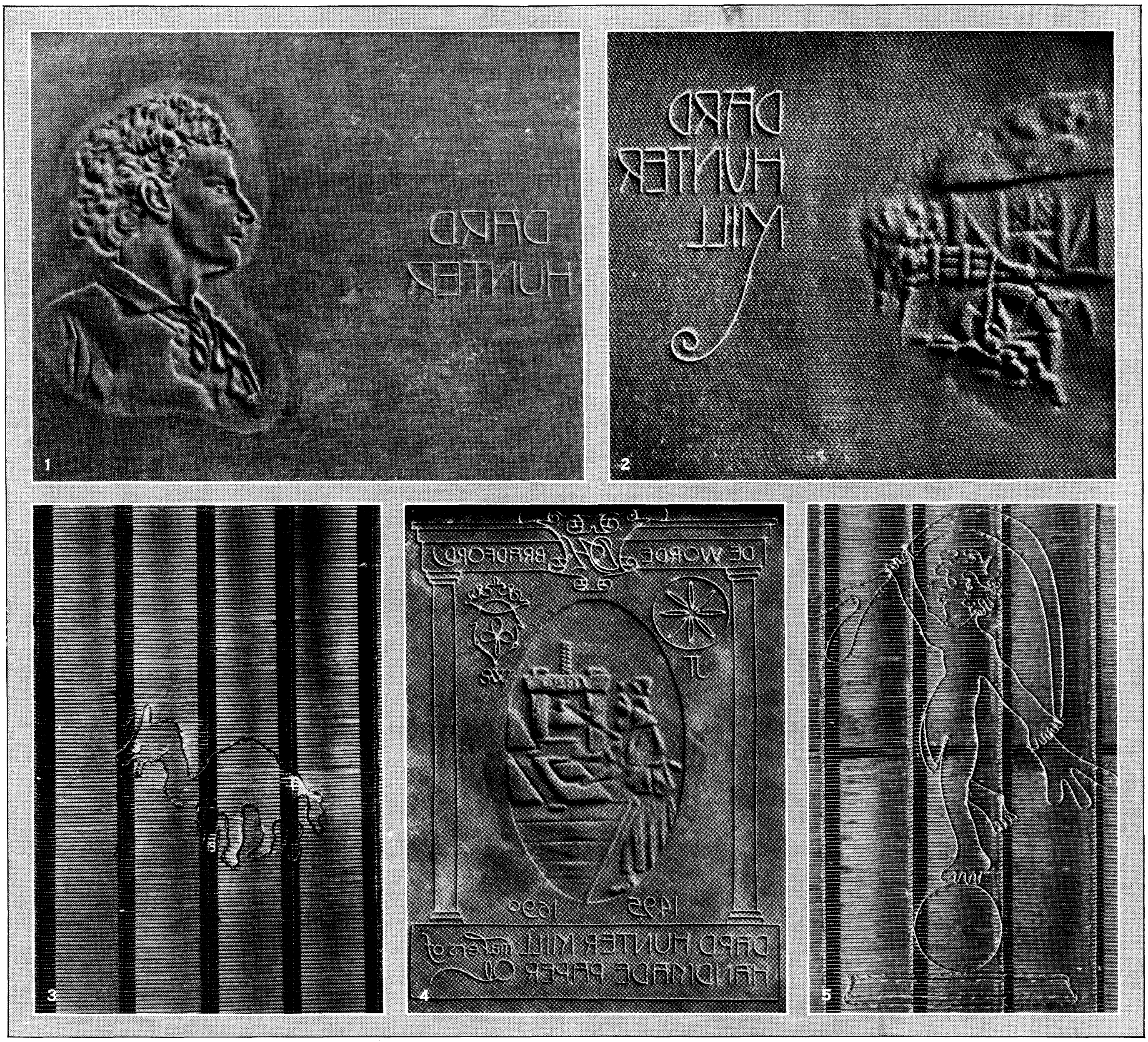
WATER POLO is played by two teams of seven players each in both outdoor and indoor pools. Although a game of "football in the water" was proposed in London as early as 1870 and aquatic handball matches were played in the mid-1870s. it was not until the 1880s that an organized game, similar to the modern one, was instituted. The London Water Polo league was founded in 1888, and the game spread in popularity to the continent and the U.S.

Until the late 1920s two types of games were played throughout the world under distinctly different sets of rules. To that time in the United States the rugged body-contact style of play, involving the use of a semi-inflated rubber ball with the premium placed on retaining possession of it, was the favoured game. In other countries the water-soccer type of play, involving a fully inflated leather-covered ball with the emphasis placed on the skillful passing and tossing of it, was exclusively favoured. The tacit recognition of both of these contrasting types of play by international sports-governing bodies resulted in a unique situation whenever the Olympic games were held. If the games were held in the United States the soft-ball water polo was played, with only teams from the United States participating, because of the unfamiliarity of the aquatic squads of other nations with the soft-ball play. Whenever the Olympic games were held outside of the Cnited States, the hard-ball game was given exclusive recognition. However, colleges in the United States, which furnished most of the American water polo players, began to abandon the rugged soft-ball type of game and to substitute the hard-ball soccer type of play. Accordingly soft-ball water polo disappeared from the sports scene and after 1937 soccer water polo, played with the hard ball, was the only style of water polo played anywhere, as well as the only style officially recognized by the Olympic games committees as an international championship water sports event. There are top ranking water polo teams and leagues in most European and some British commonwealth countries, and international competition in water polo is staged on a grand scale annually in Europe and, to a slightly lesser extent, in the Americas.

In the early days of international water polo, Great Britain took the lead, but before long the pupils began to surpass the master, and France, Germany and the Netherlands produced outstanding teams. After World War II Hungary became almost supreme in the Olympic games and European championships, followed by Yugoslavia and the U.S.S.R.

The rules and laws governing the playing of water polo are pre-

WATERMARKS



WATERMARKS AND WATERMARKING DEVICES

1. A complete mould (with deckle) for the watermarking of a portrait. The profile is first worked in wax so that various degrees of light and shade may be gained, and then intaglio and cameo dies are made from wax mcdel by electrotyping
2. Hand made paper mould, combining lettering, and light and shade device for forming sheets of paper in one colour. Wires of lettering and pressed woven wire of design cause wet paper pulp to lie in many thicknesses, thus forming watermark in the sheet of paper
3. Wire device for watermarking figure of a camel in sheets of paper. Old papermakers favoured animals for watermarks
4. Mould for making hand-made paper, which combines the ordinary wire lettering and designs with the complicated light and shade device. With this mould the oval centre is produced in separate colour from balance of sheet. The wheel or star watermark (upper right-hand side) is that of John Tate who established the first paper mill in England in 1495. Watermarking device (upper left-hand side) is that of William Rittenhouse who founded the first paper mill in the Colonies in 1690
5. Wire device for a watermark showing a child swinging a rope

scribed, and amended from time to time, by the F.I.N.A. (Federation Internationale de Natation Amateur or International Water Polo board), founded in London in 1908. In the U.S., under rules adopted by the Amateur Athletic union, the playing pool or "bath" is rectangular in shape, must not be more than 30 yd. nor less than 20 yd. from end to end, the uniform width must not exceed 20 yd. nor be less than 8 yd. Measurements of a pool for female team play are 25 yd. by 17 yd. The goal nets or cages are at both ends and must be 10 ft. wide and 3 ft. above the surface of the water when the water is 15 ft. or more in depth and 10 ft. wide and 8 ft. from the bottom of the bath when the depth of the water is less than j ft.. and extend not less than 1 ft. from the end of the pool. Markers denoting the location of imaginary lines 2 yd. and 4 yd. respectively from the goal lines and parallel to them must be posted on both sides of the pool.

The required minimum depth of the water in the playing pool is 3 ft. but for international matches a minimum depth of 6 ft. is strongly recommended in the rules. Teams consist of seven players comprising the goalkeeper, three backs and three forwards. The required officials are a referee (in complete charge). a timekeeper and two goal judges The scoring of goals is signaled by the goal judges. using white and red flags to indicate their decisions.

Time for official games is 20 minutes of play consisting of two 10-minute halves with a j-minute intermission. One team wears dark blue caps and the other white, but both goalkeepers must wear red. Each player's cap is numbered to show his position—the goalkeeper is no. 1, halfback no. 4. etc.

At the beginning of the game and after half time, all the players must be in position at their own goal lines spaced at least one yard apart. The referee blows his whistle, tosses the ball into the centre of the pool and play is on. A goal is scored by the bail passing fully over the goal line, which is one foot from the end of the pool. and between the goal posts into the goal net or cage. Whenever the ball passes over the goal line but not between the goal posts and it has been last touched by an attacking player, a goal throw is awarded to the defending goalkeeper. who makes the throw from the goal line between the posts. When the ball goes over the goal line outside of the goal posts and is last touched by a defending player, a free corner throw is awarded to an attacking team player from two yards out from the goal line at the side of the pool. All goals count one point. In deciding the winner of a championship tournament the highest goal average rule is applied whenever two or more teams are tied in games won and lost.

Interest in water polo as both a player and spectator sport increased with international competition, notably in Europe and Central and South America. Water polo enjoys a particular advantage over most other team sports in that it requires only limited space and relatively inexpensive equipment and facilities. In the United States its rise to prominence was phenomenal on the Pacific coast, where all colleges and athletic clubs have teams. Elsewhere in the United States, the failure of colleges and universities to include water polo in their athletic programs has resulted in a lag in interest, but several old established athletic clubs (*e.g.*, in New Tork. Chicago and St. Louis) maintained interest and competition in the national annual tournaments, both indoor and outdoor, and in Pan-American and Olympic championship teams (*see* OLYMPIC GAMES).

A fundamental change in rules was made shortly after the 1948 Olympic games, when the old rule whereby a player mas not allowed to move when the referee blew his whistle was changed to permit freedom of swimming at all times. The purpose of this change was to eliminate stoppages and to make the game faster.

For complete rules *see* the current edition of the Amateur Athletic Union of the U.S., *Official Swimming Handbook;* and the *1957 Rules of Water Polo* issued by the International Water Polo Board. (J. J. CN.; E. J. ST.)

WATER POWER: *see* ELECTRICAL POWER GENERATION: *Hydroelectric Generation;* POWER TRANSMISSION: *Hydraulic Power Transmission;* MECHANICS, FLUID; TURBINE: WATER.

WATERPROOF FABRICS: *see* RAIN-PROOF FABRICS.

WATER RIGHTS. By the law of England the property in the bed and water of a tidal river is presumed to be in the crown or as a franchise in a grantee of the crown, and to be extra-parochial. The bed and water of a nontidal river are presumed to belong to the person through whose land it flows, or, if it divide two properties, to the riparian proprietors, the rights of each extending to midstream *(ad medium filum aquae)*. In order to give riparian rights, the river must flow in a defined channel, or at least above ground. The diminution of underground water collected by percolation, even though malicious, does not give a cause of action to the owner of the land in which it collects, it being merely *damnum sine iniuria,* though he is entitled to have it unpolluted unless a right of pollution be gained against him by prescription. The right to draw water from another's well is an easement (*q.v.*) not a *profit à prendre,* and is therefore claimable by custom. As a general rule a riparian proprietor, whether on a tidal or a nontidal river, has full rights of user of his property. Most of the statute law will be found in the Fishery Harbours act. 191j, and the Salmon and Freshwater Fisheries act, 1923. In certain cases the rights of the riparian proprietors are subject to the intervening rights of other persons. These rights vary according as the river is navigable or not, or tidal or not. For instance, all the riparian proprietors might combine to divert a nonnavigable river, though one alone could not do so as against the others, but no combination of riparian proprietors could defeat the right of the public to have a navigable river mantained undiverted. We shall here consider shortly the rights enjoyed by, and the limitations imposed upon, riparian proprietors, in addition to those falling under the head of fishery or navigation. (See also FORESHORE.)

The right of use of the water of a natural stream cannot be better described than in the words of Lord Kingsdown in 1858: "By the general law applicable to running streams, every riparian proprietor has a right to what may be called the ordinary use of water flowing past his land—for instance, to the reasonable use of the water for domestic purposes and for his cattle, and this without regard to the effect which such use may have in case of a deficiency upon proprietors lower down the stream. But, further, he has a right to the use of it for any purpose, or what may be deemed the extraordinary use of it. provided he does not thereby interfere with the rights of other proprietors, either above or below him. Subject to this condition, he may dam up a stream for the purposes of a mill, or divert the mater for the purpose of irrigation. But he has no right to intercept the regular flow of the stream, if he thereby interferes with the lawful use of the water by other proprietors, and inflicts upon them a sensible injury" (*Miner* v. *Gilmour,* 12 Moore's P.C. Cases, 156). The rights of riparian proprietors where the flow of water is artificial rest on a different principle. As the artificial stream is made by a person for his own benefit, any right of another person as a riparian proprietor does not arise at common law, as in the case of a natural stream, but must be established by grant or prescription. If its origin be unknown the inference appears to be that riparian proprietors have the same rights as if the stream had been a natural one *(Baily* v. *Clark,* 1902, *1* Ch. 649). The rights of a person not a riparian proprietor who uses land abutting on a river or stream by the licence or grant of the riparian proprietor are not as full as though he were a riparian proprietor, for he cannot be imposed as a riparian proprietor upon the other proprietors without their consent. The effect of this appears to be that he is not entitled sensibly to affect their rights, even by the ordinary as distinguished from the extraordinary use of the water. Even a riparian proprietor cannot divert the stream to a place outside his tenement and there use it for purposes unconnected with the tenement (*McCartney* v. *Londonderry and Lough Swilly Rly. Co.,* 1904, A.C. 301).

The limitations to which the right of the riparian proprietor is subject may be divided into those existing by common right, those imposed for public purposes and those established against him by crown grant or by custom or prescription. Under the first head comes the public right of navigation, of anchorage and fishery from boats (in tidal waters) and of taking shellfish (and probably other fish except royal fish) on the shore of tidal waters as far as any right of several fishery does not intervene. Under the second head would fall the right of eminent domain by which the state takes riparian rights for public purposes, compensating the proprietor, the restrictions upon the sporting rights of the proprietor, as by acts forbidding the taking of fish in close time and the Wild Birds Protection acts, and the restrictions on the ground of public health, as by the Rivers Pollution act, 1876, and the regulations of port sanitary authorities. The jurisdiction of the state over rivers in England may be exercised by officers of the crown, as by commissioners of sewers or by the board of trade, under the Crown Lands act, 1866. These powers were later transferred to the ministry of transport. Rivers are frequently controlled by conservation under special acts, upon which their powers mainly depend (see *Thames Conservators* v. *Kent,* 1918, 2 K.B. 272). A bridge is erected and maintained by the county authorities, and the riparian proprietor must bear any inconvenience resulting from it. An example of an adverse right by crown grant is a ferry or a port. The rights established against a riparian proprietor by private persons include the right to land, to discharge cargo, to tow, to dry nets, to beach boats, to take sand, shingle or water, to have a sea wall maintained, to pollute the water (subject to Rivers Pollution act), to water cattle, etc. Where the river is navigable, although right of navigation is common to subjects of the realm, it may be connected with a right to exclusive access to riparian land, the invasion of which may form the ground for legal proceedings by the riparian proprietor (see *Lyon* v. *The Fishmongers' Company,* 1876, 1 A.C. 662). There is no common-law right of support by subterranean water. A grant of land passes all watercourses, unless reserved to the grantor.

A fresh-water lake appears to be governed by the same law as a nontidal river, surface water being *pars soli.* The preponderance of authority is in favour of the right of the riparian proprietors as against the crown. Most of the law will be found in *Bristow* v. *Cormican,* 1878, 3 A.C. 648.

Unlawful and malicious injury to sea and river banks, towing paths, sluices, floodgates, milldams, etc., or poisoning fish, are crimes under the Malicious Damage act, 1861.

A mill may be erected by anyone, subject to local regulations and to his detaining the water no longer than is reasonably necessary for the working of the wheel. But if a dam be put across running water, the erection of it can only be justified by grant or prescription, or (in a manor) by manorial custom. On navigable rivers it must have existed before 1272. The owner of it cannot pen up the water permanently so as to make a pond of it.

Batkzng — The reported cases affect only sea bathing. but Hall (p. 160) is of opinion that a right to bathe in private waters may exist by prescription or custom. There is no common-law right to bathe in the sea or to place bathing machines on the shore. Prescription or custom is necessary to support a claim, whether the foreshore is the property of the crown or of a private owner (*Brinckman* v. *Matley,* 1904, 2 Ch. 313). Bathing in the sea or in rivers is now often regulated by the bylaws of a local authority. (*See* also FERRY.)

Scotland. — The law of Scotland is in general accordance with that of England. The crown has: (1) a right of property in the *solum* and salmon fisheries of the sea — and tidal navigable rivers — within the three-mile limit, which is *inter regulia minora* and may be alienated by express or implied grant; and (2) a right of navigation and white fisheries in the same which is *inter regalia majora* and inalienable. A crown charter of lands "bounded by the sea" is a habile title to prescribe a right to the *solum* of the foreshore, between high- and low-water mark of ordinary spring tides, and if the charter contain a clause *cum piscationibus* it is a habile title to prescribe a right to the salmon fishing *ex adverso* of the lands. Where the foreshore is acquired under a crown grant it remains subject to public uses incidental to navigation and white fishing. Persons engaged in the herring fishery off the coast of Scotland have, by 11 Geo. III. c. 31, the right to use the shore for 100 yd. from high-water mark for landing and drying nets, erecting huts and curing fish. The right of ferry is one of the *regalia minora* acquirable by prescriptive possession on a charter of barony. Sea greens are private property. The right to take seaweed from another's foreshore may be prescribed as a servitude. The riparian proprietors have several rights in the *solum* of a fresh-water loch and a right in common to use its surface for boating, fishing and shooting (*Mackenzie* v. *Banks,* 1878, 3 App. Cas. 1324). As between opposite riparian proprietors the *medium filum* is only of importance in determining rights of property in the *solum,* or the exercise of fishing rights, where the opposite proprietors have each rights of fishing but neither has had exclusive possession. *See* the Salmon Fisheries (Scotland) acts 1828 to 1868. In Ireland the lam is similar to that of England. In *R.* v. *Clinton,* I.R. 4 C.L. 6, the Irish court went perhaps beyond any English precedent in holding that to carry away drift seaweed from the foreshore is not larceny. The Rivers Pollution act, 1876, was re-enacted for Ireland by the similar act of 1893.

United States. — In the United States the common law of England was originally the law, the state succeeding to the right of the crown. This was no doubt sufficient in the 13 original states, which are not traversed by rivers of the largest size, but was not generally followed when it became obvious that new conditions, unknown in England, had arisen. Accordingly the soil of navigable rivers, fresh or salt, and of lakes is vested in the state, which has power to regulate navigation and impose tolls. The admiralty jurisdiction of the United States extends to all public navigable rivers and lakes where commerce is carried on between different states or with foreign nations (*Genesee Chief* v. *Fitzhugh,* 12 Howard's Rep. 443). And in a case decided in 1893 it was held that the open waters of the great lakes are "high seas" within the meaning of s. 5346 of the revised statutes (U.S. v. *Rodgers,* 150 U.S. Rep. 249). A state may establish ferries and authorize dams. But if water from a dam overflow a public highway, an indictable nuisance is caused. The right of eminent domain is exercised to a greater extent than in England in the compulsory acquisition of sites for mills and the construction of levees or embankments, especially on the Mississippi. In the drier country of the west and in the mining districts, the common law as to irrigation has had to be altered, and what was called the "arid region doctrine" was gradually established. By it the first user of water has a right by priority of occupation if he give notice to the public of an intention to appropriate, provided that he be competent to hold land. (*See* EASEMENT; FISHERIES, LAW OF.)

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WATERS, TERRITORIAL. In international law, territorial waters are generally defined as that area of the sea immediately adjacent to the shores of a state which is subject to the territorial jurisdiction of that state. Territorial waters in this sense, sometimes called the marginal belt or coastal sea, are thus to be distinguished on the one hand from the high seas, which are common to all nations, and on the other from inland waters, such as lakes wholly surrounded by the national territory or certain bays and estuaries penetrating into the land. It became universally agreed that this marginal belt, together with the sea bed and subsoil beneath it and the airspace above, constitutes territory of the coastal state. subject only to a right of innocent passage for merchant vessels of other nations. A similar right probably exists for foreign warships in time of peace, but this is not wholly free from doubt. A state may insist that foreign vessels comply with reasonable navigation and police regulations during passage; and to a limited degree it probably may also interdict passage through particular areas for defense or security reasons, provided that no important international sea routes are thereby interfered with. The right of innocent passage does not apply to submerged submarines or to aircraft, nor does it extend to inland waters.

Historically, the concept of territorial waters originated in the controversy over the status of the sea which mas conspicuous during the formative period of modern international law in the 17th century. One point of view, that large areas of the open sea might rightfully be subject to the dominion of a single state, received its most effective exposition in the *Mare clausum* (published in 1635) of the English writer John Selden. The contrary doctrine, that the sea by its nature must be free to all. was upheld most notably in the *Mare liberum* (1609) and *De jure belli et pacis* (1625) of the Dutch publicist Hugo Grotius. The Grotian view was eventually to prevail, but Grotius himself recognized the practical need of a coastal state to exercise some jurisdiction in the waters adjacent to its shore. In 1703 another distinguished Dutch jurist. Cornelius van Bynkershoek, gave classic form to a solution foreshadowed somewhat earlier; that the jurisdiction of a coastal state should extend seaward as far as the effective range of land-based weapons. Toward the end of the 18th century some effort was made to define this range in terms of a fixed distance. and it was at this time that the three-mile limit was first mentioned (apparently without much expert knowledge of the still limited range of guns) as the equivalent of cannon shot. The Italians Ferdinando Galiani (1782) and Domenico Azuni (179j) were among the first to suggest this equivalence; and in 1793 three miles was adopted by the United States as the limit of its jurisdiction for neutrality purposes. During the 19th century many maritime states, inspired by British and U.S. practice, came to use the same limit, but it never won enough universal acceptance to become a rule of international law. It was settled, however, that the belt of territorial waters appertained automatically to the adjacent coast without any affirmative act of acquisition being required. Some theoretical dispute long continued whether the belt was actually territory of the coastal state or whether it was merely an area of the high seas in which that state enjoyed special jurisdictional rights; the former view later prevailed overwhelmingly.

In the absence of any uniform state practice with respect to the width of territorial waters, modern international law can be said to lay down no rule on the matter except that every state is entitled to claim at least three nautical miles (one marine league or 3.45 land miles). Claims in excess of 12 to 15 mi. commonly meet such widespread opposition from other states that they are probably untenable. Within these limits there is considerable variation. The United States during most of its history has adhered to the three-mile limit in its own practice and has generally declined to accept more extensive claims by other nations; the limit has received judicial recognition in many cases, notably by the supreme court in *Cunard* v. *Mellon,* 262 U.S. 100 (1923) and *United States* v. *California,* 332 U.S. 19 (1947). A similar stand has been taken by Great Britain since the 19th century. and was given parliamentary sanction with respect to criminal jurisdiction in the Territorial Waters Jurisdiction act of 1878. Belgium, France, Germany, Japan, the Netherlands, the nations of the British Commonwealth and some other states have also followed the three-mile standard for most purposes. On the other hand, the Scandinavian countries have long claimed a 4-mi. limit; Egypt, Greece, Italy, Spain, Yugoslavia and other states have claimed 6 mi.; Mexico, g mi.; and the U.S.S.R. and several smaller states, 12 mi.

The determination of the base line from which territorial waters are to be measured is another problem on which there are variations in practice. There is substantial agreement that off simple coasts the base line should be the low-tide mark along the shore, together with an artificial line across such bays and inlets as are considered to be inland waters. Various geometric techniques for ascertaining such bays and fixing the limits of territorial waters have been proposed, but none is wholly satisfactory and none has attained the status of a rule of law. With heavily indented coasts and those having many off-lying islands the base-line problem is more complex; in such cases some states have resorted to artificial straight lines connecting specified points along the coast and islands. Norway's adoption of such a method off its rugged northern coast was upheld by the International Court of Justice in the Anglo-Norwegian fisheries case in 1951 (I.C.J. Reports, 1951, p. 116), in which the court said that the method was proper if applied reasonably and in such a manner as to follow the general trend of the coast.

Bays, gulfs and estuaries along a coast are undoubtedly inland waters landward of the point (whether at or within the entrance) where they first narrow to six miles in width. Nations adhering to the three-mile limit, however, have generally relaxed the strict six-mile measure in favour of a ten-mile width similarly applied, in order to eliminate narrow tongues of high seas running down the centre of bays; this rule of convenience has been embodied in a number of international agreements, but it has been held by the International Court (in the fisheries case above cited) not to be such a rule of general international law as to preclude larger claims. States claiming more than three miles of territorial waters generally increase proportionately their claims to bays, and some states have declared all bays along their coasts to be inland waters regardless of size. Claims to particular bays of large dimensions are sometimes justified under the so-called "historic bays" doctrine on the ground of prescriptive rights acquired by long exercise of exclusive control. Straits passing through the territory of a single state present special problems; if important as international arteries they are usually governed by particular treaty arrangements, as has long been the case with the Turkish straits.

Distinct from territorial waters proper are zones in the adjacent high seas in which coastal states claim no territorial rights but assert rights of jurisdiction for one or more special purposes. These "contiguous zones," generally extending 6 to 12 mi. beyond territorial waters, are most commonly claimed in connection with the enforcement of customs and sanitary regulations; but in some instances they may be established for fishery conservation or for security purposes. Also distinct from territorial waters are the claims made after 1945 by many states to the continental shelf off their shores, the shelf being generally regarded as the shallowly submerged margin of the continent extending outward to about the 600-ft. depth line in which oil or other resources may exist. Insofar as these claims were confined to the shelf itself, without affecting the status as high seas of the waters above, they met with little opposition. Actions by some states, however (*e.g.,* Chile and Peru), which asserted jurisdiction over waters as well as shelf, evoked wide protest as amounting to unwarranted extensions of territorial waters.

Efforts to codify the international law governing territorial waters and to give greater precision to its content have been persistent but unsuccessful. The subject was exhaustively discussed at the Conference on the Codification of International Law held under League of Nations auspices at The Hague in 1930. The conference proceedings served chiefly to emphasize the great differences of view among the states represented on such matters as the width of the marginal belt and the permissibility of contiguous zones; it proved impossible to reach agreement on a draft convention designed to lay down rules of universal application. After World War II, the International Law commission organized under the auspices of the United Nations general assembly selected in 1949 the regime of the territorial sea as one of its topics for study and report. The commission's deliberations on the subject disclosed, however, that many of the difficulties encountered in 1930 still presented major obstacles to agreement.

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WATER SCORPION, an aquatic insect of the order Hemiptera (*q.v.*), family Nepidae, so called from its superficial resemblance to a scorpion, the likeness being caused by the modification of the anterior pair of legs for grasping and by the presence of a long slender process, simulating a tail, at the posterior end of the abdomen. The common British species (*Nepa cinerea*) lives in ponds and stagnant water. The common genus in the U.S. is *Ranutra.*

WATERSHED is that area from which all precipitation flows to a single stream. Synonyms are "catchment area" and "drainage basin." The boundaries of a watershed are known as a drainage divide; precipitation falling on opposite sides of a drainage divide falls onto different watersheds. Thus, all the area drained by the Mississippi river constitutes the watershed of that stream. That part of the basin drained by the Ohio river is the watershed of the Ohio; that area of the Ohio watershed drained by the Wabash river of Indiana constitutes the watershed of the Wabash, part of which is drained by the White river, which has a segment of the Wabash river basin as its watershed, and so on up to the smallest tributary stream.

The regime of the stream that drains a watershed may be of great practical interest from the standpoint of flood control, hydroelectric power development, navigation, municipal or irrigational water supply or waste disposal. The regime of the stream, in turn, is largely controlled by the size, shape, surface configuration, surface materials, vegetation and climate of its watershed.

Only part of the precipitation that falls on a watershed ultimately gets into the stream: it is known as runoff and varies widely among watersheds. The rest of the precipitation is either evaporated back into the atmosphere directly, enters the ground and eventually migrates back to the surface where it is evaporated or enters the ground and is taken up by plants and evaporated from their leaf surfaces in the process called transpiration. These two processes are sometimes lumped together under the general term "evapotranspiration."

The quantity and time distribution of runoff from a watershed is probably determined more by the quantity, type and time distribution of rainfall than by any other factor. Extreme examples are offered by the precipitation conditions in some of the tributaries of the Colorado or Rio Grande rivers whose watersheds receive only 6 or 8 in. of precipitation annually, whereas the watersheds of some of the tributaries of the Tennessee river receive 60 in. or more. Some tropical watersheds may have an annual precipitation of more than 150 in. The type of precipitation is also important. For example, many of the headnater streams of the Columbia river of Washington and Oregon receive a considerable part of their annual precipitation as snow, which accumulates for several months in the winter and then runs off entirely in a few weeks in late spring and early summer. The intensity of precipitation also controls the regime of the stream. If rain falls as short intense storms, a high percentage of the water will run off in a very short time, causing the stream to flood, followed by long periods of very low water. Such a regime is characteristic of many streams in semiarid areas. Precipitation that is evenly distributed throughout the year in gentle showers may produce streams of very even regime, few floods and ample flow at low water. Many of the streams of western Europe are of this type.

Evaporation and transpiration also have important bearings on watershed characteristics. The rate of potential evaporation is directly proportional to temperature, wind movement and, to a minor extent, humidity. High temperatures and wind velocities increase the evaporation potential. Approximately the same relationships are true with respect to transpiration. The actual rate of evapotranspiration, however, is dependent upon the availability of water to be evaporated. There may be very little evapotranspiration in a hot windy desert because there is no water available to be evaporated.

The shape of a watershed also strongly affects the regime of its stream. A circular shaped watershed may produce extremely high floods in the lower part because much of the surplus water reaches the lower end of the basin simultaneously. Conversely, a long narrow basin may produce floods with a much lower peak flow but of longer duration.

The character of the vegetation on the watershed will also strongly influence the regime of the streams because of its effect on the rate of water flow off the area, because of its effect on evaporation by shading the ground and slowing down wind movement and by transpiration.

The nature of the terrain also influences stream regime. Commonly, a natershed of steep slopes will have more runoff than a somewhat flatter area. Depth and characteristics of the soil also influence the water conditions on a watershed.

See also RIVER AND RIVER ENGINEERING. (W. C. C.)

WATER SKIING. In this sport the thrill of speed can be savoured without the usually accompanying danger. Since its inception in France in the late 1920s, the growing popularity of water skiing, especially after World War II, has paralleled that of motorboating.

Skis.—Typical, all-purpose skis are of solid or laminated wood 63 in. wide and 5 ft. 9 in. long, with a wooden stabilizing fin on the bottom near the heel. Tight-fitting rubber foot bindings stretch in case of a fall, releasing the skier's feet without injury. The skier holds onto a wooden handle attached by a 75 ft. towline to a motorboat. Speeds from 15 to 35 m.p.h. are used.

Water Ski Events.—In 1936 Dan Hains founded the American Water Ski association and categorized the sport into trick riding, slalom and jumping events. Since then annual national and international open competitions have been held in these events, except during the war years.

For trick riding, typical skis are 43 ft. long and 8 in. wide and have no fins, permitting them to be used for turning from frontward to backward and completely around while skiing. This phase of skiing is characterized by different kinds and numbers of turnarounds on one or two skis on the water, in the air and on the jumping ramp. Speeds of around 18 m.p.h. are generally used, and special tow bars with means for holding the line with the foot are employed.

Slalom competition is held in a course consisting of a specified array of buoys through which the skier must negotiate a sinuous path at increasingly higher speeds (up to 34 m.p.h.). For this, many skiers use a single ski tapered in the rear, with a large metal fin and bindings for both feet. Others use two conventional skis fitted with larger metal fins to facilitate sharp turning. This phase of the sport accentuates precise timing, ability to turn sharply and skill in crossing the boat wake.

Jumping for distance is done with heavy, conventional type skis on a 24 ft. long, waxed wood-surfaced ramp. For best distance the skier cuts sharply across the boat wake and hits the ramp as he swings far out to the side. From a 6 ft. ramp height and 35 m.p.h. boat speed, jumps of over 140 ft. are attained. Ladies and junior competitors jump at ramp height of 5 ft. and at speeds up to 28 m.p.h.

In ski races boats with skiers in tow compete at speeds up to 70 m.p.h. If a skier falls during a race, the boat may circle to pick him up again and resume, but the skier may not touch the boat. (J. AN.)

WATERSPOUT, the name applied to any narrow, rapidly spinning funnel-shaped cloud or column of water, similar to a tornado but occurring at sea. There are two types: (1) One is caused by a true tornado formed over land and passing over the water; this type has the usual causes, dimensions and behaviour of tornadoes (*q.v.*). (2) The other type is more common and often smaller, developing sporadically as funnel clouds from the bases of cumulus or cumulo-nimbus clouds over tropical and middle-latitude seas (and lakes) during the warm season. The lower tip of the funnel cloud, as it approaches the sea surface, first agitates the sea surface into a cloud of spray into the centre of which the funnel finally dips to reach the sea. Then the funnel draws up a vortex spout of sea water, probably in part still hollow, with a cloud of spray still flying out from the base. The spout may reach several hundred feet up the funnel cloud and last half an hour or more. It may twist and bend in a manner similar to that of tornadoes. Finally the spout thins and breaks away from the funnel and quickly vanishes or collapses into the sea. The wind nearby whirls around the spout with some violence, causing a rough and confused sea. (R. *G. SE.*)

WATER SUPPLY AND PURIFICATION. Water supplies, no matter how large or small, consist of a source, a means of conveyance from the source to the site of the consumers and a means of distribution. A supply for a farm, for example, may comprise a spring on a hillside above the house; a pipe carrying the water by gravity to the premises; and a system of pipes delivering the water to the dwelling and other farm buildings. If the source is a well, a pump may be used to lift the water from the well and deliver it through the supply pipe under pressure.

To give an example at the other extreme of size, in the Catskill water supply of New York city, water is collected from the uplands of the Esopus and Schoharie watersheds; uniformity of supply is assured by storing wet-weather runoff in two great reservoirs created by high masonry dams thrown across Esopus creek and the Schoharie river; the water is transported in an aqueduct that traverses over 200 mi. of varying landscape to the Kensico reservoir not far from the city; and the water is fed into the city through a tunnel in the rock of Manhattan Island, distributed into street mains from shafts rising from the tunnel and shared with the other boroughs of the city through great mains, one of which, for example, crosses the Narrows as a flexibly jointed pipe to reach Silver Hill reservoir, the service reservoir for the distribution system of Staten Island. Individual premises in New York tap the street mains through service connections. The connections supply water to pipes within the buildings either directly or, in the case of skyscrapers, with the help of pumps and water tanks.

Sources of Supply.—The selection of water sources is greatly dependent on the bounty of nature. Regional hydrology, geology and topography determine whether the water is best taken from a lake, stream or underground aquifer. Under favorable circumstances, communities do not have to reach out very far for their supply. Indeed, they may find its source at their own doorsteps, as do the cities on the Great Lakes of the U.S. and on the large river systems that drain the North American and European continents. Communities may seek their supply also from the ground at no great distance and, as in the case of a part of the supply of London, even from the geological formations on which the cities themselves rest On the other hand, less favorably situated communities, like those of southern California, may have to tap a source hundreds of miles away.

Upland sources are often superior to nearby lakes and rivers because their watersheds are sparsely inhabited. At the same time, upland sources, such as the Catskill supply of New York city, may be tapped at such elevation that their waters can be transmitted to communities and distributed within them by gravity; *i.e.,* without pumping. Power has become so widely available and relatively so cheap, however, that the search for a gravity supply is no longer quite so important as it once was. Means for water purification, furthermore, have been elaborated to such degree that pristinely pure waters need no longer be sought for their own sake. Nevertheless, there is general agreement among those concerned with conserving natural resources and protecting the public health that available water supplies should be kept as pure as possible and that the highest use of good water is to slake man's thirst. There is agreement, too, that growing competition for water requires that, wherever possible, water supply to communities be fitted into regional multiple-purpose developments of available water resources.

Classification of Sources.—A classification of water sources includes. (1) rain water from roofs stored in cisterns for small individual supplies or collected from prepared catchment areas called catches and stored in reservoirs for larger communal supplies; (2) surface water from streams, natural ponds and lakes of such size and replenishment that needed water can be withdrawn from them either continuously without major storage facilities or intermittently, seasonally or selectively in the presence of adequate storage basins or reservoirs; (3) surface water from streams with insufficient dry-weather flow but adequate annual discharge made available by impounding wet-weather flows in storage reservoirs behind dams constructed across the stream valley; (4) ground water from natural springs and from wells, infiltration galleries, basins or cribs penetrating to or lying within existing aquifers; (5) natural ground-water floas augmented by spreading waters from another source. such as a river, on the surface of the gathering ground whence it seeps into the soil, or by diffusing it into the ground through basins, ditches, galleries or wells; and (6) brackish or salt water freed from unwanted salinity by evaporation or by ion exchange, chemical precipitation or electrochemical processes.

Surface Waters.—For the collection of surface waters, intake towers are placed near the shore or at some distance from it in order to reach suitable depths or clean water, as in the Great Lakes. These vertical structures are usually provided with inlets at different depths so that water of the most suitable quality and temperature may be withdrawn. The water collected is led to pumping stations on the shore through pipes or tunnels.

Ground *Waters.*—Wells may be shallow or deep. Depending upon their size and depth, they may be dug by hand or machinery, driven into the soil as pipes under hammer blows, sunk as pipes with the aid of water jets, bored by simple augers or rotary machinery or drilled into rock. Water enters the well pipe or casing through perforations forming a strainer. Dug and bored wells are lined with suitable materials that include concrete and steel. Wells drilled in rock may be left unlined. Well strainers placed in oversized bore holes are surrounded with gravel in order to increase the yield of the well. A 10-ft. depth of watertight lining below the ground surface will usually prevent pollution by surface seepage. (See WELL.)

Infiltration galleries are horizontal collecting units constructed within deep ditches or driven through the ground as tunnels below the ground-water level. They frequently parallel watercourses in order to intercept the ground-water flow streaming to them and sometimes, too, in order to capture seepage flow from the watercourse. However, they may be blanked off against taking in river seepage if this water is unsatisfactory. In suitable formations, horizontally radiating collecting pipes may be forced into the ground from a central well shaft to extend the collection area of the well. Aquifers or water-bearing strata that lie below a confining layer of impervious material will yield water under pressure, in some cases sufficiently great to reach the ground surface as flowing wells. All such aquifers are described as producing artesian (named after the province of Artois, France) water. Fresh water can be withdrawn from suitable aquifers in contact with the sea to depths equaling approximately 40 times the height of the ground-water table above sea level, provided the rate of withdrawing fresh water does not exceed the rate of recharge from rainfall or other fresh-water sources. Much coastal intrusion of sea water into water-supply aquifers has been caused by overpumping. To oppose this encroachment on a needed resource, fresh-water barriers have been created, in southern California, for example, by the construction of lines of recharge wells and galleries that parallel the shore. Through these, surface or reclaimed water is diffused into the soil.

Although ground water is the most common source of public as well as private supplies in the United States, the number of people provided with water from municipal surface sources at the beginning of the second half of the 20th century was about three times that receiving ground water. In other parts of the world, too, expanding industry and population growth were generally making for wider adoption of surface-water sources. (See GROUND WATER.)

Quality of Water.—Desirable Qualities.—Whether water supplies need to be purified or treated in some manner and to what degree depends upon their quality at the source and the demands of the community. The community ordinarily asks that the water be: safe to drink; attractive in appearance, taste and odour; and usable for the many purposes to which it is put in household and industry. The community may demand further that the water be noncorrosive to metals and contain enough fluoride to satisfy the physiological needs of children for good dental health.

The waters from some surface and ground sources are satisfactory for all ordinary uses. They need no purification, but they may be chlorinated as a precaution against chance contamination. Other raw waters contain objectionable substances in varying degrees. These substances must be removed, reduced to tolerable limits, destroyed or otherwise changed in character to the point of acceptability. Impurities are acquired in the passage of water through the atmosphere, over the earth's surface or through the pores and channels of the ground. Impurities that cause pollution originate principally from the uses man makes of water, in particular from the waste waters he discharges into natural watercourses. Water can acquire some impurities also within the water-supply system. Among them are corrosion products of lead, zinc, copper and iron. There are opportunities, too, for the contamination of the communal supply through cross-connection with public or private industrial supplies or through backflow in domestic and industrial plumbing systems.

Important among the impurities of water are: (1) disease-producing organisms of enteric (intestinal) origin; (2) toxic substances, which are most frequently derived from industrial wastes but, in the case of lead, also can come from the lead or lead lining of old-fashioned water pipes; (3) colour, usually flushed from overflowing swamps; (4) turbidity, generally carried into suspension by the erosion of clay deposits; (5) organic materials that produce odours and tastes upon decomposition; (6) carbon dioxide, which enables water to take calcium, magnesium and, in certain instances, lead into solution; (7) iron and manganese, which are taken into solution in the absence of dissolved oxygen; and (8) algae, which release characteristic odours and tastes.

Water-borne diseases include typhoid fever, cholera, bacillary dysentery, amoebic dysentery, infectious hepatitis and a number of diseases caused by parasitic worms. Apart from certain toxic heavy metals, nitrate (NO,) is of some interest because it is toxic to infants, in whom it causes methemoglobinemia or the blood changes and cyanoses otherwise associated with nitrite (NO,) poisoning. Colour, turbidity, odour or taste, in high concentrations. can make water unattractive or unpalatable. Calcium and magnesium are the principal causes of hardness. Magnesium, furthermore, is laxative in high concentrations. Iron and manganese form, respectively, red and black precipitates when the water in which they are dissolved comes into contact with air. They also give water a metallic taste. (See also GEOLOGY: Erosion by *Ground Water;* HYDROLOGY: Ground Water.)

Prescribed *Qualities*.—In the United States, the public health service promulgates standards of water quality from time to time in connection with its responsibility for water supplied by common carriers, and these standards are widely accepted by other governmental bodies in that country. There are no standards of like scope and purpose in the United Kingdom, but the World Health organization (WHO) has proposed international standards for drinking water. In reference to chemical and physical quality, the WHO suggests permissible levels and indicates the magnitude of excessive amounts. The standards for bacteriological quality require, with some qualifications, that in 90% of the samples examined throughout the year the statistical average number of coliform bacteria shall be less than 1 per 100 millilitres in treated waters and less than 10 per 100 in untreated waters. The public health service has the single standard of less than 1 coliform organism per 100 millilitres for untreated as well as treated supplies.

The coliform standard of water safety rests on the following facts: (1) Many members of the coliform group of bacteria have their origin in the intestines of man. (2) Billions of the coliform organisms are excreted daily by man. (3) They are as hardy or more so than typhoid, cholera and dysentery bacteria. (4) They normally occur in a given population in far greater numbers than do the disease-producing bacteria and amoebic cysts. Numerically, therefore, both the U.S. and international standards imply a tremendous dilution or a high natural death rate, or both, of possibly dangerous bacteria within the water source or, otherwise, their equivalent removal or destruction by purification. Unfortunately, the numerical presence in water of the virus of infectious hepatitis and its death rate, removal and destruction are, as yet, poorly defined. (See also BACTERIOLOGY: Bacteria in Air and Water; BACTERIAL AND INFECTIOUS DISEASES: Infections via *the* Alimentary Tract)

U.S. and international committees have set the permissible level of radioactivity of public water supplies at 10^{-7} microcuries per millilitre for unknonn mixtures of isotopes and at one-tenth this amount when large population groups are exposed. Prescribed, in addition, are permissible limits for specific isotopes. These vary according to the isotope. Radioactive contamination originates in fall-out, the use of isotopes in medical therapy and research, and waste waters from nuclear power plants.

Because they narrow the required capacity range, purification or treatment plants are usually inserted in the water-supply complex at or near the source. The sequence of engineering aorks in a public nater-supply system usually is as follows: (1) the collection works at or forming the source; (2) the purification or treatment works; (3) the transmission conduits or aqueduct; and (4) the distribution system, including service reservoirs.

Purification and Treatment.— Historically, the purification of water began well in advance of the discovery of the role of water in the transmission of enteric diseases or the germ theory of disease itself. Noteworthy facts related to modern practice are: (1) that James Simpson built the first water-filtration plant for the purification of Thames river water in 1829; (2) that John Snow gave epidemiological proof that the London cholera epidemic of 1854 was traceable to water drawn from the Broad street well (or pump, as it was called); and (3) that the city of Altona. Ger., ahich took its raw water from the Elbe river, was protected by its filters against the cholera epidemic of 1892 that ravaged the neighbouring upstream city of Hamburg, which used unfiltered Elbe river water.

Opposing the degradation of water by pollution are certain natural purifying forces. Among them in surface waters are sunlight, which speeds the destruction of disease-producing organisms and bleaches colour; time, which causes pathogens to become devitalized and to die and organic matter to decompose and be stabilized; and sedimentation, which allows material held in suspension to settle out in quiescent river reaches, ponds, lakes and reservoirs. In ground waters, natural filtration is the most potent purifying force. However, crevices, large pore spaces and solution passage occur in some geological formations. In these, little if any purification takes place. The hygienic quality of waters from such sources is, therefore. always suspect.

There are three general categories of water-purification works: filtration plants, iron-removal plants and softening plants.

Filtration.—In the course of their history, filtration plants have been constructed in two forms: as slow filters and as rapid filters. The older slow filtration plants, generally speaking, have consisted of large beds of relatively fine sand of moderate depth. Through the beds of sand the water seeps vertically downward into a system of underdrains. Most of the suspended impurities are removed in the top inch or two of the sand. After operating for a month or so at a rate of downward flow of about 5 in. per hour, the resistance to further passage of water becomes so great that the top layer of sand must be removed or washed in place. Removed sand is cleaned at convenient times, and the bed is resanded when it has been reduced in depth from about 42 in. to not less than 24 in. For waters that are relatively free from turbidity and not too heavily polluted, filter performance is excellent. The effluent is clear and largely free of bacteria; the filter however, will remove only about one-third of the colour. In modern practice the effluent is chlorinated for safety.

In England, waters not suited for direct filtration have been strained through rapid filters or rotary drums covered with fine metal screens called microstrainers in order to reduce their content of clogging substances. Both turbidity and algae are removed by rapid filters, algae alone by microstrainers.

In the newer rapid filtration works, the water is treated with a coagulant, such as aluminum sulfate, ferric chloride or ferric sulfate. Flocculent precipitates are formed with the aid of stirring devices and carry down most of the suspended matter during the more or less quiescent flow of the treated water through sedimentation basins. The settled water is filtered through a group of small beds of relatively coarse but uniform sand at rates of 192 to 288 in. per hour (2 to 3 gal. per square foot per minute). The filtering bed, which is about 30 in, deep, is cleaned as a unit either by backwashing (upward-flowing water) alone or by air agitation followed by backwashing. The filtered water is disinfected with chlorine. Heavily polluted waters may be chlorinated both before and after filtration. Bad odours and tastes may be adsorbed on activated carbon or destroyed by high doses of chlorine or chlorine dioxide before filtration. In these ways a clear, colourless, palatable and safe water may be produced.

Iron and *Manganese* Removal.—Because iron and manganese are held in solution in water only in the absence of oxygen, their removal is generally accomplished by aerating the water to oxidize them to the insoluble state and by removing the resulting precipitates in slow or rapid filters. These metallic impurities are eliminated also by contact oxidation in beds of treated zeolite that are regenerated with potassium permanganate. Zeolites are natural or synthetic insoluble sodium-aluminum silicates. For iron and manganese removal, they are pretreated with manganous sulfate and potassium permanganate. (See also ION EXCHANGE: Applications.)

Softening.—Hard waters are softened either by the addition of precipitating chemicals or by passage through beds of ion-exchange media. Useful chemicals are lime for bicarbonate hardness and soda ash for chloride and sulfate hardness. Ion exchangers are beds of zeolites, carbonaceous materials or resinous substances. Depending upon their nature and that of the ions exchanged, the beds are regenerated with salt, acid, soda ash or caustic soda.

By the proper selection and protection of water sources and by rigourous treatment of the available waters, some countries have been able to wipe out epidemics of water-borne disease. To give but a single example, deaths from typhoid fever in Toronto, Ont., were 93.1 per 100,000 population in 1890, 43 in 1910 and 0 in 1945 and later. However, in many parts of the world, water-borne diseases remain among the leading causes of illness and death because sanitation in general and water supply and purification in particular lag behind attainable standards.

Transmission of Supply.—Conduits.—Large conduits through which water flows to the community by gravity are sometimes open channels, more often cut-and-cover aqueducts and sometimes tunnels. These structures are placed on grades that, although relatively flat, will overcome the frictional resistance to flow at reasonable velocities. Cut-and-cover aqueducts are normally constructed of reinforced concrete and given a horseshoe-shaped cross section for structural reasons. As their name suggests, they are built partly in cut, and the earth removed is employed to give them a protective cover. Grade tunnels are generally similar in shape. They are lined with concrete unless they serve only as passageways for one or more strands of pipe. Water-supply tunnels are driven through rock, clay or other geological formations in much the same way as vehicular and railway tunnels. Large conduits that transport water pressure are usually constructed as: (1) circular tunnels often driven beneath undulating terrain at considerable depth and of great length; (2) reinforced concrete pipe generally precast and prestressed; and (3) steel pipe in longitudinally welded 30-ft. sections joined in the field by bolted sleeves that compress rubber gaskets to seal the transverse joints.

Smaller pressure conduits are usually made up of cast-iron or cement-asbestos pipe. Cast-iron and steel pipes are protected against corrosion, internally by cement or bituminous linings, externally by bituminous paints or cloth impregnated with bituminous substances. Corrosion may be held in check also by adding lime, metaphosphates or other stabilizing chemicals to the water itself.

Pressure lines that transmit water over long distances usually are placed below the hydraulic grade line, a hypothetical line traced by the height to which water would rise from within the conduit if free to do so.

Pumping.—Water is usually lifted to desired elevations or placed under pressure by centrifugal or similar types of pumps. Pumps are generally electrically driven, with diesel engines provided as a secondary source of power where the electricity is not generated at the pumping station itself or where electric feeder lines cannot be supplied from more than one power source. Lake and river supplies that are to be purified at the source may include both low-lift pumps that raise the water to the treatment works and high-lift pumps that drive it to the community. Springs and flowing artesian wells may need no pumping. From all other groundwater sources, water must be lifted or pumped at least to the ground surface. Suction lifts must be kept well below atmospheric pressure (34 ft.). Deep-well pumps may be inserted into the well casing or bore hole at any desired depth, often below water level. If necessary, multiple-stage units can discharge water directly into distribution systems. Dug wells from which water is drawn by rope and bucket are the most primitive sources of ground water. If they must serve many users, their contamination cannot be avoided. Periodic chlorination, preferably daily, will offer some protection. If pumps are installed and the well tightly covered, pollution can be reduced.

Distribution of the Supply.—Piping.—Cast iron is the preferred material in most distribution systems. Pipes of this durable metal are centrifugally cast in lengths of up to 20 ft. and in diameters of up to 36 in. Lead and other calked joints have been superseded, very largely, by bolted compression joints with rubber gaskets. Only sizable feeder mains within the distribution system are normally made of steel. Fire hydrants, too, are usually cast in iron if they are to stand above ground; so-called flush hydrants provide an outlet to which a portable hydrant must be connected. Water mains and service pipes are laid below freezing depth. In the northern United States, this is about 5 ft. At least 2 ft. of cover is required to protect mains against street-traffic shock.

Pressure.—Water pressures in distribution systems are held at about 60 lb. per square inch (p.s.i.), even in districts where fire engines are capable of boosting hydrant pressures to adequate intensities. In order to assure a pressure of 75 p.s.i. for direct hydrant streams, the distribution pressure must be elevated to 100 p.s.i. or more. This makes for increased losses through leaks in public mains and in water systems in buildings. Pressures in residential areas are often but 40 p.s.i. and, sometimes, even less.

Booster Pumps.—Hilly communities sometimes are divided into service zones that differ in elevation by about 100 ft. The water is lifted to the high-lying areas by booster pumps. Each zone may have its own distribution reservoir or be served from a higher-lying district through pressure-reducing connections. Some communities, among them Boston, New York and Philadelphia, have separate fire-supply grids in which the pressure is raised, on call, by pumps standing by in power stations. Many factories and industrial complexes are given additional fire protection by private fire pumps, pipe grids, yard hydrants and sprinkler systems. When a fire breaks out, the pumps force water into the system from streams and other nearby bodies of water. Since these are often unsafe from a health standpoint, private systems should not be interconnected with municipal water mains. Rigid separation of the two systems is required by some public authorities; cross-connections consisting of at least two approved check valves tested for tightness at regular intervals are permitted by others.

Reservoirs.—Distribution or service reservoirs provide: (1) equalizing or operating storage; (2) fire reserve; and (3) emergency reserve. Equalizing or operating storage compensates for hourly and peak variations in demand; the fire reserve must be large enough to fight a serious conflagration; and the emergency reserve must be of such magnitude that reservoir inflow can be stopped while needed repairs are being made to supply conduits. In the interest of water sanitation, distribution reservoirs are covered wherever possible. Reservoirs that must be left open because of their large size are protected against surface drainage and human access. The water obtained from such reservoirs may be given secondary chlorination.

Service reservoirs are situated at sufficiently high elevation to provide water under adequate pressure. Where there is no suitable natural height of ground for them, they are constructed as standpipes or elevated tanks. All of the water supplied to a given area may pass through its service reservoir, or this unit may float on the line, filling through a connecting main at times of low draft and emptying through it at times of high water use.

Water-Supply Management.—Required Amounts and Capacities.—The over-all needs of the average United States community mounted at mid-20th century to about 140 gal. per person daily, divided about as follows: (1) 50 gal. each to residences and industry; (2) 20 gal. to commercial establishments; and (3) 10 gal. to public uses, such as public, buildings, fountains, swimming pools, street and sewer flushing and fire fighting. About ten gallons are lost in distribution or are otherwise unaccounted for. It is obvious that water consumption depends on the nature of the community: heavy industrialization and prosperous residential quarters, for example, can increase per capita consumption.

Representative over-all values for large cities in the United Kingdom are much lower than in the U.S. The London Metropolitan Water board, for example, in the 1960s registered a consumption of under 60 gal. per person daily. There, as well as in other growing countries of the world. however, the trend is toward higher consumption. In the United States, air conditioning, wider use of automatic household equipment and increasing numbers of fixtures, as well as industrial development, continued to push consumption upward.

The safe yield of surface waters is estimated from records of stream flow or water stage by suitable statistical methods The total length of surface streams in the United States is close to 3,000,000 mi., and their flow is recorded at about 10,000 sites. Impounding reservoirs, depending upon stream-flow conditions and degree of development, are economically useful when they store up to about 25% of the mean annual flow in well-watered regions and often more than two times the mean annual flow in semiarid regions.

The safe yield of ground-water supplies is determined by pumping tests. The volume of water in the interstices of the soil and rocks of the United States at depths less than 2,500 ft. is estimated to equal the total recharge of ground water during the last 150 years. It is for this reason that it has been possible to overpump many ground-water sources. Nevertheless, observed drops in ground-water levels in excess of 150 ft. between 1900 and 1950 are a warning that overpumping cannot be long continued with impunity. In the London area, flowing artesian wells no longer exist. Owing to overpumping, mostly of privately owned wells, the ground-water level has sunk to as low as 250 ft. below mean sea level.

The collection and transmission portions of public water supplies are generally dimensioned, for economic reasons, to deliver to the service reservoirs the maximum daily flow, or about 150% of the mean annual requirement. Pumping and purification works attached to these portions are given about the same capacity but with an allowance of one or more stand-by units to permit repairs to be made.

The distribution system and its feeder mains must care for needed fire flows and coincident draft. For the protection of the central community against runaway conflagrations, the National Board of Fire Underwriters in the U.S. required fire flows of 1,000 gal per minute for towns of 1.000 people, and up to 12 000 gal. per minute for populations of 200.000 or more, nith 2,000 to 8,000 gal. per minute for a second fire. Water must be available at these rates along nith the coincident rate of draft for at least four hours in small communities and ten hours in large communities.

The equalizing storage of distributing reservoirs usually amounts to about 15% of the average daily demand, but it may be as great as 50% when nater is pumped to storage during but 12 hours of the day. The fire reserve depends on the rates of flow and duration suggested by the National Board of Fire Underwriters. Needed emergency reserve depends greatly upon the nature of the supply. A five-day reserve at maximum flow is suggested by the National board. but, in practice, this value is rarely attained. The United Kingdom has similar fire-fighting requirements, but U.S. cities, because of the nature of their construction, much carelessness and wide necessity for winter heating, present greater fire risks and must be more fire ready.

The smallest pipes included in the distribution gridiron of U S. communities are six inches in diameter. In the United Kingdom pipes four inches or less in diameter are quite common. Distribution systems within d ellings are proportioned to meet fixture demands.

Depending upon expected rates of population growth and rates of interest on loans, large and important components of the water-supply system that are not easily increased in size or duplicated are designed to meet estimated requirements up to 50 years in the future Examples are dams, aqueducts and tunnels. The design period for wells, distribution systems and purification plants seldom exceeds 25 years. Laterals and secondary mains of distribution systems, however, are normally dimensioned to full development.

Costs and Charges.—The capital invested in the public waterworks of the U.S. at mid-20th century amounted to about $100 per person served. However, the cost of reproducing these works and of new construction was about $250 per person served. Of the various components of the system, the collection and transmission works normally cost about 33% of the total. the distribution system slightly more than 50% and the purification plant about 10%, the remainder being the cost of acquired real estate. There are wide variations from these values in individual supplies. Much of the investment in smaller communities is chargeable to fire protection.

Including interest and depreciation, as well as charges against operation and maintenance, water costs from $50 to $300 per 1,000,000 gal. to collect, purify and distribute. It is charged for accordingly. Common prices to the consumer usually range from 10 to 25 cents per 100 cu.ft. On a weight basis, this is generally four cents a ton or less delivered to the point of use, a remarkable bargain. There are a number of different methods of charging for water. In the United Kingdom, domestic water is paid for in proportion to the "rateable" or net annual value of the property supplied. The London rate is 10%, with additional charges for garden use. Industrial properties are metered, and the amounts used are billed at a rate of 14 cents per 1,000 gal. Many U.S. cities are almost fully metered and charge only for the water actually consumed. Others collect at a flat rate based either on the frontage of the premises served or the number, and sometimes also the kind, of fixtures installed. A single meter rate is applied by some communities, a sliding scale by others. The sliding scale reduces the unit cost above certain magnitudes. There may be a stand-by charge for the service whether water is drawn or not.

Organization and Ope?-ation.—Generally speaking, the organization and operation of water supplies has moved from private to public control. In metropolitan areas, multiple undertakings have been combined within single authorities. Water districts are sometimes formed by small neighbouring communities as co-operative ventures.

Not more than 15% of the community water supplies of the United States were in private hands in the 1960s. The private water companies received a return not only for water purchased by private consumers and public bodies, but normally also a hydrant rental, which is paid by the community as a ready-to-serve or fire-protection charge. In some countries, the Philippines, for example, a national water authority designs, constructs and operates all public water supplies.

Water mains are extended farther and farther into the countryside as communities spread. There comes a time, therefore, when rural networks can be constructed with good economy. The rural water supplies of the United Kingdom and Holland are examples.

Some communities, especially those with much industry, have installed dual water supplies that differ in the general acceptability but not in the safety of their product. Use of the supply of inferior quality is confined to suitable industrial purposes, sewer and street flushing, and the like; that of superior quality is used for drinking and the other needs of the people. Danger of interconnecting such supplies has kept most municipalities from adopting the dual scheme.

Large communities often recruit their own engineering force to plan and design major additions to their works. Consultants may be called in only to advise on specific matters. Smaller cities and towns often use the services of a consultant for planning and designing their entire project and for supervising its construction. By these practices, a high degree of competency can be marshalled for the development of effective water schemes.

A like degree of competency is called for in the operation of waterworks. Large sums of money are administered. There are heavy responsibilities, both ethical and legal, for the protection of the community against disease and fire. Adequate maintenance of all parts of the system is essential to their proper functioning and to the conservation of water. Good records of operation require the inclusion of recording meters on supply mains and of water-level recorders on reservoirs. Leakage or waste surveys will identify controllable water losses, including not only undetected breaks in pipes but also leaky fixtures on private premises.

See also NATURAL RESOURCES: Water; PLUMBING: Water-Supply Systems.

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(G M FA)

WATERTOWN, a town (township) of Massachusetts, U S., in Middlesex county, is on the Charles river about 7 mi. W. of Boston. Founded and incorporated in 1630 by Sir Richard Saltonstall and the Rev. George Phillips. it was one of the four earliest Massachusetts bay settlements and the first inland farming town. The name may have derived from the fact that the area was well watered. Fishing in the Charles river proved of great importance in the early periods. For about 20 years, Watertown ranked as the most populous town in the colony, but gave way to Boston. Its area once included Waltham (*q.v.*) and Weston, most of Lincoln, and parts of Belmont and Cambridge (*q.v.*). Taxation without representation was protested in 1632 when its townspeople refused to pay a tax of f60 for the purpose of erecting a stockade fort in Cambridge, Mass. Watertonn lays claim to be the "cradle of the town meeting" as the first board of selectmen was elected there in Aug. 1634. The town, fermenting with anti-British sentiment, was highly involved in the revolutionary efforts. From there Gen. Joseph Warren left for Bunker hill The provincial assembly met in the town from April to July 1775; the Massachusetts general court from 1775 to 1778; and the Boston town meetings during the siege of Boston.

The first gristmill, built on the falls of the Charles river, was constructed in the early 1630s. The second mill, a cloth fulling mill, was established in 1662. This early industrial development continued, becoming more varied and adapted to the demands of the times, especially after 1830. One of the best known plants is the United States arsenal, started in 1820. Modern manufactures include clothing. measuring tools, heating apparatus, toys, paints and rubber goods. Watertown is the location of the Perkins Institution for the Blind (founded in Boston in 1829 and removed to Watertown in 1912), which possesses one of the largest Blindiana libraries in the world. For comparative population figures see table in MASSACHUSETTS: Population. (M. E. L.)

WATERTOWN, a city of northern New York, U.S., the seat of Jefferson county, located on the Black river 10 mi. E. of Lake Ontario, is a gateway to the Thousand Islands resort region, to northeastern Ontario, Can.. and to the St. Lawrence power and seaway projects. Founded in 1800 by New England pioneers attracted to the spot by the falls in the river. Watertown was incorporated as a village in 1816 and as a city in 1869. It is the trade, banking and cultural centre of a large dairy and resort region. Unlimited electric power is available. Chief among the manufactured products are hydraulic equipment. tool appliances, snowplows, paper, paper products and papermaking machinery. Points of interest are Public square, the business heart of the city, and the Roswell P. Flower library and museum, containing relics of Indian life and of French émigrés who settled in the region after 1802. F. W. Woolworth (*q.v.*) lived for a time in Watertown and there conceived the idea of the "five and ten cent store." For comparative population figures see table in NEW YORK: Population. (M. E. MA.)

WATER TURKEY: see SNAKEBIRD.

WATERVILLE, a city of Maine, U.S., in Kennebec county, is on the Kennebec river 19 mi. N. of Augusta. A trading post was established at Ticonic falls early in the 17th century and in 1754 Gen. John Winslow built Ft. Halifax on the east bank of the river. Waterville's early settlers came from Massachusetts and were mainly of English ancestry. They were followed by French-Canadians and in the late 19th century Syrian immigrants arrived. In 1802 Waterville was separated from Winslow to the east and in 1873 from Oakland to the west. It became a chartered city in 1888.

The chief manufactures are textiles, shirts, wood products, plastics and ice cream. Railway repair shops are maintained there. Waterville is a shopping and market centre for the nearby vacation regions of the Belgrade and China lakes. The city is the seat of Colby college. a liberal arts college founded in 1813, and of two private secondary schools, Coburn Classical institute and Thomas junior college. For comparative population figures see table in MAINE: Population. (H. B. R4.)

WATERWAYS, INLAND, include both natural channels maintained for navigation and artificial channels or canals that may be used for irrigation, drainage and water supply as well as for navigation. See LAND RECLAMATION. Traffic on inland waterways and international agreements affecting them are dealt with in the article INLAND WATER TRANSPORT. (See also the articles on particular rivers, canals and places; *e.g.,* KIEL; MEUSE; THAMES.)

Early History. — The earliest waterways in the form of level cuts and adapted river sections probably served for both irrigation and navigation. Many examples of these cuts remain in Mesopotamia. About 510 B.C. Darius undertook the construction of a canal linking the Nile with the Red sea—the forerunner of the modern Suez canal. Similar projects were promoted by the Romans. Early Chinese canals include the Ling Ch'u canal in Kwangsi (3rd century B.C.), the canal between Ch'ang-an to the Yellow river (Hwang-ho), built 133 B.C., and the Grand Canal of China, joining the Pei-ho, Hwang-ho and Yangtze rivers This had sections in use by the 7th century AD. In Europe Charlemagne planned an ambitious waterways system connecting the Main. Rhine and Danube. In England the oldest artificial canal, the Fossdyke. a relic of Roman occupation, connecting Lincoln with the Trent river, was originally built primarily for drainage but was later also developed for navigation. Similar canals were built in the Low Countries, Italy, Russia and India during the 13th, 14th and 15th centuries. Although it seems that some form of incline was used on the Grand Canal of China, it was not until the lock was invented to raise or lower boats between different water levels that inland navigation could be further developed. Some doubt exists as to who invented or first made use of locks. They may have been introduced in China and Holland as early as the 14th century, but undoubtedly considerable credit for them belongs to Italy. An early lock was built in 1373 at Vreeswijk in Holland. Filippo degli Organi and Fioravante di Bologna constructed at Viarenno, near Milan, a lock chamber enclosed by a pair of gates in 1438–39 and, half a century later, Leonardo da Vinci completed six locks uniting the canals of Milan. The first pound lock in England is thought to have been built for the Exeter canal about 1564–67. The introduction of the lock marked an important phase in the development of inland navigable systems. The locked Briare canal. connecting the Loire with the Seine. was completed in 1642 and was soon followed by the Canal du Midi, or Languedoc canal (1666–81). which is often regarded as the pioneer in modern Europe. It connects the Mediterranean with the Bay of Biscay. has 119 locks in a length of 148 mi. and rises to 620 ft. above sea level. In Sweden a canal with locks between Eskilstuna and Lake Malar was finished in 1606.

MODERN DEVELOPMENTS

Great Britain. — The first canal in the modern sense was the Bridgewater canal opened in 1761 to carry coal from the Worsley mines to Manchester. Its success inspired the Grand Trunk canal, which connected the Mersey with the Trent. A canal boom ensued and new routes spread all over the country. After 1830 this remarkable expansion was severely checked by the railways.

In the 20th century the canals were hit still further by road

BY COURTESY OF BRITISH TRANSPORT COMMISSION

FIG. 1.— DIVISIONAL ORGANIZATION OF BRITISH WATERWAYS UNDER THE BRITISH TRANSPORT COMMISSION

haulage. Successive government committees made proposals for their future. The most important was the royal commission (1906–09). which recommended central control and the standardization of the four main routes from the ports to the Midlands for 100-ton barges. All the reports stressed the urgency of co-ordination, but though some government control was introduced during World Wars I and II. nothing permanent was achieved until the Transport act of 1947. This transferred most of the canals and canalized rivers, excluding undertakings such as the Manchester Ship canal. Bridgewater canal and the Thames, to the British Transport commission.

Under nationalization a unified system of about 2,100 route miles at last became possible. Considerable rehabilitation of traffic routes was carried out and scientific research fostered The major routes include the Aire and Calder. Sheffield and South Yorkshire, and Trent Navigation. from the Humber to Leeds, Sheffield and Nottingham, respectively; the Weaver Navigation from the Mersey to Cheshire; the Gloucester Ship canal and Severn river from the Bristol channel to Worcester and Stourport-on-Severn; and the Grand Union and Lee Navigations serving the Midlands and London. A substantial part of the remaining mileage of waterways is virtually unused for navigation, though still in use for drainage. water supply, etc.

Europe. — In Europe the chief canal networks are in France. the Netherlands. Belgium. Germany and the Soviet Cnion. In some cases the routes are interconnected, thereby facilitating long through hauls for international traffic. They are mostly closely related to large navigable rivers such as the Rhine. Danube. Oder. Elbe. Scheldt. Seine and Volga. Inland water transport mas developed through regularizing such rivers by canalizing difficult sections, by building lateral canals or by connecting them with entirely new artificial canals.

France. — France developed an extensive inland waterways system in the 18th and 19th centuries. Though its inland waterways total about 8,000 mi., only 3,000 mi. of canals and 2,000 mi. of rivers were being worked in the early 1960s. These comprise three main groups: the main network in northern, eastern and central France, bounded by Le Havre, Dunkirk, Strasbourg, Lyons and Nevers; and two isolated secondary networks in Brittany and southern France. Major waterways include the Seine, the Rhbne and the Rhine. The Seine has a minimum depth of $10\frac{1}{2}$ ft. downstream from Corbeil. It is canalized upstream from near Rouen and is joined by the Havre-Tankarville canal and by the canalized Oise near Paris. The Rhône. with a normal depth of 63 ft.. connects with the Sabne and with the canals to Marseilles and Sète. The 300-ton waterways form the largest group, totaling about 1.300 mi. They comply with a law of 1879 to standardize principal routes for barges 126 ft. by $16\frac{1}{2}$ ft. carrying up to 340 tons at a draft of $10\frac{1}{2}$ ft. The minor canals in Brittany and southern France total about 1,720 mi. About 50.000.000 tons are carried on France's waterways annually in a fleet of 10.400 craft (total capacity about 3,750,000 tons). An improvement program was under way in the late 1950s in the Seine and Rhône-Sabne routes. A hydroelectric project for the Rhône involved the building of eight major navigable canals. The first. 18 mi. long, between Donzkre and Mondragon. was completed in 1952. It includes the Bollène lock. 640 ft. by 39 ft. Three 300-ton routes were to be improved — Dunkirk-Bauvin-Lille; Bauvin-Etrun-Paris and Abbécourt-Strasbourg.

New waterways projects in France included the following: (1) Canalization of the Moselle to take 1,350-ton barges. (2) Grand Canal d'Alsace between Basel and Strasbourg. Two sections between Basel and Ottmarsheim were completed in 1954 and the Fessenheim section was to be completed later. Locks are two-chamber, the largest 607 ft. by 82 ft. (3) Work was resumed again on the Canal du Nord. which was started in 1907 between the Sensée and the Somme canals. The completed portion was severely damaged in World War I and, though work had been resurned later. it was halted in 1932.

Belgium.—Belgium's inland waterways total about 1.100 mi., including approximately 600 mi, of canals. some of which rank as ship canals. The system has developed largely from the Scheldt and Meuse rivers. with Antwerp as a key point. Three main routes connect the port to industrial centres at Liège via the modern Albert canal; to Brussels and Charleroi; and to Ghent and the Borinage coal district. There are also two cross-country routes, one in the south connecting the French network with Liège, the other in the north linking the coastal ports to Ghent and Antwerp. Traffic on the Belgian waterways, much of it from the French and Belgian coal fields and industrial areas, amounts to more than 50.000.000 tons annually. Major developments were planned, particularly for large-craft.

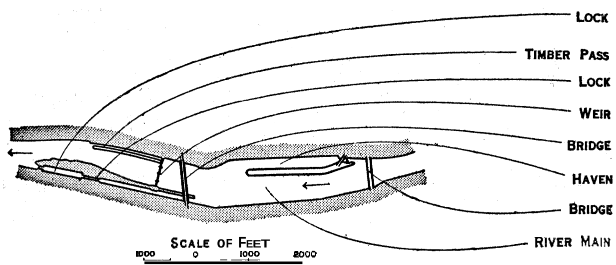
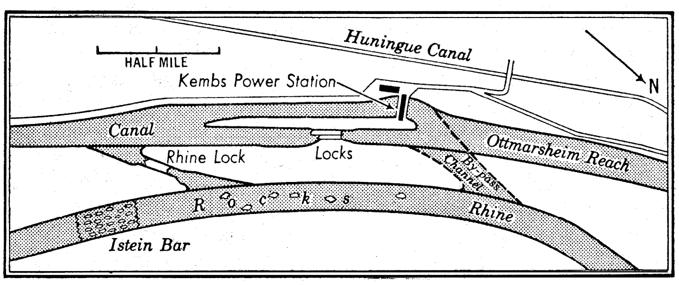


FIG. 2 — PLAN OF LOCKS, WEIR AND HAVEN ON THE RIVER MAIN NEAR FRANKFURT

Belgium's most up-to-date waterway is the Albert canal, started in 1930 and completed before the outbreak of war in 1939. Eighty mi. long. it connects the port of Antwerp with Liège on the largely canalized Meuse and it crosses a highly industrialized area. It has a minimum bottom width of 80 ft. and a middle depth of 16 ft. and can be navigated by vessels of 2.000 tons. Fast boats can do the passage in 15 hours. The authorized speed on the canal is six to seven miles an hour. There are six sets of triple locks, electrically operated, the two largest in each set being 446 ft. long and 52 ft. wide.

Improvements between Charleroi and Clabecq would enable the whole of the Brussels-Charleroi route (depth 10 ft.) to be used by 1.350-ton craft. In the Borinage area a new canal, also for 1,350-ton craft. was to link Nimy, Blaton and Péronnes. A circular canal around Ghent for 2.000-ton craft to link principally the tidal Scheldt. the Upper Scheldr and the Ghent-Terneuzen canal was also being built. The Upper Scheldt and the Ghent-Terneuzen canals were being improved.

Netherlands.—Waterways occupy a dominant position in inland transport in the Netherlands. which has the largest waterway fleet in Europe. Canal development in such a low-lying country originated partly for drainage and flood control. There are about 3,500 mi. of canals and 700 mi. of navigable rivers—nearly one-fifth of the total being usable by craft of over 1,500 tons capacity. Traffic carried by waterways is in excess of 95.000,000 tons annually—nearly four times as much as that by rail. There is a considerable network of canals in the north of the country, but the outstanding developments have been planned to enable large craft to penetrate farther inland from the seaports of Rotterdam and Amsterdam (see also Ship Canals, below). Canals were cut to link with such rivers as the Rhine. Maas (Meuse) and Scheldt, thereby serving numerous towns in the Netherlands and joining up with the waterway systems of Belgium. France and Germany. A number of projects were undertaken in the 20th century to provide



BY COURTESY OF "THE TIMES REVIEW OF INDUSTRY," LONDON

FIG. 3.— KEMBS SECTOR (NEAR BASEL, SWITZ.) OF THE LATERAL GRAND CANAL D'ALSACE PROJECT WHICH WAS PLANNED TO AVOID NAVIGATION DIFFICULTIES ON THE UPPER RHINE SUCH AS THE ISTEIN BAR

routes for barges of over 1.000 tons. Particularly notable were the developments of the route between Nijmegen and Maastricht connecting with the Rhine and Rotterdam in the north and with Belgium's Albert canal in the south. Designed for 2.000-ton barges, they comprised the Meuse-Waal canal, the canalization of the Meuse and the Juliana canal. The latter, which was opened in 1935, is about 20 mi. long, 16 ft. deep and 50 ft. wide (bottom). It has only four locks (446 ft. by $11\frac{3}{4}$ ft.). To eliminate a bottleneck at Lanaye, a better connection with the Albert canal, which is also navigable by 2,000-ton barges, was put in hand in 1958. The Wilhelmina canal (1915–23) was built to cope with expanding coal traffic from Limburg to the west of the country. and the Twente canal, opened 1936 and usable by 1,350-ton barges. connected the thriving industrial areas of the east Netherlands with the Rhine and mith the canals in the north. The ambitious Amsterdam-Rhine canal, 44 mi. long, was started in 1931 and opened in 1952. It incorporated the old Merwede canal from Amsterdam to Utrecht, considerably enlarged, but from there a new canal was built to join the Waal, a tributary of the Rhine. at Tiel. The channel from Amsterdam to Utrecht was deepened from $10\frac{3}{4}$ ft. to $13\frac{3}{4}$ ft. and widened from about 65 ft. to 164 ft. (bottom). The cut from Utrecht to Wijk bij Duurstede. where the canal crosses the Lek river, had a bottom width of $109\frac{1}{2}$ ft. and the remaining portion to Tiel $134\frac{1}{2}$ ft. The ship lock at Tiel, started in 1939 and completed in 1952, is one of the largest inland navigation locks in the world. It is 1,148 ft. long and 59 ft. wide and has two intermediate gates. The canal was designed for vessels of 2.000 tons.

Germany.—The number of large navigable rivers in Germany—the Rhine. Weser. Elbe and Oder—running southeast to northwest was conducive to the growth of canals as east-nest links to serve highly industrialized areas, and there was rapid development in the latter 19th century. Inland water transport remains most important. The waterways of western Germany (canals 690 mi. rivers 1.950 mi.) have a high traffic density, and more than a quarter of them can take craft over 1,350 tons. The large-sized German canals are intended for barges of 1.000 tons or more. mith length of 220 ft. to 262 ft., beam 27 ft. to $29\frac{1}{2}$ ft. and draft of $6\frac{1}{2}$ ft. to $8\frac{1}{2}$ ft. A notable example is the Dortmund-Ems canal (southern section). linking the Ruhr area with the North sea. It is about 70 mi long and $8\frac{1}{2}$ ft. deep. Between World Wars I and II a large-scale project to join the four rivers mentioned was undertaken. and the last link. the 250-mi. Mittelland canal giving Berlin connections with the North sea, Basel, the Oder and the Baltic, was opened in 1938. The Kusten canal from the Dortmund-Ems canal to Oldenburg, the Wesel-Datteln canal from the Rhine to the Dortmund-Ems canal, and the canalization of the Neckar as far as Heilbronn were also undertaken in the 1930s. Projects in progress in the late 1950s included a widening of the Dortmund-Ems canal: further canalization of the Main above Würzburg; the canalization of the Keckar south of Heilbronn toward Stuttgart; and further canalization of the hlittelweser between Minden and Bremen. All these projects were designed for 1.350-ton barges. Total traffic carried on waterways of the German Federal Republic was more than 110,000,000 tons annually.

U.S.S.R.—Inland waterways play a big part in Soviet economy. Flat country fostered the cutting of canals to link important rivers. The Volga is the key to the system. Since 1930 Moscow has become an inland port "of five seas," having five ship-barge canals linking it to European seas (see below). The waterways are much used for carrying passengers as well as goods.

BARGE CANALS

Choice of Line.—In laying out a line of canal the engineer is more restricted than in forming the route of a road or a railway. The canal must either be made on one uniform level or must be adapted to the general rise and fall of the country through which it passes by being constructed in a series of level reaches at varying heights, each closed by a lock or some equivalent device to enable vessels to be transferred from one reach to another. To avoid unduly heavy earthwork. the reaches must follow the bases of hills and the windings of valleys. but it may become necessary to cross a depression by the aid of an embankment or aqueduct, while a piece of rising ground may involve a cutting or a tunnel. Sharp bends must be avoided, the permissible radius of curves depending on the dimensions of the vessels for which the canal is designed and on the width of the waterway.

Aqueducts.—Brindley took the Bridgewater canal over the Irwell at Barton by means of an aqueduct of three stone arches. the centre one having a span of 63 ft., and Thomas Telford arranged that the Shropshire Union canal should cross the Dee valley at Pont-y-Cysyllte partly by embankrnent and partly by an aqueduct 1,007 ft. long and 120 ft. above the river. consisting of a cast-iron trough supported on iron arches with stone piers. In the building of the Manchester Ship canal it became necessary to replace Brindley's aqueduct at Barton, which was only high enough to give room for barges. by a swing aqueduct. the first of its kind, to allow shipping to pass in the canal under it. *(See* MANCHESTER SHIP CANAL.)

Tunnels. — In a hilly country such as England many canal tunnels were necessary. One of the earliest was completed in 1777 by Brindley at Harecastle on the Trent and Mersey canal. It was 2,880 yd. long, 12 ft. high and, being only 9 ft. wide, was suitable for one-way traffic only. Like many other tunnels it had no towpath. A second tunnel. parallel to this but 16 ft. high and 14 ft. wide, including a towpath, was finished by Telford in 1827. In tunnels without towpaths boats had to be "legged through" by men lying on their backs and propelling the boat by pushing their feet against the tunnel walls. Sometimes they were poled through or a fixed or endless chain was used. By the mid-20th century, as horses had largely disappeared, boats usually went through under their own power or with the aid of tugs. The largest canal tunnel in regular commercial use in England is the Blisworth tunnel on the Grand Union canal, completed in 1805. It is 3,056 yd. long, 15 ft. wide and $10\frac{3}{4}$ ft. high above water level.

Tunnels on European canals, especially in France, are also numerous and of much larger dimensions than those on English canals. One, on the St. Quentin canal, 6,200 yd. long, is $26\frac{1}{4}$ ft. wide and $22\frac{1}{3}$ ft. high. The Royaulcourt tunnel on the Nord canal (completed 1923) is 4,757 yd. long, 33 ft. wide and 28$ ft. high, with an enlarged passing place in the middle. The largest canal tunnel in the world is that at Rove, near Marseilles. (See below.)

Dimensions. — The dimensions of a canal, apart from considerations of water supply, are regulated by the size of the vessels which are to be used on it and. to some extent, by their speed. A good depth of water is particularly important. According to W J M Rankine (*Manual* of Civil Engineering, 24th ed. [1911]). the depth of water and sectional area of waterway should be such as not to cause any material increase of the resistance to the motion of the boats beyond what would be encountered in open water, and he laid down the following rules as fulfilling these conditions: (1) least breadth of bottom = 2 × greatest breadth of boat; (2) least depth of water = $1\frac{1}{2}$ ft. + greatest draught of boat; (3) least sectional area of waterway = 6 × greatest immersed midship section of boat.

Rankine was considering the small barges in use in his day, but his proportions are still very generally accepted. In large modern canals it is, however. usual to allow a greater clearance than 18 in. under the boat. the amount increasing with the size and the speed

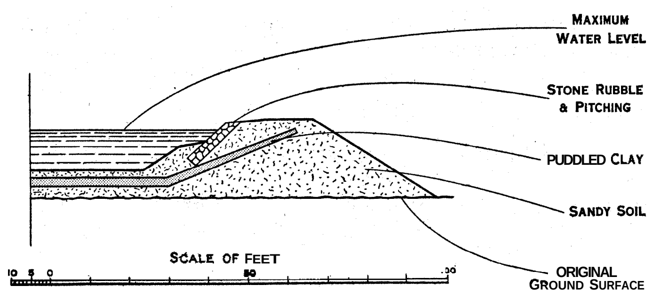


FIG. 4.— HALF CROSS SECTION OF A PORTION OF THE DORTMUND—EMS CANAL. BUILT ON EMBANKMENT OF PERVIOUS MATERIAL

of the vessels (see MECHANICS. FLUID). The ratio of wetted cross section of the canal to the immersed cross section of the boat varies in modern canals from 4:1 to 6.5:1. The larger the ratio, the less will be the erosion of the banks, which increases with the speed of vessels. The ordinary inland canal in England is commonly from 18 to 30 ft. wide at the bottom, 30 to 45 ft. at the water level. with a depth of $3\frac{1}{2}$ to 5 ft. The early continental canals were a little larger, being usually designed for boats of 100 tons or more. The tendency on all continental waterway systems has

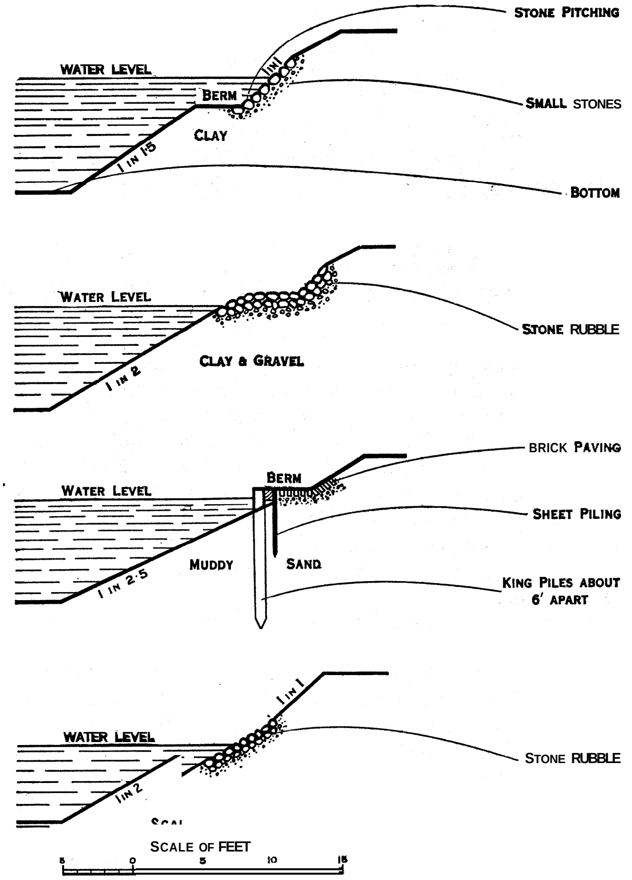


FIG. 5.— CROSS SECTION OF BARGE CANAL BANKS, SHOWING THE SLOPING SIDES. THE STONE RUBBLE TO PROTECT AGAINST WASH. AND THE BERM. A NARROW LEVEL STRIP THAT INCREASES THE CROSS-SECTIONAL AREA OF THE AVAILABLE CHANNEL IN CANALS LIABLE TO FLOOD WATER

been to increase the ruling dimensions of both canals and canalized rivers in order to allow a larger proportion of the craft using the great free rivers, such as the Rhine, to navigate the locked waterways In Germany, for instance, canals were constructed with a width of 69 ft. and more. Beyond Utrecht the Amsterdam-Rhine canal has a width of 109 ft.

Canal Banks. — To retain the water in porous ground, and especially on embankments, a watertight lining of puddle clay must be provided on the bed and sides of the channel. or some other means, such as a lining of concrete, adopted to prevent leakage (fig. 4). The difficulty of maintaining canals on embankments is always a serious one even on banks of quite moderate height.

The sides of canals are usually sloped, the angle varying with the nature of the soil from 1 in $1\frac{1}{2}$ to 1 in 3 or even flatter. In rock cuttings the sides are often nearly vertical. To prevent the erosion of the sides by the wash from boats it is usual to protect the banks at or near the water line by rushes, stone rubble or pitching, concrete or brick paving for fascine work, in some cases combined with continuous steel-sheet piling (figs. 4 and 5). A berm —a narrow, level strip along the bank at or just under the water level—is sometimes formed in the bank to minimize the effect of wash (fig 5). Such bank protection reduces cost of upkeep and prevents excessive silting.

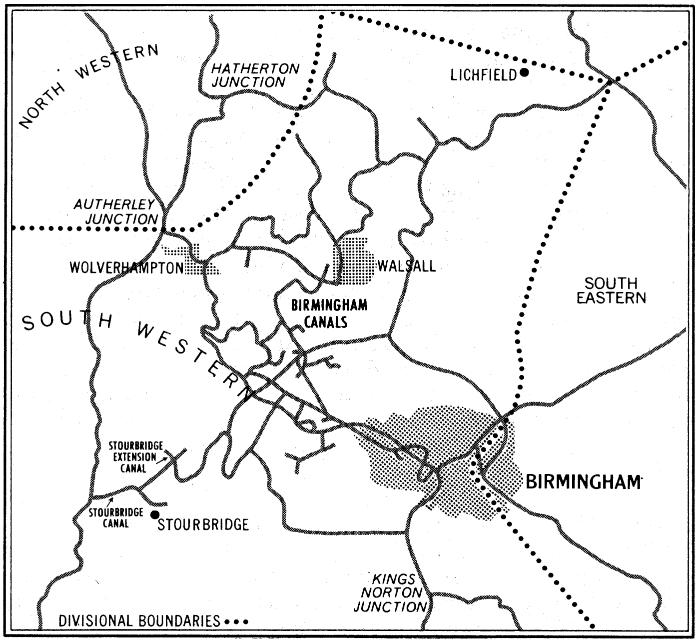
Water Supply and Consumption. — Canals may be fed from natural lakes and streams. but artificial reservoirs often have to be provided. They must be conveniently situated to enable water to flow through feeders, particularly to the summit level of the canal, whence it gravitates to make up the deficiency of water caused by evaporation, percolation, leakage and lockage. Additional feeders must also be provided for intermediate ponds. Water is lost every time a boat passes through a lock, and up traffic consumes more than down. An ascending boat entering a lock displaces a volume of water equal to its submerged capacity. The water so displaced flows into the lower reach of the canal and. as the boat passes through the lock, is replaced by water flowing in from the upper reach. A descending boat also displaces a volume of water equal to its submerged capacity, but in this case the displaced water flows back into the higher reach where it is retained when the lock gates are closed. An insufficient water supply may affect the density of traffic and prevent the enlargement of locks to accommodate more economical craft. Hence economy of water consumption is most important. This is often aided by side ponds into which part of the water from the lock being emptied is discharged and stored instead of flowing into the lower reach. It can be returned to the lock when refilling takes place. Up to half the lockage water may thus be saved. Even greater economy is possible with shaft locks by the use of side ponds placed one above the other and operated in turn. A double lock, where one acts as a side pond. inclines and lifts also facilitate economy. With some canals, however, pumping back of the water is required to compensate for losses, particularly in dry weather and on summit levels, and there are a number of electrically operated canal pumping installations in England and on the European continent.

Wasteweirs and Stop Gates.—An essential adjunct to a canal is a sufficient number of wasteweirs to discharge surplus water accumulating during floods. The wasteweirs are placed at the top water level of the canal, so that when a flood occurs the water flows over them and thus relieves the banks. Culverts, when constructed under a canal embankment to pass streams and floodwater, must be of ample dimensions (see WEIR). Safety or stop gates are necessary at intervals for the purpose of dividing the canal into isolated reaches so that, in the event of a breach, the gates may be shut and the discharge of water confined. In broad canals these stop gates may be formed like lock gates; in small works they sometimes consist of thick planks slipped into grooves. Stop gates consisting of a horizontally framed steel shutter of the width of the canal, suspended from an overhead bridge and counterbalanced, are used on some modern canals; these can be lowered by means of gearing into grooves built in the canal sides.

Locks.—A lock is a watertight chamber, generally rectangular in shape, which by means of gates at either of its ends affords communication between two reaches of a canal at different levels. A boat wishing to ascend from one reach to the next enters through the bottom or downstream gates of the lock, and these gates are then closed. The water level is raised to that of the higher reach, and the top or upstream gates are opened to allow the boat to proceed out of the lock. In descending from a higher reach the procedure is reversed, the water in the lock being drained until it corresponds with the level of the lower reach. The lock chamber is filled and emptied through sluices fitted to the lock gates, or in the side of the chamber from a culvert built in the ground, or both. Locks may be built of timber, brick or stone, but nowadays concrete and steel piling are largely used.

Water supply, changes in levels and the type of craft using the waterway all influence the size of locks, and wide variations are shown in their dimensions. Apart from ship canals, in England they range from the smaller: narrow boat locks, about 75 ft. long, 74 ft. wide and 5 ft. deep, to the longest locks on the Aire and Calder Navigation canal. 460 ft. long. 214 ft. wide and 9 ft. deep. On the European continent the range is greater. There are exceptional locks like the Tiel lock (see below), or the Ruhr lock (Rhine-Herne canal) 1.148 ft. by $42\frac{1}{2}$ ft. by $11\frac{1}{2}$ ft. On the canalized Meuse (the Netherlands) the largest measure 853 ft. by 46 ft. by $12\frac{1}{2}$ ft. Standard locks on many principal French canals are about 126 ft. long and 17 ft. wide. To economize water, canal locks are made only slightly larger than the largest vessel they have to accommodate. In many modern canals they may provide for a train of barges, and long locks for the purpose have sometimes intermediate gates so that only one section of the lock need be used if a single vessel is passing. The 1,148-ft. lock at Tiel on the Amsterdam-Rhine canal is divided into three such sections.

Lock gates may be built of oak or, in large modern canals, of steel. A pair of gates when closed meet at an obtuse angle pointing toward the higher reach of the canal so as to withstand the pressure of the water. The ends of the gates are finished with vertical mitre posts which meet and make a watertight joint. The base of the gates rests against a sill in the lock floor and also forms a watertight joint. When open, the gates fit into recesses in the walls. The timber uprights nearest the lock walls are called heelposts; they work on a pivot in the lock bottom and are rounded to enable them to rotate tightly in a hollow quoin in the wall. Iron straps round the head of the heelpost let into the coping stone support the gates, which are often operated by balance beams projecting over the lock side. With many small locks, however, hand gearing



BY COURTESY OF BRITISH TRANSPORT COMMISSION

FIG. 6—MAP SHOWING INLAND WATERWAYS IN THE AREA OF BIRMINGHAM, ENG.

is employed. On many modern canals the opening and closing of the gates and the sluices are electrically operated. Tumbling, rolling, floating. sector and lifting gates are sometimes used instead of mitre gates, sector and lifting gates being particularly suitable with steel-piled locks. Shaft locks have the upper part of the bottom gates fixed. with only the lower part opening.

Locks may be built in flights ("risers") in which the bottom gates of one lock act as the top gates of the one below. Time and water can be saved if a boat passes in the same direction through the flight. In certain later canals locks were built in groups, leaving long reaches between the groups. For example, the Albert canal in Belgium has six sets of triple locks in a length of 80 mi. The lift of canal locks rarely exceeded 12 ft. up to the end of the 19th century. The modern tendency, where physical conditions and water supply permit, is to build one lock with a high lift in preference to a number of shallow locks. Lifts of 20 to 40 ft. are not uncommon in U.S. and European canals, and the lock on the Donzère-Mondragon canal at Bollkne, which is 640 ft. long and 39 ft. wide, has a lift of 85 ft.. the highest in Europe.

Lateral Canals.—The name "lateral canal" is given to an artificial navigable locked waterway, constructed at the side of or near to the course of a river which may be unsuitable for canalization or improvement. A lateral canal can draw its supply of water from the river with which it is connected and is. in fact. a by-pass, vessels entering it at the higher end and re-entering the river at its lower end or vice versa.

Inclines.—Economy of water and time can be effected by the

Some Representative Barges on European Canals and Canalized Rivers

Type	Length (ft.)	Beam (ft.)	Draught (ft.)	Carrying capacity (metric tons)
England				
Narrow boat	71½	6%	3%	25–30
Barges	61–90½	14½–20½	4–9½	50–190
Large tank barges	135	21¼	9	400
France				
Typical narrow boat	92	8¼	3%	75
Barges (on standard canals).	127½	16%	8½	280–340
Barges on Seine	up to 272¼	30¾	10%	500–1,000
Rhine barges	262%	29%	8	600–1,350
Belgium				
Barges (on standard canals).	126¼	16½	7⅚	350
Barges on larger canals	164	22¾	8⅙	600
Large Rhine barges	328	39%	9⅚	2,000 or more
Netherlands				
Typical barges.	128–229½	23–32	8½–12¾	350–2,000
Largest Rhine barges	400	46	12	2,000 or more
Germany				
Barges (on large canals)	220–262	27–29	6½–8⅙	1,000 or more

use of inclined planes or vertical lifts in place of locks. In China rude inclines appear to have been used at an early date, vessels being carried down a sloping plane of stonework by the aid of a flush of water or hauled up it by capstans. On the Bude canal (England), now abandoned, this plan was adopted in an improved form for small boats. In some cases, as on the Morris canal, New Jersey, and between the Ourcq canal and the Marne, near Meaux, France, boats were conveyed on a wheeled trolley or cradle running on rails. Heavy-loaded barges are apt to be strained in this way, however, and to overcome the objection, inclines carrying tanks on wheels, but filled with water on which the boat floated, were introduced. Inclines of this kind were in use in England on the old Chard canal and on the Monkland canal. In 1900 a modern type was installed at Foxton on the Grand Union canal to replace a staircase of ten locks. The two balanced tanks, each capable of carrying two 30-ton boats or a 70-ton barge, moved in opposite directions on 16 wheels and eight rails up and down an incline 307 ft. long, representing a vertical rise of 75 ft. Power was provided by a steam engine. Because of high cost and difficulty of operation, however, the incline was abandoned a few years later.

Lifts.—Vertical lifts can be used instead of locks only where a marked difference in level occurs in a short length of canal, since otherwise long embankments or aqueducts would be necessary to obtain sites for their construction. An early example was built in 1809 at Tardebigge on the Worcester and Birmingham canal. At Anderton a lift was erected in 1875 to connect the Weaver Navigation with the Trent and Mersey canal, which at that point is 50 ft. higher than the river. The lift is a double one and can deal with barges up to 100 tons; the vessels are waterborne in a wrought-iron tank 75 ft. long and 15½ ft. wide. Until 1908 the tanks were raised and lowered by means of hydraulic rams, but in that year electric power was substituted, each of the two tanks being counterbalanced by weights and operated by electric winches. A similar hydraulic lift, completed in 1888 at Fontinettes on the Neuffossé canal in France, raises vessels of 300 tons 43 ft.; and a still larger example on the Canal du Centre at La Louvière in Belgium, built in 1888, has a rise of 50 ft., with tanks that will admit vessels up to 400 tons. This lift, and three others of the same character, were completed in 1921; they overcame the rise of 217 ft. which occurs in this canal in the course of 4⅓ mi. In 1899 the Henrichenburg lift on the Dortmund-Ems canal was opened. It raises 600-ton barges 46 ft. and is operated by an ingenious arrangement of balancing floats immersed in deep tank shafts. Two other notable German lifts are the Niederfinow (1933), with a rise of 117 ft. from the Oder to the Hohenzollern canal, and the Rothensee (1938), with a rise of 60 ft. between the Elbe and the Mittelland canal. They are operated by cables and counterweights and by floats, respectively, and both have single tanks 276 ft. long, 39 ft. wide, with a depth of water 8 ft.

At Peterborough, Ont., there are two hydraulic barge lifts constructed about 1908. Neither lifts nor inclines are in use in the United States. Generally speaking, canal constructors, both in the U.S. and on the continent of Europe, have for many years shown a decided preference for high-lift locks to either mechanical lifts or inclines.

Canal Barges.—The accompanying table gives an idea of the range in size of craft on European canals and canalized rivers.

Towage and Haulage.—With the increasing use of diesel-engined power craft on the waterways between World Wars I and II, haulage by horses on the towpath was largely superseded. Self-propelled craft, tugs and mechanical traction are predominantly used. Barges, self-propelled by steam power, were first tried on the Forth and Clyde canal as early as 1789, and after 1910 the use of internal-combustion engines for propulsion made rapid strides. Self-propelled diesel barges and boats are common, some of them also acting as tugs, towing one or more unpowered or "dumb" craft.

Towage by steam tug was first employed on the Forth and Clyde canal in 1802, when two barges were drawn 19½ mi. in six hours by an engined tugboat. Tugs, steam and diesel, have since been extensively employed to pull one or several barges, but they are most economically used where there are no locks, as on the Bridgewater canal in England, or where the locks are well spaced and can admit the tug and its train of barges simultaneously. For example, on the Aire and Calder Navigation canal, also in England, the largest locks have a length of 460 ft. and pass together a tug with its train of 19 coupled compartment boats carrying in all 700 tons of coal for shipment at Goole on the Humber.

Mechanical haulage by tractors on the towpath has long been practised, particularly in France and Germany, and was introduced in England. An early attempt was made with a steam locomotive on the French Bourgogne canal in 1873. Electric tractors running on rails were used on the continent after the beginning of the 20th century. They are used extensively in France, where about 1,100 of them serve nearly 600 mi. of canals: this compares with more than 600 diesel oil tractors serving about 1,600 mi. The cost of installing and working a system of electric rail traction is justified only where, as on some of the canals in the north of France, the traffic is very heavy.

Mechanical traction did not develop so markedly as towage; generally, its results do not show any considerable decrease in cost compared with other haulage or towage, nor has the speed of craft been increased materially by it. Though the hor'sepower needed for haulage by tractor is about a quarter of that needed for propeller propulsion, bank erosion is reduced and cargo capacity of the dumb craft is greater, the system is generally less adaptable.

Other means of traction include pushing tugs which, coupled close to dumb barges! convert the barges temporarily into a self-steering, self-propelled unit. Tugs fitted with winches that unwind submerged chains fixed to either end of a canal reach are also in use in France on particularly narrow canals or in one-way tunnels (St. Quentin canal). By this means a tug with a convoy of many barges can be hauled along canal sections. In the Mont de Rilly tunnel at the summit level of the Aisne-Marne canal, a system of cable traction was established in 1893, the boats being taken through by means of an endless travelling wire rope supported by pulleys on the towpath. Electric capstans are often used to facilitate the passage of boats through locks, particularly where they have difficultyin entering under their own power.

Horse traction craft on canals was a slow method, but even though by the mid-20th century boats were mostly moved me-

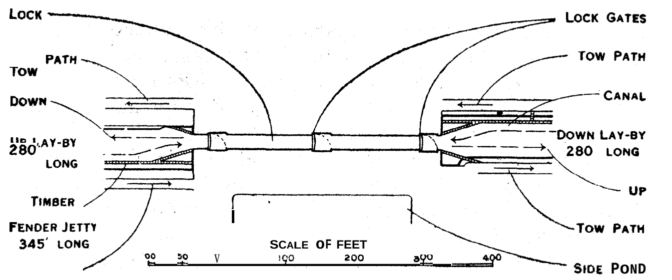


FIG. 7.—PLAN OF TYPICAL LOCK ON THE CANAL DU NORD, FRANCE

The lock is 279 ft. long, but an intermediate gate, shown in the centre of the drawing, is used when a short lock chamber suffices for the passage of barges chanically. the speed was still necessarily restricted on many canals to avoid erosion. At speeds of more than three miles an hour the wash of the craft and propeller vibration begin to cause erosion of the banks. and bank protection schemes are often necessary. The tractive effort required to haul a barge increases at a considerably greater ratio than the speed, and tests have shown that speeds much over three miles per hour are uneconomical in haulage and maintenance costs.

Speeds on British canals vary from three to six miles an hour. In France self-propelled barges are usually limited to $3\frac{3}{4}$ m.p.h., and a tug or tractor with a tow of barges may cover up to 18 mi. a day. including passage through locks. Canals of modern construction usually incorporate bank protection measures. which. with the greater depths provided, facilitate faster speeds. On the Albert canal in Belgium, the maximum authorized speed is six to sex-en miles an hour. There was a growing tendency to increase speed on Dutch waterways.

Inland Ports.—Apart from those important terminals on ship canals which rank as ocean ports, such as blanchester or Ghent, there are many other intermediate wharves and inland ports associated with canalized rivers and canals. These range from waterheads such as Worcester on the canalized Severn, small yet well equipped with landing: discharging. storing and distribution facilities, to extensive, well-developed inland ports such as Strasbourg, which is a focal point for a number of important waterways and has an international trade of 5,000,000 metric tons a year. Such ports. in an industrial environment, must have modern quays and be equipped with the latest cranes and other discharging appliances. warehouses. transit sheds. lay-bys, dry docks and rail and road access. Their terminal works. sea approaches and locks are akin to dock and harbour constructions.

CANALIZED RIVERS

A river whose discharge is liable to become quite small at its low stage. or which has a somewhat large fall, as is usual in the upper part of rivers, cannot be given an adequate depth for navigation by regulation works alone; and its ordinary summer level has to be raised by impounding the flow with weirs at intervals across the channel (*see* RIVER AND RIVER ENGINEERING), while a lock has to be constructed alongside the weir. or in a side channel. to provide for ships (fig. 2). A river is thereby converted into a succession of fairly level reaches rising in steps upstream and providing a comparatively still-water navigation like a canal; but it differs from a canal in the introduction of weirs for keeping up the water level and in the provision for the regular discharge of the river at the weirs. Canalization secures a definite available depth for na igation, and the discharge of the river is generally ample for maintaining the impounded water level. as well as providing the necessary water for locking. The navigation. however, is liable to be stopped during the descent of high floods. which in many cases rise above the locks (fig. 3); and it is necessarily arrested in cold climates on all rivers by long, severe frosts, and especially on the break-up of the ice. (This also applies to canals, even in England: and the suspension of traffic during prolonged frosts is one of the disadvantages under which canals have to operate.)

Many small rivers: such as the Thames above its tidal limit, have been rendered navigable by canalization: and several fairly large rivers have thereby provided a good depth for vessels for considerable distances inland. Thus the canalized Seine has secured a navigable depth of $10\frac{1}{2}$ ft. from its tidal limit up to Paris, a distance of 135 mi.. and a depth of $6\frac{1}{2}$ ft. up to Montereau. 62 mi. higher up. Regulation works for improving the Main river. from its confluence with the Rhine opposite Mainz up to Frankfurt, failed to secure a minimum depth of three feet at the low stage of the river, and canalization works, carried out between 1883 and 1900 by means of six weirs in the $26\frac{1}{2}$ mi. between the Rhine and Offenbach, above Frankfurt. provided a minimum depth of $8\frac{1}{4}$ ft. On ascending a river it becomes increasingly difficult to obtain a good depth by canalization because of the progressive inclination of the river bed. Thus, even on the Seine. with its moderate fall, a depth of $10\frac{1}{2}$ ft. was obtained on the lower Seine by weirs placed on the average $13\frac{1}{2}$ mi. apart, but on the upper Seine weirs were required at intervals of only about 43 mi. to attain a depth of 64 ft. (L. A. Gs.)

UNITED STATES AND CANADA

U.S. Inland Navigation.—The total length of federally improved navigable rivers in the United States is about 28,500 mi. At least 40 distinct and separate rivers have been improved by canalization. (See *Annual Report of the Chief of Engineers,* U.S. Government Printing Office.) After 1900 an immense amount of improvement of the inland waterways, both natural and artificial. was accomplished. As a rule. canalization is well inland. the lower and middle reaches of the great rivers being open to navigation. For instance. on the Hudson, the first lock is at Troy, N.Y., 153 mi. from the sea; on the Mississippi, at St. Louis. Mo., 1,375 mi.; and on the Missouri there is open navigation to Sioux City. Ia., 2,146 mi. from the Gulf of Mexico. The construction of locked waterways near seaports to connect ocean traffic with inland navigation is comparatively infrequent, although the St. Lawrence seaway (*q.v.*), the New Orleans Industrial canal and the Lake Washington Ship canal at Seattle (*see* below) are important examples.

When traffic on U.S. rivers began to be intense, recourse was had to extensive canalization in cases where shallow water and limited flow gave rise to difficulties either seasonal or continuous. Among the rivers so improved were the Ohio, with its tributaries the Allegheny and Monongahela; the Kanawha in West Virginia; the Kentucky in Kentucky; the Cumberland in Kentucky and Tennessee; the Tennessee in Kentucky, Tennessee and Alabama; the Black Warrior and Tombigbee in Alabama; the Columbia in Oregon and Washington; and the Mississippi above St. Louis.

The locks on the Ohio are among the largest on the great rivers of the United States. Between Pittsburgh, Pa.. and Cairo, Ill.. a distance of 981 mi., there are 47 locks. Four of these locks. being higher, replaced nine obsolete locks. The cost of the improvements exceeded $130.000.000. Each lock is 110 × 600 ft. internally, and in addition auxiliary locks are provided at five locations—56 × 360 ft. at Emsworth. Dashields, Montgomery and Dam 41 and 110 × 360 ft. at Gallipolis. Dashields is a fixed dam while Emsworth. Montgomery and Gallipolis are fixed dams with movable crests. The remaining dams are of the movable-crest type, which permit open river navigation during higher flow conditions. The depth over the sills varies from 9.5 to 37 ft., with the lift of the majority of the locks varying from 6 to 12 ft.

Canalization of the upper Mississippi river was completed in 1938 when the last of 24 locks and dams were opened to navigation. The project provides for a nine-foot channel between Alton. Ill., and Minneapolis, Minn.. a distance of 650 mi. Lock 19. at Keokuk. Ia.. was constructed in conjunction with a hydroelectric power dam in 1913; its dimensions are 110 × 358 ft. Upon completion of the 110 × 1.200 ft. lock under construction in the early 1950s. the older lock mas used as a stand-by unit. All other structures are provided with 110 X 600 ft. locks. with auxiliary locks of shorter length at Locks 1, 2, 15 and 26. In 1953 the Chain of Rocks canal at St. Louis, Mo., extended the canalized section of the river downstream 19 mi. Lock lifts vary from 5.5 ft. at Lock 5A (near Winona, Minn.) to 38.2 ft. at Lock 19 (Keokuk). The dams are non-navigable, with movable crests. usually Taintor gates.

Apart from the river improvements effected by the federal government. which controls all navigable rivers. several of the states undertook canal work; the most notable instance being the reconstruction by New York of the old Erie canal. which now forms the New York State Barge canal. This work, carried out between 1905 and 1918 at a cost. including branches and terminals completed subsequently, of more than $170,000.000, connects the Hudson river at Troy with Lake Erie at Buffalo. (*See* N. E. Whitford, *History of the Barge Canal of New York State,* and the *Book of Plans* [1921–22].) Altogether including branch canals and the Lake Champlain section. there are 525 mi. of canal proper, with 57 locks. Ships and barges up to 300 ft. in length and $43\frac{1}{2}$-ft. beam can navigate the canal. Some of the barges

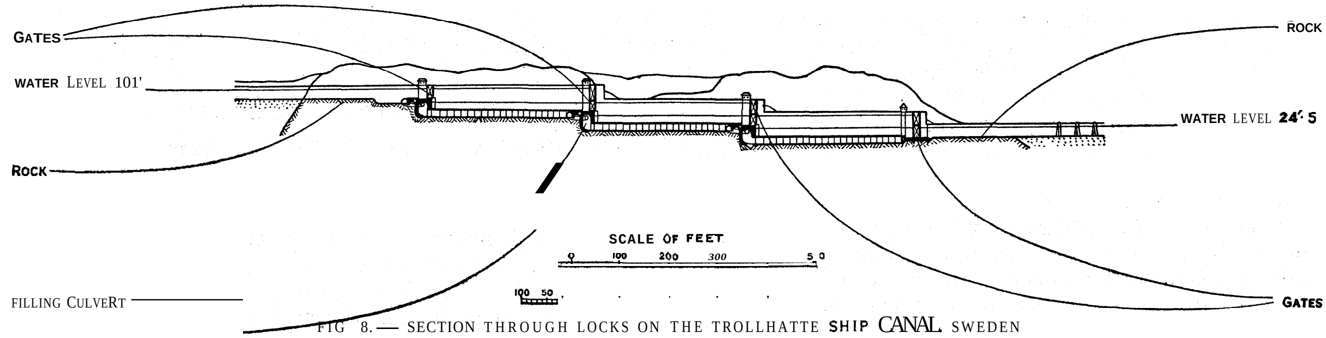


FIG. 8.— SECTION THROUGH LOCKS ON THE TROLLHATTE SHIP CANAL. SWEDEN

Completed in 1916, canal connects Goteborg with Lake Vaner. The three locks shown overcome a total rise of 77 ft. and are $321\frac{1}{2}$ ft. by 45 ft. internally

using it have a cargo capacity of 2.500 tons. All the locks have a depth of 13 ft. over sills. and the maximum lift in any one is $40\frac{1}{2}$ ft. All lock and other machinery is operated electrically. and the canal and its terminal ports are equipped in lavish manner with mechanical appliances. There is at Oswego, on this canal, a novel and interesting system of siphons for emptying and filling the lock chamber.

Locks and **Weirs in the U.S.**—After 1910 practically all locks on inland waterways in the United States were constructed of concrete. No mechanical lifts or inclined planes are in use. and no provision is made at any of the locks for mechanical haulage of vessels through them. Electric locomotives for rack traction, however. are employed for towing ships through the locks of the Panama canal. The large majority of the navigable waterways of the states being rivers of very variable flow. the provision of dams or weirs with sluices has usually been necessary in conjunction with lock construction. and many of these works are of considerable magnitude. Steel lock gates of the double-leaf mitred type are adopted generally for new works; but rolling caisson gates are also used for closing many of the river locks. particularly at the upper end. of wide locks on rivers. The silting up of the caisson chambers. however. gave trouble in some cases. and their use was abandoned in works carried out after 1916. "Tumbling" or flap gates ("bear trap") hinged on a horizontal axis have also been used in a fen. instances. Sluice valves are constructed in the lock walls and are irequently of the "butterfly" type, but Stoney gate sluices, Taintor gates and cylindrical valves predominate. The practice of placing sluice valves in the gates has been abandoned. Movable weirs of the Chanoine and needle types were formerly much used. but in the dams and weirs of later construction some form of sliding or hinged sector gates has often been adopted. The Stoney sluice is typical of the first class and the Taintor gate of the second (see WEIR).

Canadian Inland Navigation.— The-splendid inland navigation system of Canada mainly consists of natural lakes and rivers. Most of the artificial waterways are lateral canals cut in order to enable vessels to avoid rapids in the rivers. The earliest locked canal in America. completed in 1783. was made to avoid rapids on the St. Lawrence river between Lake St. Francis and Montreal. (See SAINT LAWRENCE SEAWAY; GREAT LAKES.)

(N. G. G.; G. J. Z.)

SHIP CANALS

Ship canals are of two classes. those which connect two seas or lakes and those which provide access for seagoing vessels to inland ports. The Suez canal between the Mediterranean and the Red sea. the Panama canal between the Atlantic and Pacific oceans and the Welland canal joining lakes Erie and Ontario in Canada are examples of the first class. and the hlanchester Ship canal. giving access to the great inland port of Manchester. represents the second class. An earlier though smaller British example of this second class is the ship canal between Sharpness and Gloucester, completed in 1827. Though ship canals are used by larger and seagoing vessels and cost more to construct. no rigid distinction can always he drawn between them and barge canals. The modern Albert canal in Belgium. and the Amsterdam-Rhine canal. for example. are suitable for both seagoing vessels and barges.

The four most famous ship canals with a large international trade are the Suez. Panama. Manchester and Riel. The Suez represents the canals on one level without locks. and the Panama those at varying levels that require locks. To keep pace with the increasing size of modern ships, it became necessary in some cases to enlarge the dimensions of ship canals and their locks. For example. the Suez was successively increased from a depth of 26 ft. and bottom width of 72 ft. to minima of $42\frac{1}{2}$ ft. and 197 ft. respectively. The enlarging of a locked canal is more complicated, especially if reconstruction of the locks is involved. In connection with the enlargement of the North sea canal connecting Ymuiden to Amsterdam the original entrance lock was 394 ft. by 60 ft. A much larger sea lock had to be added later, and another new lock. the largest in the world. was opened in 1930. It is 1,312 ft. long. 163 ft. wide and 50 ft. deep.

Apart from the Manchester and the Gloucester ship canals: the only other noteworthy British ship canals are in Scotland. The Caledonian canal (opened 1822), the first through ship canal in the country. connects the North sea and the Atlantic. It consists of artificial cuts (22 mi.) linking natural locks (38 mi.). The 9-mi. Crinan canal (completed 1801) crosses Kintyre. The use of both canals is limited to small ships.

The Forth and Clyde canal (completed 1790) had a great success in its earliest years, but after the beginning of the 20th century was little used. Periodically proposals were made for a mid-Scotland deep-water ship canal, the proposal of 1946 being unfavourably reported on by a government committee because of enormous cost and limited strategic value.

Belgium and the Netherlands are favourably placed for the development of ship canals. and both countries have built a number of them. The Ghent-Terneuzen canal. 22 mi. long, originally constructed 1825–27 and since enlarged to $28\frac{2}{3}$ ft. deep and up to 163 ft. bottom width, is half Dutch and half Belgian. It converted the city of Ghent into an extensive and well-equipped inland port. Bruges and Brussels similarly became inland ports through, respectively. the Bruges ship canal (1896–1907), $6\frac{1}{4}$ mi. long and 26 ft. deep. and the Rupel canal (1922), 18 mi. long and $21\frac{1}{4}$ ft. deep.

Two notable ship canals in the Netherlands are the North sea canal to Amsterdam. 15 mi. long, and 39 ft. deep, already referred to. and the "New Waterway" between the Hook of Holland and Rotterdam. which has been developed from an older waterway and which gives access to the Rhine system. The navigation channel has been improved to a width of 328 ft. and a low-water depth of 36 ft.

France has no really large ship canals. Rivers such as the Seine were canalized and some canals were built. however. for small ships as well as barges. The so-called Marseilles-Rhône Ship canal. which is about 48 mi. long. is really intended to open up the port of Marseilles to barge traffic and the whole waterways system of France. The canal is level throughout but has regulating locks. It is about ten feet deep. A remarkable feature is the Rove tunnel. $4\frac{1}{2}$ mi. long. which. with a width of 72 ft. and height of 50 ft.. has the largest tunnel cross section in the world. The lockless Corinth canal, a 3-mi. cut across the isthmus dividing the gulfs of Corinth and Aegina, was built 1882–93 and obviates a 200-mi. sea voyage. It was blocked in 1944 by the Germans but was fully reopened in

1948. It has a bottom width of 72 ft. and depth of $26\frac{1}{4}$ ft. for vessels up to 10,000 tons.

Russia. which in 1884 had completed the Kronstadt canal to open up St. Petersburg (later Leningrad) to seagoing ships, in later years promoted a number of ambitious ship canal projects. The most notable was the plan to link five seas—White, Baltic, Black, Caspian and Azov. This has made Moscow a great inland port connected to these seas by the Marie. Stalin, Moscow-Volga and Volga-Don canals. The White sea–Baltic, or Stalin canal, 141 mi. long. was completed in 1933. the Moscow–Volga canal. 79 mi. long, in 1937. The last stage in the plan, the Volga–Don canal, 63 mi., was completed in 1952 and connects the Black, Azov and Caspian seas. It has 13 locks, each with a rise of 32–42 ft. This development formed part of an immense project covering reservoirs, irrigation, hydroelectric power, soil erosion and drainage.

Sweden, a country of many lakes and rivers, also developed some ship canals. Two of the most interesting, the Göta and the Trollhatte canals. enable small sea vessels to cross Sweden between the North and Baltic seas. The Gota canal, begun in 1716 and finally completed in 1832, extends from the Baltic to Lake Vaner, which is also connected to Goteborg by the Trollhatte, 52 mi. long, completed in 1916. (L. A. Gs.)

U.S. and Canadian Ship Canals.—Important ship canals, in addition to the Panama canal (opened to traffic in Aug. 1914), were completed after the beginning of the 20th century. The New Orleans Industrial canal connects the Mississippi river with Lake Pontchartrain, $5\frac{1}{2}$ mi. distant. It was completed in 1923 at a cost of more than $25,000,000, and its construction was brought about mainly by the desire to provide increased waterside frontage at the port of New Orleans. Moreover, it forms part of the Gulf-Intracoastal waterway (see below), for connecting New Orleans with the Gulf of Mexico by way of a land cut through the marsh south of Lake Pontchartrain into Lake Borgne. The lock at the entrance to the canal is constructed on a foundation of 24,000 piles driven through a bed of very fine quicksand. The usable dimensions of the lock are 640 × 75 ft., with 31-ft. depth over sills at lowest water in the Mississippi river. The canal at its minimum section is 30 ft. deep, 150 ft. wide at bottom and 300 ft. wide at water level. The Gulf-Intracoastal waterway provides a 12 × 150 ft. channel for more than 1,100 mi., from Brownsville, Tex., to Xpalachee bay, Fla. Most of the canal is excavated from marshy land inland from the coast. Locks have been provided at certain locations to facilitate crossing streams intersecting the canal or for exclusion of salt water to adjacent agricultural areas. The Atlantic-Intracoastal waterway provides for a 12-ft channel from Key West, Fla., to New York city, a distance of about 1.700 mi. Widths vary from 90 to 250 ft. The canal was completed between Jacksonville, Fla., and Chesapeake bay, and certain sections between the bay and New York also were at project dimensions. A lateral canal across Florida through Lake Okeechobee also was completed, and a second canal starting at Jacksonville was proposed. Locks were constructed in Okeechobee lateral and in the main canal at various points to provide for differences in head and exclusion of silt and salt uater.

The Lake Washington Ship canal, eight miles long, extending from Puget sound to Lake Washington, was opened in 1916. The sea entrance at Seattle. Wash., has two locks, the larger of which has a usable length of 760 ft., with intermediate gates, and is 80 ft. wide. The depth over the sill varies from 25 to 44 ft. according to the state of the tide. Flood water is provided for by the construction of a dam with movable crest gates.

The Cape Cod canal, connecting Cape Cod bay on the east with Buzzards bay on the west of the Cape Cod isthmus, is $7\frac{2}{3}$ mi. in length with dredged approaches which make the total length of the cut $17\frac{1}{2}$ mi. Its construction was begun in 1909 and the waterway was first opened to traffic in 1914, after which the works were completed to give a depth of 32 ft. at low water. There is no regulating lock on the canal. and because of the difference in sea levels at the two ends there is. at times a considerable current flowing through it. It provides a shorter route than the exposed open sea route between New York and Boston.

For the St. Mary's Falls canal or, more correctly, canals connecting lakes Superior and Huron at Sault Ste. Marie, and the Welland Ship canal connecting lakes Erie and Ontario in Canada, see GREAT LAKES, THE. (N. G. G.; G. J. Z.)

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WATERWAYS, INTERNATIONAL. International waterways comprise international rivers and inland canals, straits and interoceanic canals. An international river or inland canal is one that flows through or separates the territory of two or more nations. While a strait in a geographical sense is any passage connecting two portions of the high seas (*q.v.*) or of the waters adjacent thereto, in its legal sense the term refers to any passage between two areas of the high seas where the territorial seas of the littoral states meet and overlap in such a way that no stretch of the high seas extends through the geographic strait. An interoceanic canal is an artificial waterway connecting two sections of the high seas.

Rivers and Inland Canals.—International rivers possess importance for navigation, fisheries, the generation of hydroelectric power. the carrying away of wastes and consumptive use for irrigation and domestic purposes.

When an international river constitutes the boundary between two or more countries, it is usual to subject the waterway to joint regulation by the riparians. Both under treaties and in the absence of treaties, the boundary line between the two riparian states is normally fixed at the middle point of the principal channel, or *thalweg*, of a navigable river, and at the middle point of a nonnavigable river.

In the 19th and 20th centuries a number of navigable rivers running through the territory of two or more nations were opened by treaty to free use by the shipping of the riparians and of other nations. The principle of free navigation by ships of all nations of certain major European rivers was first enunciated in general terms at the congress of Vienna of 1815. The Rhine was opened to free navigation by the treaty of Mayence (Mainz) of 1831, but it was not until the Act of Mannheim of 1868 that the river was opened on a nondiscriminatory basis to vessels of all nations and certain impediments to free navigation were removed. The Danube and its mouths were opened to ships of all nations by the treaty of Paris of 1856. By the treaty of Versailles (*q.v.*) of 1919, parts of the Elbe, Moldau, Oder, Niemen and Danube were declared to be international rivers upon which the shipping of riparians and nonriparians was to be treated on a basis of equality. Following World War II, the domination of the Danube by the U.S.S.R. and its satellites brought to an end for practical purposes the international regime which had hitherto existed for the river. By the general act of the Berlin conference of 1885, navigation on the Congo and Niger rivers was declared "free for the merchant ships of all nations equally." The 1885 act was substantially revised. however, by the treaty of St. Germain of Sept. 10. 1919.

In the absence of a treaty, there is no general right of free navigation by riparians and nonriparians, even in cases in which a river affords access to the sea for a landlocked state. Despite the recognition in principle by a treaty of a right of free passage, practical impediments to navigation may be created through measures of control by the riparians. For the most part tolls. other than charges for special services rendered, are no longer charged on international rivers.

The administration of international rivers used for navigation, irrigation and the generation of power is frequently entrusted to an international organization representing the riparians and, in a number of instances, nonriparians as well. The oldest of these is the Central Commission for Rhine Navigation, established in 1815 and charged with the co-ordination of works on the river and the maintenance of free navigation. Prior to World War II, free navigation on the Danube was facilitated by the International Danube commission on the portion of the river entrusted to its care. International bodies charged with supervision of the consumptive uses of international rivers (*e.g.,* irrigation and generation of power) include the Canadian–U.S. International Joint commission; the Committee for Co-ordination of Investigations of the Lower Mekong Basin; and the Spanish-Portuguese International commission, having competence with respect to the Douro (Duero) river.

Various attempts to establish a common regime of navigation for international rivers, in substitution for special arrangements for individual waterways, were not, as of the late 1950s, successful. The Barcelona convention of 1921 on the regime of navigable waterways of international concern, by which the parties agreed to accord the right of free navigation on their waterways to other contracting nations, was not ratified by a sufficient number of states to be of substantial importance. The proposal of Pres. Harry S. Truman at the Potsdam conference of 1945 that the Black sea straits, the Kiel canal, the Danube, the Rhine and other international waterways of Europe be opened to "free and unrestricted navigation" under common international supervision was not carried into effect.

The extent of the legal obligation of an upper riparian under customary international law to maintain the flow of an international river for the benefit of a downstream riparian is controverted. The rights of upper and lower riparians, and of adjacent riparians on a boundary river, to divert water are usually regulated by treaties apportioning the flow. Examples of these are the treaty of 1944 between the United States and Mexico regarding the Rio Grande and the Colorado river and the Nile Waters agreement of 1929 between Great Britain and Egypt. Agreements of this nature frequently also regulate pollution and fisheries and state what priority, if any, is to be accorded various uses of the river. During the period following World War II, international disputes over the employment of the waters of the Jordan, the Indus (split apart by the partition of India), the Helmund and other international river systems reflected an enhanced demand for the waters of these rivers for irrigation.

Straits. — Under customary international law, as enunciated by the International Court of Justice in the Corfu channel case, both merchant ships and warships have, unless otherwise prescribed by treaty, a right of free passage "through straits used for international navigation between two parts of the high seas without the previous authorization of a coastal state, provided that the passage is *innocent."* In time of war, a neutral riparian may enforce reasonable measures to protect the neutrality of its territorial sea within a strait. Such measures may include the laying of mines and compulsory pilotage, but must keep the strait open to free navigation When a coastal state is at war, it may close the strait to enemy shipping and vessels carrying contraband to the enemy and may take all belligerent measures which it would be authorized to employ in its other territorial waters or on the high seas. Because of exceptional geographical and political circumstances, passage through certain straits is restricted by treaty. The most notable instance of such regulation is the Montreux convention of 1936, which controls the passage of warships through the Turkish straits and permits the closing of the straits when Turkey is at war.

Interoceanic Canals. — In the second half of the 20th century the three major interoceanic canals, Suez, Panama and Kiel, were operated and maintained by the states through whose territory the canals passed. The three were opened to common usage by treaties which dedicated them to free navigation by the ships of all nations on a nondiscriminatory basis. Freedom of navigation through the Suez canal was secured by the Convention of Constantinople of 1888, reaffirmed by the Egyptian government in its declaration of April 24, 1957; through the Panama canal by the Hay–Pauncefote treaty of 1901 between the United States and Great Britain and the Hay–Bunau-Varilla treaty of 1903 between the United States and Panama; and through the Kiel canal by the Versailles treaty of 1919. So long as the administering state is not at war, these canals must be left open to navigation by the warships and merchant ships of all nations. The passage of the shipping of belligerents is not, in the view of the Permanent Court of International Justice in the case of the S S. "Wimbledon," inconsistent with the neutrality of the nation operating the canal. In case of a war to which the proprietor nation is a party, the canal may lawfully be closed to enemy vessels and ships carrying contraband to the belligerents. Passage through canals is at all times subject to the payment of tolls which under the treaties mentioned must be equal for all states. They are fixed by the proprietor state, which assumes responsibility for the operation and maintenance of the waterway.

See J. P. Chamberlain, *The Régime of the International Rivers* (1923). (*R. R.* Br.)

WATERWEED (Water Thyme; *Anacharis canadensis* or *Elodea canadensis*), a submersed aquatic herb of the frogbit family (Hydrocharitaceae), native to America. It was introduced into Ireland about 1836, and soon spread and became a weed in waterways, ditches, streams and ponds in England and on the continent. The staminate and pistillate flowers are borne on separate plants. If, as in England, only one kind of plant is present, the species produces no seeds but spreads by vegetative propagation. The allied *A. occidentalis* is a common native species of the northern United States; *A. densa,* native to Brazil, is cultivated as an aquarium plant for its showy petals.

WATFORD, a market town and municipal (1922) and parliamentary borough of Hertfordshire, Eng., 15 mi. N.W. of Marble arch, London, by road. Pop. (1951) 73,130. Area 8.3 sq.mi. The rivers Colne and Gade (on the east and west) and the Grand Union canal pass through the borough, which is mainly a residential and shopping town, many of its inhabitants working in London. In 1931 the Essex almshouses (1580) were restored but the mansion of Cassiobury park, the home of the earls of Essex, was demolished, though a part of the park was acquired for the public. Watford has a technical college, many schools and other educational centres, a thrice-weekly market (the first market charter was from Henry I), printing works (the biggest industry), paper mills, breweries, engineering, chemical and other works.

WATKINS GLEN, a village of New York, U.S., at the south end of Seneca lake; the seat of Schuyler county. A settlement was begun in 1791; after several changes in name, it became Watkins in 1852 in honour of Samuel Watkins, an early promoter, and in 1926 Watkins Glen. Salt production, from brine wells, is an important industry, and the annual Watkins Glen Grand Prix automobile race is held there. The entrance to Watkins Glen State park, established 1863, is on the main street. A creek flowing 2 mi. through the gorge of the 604 ac. park, descends 700 ft. to the village, forming spectacular pools, rapids and cascades. Primarily a resort, the permanent population is about 3,000. (C. C. Ma.)

WATLING STREET, the Early English name for the great road made by the Romans from London past St. Albans (Roman Verulamium) to Wroxeter (Roman Viroconium) near Shrewsbury and used by the Anglo-Saxons, just as a great part of it is used today. According to early documents the name was at first Waeclinga (or Waetlinga) straet; its derivation is unknown, but an English personal name may lie behind it. After the Conquest the road was included in the list of four royal roads which the Norman lawyers recorded or invented. (*See* Ermine Street.) Later still, in the Elizabethan period and after it, the name Watling street seems to have been applied to many Roman or reputed Roman roads in various parts of Britain. In particular, the Roman "North road" which ran from York through Corhridge and over Cheviot to Newstead near Melrose, and thence to the Wall of Pius, and which has largely been in use ever since Roman times, was not infrequently called Watling street, though there was no old authority for it and throughout the middle ages the section of the road between the Tyne and the Forth was called Dere street.

WATSON, HEWETT COTTRELL (1804–1881), British botanist, authority on the geographic distribution of British plants, was born at Firbeck, Yorkshire, on May 9, 1804. He received his scientific education at Edinburgh. About 1835 he settled in Thames Ditton, Surrey, where he died on July 27, 1881.

Beginning in 1832, Watson's publications extended over a period of more than 40 years. His most notable work, *Cybele Britannica* (1847–60), was the first serious attempt to put British geographical botany on an exact basis. His *Compendium* (1868–70) is essentially a condensed and emended edition of the *Cybele.* In these works the distribution of British plants is traced through the 18 provinces into which Watson divided Britain. In the *Supplement to the Compendium* (1872) distribution is traced through 38 subprovinces. His last large-scale work, *Topographical Botany* (1873–74), records distribution in even greater detail through 112 counties and vice-counties.

Bibliography.—Memoirs of Watson's life and works are found in *J. Bot., Lond.,* 19:257–265 (1881); *Watsonia,* vol. i (1949). For a list of his publications see *Botanisches Centralblatt,* 7:254–255 (1881).

(J. W. Tt.)

WATSON, JOHN BROADUS (1878–1958), U.S. psychologist who codified and forcefully publicized the theoretical program of behaviourism, was born at Greenville, S.C., on Jan. 9, 1878. He studied at Furman university, Greenville (M.A., 1900), and The University of Chicago (Ph.D., 1903), and was professor of psychology at Johns Hopkins university from 1908 until 1920, when he entered private business. He made many experimental contributions, especially to animal and child psychology.

Behaviourism as expounded by Watson sought to make psychology "a purely objective experimental branch of natural science" by restricting it to study of the relations between environmental events (stimuli) and behaviour (responses). Mental phenomena, as analyzed by the introspective psychologies dominant in the early 20th century, were held unverifiable in that they are directly observable only by their owners, and the abandonment of introspective methods was urged. Within the Watsonian program certain special hypotheses and judgments stand out: (1) the view that learned behaviour derives by the principles of the conditioned reflex (Pavlov) from a limited repertory of innate reflexes; (2) the theory that thinking and imagery reduce to "faint reinstatements" of the original muscular responses involved in speech and other motor behaviour; and (3) extreme environmentalism, as evidenced by the judgment that a "healthy, well-formed baby" may be made to develop in any specifiable direction and degree by appropriate environmental influence. After the early 1920s the program of behaviourism, in broad outline if not in specific Watsonian detail, was dominant in U.S. psychology, though from roughly the late '40s its influence declined.

Among Watson's books are *Behavior: an Introduction to Comparative Psychology* (1914); *Psychology From the Standpoint of a Behaviorist* (1919); *Behaviorism* (1925). He died in New York city on Sept. 25, 1958. *See* also BEHAVIOURISM.

See Robert S. Woodworth, ***Contemporary Schools*** of ***Psychology***, 2nd ed. (1948). (S. K.)

WATSON, JOHN CHRISTIAN (1867–1941), first Labor prime minister of Australia (April to August 1904), was born at Valparaiso, Chile, on April 9 when his parents were on voyage as immigrants to New Zealand. He received his primary education at Oamaru, N.Z., and began work as a compositor. In the early 1880s he immigrated to New South Wales. He became active in trade union affairs and was president of the Sydney Trades and Labor council in 1890. He was elected to the New South Wales parliament in 1894, in Labor's turn to politics after the "great strikes," but resigned in 1901 when he was elected to the first Australian commonwealth parliament and became leader of the Labor party. He was active in gaining Labor support for "New Protection," and a majority for the tariff protectionists over free traders. He retired in 1908 and died on Nov. 18, 1941. (J. F. C.)

WATSON, SERENO (1826–1892), U.S. botanist, one of its leading plant taxonomists of the 19th century, was born on Dec. 1, 1826, at East Windsor Hill, Conn. Graduating from Yale in 1847, he subsequently taught school, farmed, studied and practised medicine, and worked in insurance and banking. In 1866 he re-entered Yale to study chemistry and mineralogy, and in the following years, in California, became botanist to the United States geological exploration of the 40th parallel, under the direction of Clarence King (*q.v.*). Watson's association with the Gray herbarium of Harvard university began in 1870, and he was appointed curator there in 1874. He died on March 9, 1892, at Cambridge, Mass.

Watson described many new genera and species, particularly of plants of western North America. Outstanding among his publications are *Botany* (1871), the report on plants of the King expedition; *Botany of California* (1876–80), done in collaboration with W. H. Brewer and Asa Gray; *Bibliographical Index to North American Botany* (1878); and *Contributions to American Botany* (1873–91), a series of taxonomic papers. The sixth edition of Asa Gray's *Manual of the Botany of the Northern United States* (1890) was revised by Watson and J. M. Coulter.

See an account of Watson and a list of his publications in Proc. ***Amer.*** *Acad. Arts Sci.*, 27:403–416 **(1893).** (J. W. TT.)

WATSON, THOMAS (*c.* 1557–1592), English poet who exemplifies the spirit of the Renaissance in his use of Italian poetic forms and his facility in Latin versification. He was born in London, probably in 1557, was educated at Oxford, and while quite a young man enjoyed a reputation, even abroad, as a Latin poet. His earliest surviving work (1581), a Latin version of the *Antigone* of Sophocles, was followed by his first work in English, the *Hecatompathia or Passionate Centurie of Love* (1582). This is a collection or cycle of 100 pieces, in the manner of Petrarch, celebrating the sufferings of a lover and his long farewell to love. Although they profess to be sonnets, they are really written in triple sets of common 6-line stanza, and therefore have 18 lines each. The metre has had no imitators.

At this time, Watson was regarded, as the testimony of Thomas Nashe and others proves, as the best Latin poet of England. In 1590 he published, in English and Latin verse, his *Meliboeus,* an elegy on the death of Sir Francis Walsingham, and a collection of *Italian Madrigalls,* put into English by Watson and set to music by William Byrd. Of the remainder of his career nothing is known, except that on Sept. 26, 1592, he was buried in the Church of St. Bartholomew the Less, London. His latest and best book, *The Tears of Fancie, or, Love Disdained* (1593), posthumously published, is a collection of 60 competent 14-line sonnets.

WATSON, THOMAS EUGENE (1892–), U.S. marine corps officer, a prominent commander in the Pacific theatre during World War II, was born Jan. 18, 1892, in Oskaloosa, Ia., attended Penn college there and enlisted in the marine corps in 1912. Commissioned a second lieutenant on Oct. 20, 1916, he advanced through the various ranks to lieutenant general. Watson distinguished himself in command of the force that captured Eniwetok atoll, in the Marshall Islands, in February–March 1944. He commanded the 2nd marine division on Saipan and Tinian later in that year, and again distinguished himself in the capture of those islands of the Marianas group. After the war, he commanded Camp Lejeune, N.C., prior to his retirement in July 1950. (J. B. HN.)

WATSON, WILLIAM (*c.* 1559–1603), English conspirator, was born in the north of England, probably on April 23, 1559. In 1586 he became a Roman Catholic priest in France, and during the concluding years of Elizabeth I's reign he paid several visits to England; he was imprisoned and tortured more than once.

He became prominent as a champion of the secular priests in their dispute with the Jesuits, and in 1601 some writings by him on this question appeared which were answered by Robert Parsons (*q.v.*). When Elizabeth died, Watson hastened to Scotland to assure James I of the loyalty of his party and to forestall the Jesuits, who were suspected of intrigue with Spain. The new king did not, however, as was hoped, cease to exact the recusancy fines, and Watson became involved in the "Bye plot" or "Watson's plot," in which connection his name is best known, and in its sequel the Main or Cobham's plot.

Watson discussed the grievances of his coreligionists with another priest, William Clark, with Sir Griffin Markham and Anthony Copley and with a disappointed Protestant courtier, George Brooke. They took another Protestant, Thomas, 15th Lord Grey de Wilton, into their confidence.

It was arranged that James should be surprised and seized, while the conspirators talked loudly about capturing the Tower of London, converting the king to Romanism and making Watson lord keeper. One or two of the conspirators drew back; but Watson and his remaining colleagues arranged to assemble at Greenwich on June 24, 1603, and under the pretense of presenting a petition to carry out their object. The plot was a complete failure; Henry Garnet and other Jesuits betrayed it to the authorities, and its principal authors were seized, Watson being captured in August at Hay on the Welsh border. They were tried at Winchester and found guilty; Watson and Clark were executed on Dec. 9, 1603, and Brooke suffered the same fate a week later. Grey and Markham were reprieved, and Copley, who had made a full confession, was pardoned.

Before the executions took place, however, the failure of the Bye plot had led to the discovery of the Main plot. Brooke's share in the earlier scheme caused suspicion to fall upon his brother Henry

Brooke, Lord Cobham, the ally and brother-in-law of Sir Robert Cecil, afterward earl of Salisbury. Cobham appears to have been in communication with Spain about the possibility of killing "the king and his cubs" and of placing Lady Arabella Stuart on the throne. He was seized, tried and condemned to death; though he was led out to the scaffold he was not executed. It was on suspicion of being associated with Cobham in this matter that Sir Walter Raleigh was arrested and tried.

See the article *by* A. F. Pollard in *Dictionary of National Biography* (1885–1901).

WATSON, SIR WILLIAM (1858–1935), English poet, born on Aug. 2, 1858, at Burley-in-Wharfedale, Yorkshire, was brought up at Liverpool. In 1880 he published his first book, *The Prince's Quest,* but he first made a name in 1890 with the publication of *Wordsworth's Grave.* Besides *Wordsworth's Grave* the volume contained *Ver tenebrosum* (originally published in the *National Review* for June 1885), a series of political sonnets indicating a fervour of political conviction that was later to find still more impassioned expression. There followed: *Lacrymae Musarum* (1892); *The Eloping Angels* (1893); *Odes and Other Poems* (1894); *The Father of the Forest* (1895); *The Purple East* (1896), sonnets on the Armenian question; *For England* (1903); *New Poems* (1909); *A Hundred Poems* (1922); *Poems Brief and New* (1925), and other verse. *Collected Poems* were published in 1898 and 1905. Watson is said to have been considered for the laureateship when Tennyson died. In 1917 he was knighted.

Except in Watson's political verse there is more thought than passion. Bearing trace enough of the romantic epoch, his poetry recalls the earlier classical period in its epigrammatic phrasing and Latinized diction.

See William Archer, *Poets of the Younger Generation* (1902).

WATT, JAMES (1736–1819), Scottish engineer, the inventor of the modern condensing steam engine, was born at Greenock on Jan. 19, 1736. He made his way to London, at the age of 19, to be apprenticed to an instrument maker, but the hard work and frugal living forced him at the end of a year to seek rest at home. However, he had gained a fair knowledge of the trade and became handy in the use of tools, and upon his return to Scotland in 1756 he tried to establish himself as an instrument maker in Glasgow, only to find that the city guilds would not recognize a craftsman who had not served the full term of apprenticeship. The college, however, took him under its protection, and in 1757 he was established in its precincts with the title of mathematical instrument maker to the university.

Joseph Black, the discoverer of latent heat, then lecturer on chemistry, and John Robison, then a student, afterward professor of natural philosophy at Edinburgh, became his intimate friends, and with them he often discussed the possibility of improving the steam engine, the best type of which was at that time the Newcomen engine. It was then applied only to pumping water—chiefly in the drainage of mines; and it was so clumsy and wasteful of fuel that it was little used. Some early experiments by Watt in 1761 or 1762 had no direct result, but in 1764 his attention was seriously aroused by having a model of Newcomen's engine, which formed part of the college collection of scientific apparatus, given him to repair. Having put the model in order, he was at once struck with its enormous consumption of steam. After some unsuccessful efforts to remedy this difficulty Watt began a scientific examination of the properties of steam, studying by experiment the relation of its density and pressure to its temperature, and concluded that two conditions were essential to the economical use of steam in a condensing steam engine. One was that the temperature of the condensed steam should be as low as possible, 100° F. or lower, otherwise the vacuum would not be good; the other was, to quote his own words, "that the cylinder should be always as hot as the steam which entered it."

Early in 1765, the idea struck him that, if the steam were condensed in a vessel distinct from the cylinder, the temperature of condensation could be kept low and that in the cylinder high. Without delay Watt put his idea to the test, and found that the separate condenser acted as he had anticipated. To maintain the vacuum in it he added an air pump to remove the condensed steam and injection water with any air gathered in the condenser.

To further his object of keeping the cylinder as hot as the steam that entered it, Watt supplemented his great invention of the separate condenser by several less notable but still important improvements: a tighter packing over the piston, lubricated by oil; a steam-tight stuffing box for the piston rod, which allowed steam instead of air to press on top of the piston; an insulated casing for the cylinder; and a steam jacket that provided a layer of steam between the cylinder proper and an outer shell.

All these features were specified in Watt's first patent *(see* STEAM: *Steam Engine),* which was obtained in Jan. 1769, nearly four years after the inventions it covered had been made. In the interval Watt had been striving to demonstrate the merits of his engine by trial on a large scale. His earliest experiments left him in debt, and he agreed that John Roebuck, founder of the Carron ironworks, should take two-thirds of the profits of the invention in consideration of his bearing the costs. An engine was then erected at Kinneil, near Linlithgow, and this gave Watt the opportunity of overcoming many difficulties in details of construction. Meanwhile he was gaining reputation as a civil engineer. In 1767 he was employed to make a survey for a Forth and Clyde canal, which failed, however, to secure parliamentary sanction. During the next six years he made surveys for several canals and prepared plans for several harbours, for deepening the Clyde and for building a bridge over it at Hamilton.

In 1768 Watt met Matthew Boulton, who owned the Soho engineering works at Birmingham. Boulton agreed to take Roebuck's share in the invention, and to apply to parliament for an act to prolong the term of the patent. The application was successful, and in 1775 an act was passed continuing the patent for 25 years. By this time Watt had settled in Birmingham, where the manufacture of steam engines was begun by the firm of Boulton & Watt. Boulton left the work of inventing to Watt, in uhose genius he had the fullest faith, while he attended to the business side.

Watt's second steam-engine patent, dated 1781, describes five different methods of converting the reciprocating motion of the piston into motion of rotation, so as to adapt the engine for driving ordinary machinery. A third patent, in 1782, covered the invention of the double-action engine; that is to say, both ends of the cylinder, instead of only one, were alternately put in communication with the boiler and the condenser. This patent also described the system of expansive working, in which the admission valve is closed after only a portion of the stroke is completed, and the steam enclosed in the cylinder is then allowed to expand during the remainder of the stroke, doing additional work upon the piston without making any further demand upon the boiler until the next stroke. Recognizing that this would cause a gradual reduction of the force on the piston, Watt devised a number of contrivances for equalizing the effort throughout the stroke. He found, however, that the inertia of the pump rods in his mine engines, and the flywheel in his rotary engines, served to compensate for the inequality of thrust sufficiently to make these contrivances unnecessary. His fourth patent, taken out in 1784, describes an arrangement of links by which the top of the piston rod is connected to the beam so that it may either pull or push, and is at the same time guided to move in a straight line.

A still later invention was the centrifugal governor, by which the speed of rotary engines was automatically controlled. This is now recognized as one of the earliest applications of feedback, an essential element in automation. Another of Watt's contributions to the development of the steam engine is the indicator, which draws a diagram of the relation of the steam's pressure to its volume as the stroke proceeds. The eminently philosophic notion of an indicator diagram is fundamental in the theory of thermodynamics; the instrument itself is to the steam engineer what the stethoscope is to the physician.

By 1783 all but one of the Newcomen pumping engines in Cornwall had been displaced by Watt's. The mines were then far from thriving; many were even on the point of being abandoned through the difficulty of dealing with large volumes of water; and Watt's invention. by its economy, gave many of them a new lease of life.

His engine used no more than a fourth of the fuel that had formerly been needed to do the same work, and the Soho firm usually claimed as royalty a sum equivalent to one-third of the saving.

Watt's first patent made the steam engine quick in working, powerful and efficient, but still only as a steam pump. His later inventions adapted it to drive machinery of all kinds. Subsequent improvements consisted chiefly in the use of high-pressure steam and in the introduction of compound expansion. Both of these improvements the firm of Boulton & Watt strongly resisted.

On the expiration in 1800 of the act by which the patent of 1769 had been extended, Watt gave up his share in the business to his sons, who carried it on with a son of Boulton for many years. The remainder of Watt's life was quietly spent at Heathfield hall, near Birmingham, where he devoted his time to mechanical pursuits and inventions. He died at Heathfield on Aug. 19, 1819.

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WATTEAU, (JEAN) ANTOINE (1684–1721), the great French painter whose *fêtes galantes* ushered in the art of the 18th century, was born at Valenciennes on Oct. 10, 1684. His father, a tiler, apprenticed him to a local painter. Almost penniless, Watteau departed for Paris in 1702, where he worked in a shop in which small devotional pictures and copies of popular Dutch painters were turned out wholesale. In 1704 he entered the studio of Claude Gillot, an accomplished draftsman and a man of lively intelligence with a passionate love for the theatre, especially the Italian comedy, which became an element of Watteau's art. In 1708 Watteau went to Claude Audran, a fashionable decorative painter and keeper of the Luxembourg palace. While with Audran, he attained a mastery of arabesque and *chinoiserie* decoration and was also greatly influenced by the Rubens paintings of "The Life of Marie de' Medici," then in the Luxembourg. He executed sketches from life in the palace gardens, sharpening and elaborating his remarkable fluency of draftsmanship.

ALINARI

"GILLES" BY ANTOINE WATTEAU. IN THE LOUVRE, PARIS

In 1709 he entered for the Academy's Prix de Rome but only obtained the second prize. Disappointed by this failure, Watteau, having sold his first military picture to Pierre Sirois, decided to return to Valenciennes, where he continued his long and successful series of camp pictures. These show both the influence of Rubens' technique and the artist's own vivid observation of life. In 1710 Watteau returned to Paris and in 1712 was made an associate of the Academy on the presentation of "Les Jaloux" (National gallery, Melbourne, Austr.). From this date until 1715 there is no certain information concerning his life. He was already stricken with tuberculosis which perhaps accounts for his restless and difficult moods and his constant change of residence as well as the feverish haste to achieve as much as possible in various styles and techniques. Thanks to Pierre Crozat, one of the great financiers and collectors of his time, Watteau entered the most intelligent and artistic society of the day. In 1715 Crozat had recently returned from Italy bringing with him many drawings from which Watteau gained an immense knowledge of the old masters, especially of the Venetian and Flemish schools. He was also to hear a great deal of music, a most potent influence on his art, and to study landscape both in the gardens surrounding Crozat's house in Paris and at his country property at Montmorency. From this period onward Watteau was constantly busy with commissions. With the help of his sketchbooks, on which he relied for his apparent improvisations, he produced a series of splendid and individual works.

Group pictures of friends, often dressed in the costume of the theatre, nudes, portraits. landscapes and above all *fêtes galantes*, his unique contribution to European art, followed in quick succession, culminating in his diploma picture, "The Embarkation for Cythera" (1717, Louvre, Paris). In this work Watteau realized the perfect fusion between his own dream world and acute observation of nature and the human figure. In 1719 he decided to visit England, where he hoped to obtain further commissions and to consult Richard Mead, a well-known doctor and a keen collector who already possessed "L'Amour Paisible" (Potsdam) and for whom the artist then painted "The Italian Comedians" (National gallery, Washington, D.C.).

In 1720 Watteau returned to Paris for the wedding of his friend Jean de Jullienne, for whom he executed the "Rendez-vous de Chasse" (Wallace collection, London). He stayed with his friend and biographer E. F. Gersaint for six months and in eight mornings painted for him the "Enseigne de Gersaint" (Berlin), a signboard depicting the interior of the dealer's shop. In this picture, so perfectly composed, each stroke is filled with supreme confidence and here. Watteau realized the world of pure beauty which lies behind everyday things. The great portrait of "Gilles" (Louvre) is perhaps Watteau's last painting before, harassed by restlessness and ill-health, he moved to Nogent-sur-Marne. He sent for his former pupil J. B. J. Pater, with whom he worked on some unfinished pictures until his death in Gersaint's arms on July 18, 1721.

Watteau was a painter endowed with remarkable technical facility and unique in the combination of poetic sensibility and the passionate observation of reality. He swept away the last vestiges of the official art of the age of Louis XIV, uniting in his works not only the germ of all 18th-century art but foreshadowing many of the discoveries of later schools, especially the Impressionists. Largely as a result of the influence of the *Recueil Jullienne,* four volumes of Watteau's drawings and paintings engraved by the best artists of his time and published by Jullienne in 1735, Watteau's art remained popular all over Europe until swept away, for a time, by the revolutionary doctrines of J. L. David. The Louvre owns nine paintings of supreme quality and over 30 drawings, and Watteau is splendidly represented in the Wallace collection, which contains nine of his finest paintings, and at the British museum by a remarkable collection of drawings. In Germany some of Watteau's best works, originally purchased by Frederick the Great from Jullienne, can be seen in Berlin and at Potsdam, and there are also two fine *fêtes galantes* at Dresden. The Hermitage museum, Leningrad, contains five paintings including two of the best military pictures. In the United States, Watteau is well represented in Washington, D.C., New York city, Boston and Cleveland. *See* also PAINTING: *France: 17th and 18th Centuries;* CRAYON DRAWING.

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WATTERSON, HENRY (1840–1921), U.S. journalist, and newspaper editor, one of the great figures in a bygone era of personal journalism, was born in Washington, D.C., where his father was serving as a member of congress from Tennessee, on Feb. 16, 1840. As a youth he had literary ambitions, and after attending an academy in Philadelphia turned to journalism, becoming for a brief time editor of the *Nashville* (Tenn.) *Republican Banner* in 1861. During the Civil War he was attached to the staffs of the Confederate generals Nathan B. Forrest, Leonidas Polk and John B. Hood; was chief of scouts in the Johnston-Sherman campaign and edited the *Rebel* in Chattanooga. After further newspaper work and the first of many trips abroad, he became editor of the *Daily Journal* at Louisville, Ky. In 1868, with Walter N. Haldeman, he founded and became editor of the *Louisville Courier-Journal*, a consolidation of the *Courier*, the *Democrat* and the *Journal*. Haldeman and Watterson adopted a policy of business integrity and interest in the public service which soon made the *Courier-Journal* one of the most influential of southern newspapers. It had its unpopular days, however, in such times as the Reconstruction period, when it stood for conciliation between the two sections, and during the free silver and greenback agitations when it advocated a sound currency. Watterson was largely responsible for the Democratic nomination of Gov. Samuel J. Tilden of New York for the presidency in 1876. He was Democratic representative in congress for a short term (1876–77), where he served as Tilden's floor leader during the Tilden-Hayes electoral contest. In Aug. 1918 he sold his interest in the paper and became "editor emeritus." In April 1919 he resigned from the paper because of its support of the League of Nations. He died at Jacksonville, Fla., on Dec. 22, 1921. He wrote *History of the Spanish American War* (1898), *The Compromises of Life and Other Lectures and Addresses* (1903), and *"Marse Henry"; an Autobiography* in two volumes (1919). *Editorials of Henry Watterson* was compiled by Arthur Krock in 1923.

See Isaac F. Marcosson, *"Marse Henry"* (1951); Joseph Frazier Wall, *Henry Watterson: Reconstructed Rebel* (1956).

WATTLE AND DAUB (DAB), a term in architecture applied to a wall made with upright stakes with withes twisted between them and then plastered over. It is probably one of the oldest systems of construction. The Egyptians employed the stems of maize for the upright stakes; these were secured together with withes and covered over with mud, the upper portions of the maize stems being left uncut at the top, to increase the height. These uncut tops were bent out by the weight of the mud roof, and were probably the origin of the later cavetto cornice, the torus molding below representing the heavier coil of withes at the top of the wall (*see* MOLDING). Vitruvius refers to wattle and daub; in the middle ages it was employed as a framework for clay chimneys, and for the filling in of half-timber work.

WATTMETER, an instrument for the measurement of electric power or the rate of supply of electric energy to any circuit. Wattmeters are of three types: electrostatic, used only in standardizing laboratories; dynamometer instruments based on the principle of the Siemens electrodynamometer; and induction instruments. *See* INSTRUMENTS, ELECTRICAL MEASURING.

WATTS, GEORGE FREDERIC (1817–1904), English painter and sculptor of grandiose allegorical themes, was born in London on Feb. 23, 1817, the son of an unsuccessful piano manufacturer. From the age of ten he frequented the studio of William Behnes, the sculptor, who introduced him to the Elgin marbles. Although on the roll of the Royal Academy schools from 1835 to 1837, his attendance was irregular. Among his first three Academy exhibits were "The Wounded Heron" and "Miss Hopkins" (1837, both Watts gallery, Compton, Surrey), which display a precocious technical mastery based chiefly on William Etty and Sir Thomas Lawrence. In the Houses of Parliament competition of 1843, Watts won a first prize of 1300 for his cartoon "Caractacus," and that year left for Florence as the guest of Lord and Lady Holland, accompanying them on visits to Rome and Naples. This cultivated existence was a liberating experience deeply to affect the artist, but here also began that hothouse tending of Watts as a tame genius which was continued by Mr. and Mrs. Henry T. Prinsep at Little Holland house from 1851 to 1875. While abroad he painted "Story From Boccaccio" (Tate gallery, London), which shows his aptitude for vast mural designs. Entering his "Alfred Inciting the Saxons" ior the 1847 Houses of Parliament competition, he again won a first prize, of 1500.

In 1852 Watts unsuccessiully offered to decorate the great hall of Euston station for the cost of the materials alone, but the following year be began the fresco "Justice" in the new hall of Lincoln's Inn, completed in 1859. A much grander scheme depicting a symbolic history oi mankind, sketched out in 1848 as "The House of Life," never matured, but its subject matter, conceived in terms of vague abstract ideals, is characteristic of Watts's imprecise philosophical outlook. An agnostic, fatalistic and pessimistic, he yet believed that art should preach a universal message independent of current dogmas. Appalled by the materialism of his age, he nevertheless accepted its benefits while shunning to identify himself with its victims. Soon after his return to England in 1847, he painted a bitter comment on society in "Life's Illusions," and again in "Mammon" (1884–85, both Tate gallery).

Apart from a disastrous, short-lived marriage with the 16-year-old Ellen Terry, Watts's domestic life remained uneventful; he married Mary Fraser-Tytler in 1886. He was elected royal academician in 1867, and had begun experimenting with monumental sculpture. A small, Michaelangelesque marble "Clptie" (bronze version, Tate gallery) was in the 1868 Academy, and in 1870 he began the large equestrian statues "Hugh Lupus" (finished 1883, Eaton hall, Cheshire) and "Physical Energy" (finished 1904; second, revised cast Kensington gardens, London). The discipline of this medium influenced Watts's later paintings, which became more solidly and simply constructed; *e.g.*, "For He Had Great Possessions" (1894, Tate gallery). His technique broadened and was nearer to that of Tintoretto than Titian. The most iamous of his later works, "Hope" (1886, version in Tate gallery), is ambiguous and perhaps ironical in meaning. In addition to some excellent landscapes, Watts completed many shrewdly observed portraits of his famous contemporaries, notably that of Cardinal Manning (1882, National Portrait gallery).

Watts presented over 50 works to the Tate gallery; and there is a permanent collection at Compton, Surrey, his home from 1891 until his death on July 1, 1904. Having twice refused a baronetcy, he accepted an Order of Merit in 1902.

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(D. L. FR.)

WATTS, ISAAC (1674–1748), English theologian and hymn writer, son of a clothier, was born at Southampton on July 17, 1674. The father, who afterward had a boarding school at Southampton, also wrote poetry, and a number of his pieces were included by mistake in vol. i of the son's *Posthumous Works*. Isaac Watts studied at the Nonconformist academy, Stoke Newington, London. On leaving the academy he spent over two years at home, and began to write his hymns. In the autumn of 1696 be became tutor in the family of Sir John Hartopp at Stoke Newington, where he probably prepared the materials of his two educational works—*Logick, or the Right Use of Reason in the Enquiry After Truth* (1725), and *The Knowledge of the Heavens and the Earth Made Easy, or the First Principles of Geography and Astronomy Explained* (1726). In his 24th year Watts became assistant pastor of the Independent congregation in Mark Lane, London, and two years later, pastor. In 1712 he went to live with Sir Thomas Abney of Abney Park.

Watts preached only occasionally, devoting his leisure chiefly to the writing of hymns (*see* HYMNS), the preparation of his sermons for publication, and the composition of theological work. In 1706 appeared his *Horae Lyricae*, of which an edition with memoir by Robert Southey forms vol. ix of *Sacred Classics* (1834); in 1707 a volume of *Hymns;* in 1719 *The Psalms of David;* and in 1720 *Divine and Moral Songs for Children.* His Psalms are free paraphrases, rather than metrical versions, and some of them ("O God, our help in ages past," for instance) are among the most famous hymns in the language. Isaac Watts died on Nov. 25, 1748, and was buried at Bunhill Fields.

Among the theological treatises of Watts, which are far from conventional orthodoxy, are: *Doctrine of the Trinity* (1722); *Essay on the Freedom of the Will* (1732); and *Useful and Important Questions Concerning Jesus, the Son of God* (1746). He was also the author of a variety of miscellaneous treatises. His *Posthumous Works* appeared in 1773, and a further installment of them in 1779. *The Works of . . . Isaac Watts* (6 vol.), ed. by Jennings and Doddridge, with a memoir compiled by G. Burder, appeared in 1810–11. His poetical works were included in Johnson's *English Poets*, where they were accompanied by a *Life*, and they appear in subsequent similar collections.

WATTS-DUNTON, WALTER THEODORE (1832–1914), English man of letters, was born at St. Ives, Huntingdon, on Oct. 12, 1832. His article on "Poetry" in the ninth edition of the *Encyclopædia Britannica* was the principal expression of his views on the subject. Watts-Dunton was in later years Rossetti's intimate friend. He was the friend of Swinburne (*q.v.*), who shared his home for nearly 30 years before he died in 1909. In 1897 he published a volume of poems under his own name, *The Coming of Love.* His prose romance *Aylwin* (1898) attained immediate success, and ran through many editions in the course of a few months. Both *The Coming of Love* and *Aylwin* set forth, the one in poetry, the other in prose, the romantic and passionate associations of Romany life, and maintain the traditions of Borrow, whom Watts-Dunton had known well in his own early days. He edited George Borrow's *Lavengro* (1893) and *The Romany Rye* (1900); his *Studies of Shakespeare* appeared in 1910; in 1903 he published *The Renascence of Wonder*, a treatise on the romantic movement, as a preface to the third volume of Chambers' *Encyclopaedia of English Literature*, and in 1916 this, with his *Encyclopædia Britannica* article—both enlarged—was republished in book form as *Poetry and the Renascence of Wonder.* He died at Putney on June 6, 1914.

WAUGH, BENJAMIN (1839–1908), English social reformer and one of the founders of the London Society for Prevention of Cruelty to Children (S.P.C.C.), was born at Settle, Yorkshire, on Feb 20, 1839. After spending several years in business he entered the Congregational ministry in 1865. Settling at Greenwich he devoted himself especially to children and served on the London school board from 1870 to 1877. As a result of his information a clause, giving magistrates power to take the evidence of children too young to understand the nature of an oath, was included in the Criminal Law Amendment act of 1885. The same year Waugh gave up pastoral work. He died at Westcliff, Essex, on March 11, 1908.

In 1884 Waugh was one of those responsible for founding the S P C.C., which was established nationally in 1889 and granted a charter of incorporation in 1895. In 1889 he saw his society justified by the act for the prevention of cruelty to children, the first steppingstone to the act of 1908. (See CHILDREN, LAWS CONCERNING) The society's financial administration was attacked in 1897; an inquiry was demanded by Waugh and the commission, which included Lord Herschell, vindicated both Waugh and the society. Waugh was an honorary director from 1889 to 1895, when he became a paid director until 1905 and consulting director from 1905 until his death. Waugh edited the *Sunday Magazine* from 1874 to 1896 His *The Gaol Cradle: Who Rocks It?* (1873) was a plea for the abolition of juvenile imprisonment.

See R Waugh, *Life of Benjamin Waugh* (1913).

WAUKEGAN, a city of northeastern Illinois, U.S., the seat of Lake county. stands on a high bluff above Lake Michigan about 40 mi. N of Chicago. The alternation of highland and ravine creates a pleasant contrast. It was designated on 18th-century maps as Little Fort. The first American white settler arrived in 1835, and the name was changed to Waukegan, the Potawatomi equivalent of Little Fort, in 1849 at the time of incorporation. It was chartered as a city in 1859. As a part of the Chicago-Milwaukee industrial complex, it manufactures a wide variety of products, including wire, chemical and pharmaceutical preparations, asbestos roofing, outboard motors and steel castings. To the south is the Great Lakes naval training station, and a little farther removed, Ft. Sheridan Both help colour the life of the city and use it as a residence area. Transportation is provided by a harbour (with coal docks) on Lake Michigan, a number of major highways and railways. Pop. (1960) 55,719. For comparative population figures ***see*** table in ILLINOIS: *Population.* (E. G. HI.)

WAUKESHA, a city of Wisconsin, U.S., 16 mi. W. of Milwaukee on the Fox river; the seat of Waukesha county. First settled in 1834, it was incorporated as a village in 1852 and as a city in 1896; its name was derived from the Potawatomi Wauktsha meaning "fox." From about 1870 to 1905 it was a popular summer resort. Lying in a region of intensive dairy farming, it is a centre for the sale of superior dairy cattle. Its industries are mainly metal working, led by the manufacture of motors, jacks and castings. and also include wood products, food and beverage processing and mineral spring water bottling. Carroll college, a Presbyterian coeducational institution, was incorporated in 1846. The city has a symphony orchestra. For comparative population figures ***see*** table in WISCONSIN: *Population.* (W. *S* GR.)

WAUSAU, a city in north-central Wisconsin, U.S., seat of Marathon county, is on the Wisconsin river about 140 mi. N. of Madison. Huge forests of white pine and the water power of Big Bull falls brought settlers in the late 1830s. A settlement was established and named Wausau (an Indian word meaning "far away place") in 1850. Early population was predominantly German. Dubbed the "Lumberjack City," it was incorporated in 1872.

The chief manufactures include wood and wood products such as food package containers, fibreboards, paper, veneers and doors. Wausau is also an important agricultural and distribution centre. It is the home office of one of the country's largest writers of workmen's compensation insurance, and the headquarters of the Wisconsin Valley Improvement company, a privately owned but state-regulated enterprise which stores the water of the Wisconsin river in reservoirs and releases it on a toll basis to operating plants.

Its river situation, nearness to the upper lake country and towering Rib mountain on the city's border make Wausau a favoured area for fishing, hunting, and summer and winter sports. For comparative population figures ***see*** table in WISCONSIN: *Population* (AL. E. SM)

WAUTERS, ÉMILE CHARLES MARIE (1846–1933), Belgian painter, mainly of historical subjects, was born in Brussels on Nov. 29, 1846. He studied under Portaels and Gérôme and in 1868 produced a striking work, "The Battle of Hastings: the Finding of the Body of Harold by Edith." As his youth disqualified him for the medal of the Brussels Salon, he was sent, by way of compensation, as artist-delegate to Suez for the opening of the canal (1869). In 1870 Wauters exhibited his picture of "Mary of Burgundy Entreating the Sheriffs of Ghent to Pardon Her Councilors Hugonet and Humbercourt" (Liège museum), which created a great sensation. Even more celebrated was the "Madness of Hugo van der Goes" (1872, Brussels museum), a picture that gained for Wauters the grand medal at the Salon and led to the commission for two large works decorating the Lions' staircase of the Hôtel de Ville. His 380-by-49 ft. panorama, "Cairo and the Banks of the Nile" (1881), was exhibited with extraordinary success in Brussels, Munich and The Hague. Wauters also painted some portraits, sometimes using pastel as a medium. He died in Paris on Dec. 11, 1933.

WAUWATOSA, a city of Wisconsin, U.S., in Milwaukee county and a suburb of Milwaukee, which borders it on three sides, is on the Menomonee river. The Potawatomi Indians relinquished their title to the region in 1833, and New England and New York settlers began arriving in 1835, followed by German and Irish immigrants. First known as Hart's Mill, Wauwatosa became a village in 1892 and a city in 1897. The name Wauwatosa is a modification of an Indian word meaning "firefly."

With the extension of street railways in the mid-1880s, workers in Milwaukee and West Allis began establishing their homes in Wauwatosa; other civic developments, such as the adoption of a zone ordinance in 1921, increased this trend. Between 1930 and 1960 the population increased by 168.6% to 56,923. Industry is limited, and includes the manufacture of iron castings, interior woodwork, steel scaffolding, chemicals, cement blocks, screws and bolts. For comparative population figures ***see*** table in WISCONSIN: *Population.* (AL. E. SM.)

WAVE LENGTH, in radio, the distance traveled in one period or cycle by a periodic disturbance. The distance between corresponding phases of two consecutive waves of a wave train. The quotient of velocity by frequency. For a discussion of theory ***see*** ELECTROMAGNETIC WAVES; for wave lengths in broadcasting and wireless ***see*** RADIO.

WAVELL, ARCHIBALD PERCIVAL WAVELL, 1ST EARL (1883–1950), British army officer, a leading figure of World War II who defeated the Italians in east Africa and liberated Ethiopia, was born at Colchester on May 5, 1883. He was educated at Winchester and joined his father's regiment, the Black Watch. After war service in South Africa, India, Flanders and Palestine, he was recognized as an exceptional trainer of troops and in July 1939 was appointed to the new middle east command, in which he reached (as a full general) the high-water mark of his military career by routing in Dec. 1940–Feb. 1941 greatly superior Italian armies in Libya and liquidating the Italian empire in east Africa (Jan–May 1941). But in July 1941 after unsuccessful fighting against the Germans in Greece, Crete and Libya he was superseded and appointed to command in India. When Japan entered the war, as Allied commander in the southwest Pacific and against great odds Wavell could not prevent the loss of Malaya and Burma. As a field marshal and viceroy of India (June 1943–Feb. 1947) he had to cope first with famine and then with intractable political controversies. He died in London on May 24, 1950.

Wavell was famous for his knowledge of languages, phenomenal memory and literary gift, as shown in his life of his former chief, *Allenby* (1940–43), and his love of poetry; also for his taciturnity, which handicapped him in discussion. His sterling character, in which his uncomplaining loyalty was conspicuous, won him general respect and confidence. Wavell's only son was killed in Kenya on Dec. 24, 1953, in an attack on Mau-Mau terrorists.

Wavell's writings included *The Palestine Campaigns* (1928); *Other Men's Flowers,* an anthology (1944); *The Good Soldier* (1948); *Soldiers and Soldiering* (1953). (J. R. M. B.)

WAVELLITE, a mineral consisting of hydrated aluminum phosphate. Distinct crystals are of rare occurrence, the mineral usually taking the form of hemispherical or globular aggregates with an internal radiated structure. It is translucent and varies in colour from gray or white to greenish, yellowish, etc. The formula is $Al_3(OH)_3(PO_4)_2 + 4\frac{1}{2}H_2O$ and it crystallizes in the orthorhombic system. The hardness is 3.5, and specific gravity 2.32. It was first found, at the end of the 18th century, by W.

Wavell near Barnstaple, Devon, where it lines crevices in a black slaty rock. In the United States it has been found in Pennsylvania and near Hot Springs, Ark.

WAVE MECHANICS, a particular form of quantum mechanics which was developed as the result of researches by Louis de Broglie and Erwin Schrodinger in 1925–26. As loosely used, the term wave mechanics is practically synonymous with quantum mechanics.

See the article on **QUANTUM MECHANICS,** especially the section entitled Wave Mechanics. (J. H. V. V.)

WAVE MOTION. The study of wave motion is concerned with the propagation of disturbances in physical systems. The system may be a body of fluid, a structure or even a procession of automobiles; the disturbance may be characterized by changes in velocity of the fluid particles, distortion of the structural material, changes in automobile speed or variations in any physical quantities which contribute to the time-dependent description of the system.

As an aid to discussion, the subject is frequently subdivided into categories according to the intensity of the disturbance, its periodicity or lack thereof, the manner of its initiation and, as in the following, the type of medium in which the waves are propagating.

Waves in a Liquid.—Perhaps the most frequently observed waves are those which propagate on the surface of a body of liquid. The study of a particular example of such waves provides some insight into the manner in which the fundamental laws of physics can be invoked to provide a quantitative account of wave motion phenomena. A channel of unit width with vertical plane walls contains a layer of fluid whose initial depth distribution is defined by the solid line of fig. 1. Consider the circumstances under which

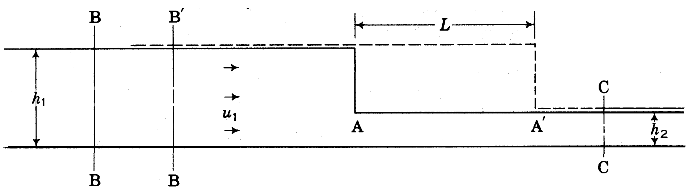

FIG. 1.— SEQUENTIAL POSITIONS OF SURFACE OF LIQUID DURING BORE PROPAGATION

the successive configurations of fig. 1 can occur. The velocity of the fluid to the left of A at time t_1 (and to the left of A' at a later time t_2) is denoted by u_1, and its depth is denoted by h_1. The depth of the motionless fluid into which the wave is advancing is called h_2. The two physical laws which must be invoked are those which state that: (1) no fluid materializes or disappears during the process; and (2) the rate at which the momentum of any element of the fluid increases must be equal to the net force externally applied to that element. If the element of fluid to which these laws are to be applied is one initially lying under the solid line of fig. 1 between B-B and C-C, it will, after a time interval t, lie under the dotted line between B'-B' and C-C; the distance from B-B to B′-B′ will be u_1t. Since the deeper fluid is moving to the right at speed u_1, the first law stated above requires that the distance L over which the formerly quiescent fluid has been accelerated during this time interval be given by

$$(hi - h_2)\ L = hi\ u_1t$$

In order to apply the second law, it should be noted that the average fluid pressure (taking atmospheric pressure as a reference) in the fluid of depth h_1 is $\rho gh_1/2$, and that the average pressure over C-C is $\rho gh_2/2$. Here, g is the acceleration of gravity and p is the density (mass per unit volume) of the fluid. The net horizontal force exerted on the fluid element under consideration during this time interval is, then, composed of two parts: (1) a force of magnitude $\rho gh_1^2/2$ exerted by the fluid on the left of the element; and (2) one of magnitude $\rho gh_2^2/2$ exerted by the fluid on the right of C-C. The net force is directed to the right and has magnitude $\rho g(h_1^2 - h_Z^2)/2$; thus, the second law states that

$$\rho g(h_1^2 - h_2^2)/2 = (\rho h_2L/t)u_1$$

where ρh_2L is the mass of fluid which has been accelerated from rest to speed u_1 during the time t, and $(\rho h_2L/t)u_1$ is therefore the rate at which momentum has been acquired by the fluid element during that time interval. These two quantitative statements now imply that

$$u_1^2 = g(h_1 - h_2)^2\ (hi + h_2)/2h_1h_2$$

and

$$L/t = \sqrt{g(h_1 + h_2)\ h_1/2h_2}$$

L/t is the speed at which the front of the deeper layer encroaches on the shallow layer; *i.e.*, the wave speed. Here, as in almost all wave phenomena, the wave speed differs from, and is greater than, the material particle speed. It must be noted that dissipative effects, variations of velocity with depth, and the difficulties associated with the determination of the detailed shape of the front have been ignored. Despite these simplifications this quantitative picture of the encroachment of a deep layer of liquid into a more shallow layer is an excellent macroscopic description of the tidal bores which occur in many of the rivers of the world. In the application of these results to such cases, speeds must be measured relative to an observer moving with the undisturbed speed of the river in which the bore is to be propagated.

The foregoing phenomenon can be observed on a small scale by allowing water to flow from a faucet into a basin. The speed can be adjusted so that two zones surround the point at which the water meets the basin; the inner zone consists of a thin flat layer of water moving rapidly outward, and the outer zone is a thicker more slowly moving layer. The size of these zones can be controlled by adjusting the faucet.

In order to relate this observation to fig. 1, the reader should imagine that he views that figure as he moves to the right at a speed equal to L/t as calculated above; *i.e.*, he moves at the speed of the bore. From this reference system the bore is stationary, the thin layer on the right is moving to the left at speed L/t and the thick layer is moving to the left at speed L/t-u_1. The leftward motion so described agrees precisely with the radial motion of the observation.

Considerations similar to the foregoing can be used to indicate the manner in which a gentler disturbance is propagated. Ordinarily, a wave whose height is very small compared with the ambient fluid depth, h, and whose extent in the direction of propagation is large compared with h, will propagate in an otherwise

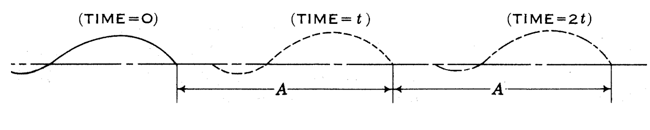

FIG. 2.— SURFACE POSITION AT TIMES O, t AND $2t$, OF A NONDISPERSIVE WAVE TRAVELING AT SPEED A/t. A DENOTES THE DISTANCE TRAVERSED IN TIME t BY THE WAVE

quiescent fluid at speed $\sqrt{gh}$ (this is consistent with the foregoing formula for L/t). This propagation speed is independent of the details of the wave shape, and the wave must propagate without change of shape (fig. 2). However, if the wave height is an appreciable fraction of the depth, so that the wave speed is significantly greater at positions of greater depth than it is at shallow spots, the propagation must occur in the manner illustrated in fig. 3. The argument presented here to account for this is by no means complete, but it does indicate the considerations which help make possible a correct prediction of the steepening of such waves and formation of bores discussed earlier. In particular, by the time configuration C of fig. 3 is reached, a bore starts to form; configuration corresponding to later times can be deduced only from a more precise theory.

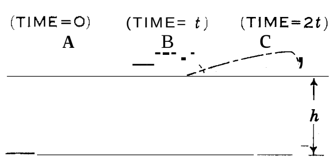

FIG. 3.— SEQUENTIAL POSITIONS OF INTENSE WAVE MOVING TO RIGHT (see TEXT)

The propagation of surface

waves in deep water provides a different picture. If the extent of the surface distorted by the wave is small compared with the water depth, only the fluid near the top moves, and the depth plays no role as it did in the foregoing. There is, in fact, no single propagation speed for low intensity waves appropriate to all wave shapes as there is in shallow water, and, with isolated exceptions, waves cannot travel without change of shape. The wave motion in systems such as this is said to be dispersive.

A study of the disturbance left behind by a motorboat first in shallow water and then in deep water affords some insight into the implications of this contrast. In shallow water of depth h, the motorboat proceeds from position O to A to B to C (in fig. 4) at a constant speed, V, which here is greater than $\sqrt{gh}$. The times of arrival of the boat at these points are 0, t_1, t_2, t_3, respectively. When the boat arrives at point O, it initiates a disturbance there which propagates outward from O at speed $\sqrt{gh}$; therefore, by the time the boat arrives at C (whose distance from O is Vt_3), this disturbance which has spread out at speed $\sqrt{gh}$ is confined within a circle of radius $t_3\sqrt{gh}$. Similarly, the wave initiated at B at time t_2 has, at time t_3, spread into a circular region of radius $\sqrt{gh}(t_3 - t_2)$. The outline or envelope of the region into which all such disturbances have spread is the wedge shown in fig. 4; in particular, the angle θ shown there is such that sin

$$\theta = \sqrt{gh}/V$$

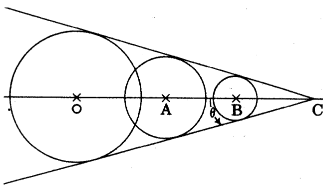

FIG. 4.—DISTURBANCE CREATED BY MOVING BOAT. POINTS O, A, B, C REPRESENT LOCATIONS OF BOAT AT SUCCESSIVE TIMES O, t_1, t_2, t_3; θ IS ANGULAR CO-ORDINATE OF ANY POINT IN FLOW FIELD (see TEXT)

Thus, the geometry of the disturbed region depends on the speed of the boat.

In deep water, on the other hand, no such elementary construction can be carried out. It happens, however, that the geometry of the wave generated by the boat depends on the boat's speed in such a way that the most rapidly propagating significant contributions to the wave pattern propagate at a speed proportional to the speed of the boat. The proportionality constant is always the same and is such that $\theta = 19°28'$. In the foregoing arguments the words shallow and deep have been (and must be) used in a relative sense. In a wave motion discussion, water is shallow whenever the distances (other than wave height) characterizing the wave geometry are large compared with the depth. When these distances are small compared with the depth, the water is said to be deep. The discussion of the intermediate case requires subtler tools and will not be discussed here.

An example of wave motion in which the surface tension of the liquid plays an important role can be observed when a stream of water about one-tenth of an inch in diameter flows from a faucet into the basin below. This stream of fluid would ideally be a slowly tapering column whose shape did not change with time, but when the stream diameter is small such a configuration is almost never observed. Even if the steady column could be temporarily established, the minute disturbances which are always present in the room would initiate a distortion of the column, and the wave so initiated would grow in magnitude until, at some position, the column would break up into droplets. The dynamics of this phenomenon are dominated by the effects of surface tension and fluid particle accelerations, and the reason that this droplet formation in the faucet experiment can be observed only for small streams is the following: The surface tension, T, has units m/t^2 (m = mass; t = time); the density p has units m/l^3 (l = length); and the stream diameter, d, has dimension l. If it is agreed that no other physical parameters play a role in the wave amplification, then the only combination of pertinent physical quantities having the physical dimension time is $\sqrt{\rho d^3/T}$.

Since relationships between physical quantities can be meaningful only when the physical dimensions involved are self-consistent (*e.g.*, the force required to lift an object must be equal to something having the physical dimension force), the droplet formation time, τ, must be equal to something having the dimension time. Since no other time-dimensional quantity is available, τ must be proportional to $\sqrt{\rho d^3/T}$. This implies that the breakup time, τ, increases rapidly with increase in stream diameter; however, τ must be a shorter time than that required for each particle of fluid to reach the bottom (roughly $\sqrt{2L/g}$, where L is the distance from faucet to sink, and g is the acceleration of gravity), and this will be the case only when d is small enough. Systems such as this, in which the initial wave motion becomes more intense with time without the aid of external excitation, are said to be unstable in the presence of such waves. The gross character of the ocean currents, the atmospheric circulation, the flow past airplane wings and the flight of a baseball would each be very different indeed were it not that their flow configurations are drastically modified as a consequence of such instabilities.

The foregoing experiment can be extended if a person will place a finger in the stream at such a position that the column assumes a stationary but wavy shape above this obstruction. When this condition is achieved the wave which is present is one which travels upward relative to the fluid at precisely the speed, V, with which the fluid in this wavy region is falling. The resulting picture is one in which the wave is stationary relative to the observer, and the ratio of the wave length, λ (distance from crest to crest), to the diameter can readily be estimated. Arguments much like those by which the droplet-forming time was estimated will indicate that this ratio should depend on the quantity $\rho dV^2/T$. A careful analysis shows that

$$\lambda = \pi d \div (1 + \rho V^2 d/T)^{1/2}$$

A sequence of such experiments with various stream speeds and diameters will confirm this result.

Shock Waves in a Gas.—The science of acoustics is concerned with the propagation of sound waves, particularly in air. Sound waves are usually defined to include only those waves whose intensity is so small that the changes in pressure and temperature which characterize them are a very small fraction of the ambient pressure and temperature. These waves travel at sound speed, a speed which depends only on the ambient state of the air. Situations are frequently encountered, however, in which larger disturbances are generated, and some of the most fascinating of these are concerned with the formation and propagation of shock waves. Whenever an object moves through a gas at a speed greater than sound speed, a shock wave will be present. As indicated in fig. 5, this shock wave is an exceedingly thin region separating undisturbed gas from gas that has already been set into motion. The flow between the dotted lines near the point A in fig. 5 is closely analogous to that discussed in conjunction with fig. 1. In fact, fig. 1 is precisely applicable when h_1 and h_2 are interpreted as gas density rather than as liquid depth. Actually, as the shock propagates into the gas, it is the density, temperature, pressure and velocity of the gas that change abruptly. In order to deal quantitatively with this wave phenomenon, one must invoke not only the mass and momentum conservation laws used above but also the law requiring the conservation of energy and a knowledge of the thermodynamic properties of the gas. The use of these laws leads to the quantitative description which follows.

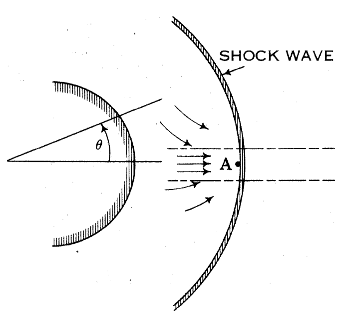

FIG. 5—SHOCK WAVE GEOMETRY
Speed of object A in supersonic flight (to the right), which is equal to speed at which shock wave advances, is somewhat greater than speed of air particles. Horizontal scale is greatly exaggerated. Arrows indicate roughly air velocity distribution; θ is angular co-ordinate of any point in flow field

When an object is flying at speeds comparable to those of meteorites or artificial satellites entering the Earth's atmosphere (say 25,000 ft. per second), the characterizing features of the shock wave are these: In the gas through which the point A on the wave has just passed, the pressure is about $.9\rho_1 U^2$, the gas velocity is about $.9U$, the density is about $10\rho_1$ and the temperature is several thousands of degrees Kelvin. Here ρ_1 is the ambient density of the air and U is the wave speed (the speed at which the shock wave encroaches upon the still gas). The gas will be compressed to a lesser extent behind the oblique part of the wave; the pressure distribution, in fact, will be well approximated by $.9\rho_1 U^2 \cos^2\theta$. It should be noted that this isolated information concerning strong shock waves for which the pressure rise is large compared with the ambient pressure is all that is needed to estimate the early motions of objects of known size and velocity entering the atmosphere.

Strong shock waves also occur when explosive charges are detonated in gas, liquid or solid. The details are very involved, largely because the relevant properties of the materials entail complicated descriptions. Once again, however, a somewhat idealized study provides a clear picture of the dominant features of the wave motion. Imagine that all of the energy, E, of the explosion has been released instantaneously at a single point in space at time 0 and that at time t the shock wave has traveled a distance R and is advancing with speed U through the gas. The only relevant quantities that enter the problem are the energy E (units ml^2/t^2) and the ambient density p (units m/l^3). Information is wanted on the history of the distance R (unit l), the pressure p (units m/lt^2), the speed U (units l/t) and the time t. The only physically meaningful relations among these must have consistent units, and the only such relations would state that R is proportional to $(Et^2/\rho)^{1/5}$, that U is proportional to $(E/\rho t^3)^{1/5}$ and that the pressure just behind the shock wave is proportional to $(E^2\rho^3/t^o)^{1/5}$. Thus, the wave starts out at very high speed but quickly slows down, and the pressure in the gas just behind the shock decreases even more quickly as the wave expands. A more detailed analysis has shown that, for explosions in air, the distance traveled by the shock in time t is $R = .97(Et^2/\rho)^{1/5}$, and that the pressure just behind the shock is $p_2 = .17(\rho^3E^2/t^6)^{1/5}$, the values of R and p_2 being centimetres and dynes/cm.^{2}, respectively. These figures are accurate only until p_2 is about three times the ambient pressure.

See also SOUND.

Traffic Waves.—When a reasonably uniform stream of traffic is traversing a long road, the flow pattern is described by a specification of the density, p (number of cars per car length of road), and the automobile speed, q. Disturbances in such a pattern are frequently introduced by traffic lights. debris, accidents, etc. The wave (characterized by change in density and velocity) which propagates through the traffic stream can be readily estimated by invoking two laws similar in character to those used earlier in this article. The first law requires that no cars materialize or disappear; the second, based on empirical observation,.postulates a specific relation between speed and density. Such observations have been made, and this relation, with sufficient accuracy for our purposes, is

$$q = q_0\,(1 - \rho)$$

'The speed q_0 may be regarded as the maximum safe speed for the road; thus, the possible speeds range from 0 when the cars are bumper to bumper to q_0 when the cars are very far apart. The first law requires that the number of cars emerging from a given segment of road per unit time subtracted from the number entering the segment per unit time should equal the time rate of density increase in the segment times the length of the segment. Those familiar with the differential calculus will recognize the mathematical statement of this equality to be

$$\partial(\rho q)/\partial x + \partial\rho/\partial t = 0$$

They will also be able to verify that these laws are satisfied by any density distribution p which changes with x (the distance along the road) and t (the time) according to the rule (the more general equality is not needed in what follows)

$$x = q_0(1 - 2\rho)\,t$$

The implications of this particular density variation can most readily be seen by plotting the positions of constant density on a picture in which the horizontal co-ordinate is distance along the road, and the vertical co-ordinate represents the time of observation (fig. 6A). This figure corresponds to a situation in which a long string of cars has stopped behind a traffic light at $x = 0$. There, at the time $t = 0$, when the light changes to "go," the density to the left of x = 0 is unity and that to the right is 0. According to the foregoing equation, the density is constant on each radial line through the origin. Thus, at the later time t, the velocity distribution is that shown plotted in fig. 6B.

When an obstruction appears in a stream of traffic in such a way that the cars must change speed abruptly a shock wave can form. To apply the first law to the flow across such a shock wave, it must be written in the form

$$\rho_1(q_1 - U) = \rho_2(q_2 - U)$$

where ρ_1 and q_1 are the values of p and q just to the left of the shock. and ρ_2 and q_2 are those just to the right of the shock; U is the speed at which the shock wave advances into the fluid, and the equality implies that the number of cars which enter the shock per unit time is equal to the number which leave per unit time.

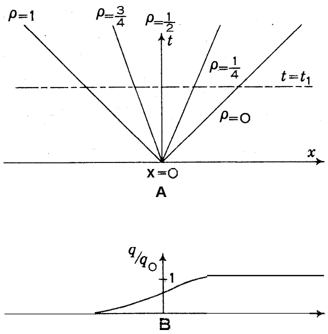

FIG. 6.—(A) LINES OF CONSTANT DENSITY WHICH FORM WHEN LINE OF TRAFFIC IS RELEASED SUDDENLY. (B) TRAFFIC SPEED (PLOTTED AS FRACTION q/q_0) V. DISTANCE x (see TEXT)

Consider now the situation in which, until time 0, the flow of traffic is essentially uniform at speed $q_1 = (\frac{3}{4})q_0$ and density p, $= \frac{1}{4}$. At time 0, an obstruction suddenly appears at x = 0, so that each car must pass it at speed $q_2 = q_0/8$ (and, according to the first equation of this section, at density $\rho_2 = \frac{7}{8}$). Fig. 7A indicates the manner in which the road chokes up in this situation. There is uniform flow at density ρ_1 approaching the obstruction, until it encounters a shock wave whose speed U is $-q_0/8$ by a region of uniform flow at density ρ_2. When the cars have just passed the obstruction, they immediately accelerate to a speed $7q_0/8$ and maintain this speed until they·catch up to the traffic stream moving at speed $3q_0/4$. This encounter occurs at $x = 5q_0t/8$, and thenceforth the stream proceeds at the unobstructed speed. Fig. 7B shows the car speed as a function of distance at time t_1. This piecing together of different speed regimes may seem arbitrary, but it is the only combination of density and speed distribution which satisfies the relation between q and p and which conserves the number of cars.

The foregoing phenomena are analogous to certain phenomena in gases. When the two ends of a long cylinder are separated by a diaphragm, one end is evacuated and the diaphragm subsequently is suddenly removed, the gas density distribution which develops is very much like the traffic density distribution of fig. 6. On the other hand, when a partial obstruction is suddenly inserted into a cylinder through which gas is flowing at high speed, the flow to the left of the obstruction may be like that of fig. 7, but the flow to the right will be quite different. This difference arises because the molecules of gas are influenced bv the neighboring molecules behind them as well as those in front, but the car speed is influenced only by the proximity of the cars ahead.

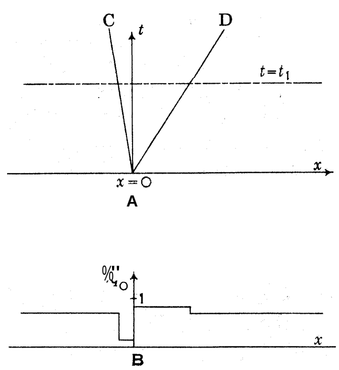

FIG. 7.—(A) SHOCK WAVE LOCATIONS IN x-t PLANE FOLLOWING SUDDEN, PARTIAL OBSTRUCTION OF ROAD. IN REGION TO LEFT OF LINE C, DENSITY IS 1/4; BETWEEN C AND VERTICAL IT IS 7/8; BETWEEN VERTICAL AND LINE D IT IS 1/8; TO RIGHT OF D IT IS 1/4. (B) TRAFFIC SPEED V. DISTANCE x

Waves in Elastic Solids.—When one end of a long cylindrical rod of homogeneous, isotropic elastic material is suddenly twisted about the axis of symmetry, the displacements which characterize the ensuing wave correspond to rigid body rotations of the successive circular cross sections. The distorting elements of material do not change volume, and the wave proceeds at the speed $\sqrt{G/\rho}$, where G is the shear modulus of the medium (for steel, G is about 6.000 tons per square inch, and the transverse wave speed is somewhat greater than 10,000 ft. per second). The particle displacements are all perpendicular to the direction in which the disturbance is progressing, and such waves are called transverse waves. If, however, a uniform pressure were suddenly applied to the surface of a spherical chunk of the same material, the wave which propagated toward the centre of the sphere would involve changes in volume of the material, and the displacements would be in the direction of propagation. Furthermore, this longitudinal wave would proceed at a speed which for most metals is $\sqrt{2(1-v)/(1-2v)}$ where v is Poisson's ratio of material. (*See* MATERIALS, STRENGTH OF: *Elasticity.*) In most structures (ranging in size from small piezoelectric crystals and machine elements to the planet earth itself), the wave propagation phenomena of interest involve both kinds of waves. This stems largely from the fact that when either a transverse or a longitudinal wave encounters any nonhomogeneity (a crack or void, a force-free surface, an inclusion of a different material, etc.) the transmitted and reflected waves necessarily are made up of both transverse and longitudinal contributions In general. a longitudinal wave exhibits a coincidence of the direction in which the wave propagates nith the direction associated with the disturbance characterizing quantity; *e g*, displacement, velocity, surface traction, electric-field intensity, etc. In a transverse wave, however, the propagation direction is perpendicular to the direction associated with the disturbance characterizing quantities.

The presence of one particular nonhomogeneity, an extended surface on nhich the externally applied force is negligible, *e.g.*, the surface of the earth, gives rise to one especially interesting phenomenon. When a disturbance occurs near the surface, *e.g*, an earthquake, some of the energy associated with the wave so generated spreads out spherically away from the point and thus diminishes in intensity in proportion to R^{-2} uhere R is the distance from the inception point However, a substantial fraction of the energy remains near the surface as it propagates, because of the manner in which the presence of such a surface requires the longitudinal and transverse waves to interact. The volume over nhich this energy spreads is smaller by a factor R than the former contribution, and it can be detected at greater distances; it is this wave, in fact. which is so frequently detected after earthquakes. When such a disturbance occurs in an unpopulated area, its source is usually located by a comparison and analysis of the particle displacement time histories collected by various seismographs throughout the world. Once again, of course, the appropriate detailed analysis requires the invocation of the laws implying the conservation of mass and of momentum and implies a knowledge of the relation between distortion and loading for the material under consideration.

See also EARTHQUAKES.

General Remarks.—The range of physical situations in which nave motion plays a vital role and the degree of sophistication with nhich such phenomena may be investigated extend far beyond the content of the foregoing examples. However. the understanding of all such wave phenomena rests on the deduction of the implications of the fundamental laws of physics and the properties of the media in the system being studied.

See also ELECTROMAGNETIC WALES; WAVES OF THE SEA; LIGHT: *Waves and Interference;* SOUND: *Analysis of Sound Propagation, What Is Sound?*

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WAVES AND SHORE CURRENTS are continually changing the shores of lakes and oceans. The most important are caused by winds and tides. Others, such as waves caused by earthquakes and volcanic eruptions (the so-called tidal waves) are so infrequent that their work in shaping shores is comparatively unimportant. In their beginning, wind-caused water waves are boundary waves such as develop at the contact between moving bodies of gases or liquids of differing densities. Once started, the energy of these boundary waves is further built up and their forms are somewhat changed by the pressure of the wind against their sides.

Water waves are of two kinds, waves of oscillation and waves of translation. Waves of oscillation are the ordinary deepwater waves in which all the particles of water within the wave move in circular orbits. At the surface, these orbits have a diameter equal to the height of the wave. They decrease rapidly with depth until. at a depth equal to the length of the wave. the movement is practically zero. In a wave of translation, the whole body of water moves forward and does not return.

Much has been written regarding ocean waves, and numerous formulas have been developed giving the relations existing between wind velocity and the length, height, velocity and energy of ocean waves.

See also WAVES OF THE SEA.

Breakers and waves of translation form when waves of oscillation enter shallow water. The rate of forward movement of the waves decreases, their height increases and they croud closer together. Along nith this decrease in length and increase in height is an increase in the diameter of the orbit of the wave until it is too large to be completely filled by the amount of nater present. It then falls forward and becomes a breaker. As the wave breaks, a part of the nater in it is thrown forward and does not return. This is a wave of translation. The action can best be seen where the uaves are breaking against a submerged ridge, the uater in the upper part of the breakers being thrown forward across the ridge top, carrying the sand with it thus forming a subaqueous dune.

Shore Currents result from the combined action of waves of translation and the drag of the wind across the water surface. During storms. the water may pile up on the shore or flow at an angle with it, depending on the direction of wind and waves and the shape of the bottom. Some of the water piled on the shore moves outward beneath the surface in a current called the undertow. However, much of its escapes here and there along the shore in a series of outward-flowing currents knoun as rip currents. These sometimes attain a velocity of 3 to 5 mi per hour and may be very dangerous to snimmers. Near shore, their width is usually 50–100 ft. Farther out, they niden and the velocity lessens until they disappear at 1,000–3,000 ft However. beyond the breaker zone, with an onshore wind there is a slow outward movement of water several feet beneath the surface and with offshore winds, a similar deep current moves slowly in toward shore. Rip currents are strongest with the, wind blowing squarely onshore, but if the wind blous toward shore at some lesser angle, a current is set up running parallel with the shore. This is the longshore current. It may reach a velocity of several miles an hour, especially uhen combined with the tidal flow. Such currents continue along shore until they encounter an outward-flowing rip current or are turned offshore by a curving shore line.

Shore Structures form along the shore as the result of transportation and deposition of sediment by the naves and currents. When a wave reaches shore. part of its nater is thronn forward on the beach as a wave of translation, producing the swash. This water. running back down the beach under the force of gravity, is the backwash. The forward movement in the swash throns the sand and other material up into a ridge just above the water line. This is the beach ridge. If the waves come in perpendicular to it, the water in the snash and backwash moves up and back in a straight line and there is no lateral movement of the material. But if the waves come in at some other angle, the movement in the swash and backwash approaches that of a distorted parabola and causes the material in the beach ridge to move along the shore. At the same time, the longshore current picks up and transports material in much the same way a river does, but with the added advantage that sediment from the bottom is stirred up and kept in suspension by the breakers. This transportation of material along the shore by the combined action of longshore current and the swash and backwash is called shore drifting.

As the material transported by shore drifting is again deposited, some of it is formed into structures such as spits, bars and cusps. A spit is an embankment of sediment having one end attached to the land and the other terminating in open water. Its crest, for some distance outward. rises above the water. The most usual place for a spit to form is on the windward side of a bay entrance. Its formation begins with deposition of sediment by the longshore current. After the current reaches the turn of the bay entrance, it continues past it in a straight line. On entering the quiet water, its velocity is reduced and it drops its load. Thus, a ridge is formed on the bottom extending part way across the bay mouth. While this ridge is building, its shore end receives material brought to it along the front of the beach ridge by the swash and backwash: Thus. the part of the spit above the water is an extension of the beach ridge superimposed on the subaqueous embankment built by the longshore current. The shape of the spit, whether long and slim or short and wide, depends on the amount of sediment available and the direction and size of the waves. Sometimes a spit is curved at the end, forming a hook. This curving is caused by wave refraction. When waves move into shore at an angle, the end that first enters shallow water is retarded while the end in deeper water continues on. This causes the waves to curve around the end of the spit and, if they are relatively strong as compared with the amount of sediment, it produces a turn at the end of the beach ridge Hooks nearly always turn toward the land, since the stronger waves come from the open water. A bar is an extended spit that closes, or nearly closes, a bay mouth. It may build from only one end. or it may result from two spits building from opposite directions. Geologists have never agreed as to the size of this opening, but it is generally assumed that it may be large enough for the passage of such vessels as navigate the waters.

Beach cusps are triangular-shaped projections of sediment extending out into the nater along a shore line. They are of various forms and sizes and may occur either singly or in series. They form in several ways. One common type that occurs in series is caused by the breaking of a beach ridge by a wave system larger than that which originally formed it. The breaks in the ridge crest are not all of the same size nor evenly spaced, but the uniform parabolic movement of the water in the swash and backwash intensifies the larger openings and closes the smaller ones until there is produced a fairly uniform series of triangular cusps. Their size and spacing depend on the size of the waves and the height and width of the ridge from which they are formed.

A rather rare shore structure that sometimes forms on sandy beaches having a very gentle underwater slope is the cuspate spit. It is started by the overloaded shore current dropping some of its load at a small obstruction or irregularity in the shoreline. This deflects the current outward and causes a small cusplike structure to form. The swash and backwash adds material and a spit is built out over the shallow bottom. On small' lakes, these often occur in series and may extend out several hundred feet. Along the shores of large bodies of water, as on the west side of Lake Huron north of Saginaw bay, they appear as fairly permanent sand structures reaching out several hundred yards from shore.

Offshore Structures, unconnected with the shore, such as barrier beaches, low and ball and ripple marks, are formed by the waves and currents on the underwater terrace. Barrier beaches are ridges of sandy sediment lying parallel to the shore and reaching above the water but not attached at either end. In North America they are numerous and large along the coasts of Texas and the Carolinas, and in Europe along the coasts of the Netherlands and the southeastern Baltic sea. Their method of formation is not well understood. Some physiographers think they'are the result of the waves throwing up ridges of sand from the bottom. Others think they may be long spits in shallow water built parallel with the shore, cut through at the neck and later widened by the addition of beach ridges on the seaward side. As they seldom or never form on lakes or inland seas, it is possible that the rise and fall of the tide is a factor in their building. Low and ball designates a series of subaqueous troughs and ridges lying parallel with the shore. Their spacing and size varies with the depth of water and the slope of bottom. In some localities, as on the gentle slopes of the bottom of Chesapeake bay and the Gulf of Mexico, they occur in a series of a dozen or more, increasing in size with distance from the shore. They are also numerous along the shore of the Great Lakes and on the south and southeast coasts of the Baltic sea. Along the east side of Lake Michigan, the bottom slope is such that they usually occur in series of three. Their spacing varies. but their average distances from shore are about 200. 600 and 1,200 ft. From the shore line outward, the trough depths average about 5, 11 and 18 ft., and the depths of the crests, 4, 8 and 12 ft.

The ridges are caused by piling up of sediment stirred up from the bottom by the downward-plunging water in the breaking waves. The effect in shallow water is to dig a depression as a waterfall does in a stream. But because of the orbital movement in a wave, the sediment stirred up from the bottom, instead of going toward the shore in the direction of wave travel, is moved a little distance in the opposite direction. This material accumulates as a ridge on the lake bottom. Theiposition of the lows (troughs) and balls (ridgesj is fixed by the average size of the storm waves. After once forming, the structures'remain nearly constant in position as long as the water level remains the same, moving only a little toward the shore or away from it with changing wave conditions. However, if the water level falls, breaks sometimes occur in the ridge nearest shore and the ends are pushed in toward shore by the waves of translation. In long continued periods of low water, the inner ridge may move in as a subaqueous dune and unite with the beach ridge.

Ripple marks (*q.v.*) are common on shallow, sandy bottoms, along the shores of oceans, lakes and on the bottoms of streams. They are formed in two ways—by the forward and backward movement produced on the bottom by the passage of waves of oscillation, or by currents in which the water moves steadily in one direction. The underwater terrace on which the above features are formed is. itself. a product of the work of the waves and currents. They take the material from the shore and work it out toward deep water. but the movement ceases at the depth at which 'the waves are incapable of moving material. Thus, a terrace is formed. Its outer edge is usually at a depth equal to about one-third the length of the average storm waves.

Closely related to the underwater terrace is the sea cliff. It forms where the sea advances against a high shore. The vertical distance that waves can cut is limited by their height. So, when they break against the face of a high cliff they undercut it until the overhanging rock is brought down by its own weight. This material is then moved away from the shore by the waves and currents, spread out and made a part of the underwater terrace. As the process continues, the terrace becomes wider and wider. A cliff formed as the result of wave cutting is a sea cliff. Where cut in solid rock, sea cliffs may endure for a long time after uplift of the land or lowering of sea level has shifted the shore line seaward. Perhaps the best known of these are the cliffs of Dover and the opposite shores of Calais on the English channel. They are also numerous at various places along the coasts of Scotland and Ireland.

The total effect of the waves and currents, over a long period of time, is to take more sediment from the land than they bring back. During storms, great quantities are torn from the shores and thrown into suspension by the waves along with that stirred up from the bottom by the plunging breakers. At such times, the rip currents are strong and great quantities are rushed offshore to deep water. But with gentle currents and waves of small size, much of this is returned to the land by the travel of the asymmetrical ripples toward shore and the work of the waves of translation. The final shape of the shelf depends on the relation between the strength of the waves and currents and the amount of sediment available. With an excess of sediment the shelf is wide with a gentle slope; with less sediment and stronger waves and currents it is narrower and steeper. *See* also LAND RECLAMATION; SEDIMENTARY ROCKS: *Sedimentology.*

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WAVES OF THE SEA. Whenever the wind blows over water, the surface is formed into waves. These grow under the influence of the wind and form a most irregular surface pattern known as "sea." When wind-raised waves travel out of a storm area they advance as "swell." and after having traveled large distances becomes a series of long, low and fairly regular undulations. These may be all but hidden by short irregular waves, newly formed on the surface, until the swell travels into shallow water. There each wave crest rises sharply from the water surface, grows steeper and steeper until it breaks, and foaming white "surf" advances toward the shore line and rushes up the beach. The terms sea, swell and surf describe, therefore, different stages of the same phenomenon, and the waves of the sea caused by wind are discussed below under these headings.

Not all waves of the sea are caused by wind. Destructive waves caused by earthquakes, submarine landslides or volcanic eruptions beneath the sea occasionally inundate low-lying coasts and cause enormous damage. Such waves are popularly known as "tidal waves," although they have nothing in common with the tides. They are discussed under *Other Ocean Waves*, below. True tidal waves are caused directly or indirectly by the attracting forces of the sun and moon and, although strictly speaking they belong to the waves of the sea, they are usually treated as a separate subject (*see* TIDES).

WAVES CAUSED BY WIND

History of Investigations.— Waves have been observed for thousands of years, yet knowledge of them is most incomplete and many fundamental questions remain unanswered. This lack of knowledge is probably due to the fact that the subject has been studied from two different points of view, each failing to take into account the results achieved by the other. To the mathematician wave motion has presented a fascinating field of study, but he has not often been concerned with the practical application of his studies to waves of the sea. To the seafaring observers waves have long been a source of keen interest but mariners have been unable or unwilling to utilize the tools developed by the mathematicians. Until about 1925 few attempts had been made to bridge the gap.

The literature dealing with ocean waves is so large that only a few of the more important works can be mentioned. The first systematic mathematical study of wave motion appears to have been made by Sir Isaac Newton (1642–1727), but not until the 19th century was the study of wave motion put on a sound mathematical basis. Among the important contributions were those by G. G. Stokes (1847), J. Boussinesq (1872) and Lord Rayleigh (1876). The first accounts of careful observations of waves were those by Leonardo da Vinci (1452–1519). Observations in wave tanks seem to have been initiated by the Weber brothers in 1825. A "Report on Waves" submitted by J. Scott Russell in 1844 to the British Association for the Advancement of Science exercised a profound influence upon all subsequent wave studies. Observations at sea were published by T. Stevenson (1850), A. Paris (1871), G. Schott (1893), V. Cornish (1934) and A. Schumacher (1928). The effect of waves on engineering structures was studied by D. D. Gaillard (1904). The first successful attempt to bridge the gap between theory and observation was made by Harold Jeffreys in 1925. H. U. Sverdrup and W. H. Munk developed a series of dimensionally complete empirical relationships on the basis of which it was possible to forecast wave height and period from weather maps. Such forecasts were made to assist amphibious landings in World War II. Thereafter much progress was made to give more complete statistical descriptions of the sea surface. In England, G. E. R. Deacon, N. F. Barber, M. S. Longuet-Higgins and F. Ursell in 1946–48 developed methods for recording the spectrum of ocean waves, and Willard F. Pierson, Jr., at New York university, developed in 1950–52 relationships for forecasting the spectrum. Carl Eckart in 1953 gave the first statistical theory of wave generation.

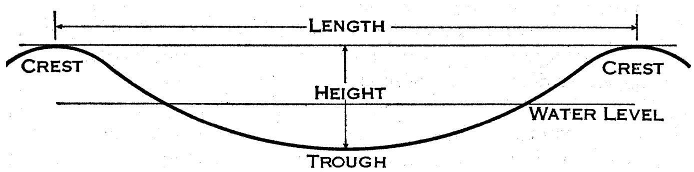


FIG. 1.— DIAGRAM OF A WAVE SHOWING HOW THE LENGTH AND HEIGHT ARE MEASURED. THE VERTICAL SCALE IS EXAGGERATED

Definitions.— The height of a wave, H, is the vertical distance from crest to trough. The length, L, is the horizontal distance between adjacent crests (fig. 1). The wave period, P, is the time interval between the passage of successive crests at a fixed point. The velocity, V, of a wave is the speed with which the wave form travels along the sea surface.

Theory.— The derivation of the basic properties of wave motion according to the classical wave theory is next indicated, but a knowledge of theory is not essential for the reader's understanding of the rest of this article.

The usual procedure for dealing with short waves in deep water is to solve the hydrodynamic equations of motion and the equation of continuity for an incompressible medium, subject to the following conditions: (1) all motion is irrotational, that is, a velocity potential ϕ exists; (2) the pressure along the surface is constant; (3) the motion ceases at great depth. Neglecting second-order terms, the simplest solution satisfying these conditions is

$$\phi = \frac{gH}{2\sigma} e^{kz} \cos (kx - \sigma t) \qquad (1)$$

where z is the vertical co-ordinate directed upward from the undisturbed sea surface, x the horizontal co-ordinate positive in the direction of wave motion, t time, g the acceleration caused by gravity, a $= 2\pi/P$, $k = 2\pi/L$. Equation (1), assumption (2) and the identity $V = L/P$ lead to the equations $L = gP^2/2\pi$, $V = gP/2\pi$ or, with good approximation,

$$L = 5P^2,\ V = 3P \qquad (2)$$

where L is the wave length in feet, P the period in seconds, V the velocity in knots. Equations (1) and (2) apply only to deep water but are approximately correct when the depth is larger than one-half the wave length. Derivations of these equations. together with a complete discussion of the entire subject of wave theory, are included in chapters 8 and 9 of Horace Lamb's *Hydrodynamics* (1932).

Wave Motion and Water Movement.— The wave velocity is the speed with which the wave form travels along the surface. The water, on the other hand, advances very little. This was known to Leonardo da Vinci, who compared water waves to waves traveling across a wheat field where the wheat itself remains rooted. There is. however, a slight surface drift in the direction of wave movement which amounts to about 1% only of the wave velocity. Although too small to be of general importance, it does affect the drift of life rafts, causes floating objects to wash ashore and contributes, in heavy surf, toward an abnormal rise of the water level against shore. the latter known as "storm tide."

Within the traveling wave any small volume of water moves in a vertical circle. At the surface the diameter of the circle equals the wave height. An object on the crest of the wave moves forward with the wave. When the object lies in the trough it moves in a direction opposite to that of the wave. In front of the crest the object rises; behind the crest it falls. The circular movement is completed during one wave period. If an object were suspended beneath the surface it would still describe circles; but the deeper the object, the smaller the circle. At a depth of a quarter of a wave length the diameter of the circle is only 10% of that at the surface, and at twice that depth practically all wave motion ceases. For that reason submarines can escape wave motion by diving to greater depth.

Wave Observations.—The theoretical relationships between wave length, velocity and period (equation [2]) have been confirmed by careful observations. The wave period is best measured by recording the time interval between successive appearances on a wave crest of a well-defined patch of foam or a floating object at a considerable distance from a ship. The wave length can be estimated by comparison with the ship's length; the wave velocity, by timing the passage of a crest between the ship's bow and stern. However, experience has shown that the wave length and velocity measured in this manner are likely to be far too small because one tends to take the crest of a wave at a point short of its actual summit. If wave length and velocity are desired it is better to measure the wave period and compute length and velocity according to equation (2).

Unlike the length and velocity, the wave height does not bear any definite relationship to the wave period. Heights of large waves can be estimated by waiting until the ship is in a trough and taking a station from which the crest coincides with the horizon. The wave height then equals the distance from the eye height to the ship's water line.

Sea.—If there were no wind there would be no waves. A small gust of wind blowing over a calm stretch of water will ripple the surface. Each little wave presents a slight obstacle to succeeding gusts of wind. As the wind blows on the waves, the pressure on the windward side exceeds on the average the pressure on the lee side, and this pressure difference brings about a transfer of energy from wind to waves: the sea grows. At the same time, by some mechanism not yet understood, the most prominent waves become successively longer. Length and height both increase, but at first their ratio remains approximately the same at 13:1. At the later stages of wave generation, the height will increase less rapidly, and the waves accordingly become flatter. In the trade-wind belt, where the wind blows steadily over large distances, a long rolling sea is generated. These long waves may eventually travel faster than the wind.

When the wind velocity exceeds 10–12 knots, some of the smaller waves grow so rapidly that their height reaches one-seventh of their length. When this critical ratio is reached, the water at the crest moves faster than the crest itself, causing the water to topple forward into whitecaps.

A heavy sea is raised when strong winds blow for many hours over large ocean areas. The height of the sea is determined, therefore, by three factors:

Fetch ....Distance over which wind blows.
Wind velocity ....Average speed of wind over fetch.
Wind duration ....How long the wind blows.

Over landlocked areas, such as bays and small lakes, the wave height is usually limited by wind velocity and fetch (distance from the windward shore); thus, in a small body of water high waves cannot be formed. Over large ocean areas the height of the sea is usually limited by wind velocity and wind duration. So, in general, the wave height may be limited either by fetch or duration. When wind velocity, fetch and duration are known, the wave height can be determined from Tables I and II, and the lower of the two values will be applicable.

The highest sea ever reliably reported consisted of 55-ft. waves. To produce such waves a 60-knot wind would have to blow about 24 hours over a fetch longer than 500 mi. Waves consistently higher than this are not found because gales do not blow over sufficiently large fetches for a sufficiently long time and because at hurricane velocities the tops are blown off.

TABLE I.—Wave Height in Feet for Various Wind Velocities and Fetches

Fe[redacted] in nautical miles	Wind velocity in knots					
	10	20	30	40	50	60
10	2	3	5	[illegible]	[illegible]	[illegible]
20	2	4	7			
50	2	6	10	14		
100	2	7	13	17	25	30
500	2	10	20	31	45	55
1,000	2	10	21	35	50	70

Sea coming from different quarters of a storm will run in different directions and a cross sea results. When two crests intersect, peaks are formed. When two troughs intersect, hollows are formed. Instead of long crests and troughs the sea surface then consists of apparently unrelated peaks and hollows. Isolated peaks up to 80 ft. have been reported; but these freaks, caused by the coincidence of two or more crests, rise high above the general water level. To a ship passing through a cross sea formed by high waves these peaks spell danger. Steep cones of water may crash over the ship causing extensive damage to superstructure and loss of personnel. A full gale sometimes tears the tops off these peaks and flying sheets of water are thrown against the ship.

TABLE II.—Wave Height in Feet for Various Wind Velocities and Durations

Wind duration in hours	Wind velocity in knots					
	[illegible]	20	30	40	50	60
6	2	5	10	14	20	25
12	2	7	13	20	30	35
24	2	9	17	30	40	55
48	2	10	22	35	45	70

Swell.—Waves leaving their storm area are known as swell. Their length, velocity and period increase as they travel away from the storm area while their height decreases because of the resistance offered by the air. Table III shows approximately how the wave height decreases. The first column gives the height of waves just as they emerge from the storm area, the other columns the height at distances of 500, 1,000, 2,000 and 3,000 mi.

TABLE III.—Approximate Height of Swell in Feet at Various Distances From the Storm Area

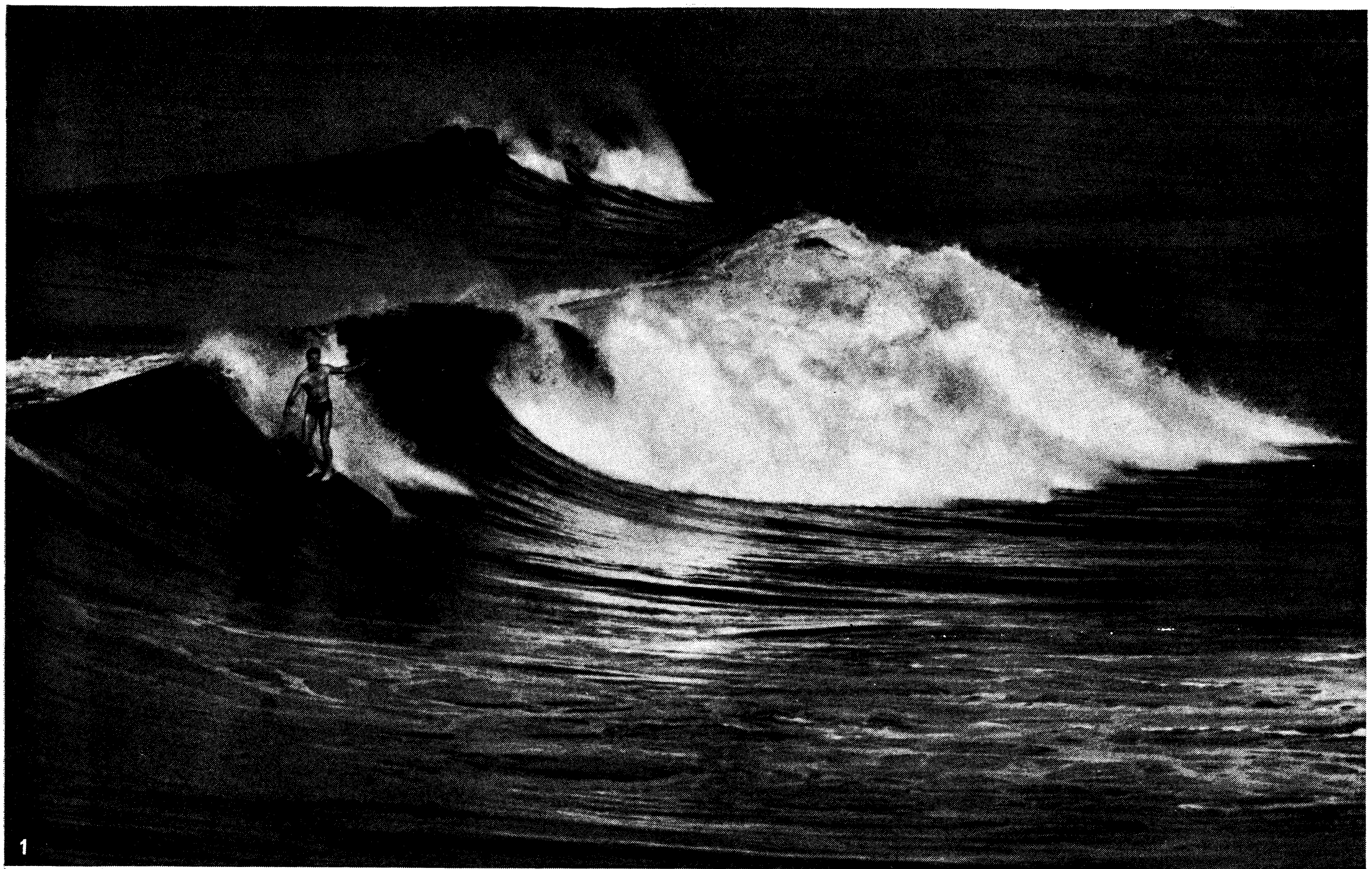
Distance from storm area in nautical miles				
0	500	1,000	2,000	3,000
40	25	20	12	8
30	19	14	8	5
20	12	8	5	3
15	8	5	3	2
10	5	3	2	1
5	2	1	0.5	—

This decay of wave heights is assisted by an opposing wind and lessened by a following wind.

Seafaring men learned to judge the distance of a storm from the approaching swell. In general, an irregular short and high swell comes from a nearby storm, while a regular long and low swell comes from a distant storm. But even the most regular swell is composed of alternate groups of high and low waves. These are caused by interference between trains of swell from different quarters of the storm. Alternate groups of high and low swell result, and these have been responsible for the popular but incorrect belief that every seventh wave is highest. Waves vary in height but without regularity.

One of the longest s ell periods ever recorded was 23 sec. According to equation (2) its length in deep water would equal 2,650 ft., about half a mile, and its velocity 69 knots. This swell was observed at Ascension Island after it had traveled across the equator from its generating area near Iceland. The rollers of Ascension are famous. Accounts of their destructive power date back to 1846 when 13 vessels were driven from their moorings and totally wrecked. The swell reaching Rio de Janeiro, Braz., is equally famous and locally known as the resaca. A 28-sec. swell which was generated in the roaring forties of the South Atlantic was recorded at the Cape of Good Hope. According to equation (2) its length must have been almost three-quarters of a mile and its speed, 84 knots.

Each ocean region has its own characteristic swell conditions which are related to the general atmospheric circulation. Along the North American west coast the swell is often the result of storms traveling south of the Aleutians into the Gulf of Alaska.



1

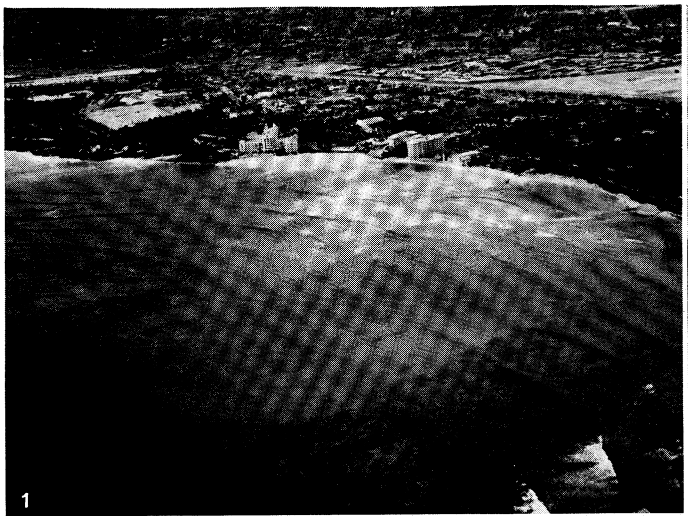
2

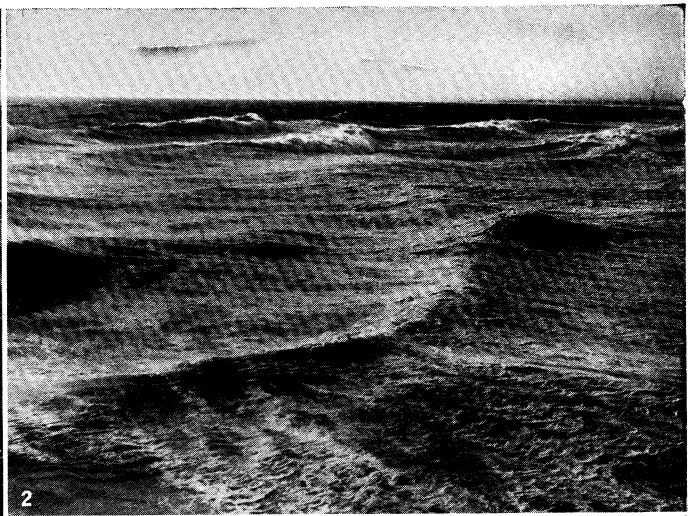
PHOTOGRAPHS BY JOHN H. BALL

1. Surf rider on plunging breaker; offshore wind is blowing spindrift out to sea

2. End of a plunging breaker

WAVES OF THE SEA





BY COURTESY OF (1) U S. NAVY, (2 3) PAUL WILLIAMS; PHOTOGRAPH, (4) CAPT. BEATON

1. Swell bends into Waikiki beach, Honolulu, Hawaii
2. Surf resulting from near-by storm. The top of the wave spills over gradually, and breaking continues over a long period
3. Surf resulting from distant storm. The crests curl and break with great intensity — with all the energy going into the initial plunge
4. Towing a sailing ship over a river bar. The wave conditions arc accentuated by the presence of the near-by bar, but are a good illustration of the severe wave conditions often found in open sea

Conditions are similar along the European and African west coasts which receive smell from storms traveling toward Iceland. Along the Oregon. Washington and Canadian coast, and in Scotland, North Ireland and Norway the swell, although heavy, is usually overshadowed by the high sea generated in local storms.

Because of the prevailing westerly winds the east coast, or lee side, of continents in the northern hemisphere does not experience a long swell, and high surf is usually the result of local storms. This applies to the American east coast as well as to the coast of eastern Asia. Swell in the southern hemisphere can be expected to be longer than in the northern because the area occupied by ocean is proportionally larger.

Surf. — All the energy which the waves have accumulated from the wind for many hours over long fetches is thrown into a narrow surf zone. High breakers can do much damage. At Ymuiden, the Netherlands, the harbour entrance to the Amsterdam canal, a wave in a gale lifted a 20-ton concrete block 12 ft. and deposited it on top of the pier which was about 5 ft. above high water. Waves breaking against cliffs and embankments may impel water skyward and cause damage high above sea level. In one instance, damage was reported 132 ft. above high water.

The transformation of a seemingly harmless flat swell into steep, plunging breakers had been thought to be primarily brought about by friction, but investigations made during the period 1943–45 indicated that the restricting effect of the sea bottom upon the water movement is the primary factor. In deep water, waves set up a circular motion which extends to a depth of about one-half the wave length. In shallow water this circular motion is squeezed into elliptical motion and at the bottom is distorted into back-and-forth movement shoreward under the crest and out to sea beneath the trough. The distortion of the water movement is associated with a decrease in wave velocity. When the depth becomes less than 15 ft., the velocities of the waves of periods longer than 8 sec. depend only upon the depth of the water as shown in Table IV.

Table IV.—Wave Velocity in Shallow Water

Depth of water in feet	Speed of wave in knots
15	13
10	11
5	8

As waves pile into the shallow water there is also a decrease in wave length as if the wave train were being compressed accordion fashion. Unlike the wave velocity, the wave length in shallow water depends not only upon the water depth but also upon the wave period. The longer the wave period, the longer will be the wave length. The wave period remains unchanged throughout

The direction of the waves also changes. Waves approaching a straight coast line at an angle tend to swing parallel to shore because the portion of the crest nearer shore is in shallower water and moves slowly while the portion of the crest in deeper water races ahead. Thus, waves turn in such a manner that the outline of the crest tends to take the shape of the bottom contours. Waves bend into bays, around headlands, points and jetties, but in doing so they lose height because they must stretch.

Bent crests give evidence of bottom features which are not apparent from configurations of the coast line. In the case of submarine canyons, the parts of the crests that advance over the centre of the canyon are in deeper water and move ahead faster than those on either side. As a result the crests are stretched and the wave height decreases. Fishermen anchor near the heads of these canyons because the waves are low there. Underwater ridges near shore have the opposite effect. When waves pass over them the crests are squeezed and the wave heights increase. Many instances have been noted of unusually violent breakers over under water ridges.

Waves entering shallow water also undergo a change in shape which depends chiefly upon whether the surf is caused by a distant swell or a local sea. A swell which is almost symmetrical in deep water, with flat long crests and flat long troughs, turns into a series of narrow steep crests isolated by flat long troughs (fig. 2). This "peaking" or "humping" is noticeable even to the casual observer when a long swell rolls in toward a smooth beach. As the wave is about to break it becomes steep, the shoreward face becomes concave and the water plunges from the top, momentarily enclosing an air space and striking the water surface in front with great force,

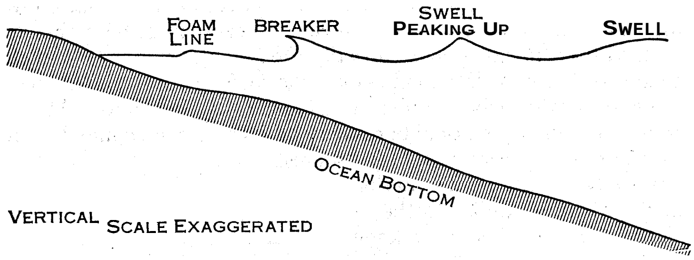


FIG. 2.— IN DEEP WATER THE SWELL IS LOW AND ROUNDED. BUT AS IT ADVANCES INTO SHOAL WATER THE CRESTS BECOME STEEPER AND THE TROUGHS FLATTER, SO THAT CRESTS APPEAR TO PEAK UP SUDDENLY JUST BEFORE THEY BECOME UNSTABLE AND BREAK

often throwing up a spray higher than the original wave. Onshore winds lessen the tendency to curl and reduce possibility of spray. Offshore winds cause the back of the wave to continue well rounded up to the point of breaking, and its front may become so deeply hollowed that a swimmer about to dive through it just as its crest is falling can look back for an instant through a sheet of falling water. These sheets of falling water have been observed to enclose and compress pockets of air which, in turn, give rise to miniature geysers of water.

As a wave breaks it appears much higher than it did in deep water, principally because it has shortened and steepened. Actually, the breaker height rarely exceeds the wave height in deep water by more than 50%. Plunging breakers occur at depths approximately equal to the breaker height.

If the surf is caused by local storms, whitecapping continues all the may to the surf zone. The top of the wave spills down the front, producing white foam and "boiling" on the leading slope, but no real plunge of water. Spilling breakers occur at depths larger than their wave height.

Statistical Waves Theory. — In the vears following World War II it became clear that because of the irregularity of ocean waves simple descriptions dealing with wave height, period and length were inadequate for many purposes. In fact, it appears that predictions based on the mathematical theory of random noise are well supported in observations of ocean waves.

OTHER OCEAN WAVES

Earthquake Waves. — Earthquakes on the ocean bottom may produce shock waves similar to those caused by depth charges. These travel in the sea at the velocity of sound, about 5,000 ft. per second. They will be felt on board ship as a shock which violently rocks the vessel. The shock may be so severe that the sailors believe their vessel has struck a rock. On early charts several such reported "rocks" were indicated in waters where recent soundings have shown the depth to be several thousand yards. These shocks are accompanied by loud noises like thunder or cannon fire. Only in exceptional cases will they cause damage.

Far more destructive are the waves caused by vertical displacements along earthquake faults on the sea bottom, by submarine landslides and by volcanic eruptions beneath the sea. A series of high so-called tidal waves (more correctly designated by their Japanese name, tsunami) may result. The velocity of these waves in the open sea is large and depends upon the depth of water in the following manner:

Depth in feet	500	1,000	2,000	5,000	10,000	15,000
Velocity in knots	75	100	150	240	340	420

The average depth of the Pacific ocean was estimated for the first time from the velocity of tsunamis and turned out to be only one-third of the previously assumed value. These computations were later confirmed by soundings. Tsunamis quickly lose height and become exceedingly long, sometimes up to 500 mi., and in the open sea they can be observed only in the immediate vicinity of their origin. Their period may lie between 10 min. and 60 min.

The tsunami is usually led by a small rise, followed by a distinct trough. On shore the arrival is first noticed by a fall in the sea level for a number of minutes, as if there were an abnormally low tide, followed by a rapid rise to levels far exceeding the high-tide level. Tsunami waves do not usually break in the manner in which sea and swell break, but coming over the reefs of coral islands they give rise to extremely turbulent and dangerous conditions. At the mouths of large rivers tidal bores may be formed, which may travel many miles upstream as solitary waves.

Seiches.—Periodic fluctuations of the sea level are also caused by disturbances similar to the sloshing back and forth of water in a large dishpan. These are known by the Swiss word, seiches, because they were first observed in lakes in Switzerland. Seiches are most likely to occur in bays and lagoons but have also been observed along the open coast The period of oscillation may vary from minutes to hours and depends largely upon the dimensions of the moving mass of water.

Internal Waves.—In the oceans, internal waves, or boundary waves, have been observed at the boundary between layers of light (warm and low-salinity) water and heavy (cold and high-salinity) water. Although internal waves may displace the boundary by as much as 50 ft.. they cannot be noticed at the surface and their velocity rarely exceeds two knots.

In the time of sailing vessels there were many reports of "dead water." The vessel appeared to stick in the water, behaving sluggishly and making little headway. This experience was common in arctic water where, by melting of ice. there was formed a layer of nearly fresh water about as thick as the draft of vessels. In such a case the power is used to produce an internal wake at the boundary between the fresh water and the salt water in addition to the ordinary wake at the sea surface, and in one instance a vessel was slowed from five knots to one knot. In extremely old sailing accounts internal waves were mistaken for sea monsters which were holding the ships back.

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WAX FIGURES. Beeswax is possessed of properties which render it a most convenient medium for preparing figures and models, either by modeling or by casting in molds. At ordinary temperatures it can be cut and shaped with facility; it melts to a limpid fluid at a low heat; it mixes with any colouring matter, and takes surface tints well; and its texture and consistency may be modified by earthy matters and oils or fats.

Wax figures of their deities were used in the funeral rites of the ancient Egyptians, and deposited among other offerings in their graves; many of these are now observed in museums. That the Egyptians also modeled fruits can be learned from numerous allusions in early literature. Among the Greeks during their best art period, wax figures were largely used as dolls for children; statuettes of deities were modeled for votive offerings and for religious ceremonies, and wax images to which magical properties were attributed were treasured by the people. Wax figures and models held a still more important place among the ancient Romans. The masks (*effigies* or imagines) of ancestors, modeled in wax, were preserved by patrician families; they were exposed to view on ceremonial occasions and carried in their funeral processions. The closing days of the Saturnalia were known as *Sigillaria,* because of the custom of making, toward the end of the festival, presents of wax models of fruit and waxen statuettes which were fashioned by the *sigillarii* or manufacturers of small figures in wax and other media. The practice of wax modeling can be traced through the middle ages, when votive offerings of wax figures were made to churches, and the memory and lineaments of monarchs and great personages were preserved by means of wax masks as in the days of Roman patricians. In these ages malice and superstition found expression in the formation of wax images of hated persons, into the bodies of which long pins were thrust, in the confident expectation that thereby deadly injury mould be induced to the person represented; and this belief and practice continued until the 17th century. Indeed the superstition still survives in the Highlands of Scotland. With the renaissance of art in Italy, modeling in wax took a position of high importance, and it was practised by some of the greatest of the early masters. The bronze medallions of Pisano and the other famous medalists owe their value to the art qualities of wax models from which they were cast by the cire-perdue (lost wax) process (see BRONZE AND BRASS ORNAMENTAL WCRK); and indeed all early bronzes and metalwork were cast from wax models. A figure in the Wicar collection at Lille is one of the most lovely examples of artistic work in this medium in existence. Wicar, one of Napoleon's commissaries, brought this figure from Italy. It represents the head and shoulders of a young girl. It has been claimed as a work of Greek or Roman art, and has been assigned to Leonardo da Vinci and to Raphael, but all that can be said is that it probably dates from the Italian Renaissance. In Spain beautiful wax figures of saints, distinguished in form and colouring, were achieved in the realm of religious art. Until toward the close of the 18th century modeling of medallion portraits and of relief groups, the latter frequently polychromatic, was in considerable vogue throughout Europe. About the end of the 18th century John Flaxman executed in wax many portraits and other relief figures which Josiah Wedgwood translated into pottery for his jasper ware. The modeling of the soft parts of dissections, etc., for teaching illustrations of anatomy was first practised at Florence. Such preparations formed part of a show at Hamburg in 1721, and from that time waxworks, on a plane lower than art, have been popular attractions. Such an exhibition of waxworks with mechanical motions was shown in Germany early in the 18th century, and is described by Sir Richard Steele in the Tatler.

The most famous exhibition is that of Marie Tussaud (*q.v.*) in London.

WAX MYRTLE (CANDLEBERRY), popular names of species of Myrica, especially M. cerifera and *M. pensylvanica* (bayberry or waxberry), small shrubs native to eastern North America. The fruits have a waxy covering and are utilized as a source of vegetable wax, used especially in New England for making candles. Sierra wax myrtle or sweet bay (M. *hartwegi*) is a similar shrub, found in the Sierra Nevada mountains; the western wax myrtle (M. *californica*), a large evergreen shrub with resinous wax-covered fruit, occurs along the coast from Los Angeles to Washington. M. gale is the native British gale or sweet gale (*q.v.*). Toxicodendron succedanum is the wax tree of Japan.

WAXWING. The three species of waxwing are among the most beautiful of the smaller birds. Their sleek plumage has an exquisite silky texture and is generally brownish or grayish but with some black around the eyes and throat edged with white. The name "waxwing" is given because of the red, waxlike tips of the shorter wing feathers (secondaries). The cedar waxwing (*Bombycilla* cedrorum) of North America averages seven inches in length and has shades of soft brown fading to yellowish underneath. The Bohemian waxwing (B. garulla) of the colder regions of North America, Europe and Asia is larger, about eight and one-half inches long. It is grayer with the wing quills edged with yellow and white. The Japanese waxwing (B. *japonica*) is about six and one-half inches long and is of a warmer shade of brown. It lacks the curious waxlike tips

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CEDAR WAXWING. OR CEDAR BIRD, (BOMBYCILLA CEDRORUM) but the feather itself is tipped with red as is the tail, unlike the other two species which have the tail tipped with yellow. It is found in Japan and adjoining parts of Asia.

The waxwings are attractively crested. They feed on berries so ravenously at times that they are unable to fly; they are also avidly fond of potato bugs and other insects. Their voices have a lisping quality; they are not songbirds. Waxwings often nest in coniferous trees, building rather bulky nests of twigs, rootlets and grasses lined with soft material. They lay from four to six neutral-tinted eggs spotted with blackish. (K. P.)

WAYCROSS, a city of southeast Georgia, U.S., and the seat of Ware county, is situated on the coastal plain 60 mi. from the Atlantic ocean. In colonial days, the site was the hub of stagecoach roads and pioneer trails. Settlers moved into the land around Kettle creek in 1818, to build forts for protection against Indians but as late as 1870 the village had only 50 inhabitants. The area developed rapidly as a commercial centre after the coming of the railroads. Bee culture, production of naval stores, tobacco warehousing and pecan shelling are leading industries in the city and area. Waycross was incorporated in 1874. The name signifies the city's strategic location at the junction of six rail lines.

Seven miles south of Waycross is the entrance to the Okefinokee swamp (*q.v.*), a 700 sq mi. wildlife refuge. The name, Okefinokee or "land of trembling earth" was given to the swamp by the Seminole Indians because of the quaking nature of its soil. The Suwannee river, immortalized by Stephen Foster, and the St. Mary's river rise in the Okefinokee. For comparative population figures see table in GEORGIA: *Population.* (J. N. A.)

WAYLAND, FRANCIS (1796–1865), U.S. educator, fourth president of Brown university, Providence, R.I., was born in New York city on March 11, 1796. He graduated from Union college in 1813 and subsequently studied medicine and theology. He was a tutor at Union college, 1817–21, pastor of the First Baptist church of Boston for five years, and was elected professor of mathematics and natural philosophy at Union in 1826. He held that post for only a very short time, being called in 1827 to take over the presidency of Brown university. During his 28 year administration Wayland became famous for introducing electives, developing the library and emphasizing science. His textbooks on ethics and economics were widely used, and his Thoughts on the Present Collegiate System in the United States (1842) and Report to the Corporation of Brown University (1850) promoted educational reforms. They proved to be more influential elsewhere than at Brown, where later administrations reversed his policies. He was a leader of the "law and order" group during the Dorr rebellion of 1842 (see RHODE ISLAND).

Wayland died on Sept. 30, 1865.

His son, also FRANCIS WAYLAND (1826–1904), was for 30 years dean of the Yale law school.

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WAYLAND THE SMITH, hero of romance (Scand. Volundr, Ger. Wieland). The legend of Wayland probably had its home in the north, where he and his brother Egill were the types of the skilled workman, but there are abundant local traditions of the wonderful smith in Westphalia and in southern England. His story is told in one of the oldest songs of the Edda, the *Völundarkviða,* and, with considerable variations, in the prose *Þiðrekssaga* (Thidrek's saga), while the Anglo-Saxon *Beowulf* and Deor's Lament contain allusions to it. The first part of the tale contains obviously mythical features connected with his parentage and marriage. The second part concerns Volundr, lord of the elves, the cunning smith, who, with his sword Mimung, made famous in German epic poetry, defeated in fight at the court of king Niþoþr, the smith Amilias. Niþoþr, in order to secure Völundr's services, lamed him and established him in a smithy. The smith avenged himself by the slaughter of Niþoþr's two sons and the rape of his daughter Bodvildr, then soared away on wings he had prepared. The story in its main outlines strongly resembles the myth of Daedalus, but the denouement of this tale, which first appeared in European literature in the De obedientia (Opera, Venice, 3 vol., 1518–19) of Jovianus Pontanus (d. 1503), is different. The Aaron of Shakespeare's Titus Andronicus was derived from this source. King Rhydderich gave a sword fashioned by Wayland to Merlin, and Rimenhild one to Child Horn. English local tradition placed Wayland Smith's forge in a cave close to the White Horse in Berkshire.

The earliest extant record of the Wayland legend is the representation in carved ivory on a casket of Northumbrian workmanship of a date not later than the beginning of the 8th century. The fragments of this casket, known as the Franks casket, were presented to the British museum by Sir A. W. Franks. One fragment is in Florence.

See also Vigfússon and Powell, *Corpus poet. bor.,* i, pp. 168–174 (1883); A. S. Napier, *The Franks Casket* (1901); G. Sarrazin, *Germanische Heldensage in Shakespere's Titus Andronicus,* Herrig's *Archiv.,* xcvii (1896); P. Maurus, *Die Wielandsage in der Literatur* (1902); C. B. Depping and F. Michel, *Véland le Forgeron* (1833). Sir Walter Scott handled the Wayland legend in *Kenilworth;* there are dramas on the subject by Borsch (1895), English version by A. Comyn (1898); August Demmin (1880); H. Drachmann (1898); and one founded on K. Simrock's heroic poem on Wieland is printed in Richard Wagner's *Gesammelte Schriften,* vol. iii, 2nd ed. (1887).

WAYNE, ANTHONY (1745–1796), U.S. army officer, was born at Waynesboro, Pa., on Jan. 1, 1745. After a trial at surveying he operated the tannery on his father's estate and later inherited the property. He was commissioned a Continental colonel Jan. 3, 1776. His regiment was sent to reinforce Benedict Arnold's retreating Canadian expedition, and he later commanded Ft. Ticonderoga. He was promoted to the rank of brigadier general early in 1777 and took a prominent part in the battles of Brandywine and Germantown. After being defeated at Paoli he spent the winter at Valley Forge. At Monmouth courthouse on June 28, 1778, he led the attack on the British. The storming of Stony Point, July 16, 1779, was his most dramatic stroke. The name "Mad Anthony" rose from a deserter's complaint. When the treason of Benedict Arnold was discovered, Wayne moved promptly to safeguard West Point. In 1781 he was sent south to help Lafayette. At Green Springs, Va., on July 6, he took on Cornwallis' larger army, but extricated himself with small loss. He was present at the siege of Yorktown and then was dispatched to join Gen. Nathanael Greene's southern army. He served largely in Georgia, recovering the state and defeating the enemy Indians.

The Georgia legislature elected him to the U.S. house of representatives in 1790, and he served nearly two years before his seat was declared vacant because of state election frauds. President Washington then appointed him commander in chief of the small U.S. army, which had suffered defeat in Ohio by Indians. Wayne trained his enlarged army for two years before advancing slowly north of the Ohio river. At the battle of Fallen Timbers, Aug. 20, 1794, near modern Toledo, he routed the British-inspired Indians. This defeat and the Jay treaty (*q.v.*) with England enabled Wayne to negotiate, with the Indians, the treaty of Greenville, 1795, by which the Indians agreed to open a large part of Ohio for peaceful settlement. The next year the British yielded their posts on the U.S. side of the Great Lakes. Wayne died at Erie, Pa., on Dec. 15, 1796 while on duty.

See Thomas Boyd, *Mad Anthony Wayne* (1929); Harry E. Wildes, *Anthony Wayne* (1941); Richard Knopf (ed.), *Anthony Wayne, a Name in Arms* (1960). (H. H. P.)

WAYNFLETE (WAINFLEET), **WILLIAM OF** (WILLIAM PATYN; 1395?–1486), English lord chancellor and bishop of Winchester, founder of Magdalen college, Oxford, took his name from his birthplace, Wainfleet-All-Saints, in Lincolnshire. Little is known about his early years, but he evidently established a reputation as a scholar before he became master of Winchester college in 1429. In 1442 he went to Eton where he is believed to have acted as master; it is known that he was provost in Sept. 1443. In 1447 he was consecrated bishop of Winchester, which office he retained until his death at Bishop's Waltham, Hampshire, on Aug. 11, 1486.

In 1448 he began his great work, the establishment of the College of St. Mary Magdalen, Oxford, but the wars hindered the completion of his plans and it was not until 1480 that the college was fully working. The statutes of the college were modeled on those of William Wykeham for New college, but with some important differences. Waynflete's 70 scholars were divided into 40 fellows and 30 junior scholars. Waynflete attached great importance to grammar as a foundation for further studies. A master and usher were in charge of the grammar teaching and three readers were appointed to lecture on theology and different branches of philosophy. Their stipends were on a generous scale and they were the first endowed teachers of the university. Magdalen college took a leading part in Renaissance studies. Waynflete's suppression of religious houses to increase the endowment of his college set an example for Cardinal Wolsey. In 1484 it is thought that Waynflete began building Magdalen college school, Brackley, Northamptonshire.

When Jack Cade's rebellion occurred in 1450 Waynflete was employed with Archbishop Stafford, the lord chancellor, to negotiate with the rebels. A full pardon was promised, but afterward he was one of the special commissioners to try the rebels. In 1457, as chancellor, Waynflete took part in the trial and condemnation for heresy of Reginald Pecock, whose books were then burned. He resigned the chancellorship upon the Yorkist success in 1460, but came to no harm in the changing fortunes of the Wars of the Roses.

See H. A. Wilson, *Magdalen College,* pp. 1–48 (1899). (S. J. C.)

WAYS AND MEANS COMMITTEE. The traditional name in English-speaking countries for the committee responsible for revenue legislation in the lower house of the national legislative body. The nature of the committee, however, is different in Great Britain and other countries with the parliamentary form of government from what it is in the United States.

In Great Britain, the committee on ways and means consists of the entire house of commons, meeting under somewhat different rules from those prevailing for the house itself. This practice formally originated in 1707, but had actually developed on an informal basis at an earlier date. It developed primarily because the speaker of the house was at that time a designee of the crown, and parliament wished to increase its independence of the crown and its privacy in acting on revenue measures by meeting under the chairmanship of one of its own members. At first the term "committee of the whole house" was used. By the middle of the 17th century the practice had developed of using two designations for the house meeting as a committee — supply, and ways and means. The former dealt with expenditures, the latter with voting the money to meet the expenditures, and providing for methods of financing.

When the house meets as the committee on ways and means the chancellor of the exchequer presents his budget statement. The committee immediately votes on the proposed resolutions to authorize continuation of existing taxes, make changes in taxes or add new levies. The resolutions passed by the committee are then submitted to the house itself, meeting under its normal rules, and their contents are incorporated into the finance bill. This bill is subject to debate on second reading, and is open to amendments which may reduce taxation but not increase it.

The Canadian version of the ways and means committee is similar to the British. The committee consists of the entire membership of the house of commons meeting in this capacity and thus under less formal rules than those applying to the house itself. However, unlike the British practice, each paragraph of the resolutions relating to tax changes is explained, discussed and debated while the house is in committee. When the resolutions relating to the changes have been approved by the committee on ways and means, a report is made to the house itself. Amending bills are then introduced, debated and enacted.

In the United States, the ways and means committee, consisting in the late 1950s and early 1960s of 25 members of the house of representatives, handles all measures in the house relating to the raising of revenues, including taxes, tariffs, social security levies and debt policy. This was one of the earliest committees established in the house, first as a select or special committee in 1795, and then as a permanent or standing committee in 1802. The committee originally handled both appropriations and revenue measures, but this placed a heavy work load on the committee and concentrated too much power in its hands. To remedy this situation control of expenditure measures was transferred to an appropriations committee, established in 1865. Since the constitution provides that all revenue legislation must originate in the house of representatives, the ways and means committee occupied a somewhat more strategic position than its senate counterpart, the finance committee. Gradually, however, the senate adopted the practice of making drastic changes in tax measures approved by the house, and the position of the two houses is now in practice more nearly equal. The ways and means committee, however, makes more detailed examination of tax questions than does the senate committee.

Under practice as evolved by 1960, most changes made in tax legislation originate in the committee itself, initiated either by recommendations of the president and the secretary of the treasury, or by the work of the committee. The committee holds lengthy and detailed public hearings on proposed tax legislation, with testimony from various business, farm, labour and other organized groups, the treasury and interested individuals. Next, meeting in executive session, the committee reaches its decisions and brings forth a measure to the house. Under usual rules of the house, debate is limited and amendments are not permitted. The house can, of course, reject the measure, but it rarely does so. The bill as passed by the house then follows the usual procedure for legislation. Bills on revenue matters introduced by individual house members are referred to the committee but rarely receive serious consideration.

The distribution of membership on the committee is established roughly in proportion to the relative membership of the two parties in the house. The senior majority member is chairman. This position is one of great influence, both with regard to the selection of measures on which committee action is to be taken and the actual contents of the revenue measures.

See also CONGRESS, UNITED STATES; EXCHEQUER; PARLIAMENT.

See H. Brittain, *The British Budgetary System* (1959) ; D. T. Selko, *The Federal Financial System* (1940). (J. F. D.)

WAZIRABAD, a municipality and tehsil (subdistrict) in Gujranwala district, Lahore division, West Pakistan. The town, near the left bank of the Chenab river, is 62 mi. N. of the city of Lahore.

The population of the town was 33,027 in 1951.

It is an important railway junction. The main line of the North-Western railway there crosses the Chenab by the Alexandra bridge, opened in 1876. Boat building and manufactures of steel and iron are carried on. Wazirabad tehsil had a population of 217,198 in 1951.

WAZIRISTAN, a mountain tract in West Pakistan, between Dera Ismail Khan, Bannu and Kohat districts (Dera Ismail Khan division) and the Afghanistan frontier, which was there demarcated in 1894; total area 4,473 sq.mi. The tract is controlled as two agencies—NORTH WAZIRISTAN (pop., 1951, 128,235) and SOUTH WAZIRISTAN (pop., 1951, 135,784) — administered by the central government through an agent (ex officio the commissioner of the Dera Ismail Khan division, to which for all practical purposes they are attached).

The central range of Waziristan is enclosed on the north by the Tochi valley and on the south and west by that of the Gomal; it is connected with the great limestone ranges of the Suliman hills to the south, and dominated by the great peaks of Shuidar (Sheikh Haidar) and Pirghal, both of them between 11,000 and 12,000 ft. above the sea. From these peaks a view is obtained westward across the grass slopes and cedar woods of Birmal and Shawal to the long, serrated ridges of the central watershed which shuts off the plains of Ghazni. To the eastward several lines of drainage strike away toward the Indus, and are, as usual, the main avenues of approach to the interior of the country. They are the Khaisora and the Shakdu on the north, which, uniting, join the Tochi south of Bannu, and the Tank Zam (which is also called Khaisor near its head) on the south. The two former lead from the frontier to the military station of Razmak and the village of Makin, situated on the slopes of Shuidar, and the latter leads to Kaniguram, the Waziri capital and the centre of a considerable iron trade. Kaniguram lies at the foot of the Pirghal mountain.

The Waziri tribes are the largest on the frontier, but their state of civilization is very low. Neighbouring Mohammedan tribes, seem inclined to deny their title to belong to the faith.

Except in a few of the highest hills, which are well wooded, the Waziri country is a mass of rock and stones, bearing a poor growth of grass and thinly sprinkled with dark evergreen bushes.

The Waziris are divided into two main sections, the Darwesh Khel. referred to as "Wazirs," and the ilfahsuds.

The Darwesh Khel are the more settled and civilized of the two, and inhabit the lower hills bordering on Kohat and Bannu districts and the ground lying on both sides of the Kurram river. between Thal on the north and the Tochi valley on the south. The Mahsuds, who inhabit the tract of country lying betneen the Tochi valley on the north and the Gomal river on the south, have earned for themselves an evil name as the most confirmed raiders on the border. The Mahsud country is more difficult even than Tirah. The Tochi valley is inhabited by a degraded Pathan tribe, known as Dauris, who placed themselves under British protection in 1895.

Following the independence of Pakistan in 1947, and the accession of the tribal areas to the new dominion, attempts were intensified to foster education, industry and agriculture in those areas.

Campaigns in Waziristan.—British expeditions were needed against various sections of the Waziris in 1852, 1859, 1860, 1881, 1894, 1897, 1902, 1917, 1919–20, 1922, 1936–37 and during World War II.

There is no need to recount in detail the course of the earlier expeditions into Waziristan. In 1860, after some sharp minor actions, a column of all arms occupied Kaniguram and Makin, the centres of population in the Mahsud country; and the success of Sir Robert Sandeman (*q.v.*) in subduing the Baluchi tribes after 1866 subsequently led to similar attempts to open up Waziristan to British civilization. In 1879, however, the Mahsuds had to be subjected to an economic blockade, and in 1893 a well-conducted expedition under Sir W. Lockhart overran Waziristan. The Pathan was much more democratic and much less subject to the influence of his maliks than was the Baluchi to the authority of his chiefs, and the policy of civilization by influence finally broke down in 1894, when the Waziris made a night attack upon the camp of the British delimitation commission at Wana. The attack was delivered with such determination that the tribesmen penetrated into the centre of the camp, and it was only with the greatest difficulty that friend could be distinguished from foe. A force of 11,000 British troops subsequently traversed the tribal country, destroyed the toners and dictated terms. one of which was that the Tochi valley should be occupied by British garrisons. In 1896 Wana was occupied at the request of the Wazirs themselves. But still there was trouble. leading to the Tochi expedition of 1897. In 1900 a second blockade of the illahsuds was initiated, but dragged on for over a year until several columns had devastated the most fertile of the Mahsud valleys. In 1902 attempts to "Sandemanize" Waziristan were given up by Lord Curzon. In 1917 a brief expedition penetrated up the Shahur river and effected a temporary submission of the Mahsuds.

The close of World War I was followed in May 1919 by the outbreak of the third Afghan War. For some time past Wazirs and Mahsuds alike, excited by Afghan propaganda. had been growing bolder in their brigandage. The climax came when the evacuation of the military posts maintained in the Tochi and Gomal valleys was effected. These trade routes had in the past been guarded by fortified posts garrisoned by native forces known as the Northern and Southern Waziristan militia respectively. These forces. composed of tribesmen under British officers, with few exceptions deserted early in 1919, and thereby provided their Mahsud compatriots with an invaluable stock of rifles and ammunition; while, more serious still. they formed a nucleus of skilled leaders for the *lashkars*. However, in Nov. 1919 an expeditionary force was placed under the command of Maj. Gen. S. H. Climo. This force amounted to 30,000 combatants, figures later augmented.

On Nov. 17, General Climo received unconditional surrender of the Tochi Wazir tribes at Datta Khel. It was now decided to move the striking force to the Tank Zam valley and to advance in one column by that route to Kaniguram and Makin in the heart of the Mahsud country. The force was completely assembled at Jandola on the Tank Zam by Dec. 13, whereupon a beginning was made to picket the valley on either flank by crowning the heights with small fortified works.

On Dec. 17 the Mahsuds made a fierce onslaught on the advanced troops of the striking force, or "Derajat column," under cover of a parley. They were driven back and the column moved next day. An attempt to seize Mandanna hill, made on the 19th, failed. A second attempt. on the 20th, conducted by stronger forces and supported by aircraft, met with negligible resistance. Leaving 100 men to complete the fortification of a detached post on the hill, the troops returned to camp. No sooner had they withdrawn than a fierce Nahsud attack swept away the remaining detachment, and the hill was lost again. A similar attempt to seize Tarakai or Black hill on the 22nd eventually succeeded. The Mahsud losses, occasioned by some close-quarter fighting and artillery fire: proved very heavy for this class of warfare. Tarakai was held as the enemy retired.

On Dec. 25 Mandanna hill was occupied afresh and permanently. An advance of four miles was made to Kotkai where the column remained until Jan. 7, preparing to force a precipitous defile known as the Ahnai Tangi. Three attempts, on the 7th, 9th and 10th, failed. In view of this situation, now daily growing more unsatisfactory, Gen. Andrew Skeen ordered a night march for the small hours of the 11th. On the 14th the entire column passed through the defile.

The task was still formidable. The eastern bank of the Tank Zam was formed by two long ridges, the nearer being christened Flathead Left and the farther Flathead Right, while to the north of a deep depression came yet another height dubbed Marble Arch. The right flank guard soon became heavily engaged on Flathead Left while the advanced guard met with a heavy fire from Marble Arch and was checked. After a savage action at close quarters, Flathead Left was taken and held throughout the day, aircraft contributing to this result. After a night march on the 28th, the column passed through the gorge.

Although the Mahsud resistance was on the wane, Afghan emissaries were busy stirring them to further efforts. Two Afghan mountain guns arrived to reinforce moral persuasion. On Feb, 1 General Skeen once more ordered a night march against the Mahsud position, held in great strength, near Aka Khel. A striking success resulted; the enemy's resistance collapsed with no seeming hope of its reviving; Afghan help did not materialize, while the two mountain guns proved a dismal failure. But the Mahsuds showed no sign of accepting the government's terms and so the column marched farther up the Tank Zam valley. A coercive policy was now enforced. appropriate measures being taken for the destruction of hfahsud property.

On Feb. 16 the column arrived at Tauda China, 2 mi. from Makin, which centre of population and agriculture. failing submission by the Mahsuds, was to be ravaged. According to the terms of an ultimatum, the days of grace expired on Feb. 19. when, until the 29th, the fortified Mahsud villages were systematically shelled or raided. On March 2 the column moved to Kaniguram, the only so-called "town" of the Mahsud country. The place itself was not occupied, the troops being kept within a fortified camp constructed at Ladha close by the town. A certain number of rifles were surrendered, but as a whole the Mahsuds remained untamed and hostile. The column remained at Ladha when, on April 6, it carried out an important punitive operation northwest of Kaniguram. This showed the tribesmen to be still as contumacious and bellicose as ever. Ladha was consequently converted into a standing camp connected with Tank by a strong series of posts down the Tank Zam valley. The Waziristan force was reduced, the Derajat column as such was broken up; one brigade remained at Ladha while another guarded the road to Tank. Then finally, in the autumn, the long-deferred expedition to Wana was organized as the Wana Wazirs had failed to comply with the government's demands for reparation for the outrages of 1918–19. Moreover, the Wazirs were then undoubtedly harbouring Afghan agents who were intriguing against the government of India.

On Nov. 12 the Wana column, commanded by Maj. Gen. W. S. Leslie, left Jandola for Sarwekai where a lengthy pause was made. Then, on Dec. 15, the troops moved again and reached Wana on Dec. 22. The only incident of the advance was a spirited little affair at the pass of Granai Mara Narai where a night march once more dislodged the Wazirs from their position virtually without fighting. The beginning of 1921 thus found a brigade of Indian troops at Ladha and Wana respectively with every prospect of a permanent occupation of Waziristan. But a great circular motor road was now to be constructed from Bannu up the Tochi valley; thence across the passes to Razmak and so down the whole Tank Zam valley to Tank. This road would allow of military operations being conducted under very different conditions to those prevailing in 1919–20. Moreover, the royal air force was now in possession of a new aerodrome at Dardoni in the Tochi valley. Lastly, two 6-in, howitzers were to be stationed at Ladha.

At the close of 1922, on the impending completion of the new motor road, the garrison of Ladha was ordered to move into the new and more salubrious camp of Razmak. The Mahsuds, mistaking this change for a symptom of weakness, committed acts of open hostility. The situation grew so bad that punitive operations became inevitable. The plan of operations was for one brigade to advance from Razmak and to unite with the brigade from Ladha in the Makin area. Before this could be effected the last stages of the motor road had to be completed and this proved an arduous task. Starting from Idak in the Tochi valley the 7th brigade reached Razmak on Jan. 23, then effecting a junction with the 9th brigade from Ladha on Feb. 4 at Tauda China. The Makin area was once more devastated; aeroplanes, 6-in. and 3.7-in. howitzers were all employed in the task. By the 12th enough destruction had been accomplished, and on the 22nd the last recalcitrant tribes made their submission.

After many years of peace, serious fighting once more took place in 1936–37 because of the anti-British activities of the fakir of Ipi. Punitive operations were also necessary during World War II.

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WAZZAN, a small town: 60 mi. N.W. by N. of Fez, Morocco, on the slopes of the Djebel Bu-Hallal. Pop. (1952) of Wazzan, chief town of a territory, 21,353. It manufactures a coarse woollen cloth, from which the hooded cloaks (called *jellábs*) are made. There is Dar D'manah — "House of Safety" — as it is sanctuary for any who gain its limits, on account of the tomb of a sainted Idrisi Sherif who lived there in 1727 and was the founder of one of the important religious brotherhoods of the Moslem world, called the Taibiya. After the conquest of Algeria the sherifs of Wazzan, chiefs of the brotherhood, were placed under the protection of France. French troops occupied Wazzan in 1920. (P. W. I.)

WEADOCK, THOMAS ADDIS EMMET (1850–1938), U.S. lawyer, legislator and jurist, was born in Ballygarrett, County Wexford, Ire.. on Jan. 1, 1850. He was brought to the United States in infancy, his family settling on a farm near St. Marys, O. He was educated there and taught in the district schools nearby before receiving his L.L.B. degree from the University of Michigan, Ann Arbor, in 1873.

Admitted to the Ohio and Michigan bars in that year, he began practice in Bay City, Mich., was prosecuting attorney (1877–78) and mayor (1883–85), and served as a Democratic representative in the 52nd and 53rd congresses (1891–9j), refusing to try for re-election in 1894. He resumed law practice in Detroit, mas appointed professor of law at the University of Detroit in 1912 and served as a justice of the supreme court of Michigan in 1933–34. He died in Detroit on Nov. 18, 1938.

WEAGANT, ROY ALEXANDER (1881–1942), U.S. electrical engineer and inventor, who helped solve the problem of static in radio, was born on March 29, 1881, in Morrisburg, Ont. His great-grandfather had gone to Canada from Baltimore, Md., early in the 19th century. In 1884 the Weagants moved to Derby Line, Vt.. and after the death of the father, the widow's marriage to a U.S. citizen gave her and her son U.S. citizenship. Weagant studied two years at Stanstead college and received his B.S. degree from McGill university (Montreal. Que.) in 1905.

He worked successively for the Montreal Light, Heat and Pomer company (1906); Westinghouse Electric and Manufacturing company in Pittsburgh. Pa. (1907); De Laval Steam Turbine company, Trenton. N.J. (1908): and National Electric Signaling company (1908–13). He was chief engineer of the Marconi Wireless Telegraph company (1915–20), and in 1919 completed the invention which reduced static and also reduced power needed and eliminated the need for tall steel towers. He was consulting engineer for the Radio Corporation of America, successor to the Marconi company (1920–24). After 1924 he was chief engineer and vice-president of the De Forest Radio company and consultant patent expert for the Radio Corporation of America. He received the Morris-Liebman prize for his static-reducing invention.

Weagant died in Newport, Vt., on Aug. 23, 1942.

WEA INDIANS, a subtribe of the Miami, a tribe of North American Indians of Algonkin stock.

The name Wea was probably contracted from *Wawiaqtenang,* the name for place of the round, or curved, channel; or from *Wayahtónuki,* "eddy people," from *wayaqtonwi,* or eddy.

The Jesuit Relation (1673) reported the tribe in eastern Wisconsin; they later lived in western Wisconsin. In 1719 their chief village, Ouiatenon, which became a French trading centre, was on the Wabash river near Wea creek, Ind. The Wea, also representing the Piankashaw Indians, signed the treaty of Greenville, O., Aug. 3, 1795. By 1820 they had sold all their land in Indiana and, with the Piankashaw, went to Illinois and Missouri. In 1832 they sold their claims there and followed other members of the group to Kansas. The Wea and Piankashaw joined the Illinois, known then as the Kaskaskia and Peoria. in 1854, the consolidated group totalling only 259. They went to northeastern Oklahoma in 1868.

WEAKFISH (Cynoscion regalis), an important North American food fish, so-called from its tender mouth. It inhabits sandy shores of the Atlantic coast from Cape Cod to Florida and is greenish-brown above, silvery below, with brown markings. The weakfish is known as squeteague in New England, as weakfish in New Jersey, and as sea trout in Chesapeake bay and to the south. It rarely reaches a weight of 30 lb. (average 5 lb.). The commercial fishery centres in Chesapeake bay, to which fish spawned in waters both to the north and to the south migrate. It is a popular sport fish, especially from Long Island to Chesapeake bay.

WEAKLEY, ROBERT (1764–1845), U.S. soldier and legislator, who was active in the founding of the state of Tennessee, was born in Halifax co., Va., on July 20, 1764. He attended schools in Princeton, N.J., until at the age of 16 he entered the Revolutionary army and served to the end of the war. In 1785, with the horse he rode and $1.75, he went to the territory west of the Alleghenies which North Carolina later ceded for the creation of the state of Tennessee. Weakley fought in the wars with the Creek and Cherokee Indians under James Robertson, rising to the rank of colonel.

In 1789 when he was 22, Weakley was a member of the North Carolina convention that ratified the Constitution of the United States. He was elected to the house of representatives in the first Tennessee general assembly in 1796, and served as a representative from Tennessee in the 11th congress from 1809 to 1811. He served in the senate of the general assembly in 1811, 1819 and 1823-24, in the last two cases being the speaker. In 1819 he was U.S. commissioner in negotiations with the Chickasaw Indians. In 1834 he was a member of the convention which wrote the second of Tennessee's constitutions.

He died near Nashville. Tenn., on Feb. 4, 1845, and was buried at his estate, "Lockland," near there.

WEALD, THE, an area about 100 mi. long and 40 mi. broad in southeast England, enclosed by the continuous chalk escarpment

(180 mi. long) of the North and South Downs. Within the chalk, forming roughly concentric rings, are outcrops of Upper Greensand, Gault, Lower Greensand, Weald Clay and, in the centre, the Hasting Sands which stretch from Horsham to Hastings and rise in places to 800 ft. It is drained by rivers running through gaps in the Downs (*q.v.*): the Wey, Mole, Darent, Medway and Stour to the north and the Arun, Adur, Ouse and Cuckmere to the south. The Forest Ridges (High Weald), running east to west in the centre of the area, divide the Yale of Sussex from the Vale of Kent. The total area under forest about 1660 was more than 200,000 ac.; the chief remains are Ashdown, St. Leonard's and Tilgate forests. The Weald is stil! heavily wooded, though the area is mostly agricultural and. in parts, residential.

The National trust owns about 100 areas (including historic buildings) within the region.

There are Mesolithic, Neolithic, Bronze and Iron Age sites. The Romans called the great forest Sylva Anderida (the Roman port Anderida is now Pevensey, the coast being then different in outlinej and the Anglo-Saxons named it Andredsweald. The forests were used extensively for fuel in the ironworks of Sussex, which were worked by the Romans and earlier! became important in the 16th and 17th centuries and died out early in the 19th century. Stane street was built by the Romans across the Weald from Chichester to London. In 477 the South Saxons descended from over the sea upon the Sussex coast, to which they gave their name, and populated it. Name endings of towns and villages bear witness to early settlements: those ending in *-ing* are the oldest; *-ham* is also early; *-ton* is later and *-hurst* and *-den* later still.

See S. W. Wooldridge and F. Goldring, *The* Weald (London, Toronto, 1953).

WEALE, JOHN (1791–1862), English pcblisher, born in 1791, issued many technical books and educational works; particularly in the field of architecture.

He published *Catalogue of Works on Architecture and the Fine Arts* (1854), a bibliographical work; *A Series of Examples in Architectural Engineering and Mechanical Drawing* (London, 1841); *Designs of Ornamental Gates, Lodges, Palisading, and Ironwork of the Royal Parks Adjoining the Metropolis, Edited by John Weale* (London, 1841); *The Theory, Practice, and Architecture of Bridges of Stone, Iron, Timber, and Wire, Edited by Jolzn Weale,* 2 vol. (London, 1843); *Letter to Lord John Russell on the Defence of the Country* (London, 1847); *Rudimentary Dictionary of Terms Used in Architecture, Building, and Engineering* (1849–50; jth ed., 1876); *Designs and Examples of Cottages, Villas, and Country Houses* (London, 1857); *Old English and French Ornaments, Comprising 244 Designs. Collected by John Weale* (London) 1858). Weale was editor of *Weale's* Quar*terly Papers on Engineering* (London, 1843–46) and *Weale's* Quar*terly Papers on Architecture* (London, 1843–4j).

He died in London on Dec. 18. 1862.

WEALTH AND INCOME. The term "wealth" commonly refers to the stock of economically significant objects or items owned by a particular unit—a nation, a class or an individual. When applied to the individual the concept appears to be relatively clear and free from ambiguity. It denotes his holdings of various assets—real property, securities, intangibles such as copyrights and patents and money—minus his debts or obligations. Even in this case questions can arise as to the inclusion and valuation of certain assets. When dealing with the wealth of a nation, these questions are more insistent, and they can be answered in various ways depending upon the precise use to which the concept or measure is to be put. Nevertheless, despite possible differences in meaning, the different wealth concepts will have. as we shall see, a common feature: the idea of a *stock* or *inventory* existing at a certain date or point in time.

The term "income," by contrast. is concerned with a *flow* over a period of time: a flow of earnings, or purchasing power, or economically significant items for any period of time—usually a year. Even if we could determine the income level for a certain day. or for one minute or one second of that day, it would still have to do with a flow of "economically significant" iteins during the relevant period of time. The analogy is frequently used of wealth as a lake and income as a stream flowing into it, or through it, at a certain rate per unit of time. More concretely, the stock of wheat (so many bushels) would then be a component of wealth; the production of wheat (so many bushels a year, or a month) would be a part of income.

Many of the questions that arise about whether to include and if so how to value items in the measure of wealth arc bound to come up again in estimating income. However, there is not an exact parallelism in the answers given. Certain items which are commonly included in income have no place in wealth, and vice versa, and it follows that the analogy set out above is by no means exact. The water which fills the lake is not of precisely the same composition as the water that runs down the stream.

NATIONAL WEALTH

The determination of what to count in wealth is necessarily arbitrary, chiefly because the decision as to what items are economically significant depends upon the nature of the inquiry. Items which possess no value in the market presumably do not qualify, for the fact that they are free is an indication either that they are not wanted or alternatively that, like air, though useful they are available in amounts that exceed requirements. In either case, such items would not be economically significant for they are not economized. Items which though desired and relatively scarce are not marketed—for instance, labour in any but a slave economy—would normally be omitted too because there is no way to set a value upon it. But what about durable goods in the possession of consumers—say, vacuum cleaners and refrigerators? What about nondurable goods owned by business firms, or their intangible assets, like patents and good will? And what about items which cannot be reproduced—for instance, subsoil wealth, or a Gutenberg Bible? And finally, to illustrate the complexity of the problem with one more example, what should be done with items which have only a military value—long-range jet bombers; for instance? No simple rule can be laid down that would be appropriate in all circumstances. If we are interested in measuring aealth because it provides one indication of the economy's capacity to produce, we should probably not find it advisable to include consumer durables or military equipment, though we should want to cover the value of such nonreproducible items as land and subsoil wealth. If, instead, our concern is with wealth as an index of economic growth, we might exclude the category of nonreproducible items which, after all, are not created when the economy progresses, while we would include most of the other categories.

Unfortunately the decision as to whether items of a certain kind are to be included in the concept or not must rest in many cases on a quite different ground—namely, whether adequate data can be secured. In most cases, for instance, it is quite impracticable to collect reliable information as to the value of the various intangible assets of business firms—their good will, patents and so on—because firms typically set down only a nominal figure for such assets in their balance sheets.

It will be noticed that no mention has been made of holdings of securities—government bonds, for instance—and money. When we are dealing with the wealth of an individual or a particular group in the economy, such an ornission would be a mistake. Quite properly an individual's bank deposit and cash holdings are counted as a part of his wealth. But the situation is somewhat different when we are dealing with the wealth of a nation.

This is not because the value of the money or securities suddenly disappears as our interest is transferred from the individual to the nation. The reason is, instead, that though their value to their holders continues to be recognized, so too must the obligations they impose upon their issuers. Just as they are clearly assets to their owners, so are they liabilities of an equal amount to the firms: government bodies or banks which have created them. Thus, when individual wealth accounts are consolidated to form the nation's account, these assets are offset by matching liabilities. There is no such offsetting for the other items of wealth noted earlier. Hence, in determining a nation's wealth. holdings of money and securities (and other evidences of debt) are commonly neglected.

There is one exception to this rule which it is worth while to note. There may be assets owned in one country which represent a debt of residents of another. Confining our attention to the mealth of either country, the worth of these assets is not offset by liabilities. Holdings of Canadian government bonds in the United States would then be counted as an item in the wealth of the Cnited States, while U.S. holdings of the bonds of its own government would have to be ignored. Likewise, Canadian-owned deposits in a United States bank would be a part of Canada's wealth, while Canadian holdings of deposits in Canadian banks would not be included. We conclude then that financial assets, apart from those which are international in scope, do not constitute part of a nation's wealth. Only real assets, perhaps together with such intangibles as patents (if their value can be estimated) and selected intangibles would make up a nation's wealth.

A highly regarded estimate of United States national wealth! prepared by Raymond W. Goldsmith (*A Study of Saving in the United States*, vol. iii, Princeton, N.J., London, 1956), illustrates the composition of U.S. mealth. In 1949 the total stood at more than $950,000,000,000 in prices of that date. The components of this total (in such prices) follow, in billions of dollars:

Reproducible tangible durable wealth (except consumer durables)	$593.7
Durable consumer goods	99.3
International assets	45.3
Land and subsoil wealth	160.0
Military tangible durable assets	70.4
Total	$968.6

This is perhaps as broad an estimate as could ever be required. For most purposes, one or more of the items listed here would be dropped. Incidentally, it should be pointed out that the accuracy of some of these estimates is distinctly questionable.

There is an inclination to regard a nation's wealth as synonymous with, or at least a very good index of, the economic well-being of its residents. This tendency should be resisted. While a country with great wealth is likely to provide its residents with a high level of living, such a result is by no means a certainty. Other factors, notably the size and ability of its labour force, the level of their employment and the technical skill with which its productive factors are administered, help to determine the economic results, and their influence may be predominant. A country with immense stores of mineral resources but with an inadequate technology or a serious shortage of skilled labour would be unable to provide a high level of economic well-being. An adequate national wealth is a necessary but not a sufficient condition for real prosperity.

Recognizing this fact, some economists have sought to extend the concept over a wider range. Some discussions of national wealth refer to gifts of nature — climate, rivers, coast line and so on; to a country's labour force, as the living depository of skills and productive power; and to the moral characteristics of the population. All these, and many other conditions under which a nation lives and thrives, are important in determining its productive capacity. But if the concept of national wealth is to have a measurable counterpart and is to be useful in economic analysis, it must be limited to goods external to members of the nation, goods that enter into economic transactions and find a measurable value on the markets of the economy.

The problem of measuring or valuing the components of the national wealth must be considered briefly. These components include a wide variety of goods reducible to a common denominator only through the yardstick of the market price. But of all these goods, only a small percentage changes hands and passes through the market during the year. For this reason, special difficulties are encountered in establishing realistic current valuation indices for most of the components of the national wealth. The prices of the new additions to wealth can usually be recorded, but the reassessment of durable items (which have in all likelihood depreciated too) in a period of changing prices is bound to raise serious problems.

The national wealth total as a stock of tangible commodities usually includes: (1) land for various uses (agricultural, industrial plant location, houses, etc.) and the stock of mineral resources in the land; (2) construction and various types of improvement attached to land (houses, plants, roads, bridges, etc.); (3) durable equipment in the hands of enterprises (machinery, tools, rolling stock, etc); (4) inventories of goods in the hands of business enterprises and other producing agencies; (5) stocks of goods, mostly durable and semidurable, in the hands of ultimate consumers (automobiles, furniture and clothing. in the households). The sum total of values for these five categories is wealth located within the boundaries of the country. In order to convert it into national uealth, *i.e.*, wealth owned by the nation's members, either individually or collectively. one must add: (6) the excess (positive or negative) of claims by the nation's members against foreign countries over the claims by foreigners against the members of the nation (usually designated the net balance of foreign claims).

Referring again to the data already supplied on the national wealth of the United States in 1949, and to the source there noted for further details. we find that on the broadest possible concept (nhich includes military assets) wealth in structures (housing, business plant and government buildings) came to 42% of the total; wealth in equipment (including consumer durables but excluding military items), to 21% of the total; in inventories, to about 8.6%; in military items, about 7.25% of the total; in the form of nonreproducible assets (land and subsoil wealth), to 16.5%; and in international assets, to about 4.75%. Reproducible wealth, that is, the total excluding land and irreproducible resources. was about $808,600,000,000 (in 1949 prices) and the relative weight of its various components — structures, equipment, inventories and so on — is shifted accordingly.

Naturally, the physical assets composition of national wealth differs from country to country, and for the same ,country from time to time — largely with the stage of economic development. In countries that are not developed industrially and in which the per capita income level is relatively low, land and irreproducible resources are naturally a much larger percentage of total wealth; reproducible wealth is proportionately less significant; stocks of goods in the hands of consumers tend to be relatively low; and the net balance of foreign claims is likely to be negative rather than positive. In countries in which agriculture is proportionately less important than in the United States, *e.g.*, Great Britain, the relative weight of land is smaller; and, before World War II the net balance of foreign claims loomed larger in total wealth.

Control Over **Physical** Assets. — The physical assets constituting national wealth can also be classified by the type of economic agent that has direct control over them (who or what makes use of them). The most common basis of classification distinguishes business enterprises (as unincorporated, nonfinancial corporations and various forms of financial institutions); households (nonfarm and farm); government (federal, state and local and government corporations); and nonprofit institutions. This kind of classification must be distinguished from a related one, that in which the assets are shown in accordance with their ultimate owners. The obvious purpose of this present scheme is to relate the existing stock of mealth to the various types of use to which it is put.

Such a classification can be illustrated for 1949; once again the results are R. W. Goldsmith's. Of the approximately $880,000,000,000 of tangible assets (nonmilitary) in the country (in 1949 prices) in 1949, nonfarm households had about 38%; farm households. 14%; nonfinancial corporations, 23%; financial institutions, 3%; government (including nonprofit institutions), 16%; and unincorporated business, 6%. Naturally, the kinds of assets each sector held had their own special features, nonfarm households having very nearly 60% of their holdings of tangible assets in the form of residential structures, while farm households held only 10% in this form.

The basic tripartite division among consumers, business and government, and the industrial distribution within the business sector, are likely to vary from country to country and from time to time. In the United States the share of government increased perceptibly in the 1930s and 1940s so that at mid-century it was nearly double what it had been 50 years before; it was much less than 10% in the 19th century. Likewise, with the rise in the level of living and increased use of durable goods, the share of consumer wealth may have been higher in later decades than in the 19th century Shifts in the industrial structure of an economy over time or differences in structure among different countries are naturally reflected in the industrial attachment of wealth within the business sector proper. However, industries differ in their ratio of capital or wealth to output, so that shares of industries in total wealth are not necessarily identical with their shares in total output.

Ownership of Wealth. — Attaching values to the various physical items that enter the stock of wealth is not the only way of estimating its value. An alternative approach can be followed which leads to a different system of classification and to a different set of insights. Each item of wealth is owned by somebody, either an individual or a collective, and that ownership. certified as it is in some overt form, can ordinarily be valued. By adding the values of all the ownership claims of private individuals, whether to commodities used by them directly or to those used by firms. and to this subtotal adding the value of the wealth owned by collectives, net of any claims by individuals (since these are already counted), one should get an alternative figure for national wealth. The classification suggested by this ownership or claims approach is between privately and collectively owned wealth; and within the former class; by type of private owner. classified, for instance, by size of holdings or level of income. Instead then of looking at the objects owned, one may study the owners and the amounts they hold.

The claims approach will not necessarily yield a total for national wealth identical with. or as reliable as. the totals derived from taking an inventory of physical assets. The market value of an indirect claim to a physical asset, in the form, for instance: of a share of common stock in a business firm, is subject to violent fluctuations and sometimes does not appear to be closely related to the values oi the underlying physical assets estsblished by independent methods, say cost or reproduction value. Since the market value of such claims is so unstable, this method of estimating national wealth may not give a very reliable picture of the country's productive power. or of its past investment or prospective capital needs. And yet for certain purposes, notably when the behaviour of agents is influenced by what they regard as the value of their holdings, the claims approach is a sound one. Even when it is desirable, however, the investigator may have to face technical difficulties in getting reliable information on holdings of claims from individuals, since individuals are usually reluctant to provide such data, and they are not likely to be well informed: in any event, about the value of their holdings.

Nevertheless, the claims approach has been widely used in several countries, based either directly upon some current statistics of ownership by living persons. or more often upon data on estates of decedents. The former must always be supplemented by data on physical assets, to check on underreporting, to cover cases of direct owner use and to include assets by collectives not offset by private claims on them. The estates data involve the difficult problem of passing from wealth of the decedent to that of the living population. The derivation of the necessary conversion coefficients is difficult, since accurate data on mortality rates among different economic groups in the population are not usually available. Only once was a census of wealth based on a direct questionnaire survey of the population (in Australia in 1917).

Distribution of Wealth by Size of **Holdings.**—The claims approach to national wealth. although of limited value in estimating the total, is useful in describing the distribution of wealth among individuals by the size of their holdings, or their income, or by some other variable. For the United Stares, information on the distribution of wealth by households has been gathered periodically for the survey of consumer finances. The results for early 1950 were brought together in vol. iii of A *Study* of *Saving in the United States*. Although there is obvious underreporting for some categories, and there are serious problems in proceeding from results based upon a relatively small sample to the whole population, the results are nevertheless suggestive. The households' total asset holdings as covered in the survey came to $613,000,000,000—about two-thirds of the amount which the alternative method of estimating national wealth indicated. Households with more than $60,000 of wealth held about 32% of the total wealth; these households constituted about 3% of all families. The approximately 8% of families whose wealth was between $25,000 and $50,000 had about 23% of the total wealth. The 17% of all families whose wealth amounted to less than $400 had among them negative wealth amounting to 1.5% of the total. And finally, the 50% of all families which had wealth of less than $4,900 owned only 6% of all household wealth.

Another approach to the question of the distribution of wealth can be obtained from reports on the distribution of income from property (dividends, rent and interest). On the basis of reasonable assumptions, it can be inferred that the distribution of property incomes by size among individuals reflects the distribution of wealth by size of holdings, at least of income-yielding wealth (excluding stocks of consumer goods, although the size of such holdings is likely to be positively associated with the size of property in income-yielding wealth).

The distribution of wealth among individuals is much more unequal than is that of income. Thus during the period between World Wars I and II. the top 5% of the income population of the United States received from 25% to 30% of total income. During the same period, they received about 77% of all dividends paid to individuals, 42% of all interest and about 38% of all rent—a total of about 54% of all property incomes. These percentages are measures of the minimum rather than the true inequality in the distribution of income-yielding wealth by size of holdings. In England and \Vales, 1% of the population 2j years and over owned 55% of the total property in private hands in 1936, and 60% of that property in 1925–28.

National and Group Balance Sheets. — Describing and analyzing the structure of claims and obligations attached to the physical assets that comprise the national wealth is an aspect of the claims approach which was still in its early development in the 1950s. The machinery, buildings and inventories used by a business firm are the subject of clainis of the firm's stockholders and creditors; and these claims may be in part overlaid by the claims of their creditors — for instance. claims of depositors in banks which have made loans to the firm. When national wealth is estimated by adding net claims: only the residual figure enters; claims and counterclaims partially offset one another. But in order to analyze and understand the behaviour of groups of enterprises and ultimate consumers, it may be important to establish for each group or subgroup the full complex of assets, real and financial: and obligations to which each is subject, without any cancelling and netting. This is because we can probably expect economic units with the same net worth but with different structures of assets and liabilities (for instance, assets of different liquidity) to behave differently.

Probably the greatest value of the claims approach to the determination of national wealth lies just here; not that it provides a superior estimate of the total, but rather that, almost as a by-product, it supplies detailed information about the multiple structure of claims and obligations, assets and liabilities of particular groups of enterprises and ultimate consumers. Data available for these purposes are of rather recent origin. and were not fully adequate for the task in the latter 1950s. A start had been made, however, and Raymond Goldsmith set out both national and sector balance sheets for a number of years between 1896 and 1949 in vol. iii of his *Study of Saving in the Cnited States.*

Uses of National Wealth Estimates. — Estimates of national wealth reach at least as far back as those for national income — in some countries to the late 17th century (Great Britain) and in increasing numbers during the 19th century. Indeed, in the latter century more attention mas paid to estimates of national wealth than to those of national income. The reasons, which can only be conjectured, lay partly in the emphasis on the need for accumulation of capital (business and consumers') to satisfy the demands of a growing industrial system and a rapidly growing population; partly in the concern in some countries about the size of the national debt; and partly in the greater ease with which the scanty statistical data could be used to identify the major blocks of tangible wealth, as contrasted with the difficulty of getting an adequate picture of the flows constituting national product. Only in the years after 1920 did the emphasis definitely shift toward national income, with comparative neglect of work on national wealth totals.

In considering the uses of national wealth estimates, two qualifications already indicated must be reiterated. First, the estimated total of national wealth. being limited to alienable economic goods, falls far short of measuring the sum total of a country's productive capacity, of revealing the variety of factors that condition the latter. Second, the valuation of national wealth is a difficult problem because only a small proportion of it, often under atypical conditions. passes through and is evaluated on the markets of the economy in any given year.

Within these major qualifying limitations national wealth estimates serve t o important groups of uses—corresponding to the real assets and claims approaches respectively. The first group comprises uses of estimated stocks of goods as elements in the framework of a producing economy. Comparisons of stocks of plant, equipment and inventories used by producing enterprises with their output of current product, or the amount of labour they use, for industrial sectors in the same country over time or for various countries at a given time. even for national aggregates, shed light on the ways in which technological and other changes affect the demand for accumulated capital. Comparisons of stocks of consumers' capital (houses, durable goods, etc.) with the demand for their services illuminate factors in the structure of current and prospective production and suggest the role of saving in this particular investment process. Value of land and other nonreproducible assets, in comparison with other factors, provides light on the dependence of production on natural resources in different countries and in different times. In these ways. data on wealth as a stock of tangible commodities are indispensable for analysis of the operation of the productive system, and particularly of the extent to which accumulation of capital is a prerequisite of levels of productive performance, in their changes over time or in their differences across space. Current discussions of capital needs of underdeveloped countries, or of the presumptive slackening of demand for capital in the mature economies, are conspicuous examples of the uses to which estimates of national wealth and their physical components are put.

Somewhat less developed, but of obviously equal importance, is the type of use connected with the claims approach. The influence of the structure of assets and liabilities on the behaviour of enterprises and of individuals is obvious, particularly for the short run. The extent to which the real assets of the economy are controlled by productive enterprises, or by financial institutions that serve as intermediaries between the ultimate savers and the ultimate users of capital funds, or by government either as a fund supplier or guarantor, is important in understanding the functioning of the economy. This and related aspects of national wealth as a network of claims and obligations call for tracing the latter from their attachment to real assets in the hands of producers to claims in the hands of ultimate savers.

Naturally, effective use of the national wealth estimates, like that of any empirical measure, is contingent upon adequate knowledge both of the statistical characteristics of the estimates and of the system of analysis that provides the framework within which the estimates must be built. Progress in understanding of the wealth aspect of economic structures is made by a continuous interplay of empirically grounded hypotheses nith proper absorption of additional data relating to an increasing variety of historical periods and types of national economies.

NATIONAL INCOME

The concept of individual income is a relatively familiar one.—the earnings per unit of time. The very notion of earnings implies that the payments received are payments for something; presumably for productive services rendered. We associate wage and salary income with the payment for work performed; rent and interest income, with the payment for the use of property and liquid assets; and profit with the payment for entrepreneurial services. When we move from a consideration of the individual to the nation we find a counterpart to income regarded as a total of earnings which corresponds to real assets as the wealth counterpart to the value of claims. It is the value of the economy's production, which is merely another way of indicating the total value of all services rendered by the economy's factors of production. By looking at the national income from these two different aspects, a good deal of significant information can be secured.

A number of questions, somewhat analogous to those already considered in connection with wealth, must first be dealt with.

If the national income corresponds to the value (appropriately measured) of the nation's production: only payments for co-operating in "production" are to be counted. What about. then, payments made to the unemployed, under an unemployment insurance scheme? It is agreed, generally, that since such payments are not made for a productive service, they should not be included. In most countries a similar ruling has been adopted for payments of interest on government debt. There is certainly no suggestion that these payments are undeserved; whether they are a part of the national income or not has nothing at all to do with that question. But they do not correspond to an act of production, and as a result they are not counted as earned income. (To make matters more confusing, they are a part of what is called personal income.) Unlike them, payments of interest on private debt, as for instance on corporation bonds, are commonly treated as payments for productive services, and hence do constitute a part of the national income.

The value of goods or services which are priced on the market is recorded at the price the market actually sets. In an economy like that of the United States or Great Britain, the greater part of output is so valued. But even in so preponderantly private an economy as the former. some output does not pass through the ordinary market. As an example, consider the services of schoolteachers engaged in the public-school system. How should their output be valued? Or the output of military personnel? Or policemen? The usual procedure is to suppose it to be equal to the earnings of those who render the service. Then the national income and its counterpart, the value of the economy's production, include the pay of government employees, including those in the armed forces.

As a rule, production can only proceed at the cost of "using up" existing wealth. Stocks of raw materials are of course consumed when production goes on. If we are to have a meaningful concept of the nation's production, we are bound to allow for this. The gross national product, a measure in frequent use. actually takes the value of the economy's production after allowing for the consumption of raw material and other inventories.

But there is another kind of capital consumption to be taken into account too—the depreciation of capital assets. Depending upon the purpose of the measure, we may wish to subtract this figure from the gross national product. If we do, we have what is technically known as the net national product. The brevity of this account should not suggest that the determination of either of these allowances—the using-up of goods in inventory and the wearing out of more durable assets—is a simple matter. Serious problems, not only of statistical methodology but even of principle, frequently arise.

The value of the output, whether gross or net, is measured by what a market is willing to pay (the purchase price). But that price includes sums that are to be paid directly to the government for either sales or excise taxes. Since these payments cannot constitute income in any sense, output is often valued instead at its market price minus the payments for these taxes—the indirect business taxes as they are called. The net national product valued in this way (at factor cost, to use the technical term) is the output counterpart of the national income.

There is one further point to notice. Allowance is commonly made in output, and hence in the income generated by its production, for certain services for which no transaction occurs. The most important example of this is the use of a house occupied by its owner. Had the house been occupied by a tenant, his rental would have measured the value of the service he purchased; that sum would have entered into the national income, and also the net national product. at factor cost. When the house is not rented but instead provides accommodation for the owner, it is now the common practice to set a value for the service it provides and to add this both to income and output. Certain other imputations are made too; for example, the value of agricultural product consumed on the farm.

It can be argued that the value of housework done by the housewife should be regarded as a part of the national product and of national income. If any payment is made for the work, its value is counted; in principle. But the line is usually drawn at this point. If the work is not paid for it is not included in the total.

It might also be argued that if the value of the use of existing houses is treated as a part of the national product and income, a similar allowance should be made for the use of the stocks of durable consumer goods: home furnishings, refrigerators. automobiles, etc. But again. the rule that has been followed allows these entries only if payment is received for their use—for taxis or rented furniture. for example. but not for the nonbusiness use of an automobile by its owner. It cannot be denied that these rulings are somewhat arbitrary. They can perhaps find some justification in the fact that almost all countries, except for the Soviet bloc, follow them.

Source of Income, by Sector.—We may briefly note that various aspects of the national income, rather like those already considered in connection with the national wealth, may be described. We may. for instance, secure data on the relative importance of the different sectors of the economy as sources of income. The United States department of commerce, responsible for the "official" estimates of the national income, presented the data given in Table I for 1929 and 1953. The changes in the relative standing of each sector should be noted.

TABLE I.—*Sources of U.S. National Income*
(in $000,000,000)

Source	1929	1953
Total U.S. national income	87.4	305.0
Originating in agriculture	8.0	16.8
in mining	2.1	5.5
in contract construction	3.7	15.2
in manufacturing	22.0	97.3
in trade	13.1	52.3
in transportation	6.6	16.0
in communications and public utilities	2.9	10.2
in service	10.2	28.8
in government	5.1	33.9
in finance	13.1	26.4
in rest of the world	0.6	1.5

Distribution of Income, by Function.— The division of income between labour and property and then among different kinds of property holders can also be described. Official data for 1954 is given in Table II.

TABLE II.—*Division of U.S. National Income, 1954*
(in $000,000,000)

National income	$299.7
Compensation of employees	207.9
Property income	91.8
Proprietors and rental	40.4
Corporate profits (before taxes)	33.8
Net interest	9.6

Distribution of Income, by Income Class.—A great deal of information has become available on the share in total income of the different income classes or occupational groups. Much of this information is secured by the federal reserve board's annual survey of consumer finances (results of these surveys are generally carried in several numbers of *The Federal Reserve Bulletin,* beginning in the spring). Reference should also be made to the report of the U.S. department of commerce: *Income Distribution in the United States* (1953).

One form in which the data are presented is especially familiar, though it can be somewhat misleading. From it we can learn that in 1935–36, 43.5% of families had incomes of less than $1,000. and their income totalled $9,150,000,000. In 1953 only 5.7% of the families were in this category, and they earned a total of $1,430,000,000. The danger in using statistics in this form is that, with changing prices, an income of $1,000 in 1935–36 would have to be matched against one of nearly $2,000 in 1953. With no change in the real distribution of income, in a period of rising prices there would be a decrease in the number receiving less than some low figure, and an increase in the number who got more than a specified relatively high figure.

TABLE III.—*Percentage Shares of Family Personal Income*

percentage group	1953	1947
Lowest 20%	5.0	5.0
Second quintile	11.3	11.0
Third quintile	16.5	16.0
Fourth quintile	22.3	22.0
Top 20%	44.9	46.0
Top 5%	20.7	20.9

A more satisfactory procedure is to set the share of aggregate income received by a particular percentage of income recipients —say by the top 5% or the lowest quintile. Table III, adapted from U.S. department of commerce statistics, illustrates the form.

A slight tendency to more nearly equal incomes can be observed between 1947 and 1953. Comparing post-World War II data with those for the years before the war (1935–36 or 1941), a more pronounced shift in the direction of equality can be seen.

NATIONAL WEALTH AND INCOME COMPARED

National wealth and income do not cover exactly the same things, as we have seen. Moreover, their components necessarily have to be valued differently. For this reason caution must be exercised in comparing the two totals.

Nevertheless, the significant relation between the national wealth and income totals warrants comparisons despite qualifications imposed by the difficulties of establishing full statistical comparability. If national wealth is limited to reproducible goods that can ordinarily be duplicated in the process of production, the origin of the stock is exclusively in the past process of production; and one can calculate. by comparing it with national income as a measure of total annual output; how many years' supply national wealth represents. Comparisons for several countries in 1914 and for a much smaller number of countries in later years (largely just before World War II) show that the ratio of reproducible wealth to annual national income ranges from four to one to six to one; in other words, it equals the nation's total output for about four to six years. In general, the higher ratios characterize the older countries. like the United Kingdom, France and Germany; and the lower ratios the younger countries with somewhat higher per capita income levels: like the United States and Australia.

It may at first seem surprising that the total stock of wealth (excluding land and irreproducible mineral resources) should equal only four to six years' output. But this obviously does not mean that it could be recreated in four to six years. Most annual output goes into current consumption and not into saving and accumulation of wealth. If we assume an investment-income ratio of roughly 10%, it would take 40 to 60 years, not 4 to 6, to recreate the existing stock of reproducible wealth. Even this interpretation is unrealistic because in the absence of the existing stock of wealth, the given level of national income could not be attained. All that the comparison means is that given the ratio indicated above, the stock of reproducible national wealth existing at any given moment is the result of accumulation of a past period certainly exceeding 40 to 60 years (to allow for the smaller average size of national income over the decades preceding the point of comparison)—in other words, the savings of at least two generations.

The Real Income.— In periods of rapid price change. the figure for money income for any year can be misleading if set beside the figure for another year. The fact that the price level is different means that even if the real income is unchanged, income expressed in money will be different. For this reason income (and product) and wealth estimates are often prepared on the basis of constant prices—say the prices ruling in 1929 or 1947. There is no room here to suggest the many problems that arise in recomputing these values in prices of another period. It is enough to urge that the results have to be treated with caution.

Statistics of Wealth and Income.— National income estimates have been prepared, with varying degrees of detail. by government agencies of a number of countries, and many of these are published periodically as official documents. Of about 50 or more such estimates assembled by the statistical office of the United Nations at mid-20th century (covering figures back to 1938 when available. and released in reports under the general title *National Income Statistics*) considerably more than half are prepared and published by government agencies. Of the remainder quite a number are prepared by semipublic institutions. Uses of national income estimates as comprehensive records of a country's economic activity. as bases for government policy and economic planning and as indices for allocation of contributions and for policy making by international agencies warranted active interest by governments in their preparation and publication in an increasing number of countries. It should be noted, however. that some governments prepared estimates without releasing them; this was true after World War II of the U.S.S.R. and countries in the Soviet bloc! as they began to view such data as having strategic importance to be withheld for presumptive security reasons.

No such widespread information was available at mid-20th century on national wealth. Apparently periodic estimates of the stock of goods are considered less useful than annual measures of the current flow of total output. Even in the United States the decennial census of wealth. a long-standing practice. had been abandoned partly because of a clearer realization of the difficulties involved in securing reliable figures, partly because the availability of annual national income figures had lessened the need for wealth estimates. The last census of wealth in the United States was taken for 1922; those that would ordinarily have been taken for 1932 and 1942 were omitted, the former because it was felt that the depressed conditions of the time would yield atypical values and the latter because of the pressure of war problems. In other countries. interest in estimates of national wealth was also lagging, although some pressure for them had been stirred by attempts to gauge damages caused by World War II (with resulting rough figures, not widely released, for China, Japan, the Netherlands and France).

This contrast between the emphasis on income estimates and the neglect of wealth estimates might well be a passing phase. Because of the technical and analytical relations between the two measures, the development and use of the income estimates were likely to be hindered by a complete neglect of the wealth side of the economic picture. Once the current estimates of national income reached the stage of development where they became directly useful in the study of saving, investment and capital accumulation. pressure would arise for better and more current estimates of at least reproducible wealth. Indeed, interest in national wealth had already been revived and exploration of wealth estimates renewed by national income analysts in the United States and elsewhere.

The long history of national income and wealth statistics goes back to the late 17th or early 18th century in some of the western countries. Government interest and responsibility for national income estimates are quite modern. Even in the Cnited States and the United Kingdom, no official estimates were available before the 1930s and the 1940s respectively (except for some sporadic cases). Preparation of national income estimates for the most part had been the labour of individual scholars. The same was largely true of national wealth estimates: except for the official decennial series in the United States and occasional government estimates elsewhere. This origin in work by individual scholars meant that the national income and wealth estimates were not prepared regularly and were diverse in quality — reflecting differences in the supply of data and the statistical skill, diligence and imagination of the individual authors.

Because of this diversity in quality. compilations of the results would be most useful if made with a critical review of each author's work and with full knowledge of the statistics for the country and for the period to which the figures apply. Such a task, especially if attempted on an international scale. would demand on the part of the compiler omniscience, critical thoroughness and unusual diligence. Naturally, the compilations of available past estimates (see *Bibliography* below) fall short of this ideal. They are useful, however, as reference lists and as preliminary summaries, even though they must be supplemented in any serious work by references to the original writings.

Methods of Estimating. — Effective understanding and use of income and wealth statistics depend upon some knowledge of the methods that can and have been used in arriving at the totals and their components; of the questions of definition and valuation that must be answered in the process of estimation; and of the character of the basic data used.

In estimating national income. one or several of four approaches can be employed. (1) For each industry the gross income (value of sales, total revenue or a similar gross volume total) is estimated; then capital depreciation and consumption of products of other industries (materials or services) are subtracted to yield net income originating in each industry. The sum of these incomes, plus net balance of income receipts across the boundaries, is the national income total. (2) For each industry, net income originating is derived directly by totalling employee compensation, entrepreneurial income, dividends, interest, rent and undistributed profits of corporations (including, or in some variants excluding, such profits for government). The total of these, plus net balance of income flows across the boundaries. is the national income. (3) From data on income receipts by individuals, the total of all individuals' incomes can be derived, either directly or by supplementing data on income receipts with data from enterprises (using a variant of method 2). To this total of individuals' incomes the undistributed profits of business firms and other producing enterprises (including, or in some variants excluding, those of government) are added, to yield the national income total. (4) The sum of expenditures on consumers' goods by individuals and households, expenditures on net additions to capital goods by business and other producing enterprises (including government, although some variants include expenditures by government on all goods) and net changes in claims against foreign countries will also yield the national income total. Method 1 was used to derive estimates for Sweden for a period extending from 1860 to the later 1930s. Methods 2 and 4 are used to derive estimates for the United States; formerly only method 2 was used. Method 3 has been employed in preparing the estimates for the United Kingdom.

The two basic approaches to estimating national wealth are, as we have already seen, the inventory of physical assets and the valuation of claims. The inventory method has been followed in the census of wealth estimates in the United States. A combination of the two found frequent application in the western European countries in the 19th century. It should be noted that since the estimates of national income by method 4 provide information on current net additions to reproducible wealth, an inventory of physical assets once arrived at in approximating national wealth can be kept perpetual by the addition of net changes derived from the national income estimates for the following periods.

Questions of Definitian and Valuation. — No matter which method is used in deriving income and wealth estimates, questions of definition and valuation are bound to arise. There is first the problem of deciding what activities are to be regarded as economic or what are economically significant goods. Then there is the problem of defining the net output, or income, by allowing for the consumption of capital goods and perhaps, too, for the services to production rendered by government. Finally, there are the many problems of valuation: market value or cost? valuation of goods and services which do not pass through the market? These and other questions like them have already been discussed in some detail.

It is clear from the mere listing of the questions of definition and valuation that national income and wealth totals are synthetic aggregates involving many decisions necessary to render them precise in scope and unequivocal as to the value base used in weighting the numerous components. While, by and large, there is agreement on the answers to these questions, differences in definition and valuation among countries and among periods do exist, and such differences must naturally be examined in any comparison of the resulting figures.

Value of Income and Wealth Statistics. — Despite the margins of error and the controversial questions of definition and valuation, the usefulness of national income and wealth estimates should not be minimized. With all their faults, these estimates indicate important orders of magnitude which are fundamental to any intelligent view of the structure and operations of a national economy. The study and analysis of the economic development of nations and of their adaptations to short-term changes (such as business cycles or wars) are well nigh impossible without national income and its components as measures of total activity and national wealth as the measure of capital stock and of the complex of claims and obligations. Furthermore, public policy on economic problems finds in estimates of national income and wealth valuable means for testing any specific decision by placing it within a broad framework of the operating economy as reflected in these measures. The limitations of the estimates should be recognized and studied as a condition of their effective use and, in the hands of active scholars, as a basis for their further improvement. But they should not lead to a disregard of the high value of these measures, or to a reluctance to use them effectively to narrow the area of ignorance and of disagreements resulting from lack of knowledge.

BIBLIOGRAPHY.—The most complete account of national wealth (U.S.) is to be found in Raymond W. Goldsmith, *A Study of Saving in the United States*, 3 vol. (Princeton, N.J., London, 1955–56). *See* also *Income and Wealth*, series i–iv, published by Bowes and Bowes (Cambridge); Kational Bureau of Economic Research, *Studies in Income and Wealth*, various volumes.

Simon Kuznets *et al.*, *National Product Since* 1869, National Bureau of Economic Research (New York, 1946), and *Long-Term Changes in the National Income of the United States of America Since 1870*, in series ii, *Income and Wealth*.

The most complete listing oi later literature on both national income and wealth is the bibliography prepared by the International Association for Research in Income and Wealth (with headquarters at the National Institute for Economic and Social Research, London). The bibliography which is published by Bowes and Bowes, Cambridge, covers in the first volume, published in 1951, the years from 1938 through 1949, and is kept up to date by annual or biennial volumes.

Statistics on national income for a number of countries are assembled in most convenient iorm in compilations by the Statistical Office of the United Nations. Published volumes are: *Kational Income Statistics, 1938–1947* (1948) and *National Income Statistics, 1938–1948* (1950), both with extensive bibliographies. Several additional surveys and special studies were published by the Statistical Office of the United Nations. Estimates for the United States are published in the *Survey of Current Business*, usually in the July issue of the following year. A most useful assembly oi series and explanatory notes is in "National Income and Product oi the United States, 1929–1953," 1954 supplement to the *Survey of Current Business*. Those for the United Kingdom are released in an annual White Paper.

Of compilations oi past estimates, a later work is Colin Clark, *Conditions of Economic Progress* (New York, London, 1940). An earlier compilation, relating to 1914 but still of value, is that in an article by Lord Stamp, "The Wealth and Income of the Chief Powers" (originally in the *Journal of the Royal Statistical Society*, 1919, and reprinted in *Current Problems of Finance and Government*, London, 1924). For compilation of past estimates of national wealth, Corrado Gini, *L'Ammontare e la Composizione della richezza delle nazioni* (Turin, 1914), while old, is still indispensable. *See* also Richard Stone, *Measurenzent of Sational lnconze and the Construction of Social Accounts*, United Nations (Geneva, 1947). (L. Ts.)

WEAPON, any instrument of offense or defense, more usually a term confined to offensive or attacking instruments.

The word is derived from the Old English *wǣpen;* compare the Dutch *wapen*, the German *Wappe*, also *Wappen*, a coat of arms, heraldic shield.

See AMMUNITION, ARTILLERY; ARMS AND ARMOUR; GUN, MACHINE; HALBERT; LANCE; ORDNANCE; PISTOL; SMALL ARMS, MILITARY; SWORD.

WEAPONS, PRIMITIVE. Among primitive peoples it is often impossible to say of any object whether it is a weapon of war or an implement of agriculture or the chase. Thus in Assam the knife or *dao* fells trees, kills animals, defends its owner against human aggression and takes heads for him. A bow and arrow may be used for war or for hunting only. Instruments of war may be roughly classified as those of offence and defence.

Stones.—The earliest missiles which man or sub-man used were the untrimmed stick or stone, hand-thrown. (For BOWS AND ARROWS, BLOWGUN, and the weapons of civilized peoples *see* separate articles.) To give greater force and carrying power to stones, devices such as the sling and pellet-bow have been constructed. By far the most common sling is the *cord sling*, found sporadically throughout the world. It consists of a wide, short strip of material, which forms a pouch to hold the stone, to the ends of which one or more strings are fastened for grasping in the hand. The *pellet-bow*, a more elaborate contrivance found in India, is a bow fitted with two strings; between these, about half-way down, is a small pouch for holding the stone or clay pellet.

Throwing-sticks and Clubs.—The stick thrown by hand has also become a specialized weapon. As an object for piercing it has developed into the dart, javelin, spear and arrow; as an object for stunning or crushing into the throwing-stick and throwing-club. As an implement of the chase the throwing-stick was used in ancient Egypt and is still found in Abyssinia, India and among the Hopi of North America; as a weapon of war, however, the flat throwing-stick is practically confined to Australia, though two specimens have also been found in the island of Santo (New Hebrides, West Pacific). In Australia the fighting *boomerang* (*q.v.*) is rather long and narrow and curved within the plane of the flattened sides. It differs from the better known returning *boomerang*, which is of lighter build and curved out of the plane of the sides, which propeller-like twist gives it its returning powers. This latter is used exclusively for fowling or as a game. The Australian *waddy*, and the *ulas* of Fiji are throwing-clubs; the former has typically a flat triangular head, the latter is short with a spherical head and a handle carved to make the grip more sure. Other clubs are sometimes thrown without being specially designed for the purpose. The many-bladed throwing-knives of certain tribes in the Sudan, of those throughout the Congo basin and north to Lake Chad are metal derivatives of the African wooden throwing club.

Throwing-spears.—As to piercing missiles, such as darts, javelins and throwing spears, the variety is endless. The simplest are composed of a single piece of wood one end of which is pointed and often hardened in the fire. More usually there is a separate shaft and fore-shaft of which the latter is often heavily barbed by means of carving or the attachment of separate pieces of bone or wood. Heads of obsidian or other stone, bone and—especially in Africa—metal are often added. To give greater range to the throwing spear certain tribes use mechanical aids, of two main varieties, the *spear-thrower* and the *beckett*. The former, constructed of wood or bamboo, performs the function of an extra joint in the arm. The spear lies along the spear thrower, with its butt resting against a projecting peg, or, where the thrower is of bamboo, in the slight socket made by the septum of the node. This device is typical of Australia; it is also used in parts of New Guinea and in some of the islands of Micronesia, and was formerly used in Central and South America, whether in the chase or war is not clear. The Eskimo and tribes of the northwest coast of America also use it for discharging harpoons and fish-spears.

The *beckett* consists of a short length of cord with a knot at one end. It is wrapped once round the spear, the knot passing under the free end and being thereby kept in place. The free end of the cord is then wrapped round the index finger of the throwing hand. The resultant action when the spear is thrown is on the same principle as that of the sling, and the spear is given greater force in its flight than if thrown by hand, and is made to spin as it flies. For use in warfare the *beckett* appears to be restricted to Oceania, but as a toy it is found both in Australia and Europe. A similar contrivance was used by the soldiers of ancient Greece and Rome and also by some North African peoples who may well have borrowed it from them. It differs from the *beckett* in that the cord is attached to the spear and is not retained in the hand.

In East Africa an unusual form of spear-thrower is found. A shaft of wood terminating in a swollen head has this part hollowed out; into it is fitted the butt of the spear. The man then manipulates the thrower as though it were a part of the spear-shaft, but it does not leave his hand.

Bolas.—An unusual missile now used almost exclusively for hunting or as a game is the *bolas*. Among the Patagonians and the Gauchos of La Plata, who formerly used it in warfare, it is composed of three (less commonly two) balls of stone connected with each other at a common centre by thongs several feet long. One ball is usually smaller than the rest, and this is held while whirling the *bolas*. The aim is to entangle the victim in the thongs rather than to kill him. Among the Ho of Togoland, West Africa, a long cord with a stone attached at either end is similarly used for hindering an advancing enemy. Elsewhere a few tribes in Central and East Africa use the same instrument as a toy. The Eskimo uses a many-thonged *bolas* for catching birds.

Thrusting-spears and Clubs. — These are the most important weapons used in hand-to-hand fighting. The former are very similar to the throwing-spears, though usually heavier, and, since nicety of balance is not necessary more often made without a separate foreshaft. Many of them are heavily barbed as in the beautiful specimens found in Fiji. Clubs are of diverse kinds. Primarily they are for bruising or crushing, but some, such as the bird-headed clubs which are used in New Caledonia are well adapted for piercing. A distinction can also be made between those which are all of one piece and those having a head of different material from the shaft — usually of stone. Among those of the former type the business end is usually considerably thicker than the shaft and carved with spikes or rugosities (sometimes in imitation of its prototype the torn-up sapling) which make it more effective; but in the W. Pacific bat-shaped clubs, called by the early travellers "swords," are also found, though to-day they seem to be used more often for ceremonial than for military purposes. Clubs made entirely of any material other than wood are not very common, but the nephrite *mere* and bone *patu* of the Maoris are examples, and also the rhinoceros horn clubs of the Bechuana. These former are not only striking but also thrusting weapons, and are supplied with sharpened edges for the latter purpose.

Poisons. — The art of poisoning their weapons is known to many tribes. The poison is extracted from plants, as the upas tree in Indonesia. and also sometimes from reptiles and insects. In many parts of the world, however, weapons are said to be poisoned but are not, for deaths due to tetanus which so often followed wounds from these have frequently been mis-attributed to poison. The belief arose partly from the statements of the natives themselves, partly from the presence (in the West Pacific) of a green gummy substance at the base of the arrow or spear-heads. The latter is, however. only the vegetable cement fastening head to foreshaft, while the former refer to the magical power supposed to be given the weapon by using human instead of animal bone for the head or barbs.

Primitive Armour. — With the exception of shields, weapons of defense are not common among primitive peoples, though some have armour of a sort. In New Guinea, a few tribes wear a body-covering of basket work, sometimes with a high back to protect the neck and head. In the Gilbert Islands, owing to the dearth of timber, native weapons of the ordinary kind are not found, but in their stead, slender spears and many pronged "swords" edged with sharks' teeth; as a protection against these, armour of coconut fibre is worn often covering the whole person, including the head. From West Africa and among the Baggara of the northeast occasional suits of chain mail have been recorded, probably the result of Arab influence. Plate armour is found in northeast Asia and on the northwest coast of America, and among the Haida cuirasses of wooden or bone slats are used, whose form is reminiscent of this. In Indonesia corselets of hide or basketry and wadded coats covered with feathers give protection, and helmets of cane or skin are also found in this area and in Indo-China, and Assam.

Shields. — Shields vary greatly in material and form. In Africa hide and basketry are much used, the former mainly in the east and south among the cattle-rearing people. In Indonesia, Australia and the Pacific region those of wood are more common, though basketry ones are also found. The Australian shields are small and light, suitable for parrying blows, and in this are similar to those of the Dinka and Mundu of the Sudan; elsewhere they are mostly for covering the most vital parts of the body. The shield is essentially the means of defense for those who use the club and spear and who fight mainly in the open. It is not convenient for a bow and arrow people. since it interferes with the free use of both hands. In New Guinea, however, this difficulty has been overcome. Among the Tapiro pygmies of Netherlands New Guinea a small shield is hung around the neck in a net bag in such a way as to protect the chest. Among the Gulf tribes of Papua a large wooden shield, which has in its upper edge a deep slot for the passage of the left arm, is suspended over the shoulder.

See Horniman Museum Handbook, *Weapons of War and of the Chase.* (C. H. W.)

WEAR, a river in Durham, Eng., rising in the Pennines, and traversing a 65-mi. valley to the North sea. The stream flows east to Bishop Auckland, then, turning northeast, it meanders past the bold rock which bears the cathedral and castle of Durham. Before the Ice Age it joined the Tyne at Newcastle, but now it turns east to Sunderland (*q.v.*) where, near its mouth, the steep banks are lined with shipyards, engineering works and coal-loading and timber-landing wharves.

WEASEL (*Mustela nivalis*), the smallest European species of the group of mammals of which the polecat and stoat are well-known members (*see* CARNIVORA). The weasel has an elongated slender body, head small and flattened, ears short and rounded, neck long and flexible, limbs short, five toes on each foot, all with sharp, compressed, curved claws, tail rather short, slender, cylindrical, and pointed at the tip, and fur short and close. The upper-parts are reddish brown. the under-parts white. In cold regions the weasel turns white in winter, but less regularly and at a lower temperature than the stoat, from which it is distinguished by its smaller size and the absence of the black tail-tip. The length of the head and body of the male is about 8 in., that of the tail $2\frac{1}{2}$ in.; the female is smaller. The weasel is distributed throughout Europe and northern and central Asia; and is represented by closely allied animals in North America. It possesses all the active, courageous and bloodthirsty disposition of the rest of the genus. Mice, rats. water-rats, moles and frogs constitute its principal food. It can pursue its prey not only through holes and crevices and under dense herbage, but can follow it up trees, or into the water, swimming with ease. It constructs a nest of dried leaves and herbage, placed in a hole in the ground or hollow tree, in which it brings up its litter of four to six young ones. The mother will defend her young with the utmost desperation. Instances are known of weasels being met with in packs.

Among the American species may be mentioned the pygmy weasel (*M. rixosa*), probably a race of the true weasels and the long-tailed weasel (*M. frenata)* of the United States, which is chocolate-brown above and may turn white in winter. The short-tailed weasel (M. *cicognani)* is about 5 in. shorter than the last and is darker in summer. It inhabits Canada and the northern United States and the fur is an important source of ermine.

WEATHER FORECASTING is the application of the principles of physics, supplemented with a variety of statistical and empirical techniques, to the problem of prognosticating the weather. The term weather is used here in its widest meaning and includes all atmospheric phenomena which substantially affect man's activities. Included also are certain changes in the earth's surface which are caused by atmospheric conditions. Thus, forecasts of soil frost, snow cover, travel conditions, swell and surf, storm tides and floods are usually referred to as weather forecasts.

After a short section on terminology and time scales, this article is presented in the following major sections:

See also METEOROLOGY and CLIMATE AND CLIMATOLOGY for more general discussions of weather matters. *See* also articles on specific weather phenomena such as CLOUD; FOG; HUMIDITY, ATMOSPHERIC; THUNDERSTORM; TORNADO; and WINDS, GENERAL CIRCULATION OF, etc.

The term weather forecasting was introduced by Robert Fitzroy about 1860 in order to avoid the use of the stricter term prediction and to discourage the use of the looser term prophecy. By mid-20th century what were called numerical predictions (see Forecasting Based on *Physical* Theory and Time-Series Analysis, below) had become possible; these are skeleton prognoses of the large-scale motion and weather systems of the atmosphere by strict numerical processes.

By the late 1950s weather forecasts were provided on a variety of time scales. Warnings of severe local weather, such as tornadoes. destructive gusts and hailstorms, are usually issued 6 to 12 hours in advance and are valid for a period of about 6 hours. The routine forecasts issued to the general public usually cover a period of 24 to 48 hours. Forecasts ranging from a few hours to about two days are referred to as short-range forecasts. In the United States and certain other countries general outlooks for periods covering a week or a month are provided as a public service, and these are referred to as medium-range forecasts. The term long-range forecast is commonly reserved for general and broad outlooks covering one or more seasons or years. The techniques underlying long-range forecasting were in an experimental stage, and the success had not been adequately documented.

I. HISTORICAL

1. Weather Lore.—Long before science began to take form, man noted the characteristics of the seasons, watched the sky and tried to arrange his activities as well as he could according to the changing ueather. Undoubtedly many astute observers were able to gain considerable knowledge of the more typical weather sequences and to formulate rules which were useful on occasions. In the ancient cultures of the near east the weather was believed to be controlled by the gods and the stars. In the Babylonian writings the idea of an astral control was prominent, while the Hebrews expressed strong beliefs in a divine influence. The thought of an extraneous control weakened under the influence of the Greeks and the Romans, and although religious undertones have been strong until modern times there are few reflections of them in the weather lore and proverbs found in the writings of the western world. On the whole. western weather lore may be divided into four main groups in which the future weather is related to: (1) the phases of the moon; (2) the reactions of people and animals to the changing weather conditions; (3) such optical phenomena as rainbows and halos; and (4) certain weather sequences.

The weather proverbs belonging to the first group are generally void of scientific substance; analyses of observations have failed to reveal any lunar influence on the weather processes. and there is no theory to suggest the existence of such influences. A few of the ueather sayings relating to human and animal reactions seem to lend themselves to scientific explanation, in the sense that people and animals react to the existing weather, and the coming weather is often related to that which exists. Some of the sayings relating to optical phenomena are meaningful. For example. the proverb: "When the sun is in its house (halo; q *v.*), it will soon rain," reflects the fact that halos form as a result of refraction of the direct light from the sun or the moon in ice crystal clouds at high levels, and such clouds are often the forerunners of rain-producing weather systems. Some of the weather' proverbs belonging to the group relating to weather sequences reflect sound principles, though most of them cannot be substantiated on scientific grounds. For example, the proverb: "Thunder in spring, cold will bring," reflects the well-known fact that spring thunderstorms in middle latitudes most frequently occur along the forward side of an advancing mass of cold air.

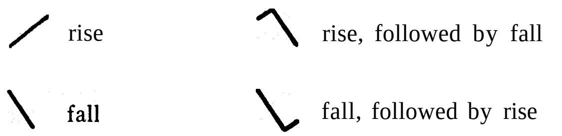
Although some of the weather sayings can be explained in the light of scientific knowledge. their value in forecasting is negligible. On the whole the substance of the weather proverbs falls far short of the considerable weather wisdom possessed by mariners. particularly during the time of sailing ships. By watching the changing sky, the drift of the clouds, the winds, the swell, etc., and by keeping and preserving accurate logs, the mariners accumulated much useful information and used their knowledge to take advantage of the winds and, as far as possible, to avoid devastating storms. After some major sea disasters in Europe in the middle of the 19th century the feasibility of providing a storm warning system became the subject of investigation.

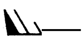
2. Technological Advances.—Although meteorology is as old as the other branches of the physical sciences. weather forecasting as a public service is only about 100 years old. It was only after the invention of the electric telegraph (about 1840) that it became possible to establish a communication system suitable for the rapid collection of weather reports. The first systematic experiments in weather telegraphy and forecasting began about 1860 and were conducted by Robert Fitzroy in England, Urbain Jean Joseph Leverrier in France, and the Smithsonian institution in the United States. A decade later forecasting services had been established in several other countries. Initially, the meteorologists were concerned mainly with the forecasting of major storms. Many of these came from the oceans, and forecasting services were hampered by lack of observations from the high seas. The next advance came from 1900 to 1920 after the invention and development of radiotelegraphy. As radio became standard equipment on ships it became possible to collect weather reports also from ocean areas. At the same time, and particularly after World War I, aircraft equipped with instruments began to provide information on the state of the atmosphere at higher levels: A major advance was made about 1930. At this time development of the radiosonde (see UPPER AIR SOUNDINGS) permitted soundings of temperature, pressure and humidity through the troposphere and lower stratosphere (see ATMOSPHERE). During World War II, the radiosonde was improved to provide also observations of the winds. At the same time radar was developed and used to provide information on clouds and precipitation. In the late 1950s it was much used in locating and tracking thunderstorms, tornadoes and tropical, revolving storms (see RADAR METEOROLOGY). The most recent technological advance affecting weather forecasting is the invention of the electronic computer. Such machines, in a variety of types, have contributed greatly to improvement in the processing of meteorological data, and made it possible to solve many mathematical problems which could not readily be tackled by customary techniques.

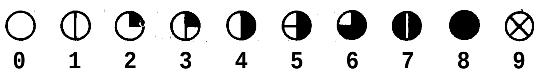
II. BASIC PRACTICES

1. Observations and Reports.—The early experiments in weather telegraphy and forecasting were based upon reports from a few land stations observing once or twice a day. The number of observing stations and the frequency of reports grew slowly until about 1920. With advances in meteorological theory and the development of aviation came demands for denser networks, more frequent observations, upper-air soundings and facilities for rapid exchange of reports between continents. Although much progress was made prior to the outbreak of World War II, it was only after the end of this war that world-wide networks of surface and upper-air stations and meteorological telecommunication channels became established. The international network of observing stations and the telecommunication services continued in a state of expansion, particularly in the regions which were undergoing rapid technological development. In the late 1950s there were about 10.000 ordinary land stations which provided surface reports, and about 1,000 stations which made soundings of temperature. pressure, humidity and wind through the troposphere and lower part of the stratosphere. About 3.000 commercial ships and about 50 specially equipped weather-observing ships provided observations from ocean areas. Several squadrons of aircraft equipped with meteorological instruments and radar engaged in meteorological reconnaissance over ocean areas where ship observations were absent or sparse. Much of the improvement in the forecasting of tropical storms (*q.v.*) resulted from information provided by meteorological reconnaissance. Commercial aircraft provided much useful information on the cloud and wind systems aloft. and a steadily growing network of radar stations gave detailed reports on severe local weather.

To ensure uniformity in the observations and the reporting procedures throughout the world, sets of definitions, scales, standards and codes were adopted in the 1950s by international agreements under the auspices of the World Meteorological organization. Instrumental observations (*e.g.*, pressure and temperature) are reported as numbers, and visual observations (*e.g.*, types of clouds, rain and snow) are translated into numbers according to internationally adopted specifications. The observations are then composed into coded messages and transmitted through established communication networks to all forecasting centres, where the instrumental observations are decoded and plotted as numbers, while visual observations are represented by symbols. An important element in weather forecasting is the barometric tendency, or the change in pressure over the three-hour period preceding the observation. The amount of change is plotted in millibars (mb.) (unit of pressure), and the trend of the barograph trace is indicated by such symbols as

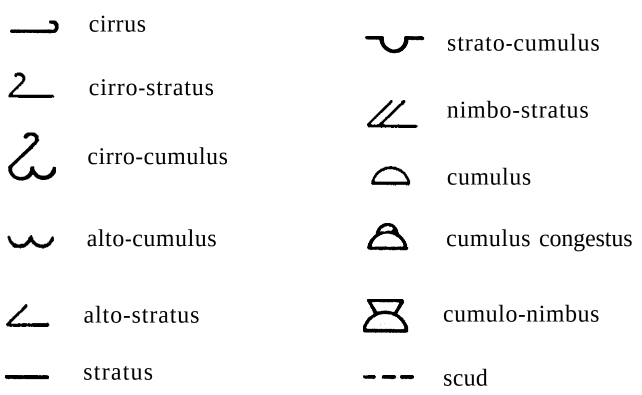


The wind direction and speed art: indicated by an arrow (), the shaft of which indicates the direction from which the wind blows, and the barbs signify the number of knots. A short barb indicates 5 knots, a long barb 10 knots, and a filled triangle 50 knots. The state of the sky, the weather elements, etc., are represented by symbols which, as far as possible, are constructed on mnemonic principles. The observing station is represented by a circle, and the amount of cloud cover is represented on an octadic scale by proportional filling. Thus:

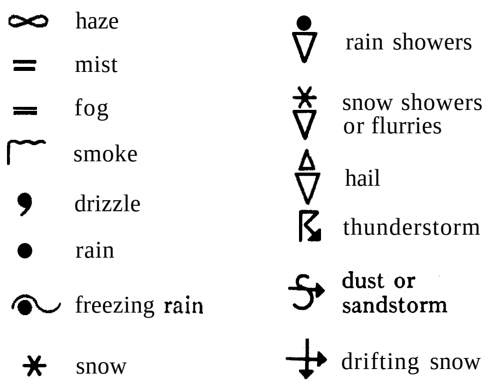


where o means clear sky, and g indicates that the sky is obscured (*e.g.*, by smoke).

The cloud forms are represented by combinations of the following symbols:



The forms of precipitation and the impurities of the air are represented by combinations of symbols, the more important of which are:



The various weather elements are plotted as shown in fig. 1, so that each element occupies a fixed position in relation to the station circle.

2. Analysis. — The weather charts for any extensive region in middle and high latitudes show well-defined pressure systems, the horizontal dimensions of which are generally of the order of a few thousand kilometres. These systems are represented by isobars, or lines which connect the points having the same sea-level pressure. The wind blows nearly along the isobars with low pressure to the left in the northern hemisphere, and low pressure to the right of the wind in the southern hemisphere (*see* also BUYS BALLOT'S LAW). The primary types of such pressure configurations are shown in fig. 2. They are: (1) Areas of low pressure surrounded by closed isobars, commonly called lows, depressions or cyclones. (2) Areas of high pressure surrounded by closed isobars, commonly called highs or anticyclones. (3) Troughs of low pressure along which the direction of the isobars and the accompanying winds change either gradually or abruptly. (4) Ridges or wedges of high pressure along which the direction of the isobars and the accompanying winds change gradually. (5) Cols, or saddle-backed regions, between pairs of highs and lows.

Early experiments in weather forecasting showed that stormy and rainy weather was normally associated uith cyclones and troughs, while fair weather was characteristic of the anticyclones and wedges of high pressure. It is this experience that is reflected in the construction of the aneroid barometer (*see* BAROMETER), where weather notations are affixed to the pressure scale. Furthermore, it was found that the centres of low pressure normally drifted toward the east or northeast, while the high-pressure centres drifted to the southeast or east. Until about 1920 the forecasters were concerned mainly with the charting of the pressure systems and extrapolating the past movements of the systems 24 hours into the future. By using the normal relation between pressure configurations and weather, and by using a number of empirical rules derived from past experiences, forecasts were obtained.

A major advance in weather analysis. with far-reaching effects on modern forecasting procedures. began at the end of World War I when Vilhelm Bjerknes. assisted by Jakob Bjerknes, Tor Bergeron and Halvor Solberg, undertook systematic investigations of the more important weather and motion systems in middle and high latitudes. The research group became widely known as the Norwegian school of weather forecasting, and the techniques developed are generally known as the air-mass and polar-front methods. Bjerknes and collaborators found that the cyclones in middle latitudes were made up of two distinct air masses (*see* AIR MASS) separated by a shallow and sloping layer of transition. One of the masses was found to be cold or cool air of polar origin, and the other was warm and moisture-laden air from the subtropics. The zone of separation between the air masses was called a front (*see* FRONT). Of primary importance is the polar front, or the front that separates the polar and tropical air masses. Important also is the arctic front which separates arctic air from the less extreme air masses in subpolar latitudes.

In normal cases a cyclone would form as an unstable wave disturbance on the polar front; the wave amplitude would grow and the disturbance would gradually develop into a large vortex surrounded by closed isobars. During the development the warm air would ascend over the frontal surface and be replaced by colder air at low levels. The ascending air would cool by expansion, with the result that part of its water vapour content would condense and fall out as precipitation.

The internal processes in the air masses were found to be important also. Thus, a polar air mass would absorb heat and moisture when streaming southward over a warmer surface. As a result, the stratification would become unstable; vertical overturnings would set in, leading to the development of cumulus clouds, showers and, in severe cases. thunderstorms. Conversely. a tropical air mass streaming northward would be cooled by the underlying surface: the air mass would become increasingly stable and part of its water vapour content would condense at low levels, producing low stratus clouds, fogs and drizzle.

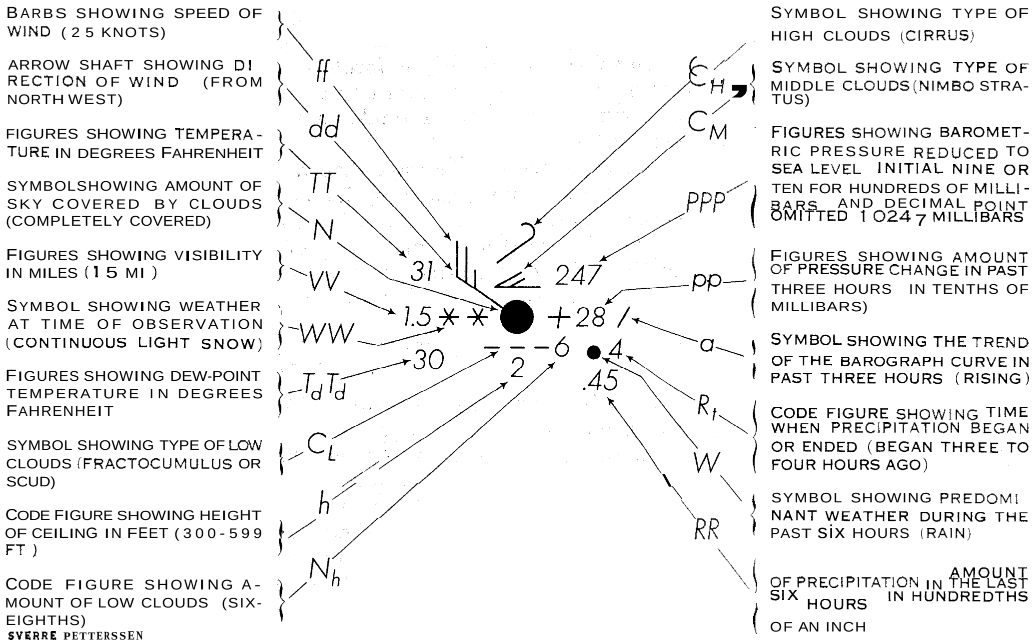


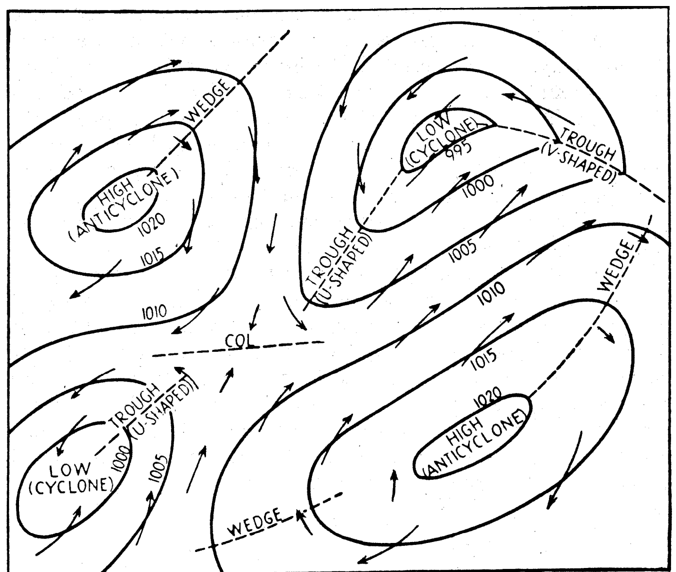
FIG. 1.— PLOTTING MODEL FOR WEATHER OBSERVATIONS

In the scheme developed by the Norwegian school the results of the analyses of the motion and weather systems in the lower atmosphere are represented by a set of symbols, the more important of which are shown in fig. 3. Here, a warm front is one along which warmer air replaces colder air, a cold front is one along which colder air replaces warmer air and an occluded front results when a cold front overtakes a warm front. The motion systems are represented by isobars, and the weather systems are referred to such principal processes as general ascending motion (notably along frontal surfaces), orographic upglide motion and exchange of heat and moisture between the air masses and the underlying surface. The methods of analysis have found world-wide acceptance and their application may be illustrated by reference to fig. 4 (see also SYNOPTIC WEATHER CHART). The low-pressure area near Iceland is recognized as a cyclone in the decaying stage. The warm air has been displaced to higher levels and cooled by expansion; the vortex has become surrounded by cold air which, when streaming southward over the warm Atlantic waters, produces showers and squally weather. The low-pressure area over the eastern part of North America is recognized as a young developing cyclone consisting of a cold and a warm air mass separated by a distinct front. The extensive belt of precipitation is interpreted as being the result of warm air ascending over the frontal surface. Furthermore, the warm air that streams northeastward along the east coast of North America surrenders heat to the underlying surface and produces low stratus clouds and fog. During the following 24-hour period (see fig. 5) the old cyclone near Iceland weakened while the young cyclone over North America moved northeastward, intensified and carried its weather systems with it. At the same time, showers and squally weather developed in the cold air mass that moved from the North American continent onto the warm Atlantic waters.

The analysis techniques developed by the Norwegian school are described in terms of models which represent stages in the evolution of the large-scale motion and weather systems, and these models are used by the forecasters to identify the observed states with stages in evolutionary processes, the broad aspects of which are well understood. In the late 1950s Horace Robert Byers and Tetsuya Fujita developed similar techniques for analyzing small-scale weather systems of the type commonly known as squall lines and clusters of thunderstorms.

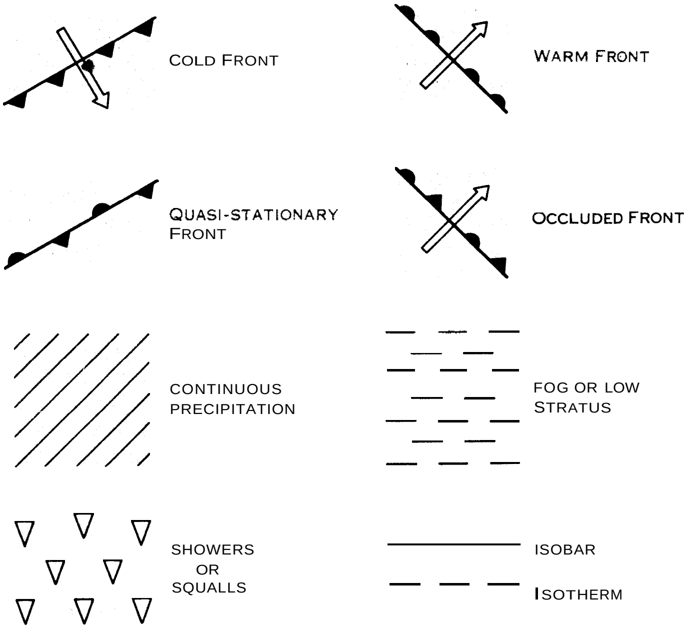
The analyses of the conditions of the upper atmosphere are represented in isobaric surfaces, or surfaces in which the atmospheric pressure is constant. The horizontal pressure force is proportional to the slope of an isobaric surface, and the slope is represented by the isohypses (lines connecting points of equal height) of the surface concerned. The wind blows very nearly along the isohypses (fig. 6), with decreasing height to the left of the wind in the northern hemisphere, and decreasing height to the right in the southern hemisphere. The speed of the wind is very nearly inversely proportional to the distance apart of the isohypses. In routine analyses the isohypses are taken to represent the wind. In more detailed analyses the wind field is represented by streamlines, or lines which everywhere are tangent to the wind direction, and isotachs, or lines connecting the points having the same wind speed. This latter type of analysis is widely used in low latitudes where the relation between the wind and the horizontal pressure force is less firm. Methods of analysis suitable for application in the intertropical belt were developed during the 1950s, notably by Clarence E. Palmer and Herbert Riehl. Outside the equatorial belt routine analyses containing isohypses, isotherms and isopleths of moisture content are provided for the levels 850, 700, 500 and 300 mb. The conditions at intermediate levels can normally be obtained with satisfactory accuracy by interpolation. In regions where aircraft operate above the 300 mb. level, additional analyses are provided. At levels above about 100 mb. observations are generally sparse and the analyses less complete.

While the sea-level charts (see fig. 4 and 5) are generally dominated by centres of high pressure and centres of low pressure, surrounded by closed isobars and moderate winds, the predominant feature in the middle and upper troposphere and lower stratosphere is a strong westerly current (see fig. 6) between slowly moving air in the tropical and polar regions. The strong circumpolar current aloft is often concentrated in a narrow meandering band with four or five major waves upon which minor waves are superimposed. Much evidence has accumulated to indicate that the movement and development of such upper waves are closely related to the



FROM "INTRODUCTION TO METEOROLOGY" BY SVERRE PETTERSSEN (MCGRAW HILL BOOK CO.)

FIG. 2 —TYPES OF PRESSURE SYSTEMS AS REPRESENTED ON WEATHER CHARTS



SVERRE PETTERSSEN

FIG. 3.— SYMBOLS USED IN REPRESENTING THE ANALYSES OF WEATHER CHARTS

development of weather and motion systems near the earth's surface.

III. TECHNIQUES USED IN SHORT-RANGE FORECASTING

The immense complexity of the atmospheric processes is reflected in the methods used in prognostication. It is typical of weather forecasting in the mid-20th century that the methods vary over a wide range. At the one end of the range, use is made of mathematical and statistical operations so complex that high-speed electronic computers are needed to solve the-equations. At the other end, reliance is placed on vaguely formulated experience which has accumulated in the minds of the forecasters after several years of practice. Weather forecasting commenced long before any theory was developed that could explain, even in broad outline, the evolution of the weather and motion systems. Until about 1920 the prognostication was based almost exclusively on practical experience. From 1920 to 1930 the air-mass and frontal methods of analysis were developed. Although these methods did not deal specifically with prognostication, the increased understanding of the large-scale weather processes and the greatly improved analyses that resulted therefrom contributed greatly to improvement in weather forecasting and formed a basis from which specific forecasting techniques could be developed. Most weather forecasts are produced as a compromise between the results of several techniques in which experience and judgment play an important part. In broad outline, distinction may be made between five groups of general techniques used in the preparation of prognostic charts.

1. Computation of Displacements. — In 1933 Sverre Petterssen provided a set of kinematical formulas by the aid of which the rate of movement of well-defined pressure systems could be computed. The types of systems to which the formulas apply are shown in fig. 2. For example, in the case of a trough of low pressure the x-axis, or the axis along which the speed is to be computed, is chosen at right angles to the trough line. If p denotes atmospheric pressure, and *t* denotes time, the formula for the speed (C) of the trough line is

$$C = -\frac{\partial^2 p/\partial x \partial t}{\partial^2 p/\partial x^2} \qquad (1)$$

The rate of movement can thus be computed from the observed distribution of the pressure and the local time rate of change of pressure. Similar formulas hold for the other pressure configurations shown in fig. 2, and other formulas provide estimates of the rate of intensification of pressure systems. In the case of well-defined pressure systems the formulas give fairly accurate results for periods of 12 to 24 hours into the future, but the errors tend to accumulate and the formulas are of little value for longer periods.

The movement of the wave-shaped flow patterns in the upper atmosphere was investigated by Jakob Bjerknes (1937) and Carl-Gustaf Rossby (1939). By using some plausible assumptions Rossby showed that the movement of the long waves aloft was controlled, to a large extent, by the mean zonal speed of the wind (U) and the length (L) of the wave, such that

$$C = U - \beta\left(\frac{L}{2\pi}\right)^2 \qquad (2)$$

Here, β is a factor that depends on the earth's rotation and is a function of latitude only. On account of the underlying assumptions, the formula is applicable only at intermediate levels, such as the 500 or 600 mb. surfaces. Rossby's theory was applied extensiveiy by George Cressman, Riehl, and others, who developed a number of rules concerning the influence of the long waves aloft on the development of motion and weather systems at low levels. Rossby also developed a technique for predicting the trajectories of the air in the upper waves. While this technique lacks precision in detail. it has been found useful for estimating changes in the number of waves around the hemisphere.

Rossby's formula was extended by Petterssen, who found that

$$C = \frac{U_{max} - \beta\left(\frac{L}{2\pi}\right)^2}{1 + \left(\frac{L}{2\pi B}\right)^2} \qquad (3)$$

Here, U_{max} is the maximum wind speed and B is a measure of the concentration of the current. This formula is applicable to long waves as well as to short waves, and tests have shown that it is capable of predicting the 24-hour displacements of waves with an average error which is about 15% of the observed displacement. Formula (2) is not highly demanding in regard to observations

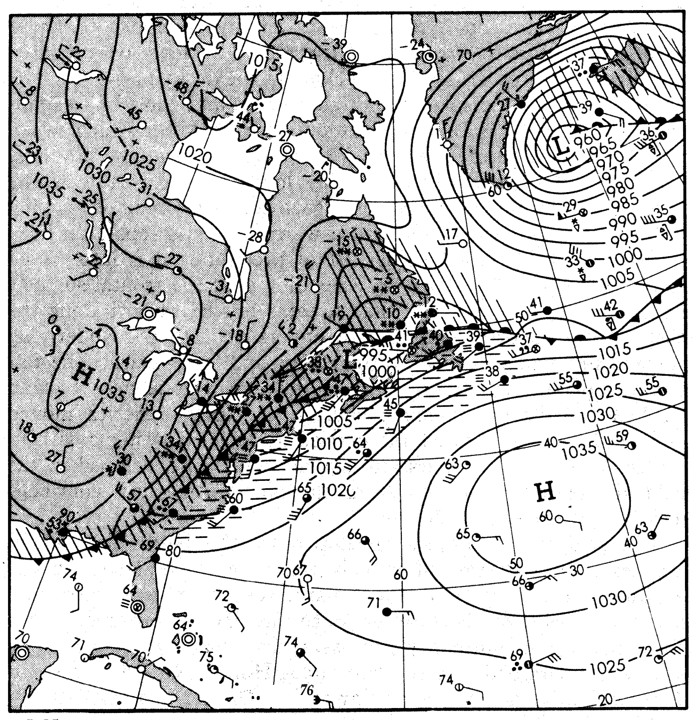


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FIG. 4.— AN EXAMPLE OF A WEATHER MAP AT SEA LEVEL: JAN. 23, 1957, 1200 G.C.T. (GREENWICH CIVIL TIME). L AND H REPRESENT CENTRES OF LOW AND HIGH PRESSURE. THE PRESSURE DISTRIBUTION IS REPRESENTED BY ISOBARS AT INTERVALS OF FIVE MILLIBARS. EXPLANATION OF THE OTHER SYMBOLS MAY BE FOUND IN FIG. I AND 3. MUCH OF THE DATA USED IN OBTAINING THE ANALYSIS HAVE BEEN OMITTED

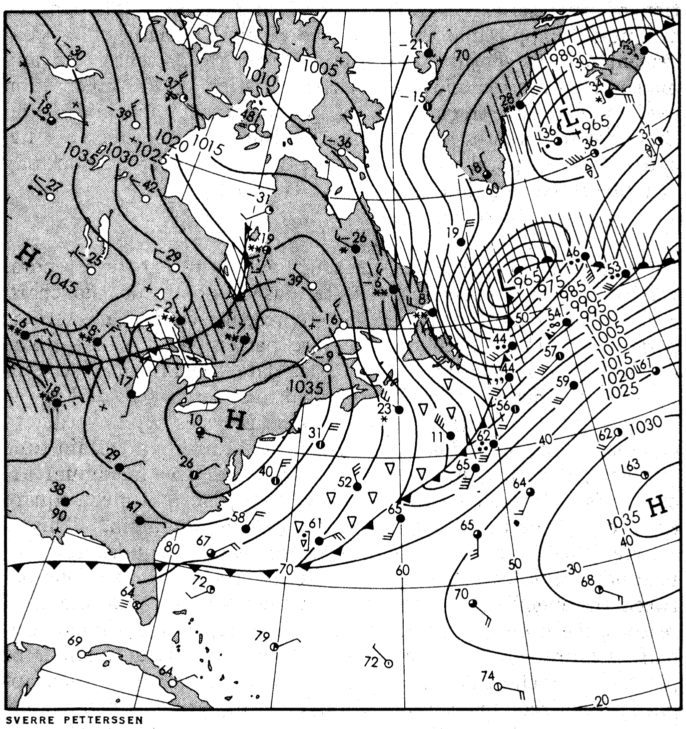

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FIG. 5.—THE GENERAL WEATHER SITUATION 24 HOURS LATER THAN THAT OF FIG. 4

and is therefore well adapted to general uses. Formula (3), on the other hand, is more demanding and can be used only where the network of upper air observations is relatively dense.

Though the foregoing formulas are simple, several difficulties are encountered in their application. In formula (1) the differential quotients have to be replaced by finite differences, and this may introduce errors, particularly when the systems are small and of irregular shape. All three formulas give only the instantaneous rate of movement, and allowances must be made for accelerations. Furthermore, the formulas can be applied only to special lines and points, and they do not provide information on the movement of the field in general. A far more elaborate technique which, at least in principle, is capable of predicting the changes of continuous fields can be obtained by seeking more complete solutions to the equations of physics.

2. Forecasting Based on Physical Theory.—From the point of view of theoretical physics, weather forecasting may be regarded as an initial-value problem. If, in any physical system, an initial state and the laws that govern its changes are known, the future behaviour can be predicted by mathematical deductions, provided that mathematical techniques are available for obtaining solutions to the governing equations. In the atmosphere none of these prerequisites is fully satisfied. Although the general laws of hydrodynamics and thermodynamics are well established, two formidable difficulties are encountered. In the first place, the structure of the equations that govern the atmospheric processes is so complex that solutions can be obtained only on the basis of several simplifying assumptions. Secondly, and perhaps more restrictive, is the absence of adequate observations, particularly over the oceans and in the polar and equatorial regions.

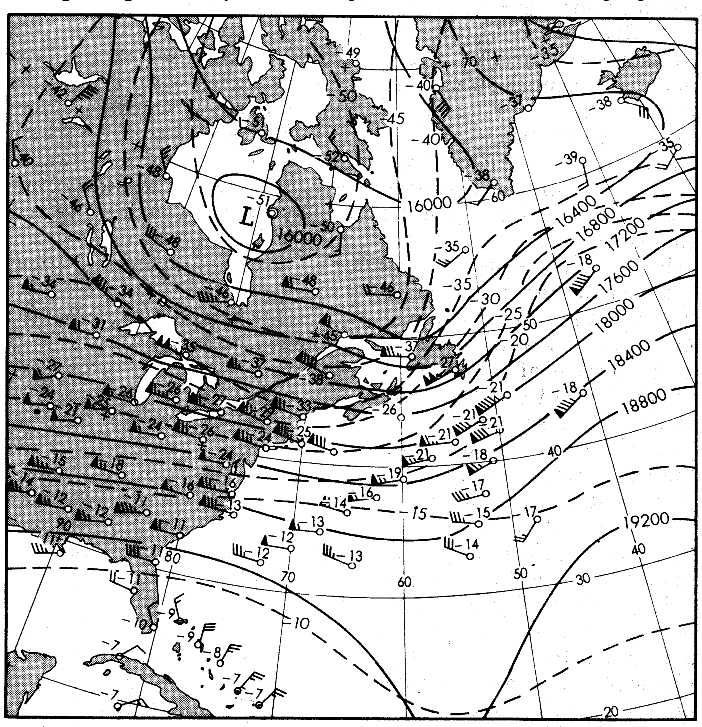
The formulation of weather forecasting as an initial-value problem was first enunciated by Vilhelm Bjerknes in 1904. The first attempt at producing a forecast by this method was made by L. F. Richardson during World War I. Although the results were disappointing from a practical point of view, Richardson's work brought to light some of the difficulties involved and indicated a direction which proved fruitful after upper-air observations and high-speed electronic computers became available.

In 1947 Reginald Cockcroft Sutcliffe outlined a theory for the development of cyclones and anticyclones which lends itself to prognostic application in connection with conventional weather charts. At the same time Jule Gregory Charney devised a scheme for filtering out the effects of inertial and gravitational oscillations, and thus provided a set of simplified differential equations which are capable of representing the changes resulting from the large-scale motion systems with which the predominant weather systems are associated. The basic equations are: (1) the Newtonian equations of motion, which relate the acceleration to the forces; (2) the equation of continuity, which states that the mass is conserved; (3) the thermodynamic energy equation, which relates the supply or removal of heat to the changes in the internal energy and the work done in expansion; and (4) the Boyle-Charles law, which describes the physical state of gases.

This set provides a number of equations equal to the number of unknowns, and solutions are possible in principle. In application to forecasting certain simplifications are used, and the more important ones may be outlined as follows. In the first place, terms representing frictional stresses are omitted. Secondly, the effects of heat and cold sources are ignored, so that the changes of state are assumed to be adiabatic (see ADIABATIC PROCESSES IN ATMOSPHERE). Thirdly, in certain terms which are not highly sensitive, the actual wind is replaced by the geostrophic wind, or the wind that would result if the horizontal pressure force were balanced by the force resulting from the earth's rotation. In the more sensitive terms the characteristics of the wind field are obtained from the equation of continuity.

The structure of the atmosphere is represented by model structures and expressed by a set of equations the number of which depends upon the number of levels for which prognoses are required. Together with suitable boundary condition, the equations are solved by relaxation techniques, using either electronic computers or a graphical procedure developed by Ragnar Fjörtoft. The computations commence with a set of analyzed charts which represent the initial state of the atmosphere at a given time, say t_0. Next, small increments of the pertinent variables are computed for a future time interval At. The increments are then added to the initial values at t_0, and this provides an approximation to the state at the time $t_1 = t_0 + At$. The process is then repeated in small time steps until the end of the forecast period is reached.

Beginning about 1950 several prediction models were proposed



SVERRE PETTERSSEN

FIG. 6.—THE ANALYSIS OF THE CONDITIONS AT THE 500 MB. LEVEL. JAN. 24. 1957, 1500 G.C.T. FULL LINES SHOW THE ISOHYPSES OF THE 500 MB. SURFACE EXPRESSED IN FEET. BROKEN LINES ARE ISOTHERMS EXPRESSED IN DEGREES CENTIGRADE. OTHER SYMBOLS ARE EXPLAINED IN FIG. 1 AND 3

for application to the large-scale motion systems of the atmosphere. The simplest and most thoroughly tested one is the barotropic (*q.v.*) model which is capable of providing prognoses at only one level which must be chosen in the middle troposphere where the divergence of the wind normally is small. Other models provide predictions for two or three levels, one of which may be chosen at or near the earth's surface. The computational work increases rapidly with the number of levels, and models involving more than three levels had not been tried by the late 1950s. Predictions based on physical models were produced on an experimental basis in several countries. In the United States such predictions mere provided routinely and distributed to the forecasting centres, where they were used together with results obtained by other forecasting techniques. The theories and techniques based upon physical prediction models were in a state of rapid development. Experience indicates that these models are capable of providing useful forecasts of the behaviour of the large-scale motion systems in the middle and upper troposphere, while they are less able to account for the changes associated with the smaller and more irregular systems near the surface of the earth.

3. Analogues and Types. — Numerous attempts have been made to classify past weather charts for the purpose of establishing systems of analogues or types which can be used in forecasting. The thought underlying these endeavours has been that if two atmospheric states are similar their evolutions must also be similar. The current weather charts are matched against established types until a maximum of similarity is found, and a forecast is provided on the assumption that the evolution of the current situation will be similar to that indicated by the analogue. Though forecasts based on analogues have been remarkably successful on occasions, failures have been frequent. The selection of pictorial analogues and matching by inspection involves a considerable amount of subjectivity. Furthermore, the variety of atmospheric states is so great that it is not often possible to find within the period for which historical weather charts are available, two situations which are similar in all respects over a sufficiently large area. While analogues and types have proved useful as background information and for broad classification, provision of specific forecasts based on analogues alone has not proved feasible.

4. Regression Equations and Diagrams. — In an endeavour to establish objective forecasting techniques a search has been made for simple statistical relations between past and future events. In the first place, certain parameters, which theory or experience has shown to be importantly related to the weather element to be predicted. are chosen. These parameters are called predictors, while the weather element is called the predictand. Next, a long series of past data is analyzed, and a multiple regression equation between the predictand and the predictors is established. 4 more flexible scheme is to seek graphical relations between the predictors and the predictand. For example, if X_1, X,, X_3 and X_4 are the predictors, the predictand may be plotted in one diagram as a function of X_1 and X_2, and in another diagram as a function of X_3 and X_4. If the predictors are meaningful, the analyses of the diagrams will normally result in the establishment of two separate first approximations (Y_1 and Y_2) to the predictand. A second approximation is then sought by plotting the predictand, in a third diagram, as a function of Y_1 and Y_2. The prediction diagram thus prepared is then tested on an independent set of data to determine its stability.

Prediction diagrams of this type have proved useful in the forecasting of certain weather phenomena in places where a few local influences are so pronounced that a small number of well-chosen parameters suffice to establish useful relationships. For general application the procedure has severe limitations, for most atmospheric phenomena are governed by a complex set of equations, and only solutions to simple equations can be approximated by diagram analyses of this kind.

5. Time-Series Analysis. — A far more ambitious and promising scheme for application of statistical theory to meteorological prediction was initiated by Thomas Francis Malone and collaborators in the mid-1950s. Essentially it consists in an extrapolation of time series as applied to weather charts. Though the technique is applicable to any meteorological variable, it is convenient here to consider only the atmospheric pressure. In any meteorological prediction, the characteristics of the air motion over an extensive region are of predominant importance, and these are well represented by the pressure distribution (*see* fig. 4–6). The temporal variation of pressure at a given station may be represented by a time series $f(t)$. If we let

$$F_i(t) \quad (\text{with } i = 1, 2, 3, \ldots\ldots n)$$

denote a group of such series, the group will represent the temporal variations of the pressure at n stations or points on the chart. Each member of the group will represent some characteristic parameter pertaining to the pressure pattern as a whole. The problem then is to extract from past data the information contained in the history of each individual time series $f(t)$ and in the group $F_i(t)$, from a time as far back as is necessary, in order to extrapolate the individual time series forward over a certain time interval *At*, with a maximum of accuracy. The maximum accuracy is determined by demanding that the root-mean-square error of the extrapolated values shall be a minimum. This is accomplished by establishing an operator which includes autocorrelations within each time series as well as cross correlations between the members of the group of such series. For practical reasons, the pressure distribution, as indicated by continuous isobars, is represented by the pressure values at a large number of points in a rectangular grid. A screening procedure is then applied so that redundant information, or information of little value, is eliminated. The end result is an operator which establishes a relation between the past history of the time series, the current weather charts and the future weather situation.

While forecasts based on physical theory are deterministic, in that they provide one, and only one, solution, the forecasts based on statistical theory are probabilistic, in that they indicate the most probable value and certain limits within which the actual value may be found. Since weather forecasts are used, essentially, for the purpose of minimizing a risk, the probabilistic forecasts are particularly suited to operational needs.

The development of forecasting techniques based upon statistical operators began only in the 1950s, and in the late 1950s such forecasts were provided only by one private organization in the United States. It is evident that this technique incorporates all that can be accomplished by the more limited procedures described in the sections on *Analogues and Types* and on *Regression Equations and Diagrams.*

IV. EXTENDED-RANGE FORECASTING

The time interval for which forecasts can be provided by operations on individual weather charts is limited to about 48 hours. Beyond this range the behaviour of individual weather systems cannot be accounted for by present techniques except in special cases. It is possible, however, to provide general outlooks which indicate the broad aspects of the predominant weather patterns for longer periods. An elaborate scheme for the provision of such outlooks was developed in the U.S. weather bureau by Jerome Namias after 1940. Essentially, the scheme is built around extrapolation of meteorological charts which are averaged over a period of several days. As compared with long-term normals, these charts exhibit well-defined anomalies, the movements of which can be traced and extrapolated. On account of the averaging process, the small and usually fast-moving systems become largely eliminated, while the large centres of action, the main zonal current and the long waves aloft retain their identity. Rossby's theory, to which reference was made earlier, shows that the motion of the long waves aloft is controlled by the wave length and the mean zonal wind. The zonal current averaged around the world is called the zonal index, and empirical evidence shows that the zonal index undergoes certain quasi-rhythmic changes which can be foreshadowed. Rossby's formula (2) is used to compute the movement of the mean long waves, with such empirical corrections as experience has shown to be appropriate. The average weather patterns at sea level, and particularly the anomalies in temperature and rainfall, storm tracks, etc., are related to the positions of the centres of action, the variations in the zonal index and the movement of the long waves, and from various analyses of the mean states, general outlooks for periods from 5 to 30 days are obtained.

V. SPECIAL WEATHER FORECASTS

In all countries weather forecasts for periods of 24 to 48 hours are distributed over customary channels for the information of the general public. Since these forecasts are highly generalized and intended to refer to relatively large areas, they do not readily lend themselves to specific applications, particularly where critical limits and timing of events are involved. Far more useful are the forecasts prepared for operations or conditions the specifications of which are known to the forecasting team. During World War II all major military operations were planned on meteorological advice, and the launchings were timed on the basis of weather forecasts. Of major importance were the highly specialized forecasts prepared for massive air operations in darkness, amphibious operations, etc. The largest of all operations, namely the assault on the continent of Europe by the Allied forces in June 1944, was successfully postponed for 24 hours on the basis of weather forecasts which had to satisfy a number of operational specifications. The importance of military weather forecasting has increased greatly with the increase in military technology, and forecasting services have become integral parts of the military establishments.

After the end of the war, industry and business, particularly in the United States, developed an increasing interest in the application of weather forecasting to their operational problems. In the late 1950s several companies employed weather forecasters, and others obtained services from meteorological consultant firms. The problems in industrial forecasting cover a wide range and include warnings of local floods and storms which may interrupt operations or cause damage; warnings of sea, surf and swell for offshore oil drilling; forecasts of cloud cover, light conditions, etc., for outdoor photography; forecasts for scheduled and nonscheduled aircraft; and forecasts of temperature for shipping of sensitive goods, scheduling of fuel deliveries and regulation of pipeline loads. In general, the special industrial forecasts are based on the public forecasts, supplemented in detail to satisfy the needs of the client.

The types of forecasts issued by the national weather bureaus vary greatly from one country to another. Most varied are the forecasts provided in highly industrialized countries which are sufficiently large to span over several climatic regions. In addition to the general prognoses mentioned above, special warnings and forecasts are provided by the U.S. weather bureau in the categories indicated below, and similar services are provided in most other countries where a need is present.

1. Marine forecasts and warnings. These provide information on all weather conditions that affect shipping. A similar service is established for the Great Lakes.

2. River and flood forecasts and warnings. These indicate runoff potentials, icing conditions and flood stages for the principal rivers.

3. Agricultural forecasts. These include information on the weather elements that affect the growing of crops and livestock. Of special importance are the fruit-frost forecasts which are used for the scheduling of frost prevention operations.

4. Fire-weather forecasts. These give information on the conditions, such as excessive dryness, which are generally favourable for forest and brush fires, thunderstorms which may initiate fires, and the winds which may spread fires.

5. Cold waves, blizzards and related warnings. These serve all interests which are affected by severe cold, snowstorms, icing storms and blizzards.

6. Severe local storm warnings. These include general alerts and specific warnings of destructive thunderstorms, gusts, hailstorms and tornadoes.

7. Hurricane warnings. On the basis of general meteorological observations and aircraft reconnaissance, general alerts and specific warnings are issued to all threatened areas.

8. Aviation forecasts. These provide regional information on the conditions that affect flying in general, and specific information on terminal and route conditions.

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WEAVER, JAMES BAIRD (1833–1912), U.S. lawyer, political reformer and presidential candidate of the Populist party, was born at Dayton, O., June 12, 1833. He took a degree at the Cincinnati, O., Law school, and entered practice at Bloomfield, Ia. An adherent of Free-Soil ideas and active in local Republican politics, he volunteered shortly after the outbreak of the Civil War and saw active service in the Union army. In March 1865 he was brevetted brigadier general. In 1866 he was elected district attorney of the 2nd Iowa judicial district and held the appointive office of federal assessor of internal revenue. 1867–73. His hostility to the railroads and other corporations and his inflationist views, however, blocked his further advancement in the Republican party, and he turned to the Greenbackers, on whose ticket he was elected to congress in 1878, 1884 and 1886. He was the Greenback candidate for president in 1880. He was nominated for president by the People's or Populist party in its first national campaign in 1892. After a vigorous campaign he received 1,027,000 votes, 8.5% of the total.

Weaver died at Des Moines, Ia., Feb. 6, 1912. (R. HR.)

WEAVERBIRD, the name by which a family (Ploceidae) of birds are usually known, from their often elaborately interwoven nests. They are small sparrowlike birds, but the males are often conspicuously coloured. Perhaps the most remarkable is the African sociable grosbeak (Philetaerus *socius*); some 100 or 200 pairs build their grass nests together in one tree, forming a gigantic mushroom-shaped mass. Each nest is entered from below.

The subfamily of the widow birds (Viduinae) have long tail feathers, reaching in Vidua *paradisea,* a bird the size of a sparrow, a foot in length. This decoration is confined to the males. The Ploceidae are closely related to the Fringillidae (see FINCH), and are distributed over Africa, Australia and the warmer parts of Asia.

WEAVING. The process of weaving consists in interlacing, at right angles, two or more series of flexible materials, of which the longitudinal are called warp and the transverse weft. Weaving, therefore, embraces only one section of the textile industry, for felted, plaited, netted, hosiery and lace fabrics lie outside this definition.

Felting consists in bringing masses of loose fibres, such as wool and hair, under the combined influences of heat, moisture and friction, when they become firmly interlocked in every direction. Plaited fabrics have only one series of threads interlaced, and those at other than right angles. In nets all threads are held in their appointed places by knots, which are tied wherever one thread intersects another.

Hosiery fabrics, whether made from one or many threads, are held together by intersecting a series of loops; while lace fabrics are formed by passing one set of threads between and round small groups of a second set of threads, instead of moving them from side to side.

The invention of spinning (*q.v.*) gave a great impetus to the introduction of varied effects; previously the use of multi-coloured threads provided ornament for simple structures, but the demand for variety extended far beyond the limits of colour, and different materials were employed either separately or conjointly, together with different schemes of interlacing. Eventually the weaver was called upon to furnish articles possessing lustre, softness and delicacy; or those that combine strength and durability with diverse colourings, with a snowy whiteness, or with elaborate ornamentation.

To meet the requirements the world has been searched for raw materials. From the animal kingdom, wool, hair, fur, feathers, silk and the pinna fibre have long been procured. From the vegetable kingdom, cotton, flax, hemp, jute, ramie and a host of other less known materials are derived. Among minerals there are gold, silver, copper, brass, iron, glass and asbestos. In addition, strips of paper, or skin, in the plain, gilt, silvered and painted conditions are available. Finally, artificial fibres are used, especially artificial silk, which has come into very extended use.

The processes of bleaching (*q.v.*), mercerizing (*q.v.*), dyeing,. printing (*see* TEXTILE PRINTING) and finishing (*see* COTTON MANUFACTURE) contribute to the resultant product.

FABRIC STRUCTURE AND DESIGNING

The following classification will be adopted: Group 1, to include all fabrics made from one warp and one weft, provided both sets of threads remain parallel in the finished article and are intersected to give the requisite feel and appearance. Group 2, to include *(a)* fabrics constructed from two warps and one weft, or two wefts and one warp, as in those that are backed, reversible and figured with extra material; *(b)* two or more distinct fabrics built simultaneously from two or more warps and wefts, as in two, three and other ply cloths; (c) fabrics built by so intersecting two or more warps and wefts that only one texture results, as in loom-made tapestries and figured repps. Group 3, to include fabrics in which a portion of the weft or warp rises vertically from the ground-work of a finished piece, as in velveteens, velvets, plushes and piled carpets. Group 4, to embrace all fabrics in which one portion of the warp is twisted partially, or wholly, round another portion, as in gauzes and lappet cloths.

The structure of a cloth, and its ornamentation by weaving, is worked out by the cloth designer on squared paper. Successive vertical lines of squares are taken to represent the warp threads, whilst horizontal lines similarly represent weft threads. A filled-in square then indicates that the warp thread it represents is above the weft, whereas a blank means weft above warp. This can be seen clearly in fig. 1. When two or more warps or wefts are used in a cloth, different colours or kinds of marks are generally used to show the working of the different warps or wefts. Thus, in fig. 15 the crosses represent ground warp above ground weft, whereas the filled squares show ground warp above the extra or figuring weft.

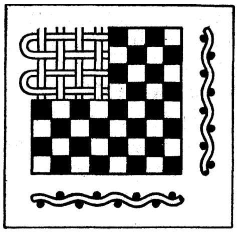


FIG. 1.—PLAIN CLOTH

Fabrics in Group 1.—These are affected by the nature and closeness of the yarns employed in their construction, by colour, or by the scheme of intersecting the threads. The most important section of this group is *Plain cloth,* in which the warp and weft threads are approximately equal in thickness and closeness, and pass over and under each other alternately, as in fig. 1, which shows a design, plan and two sections of plain cloth. Such a fabric would, therefore, appear to admit of but slight ornamentation, yet this is by no means the case, for if thick and thin threads of warp and weft alternate the resultant fabric may be made to assume a corrugated appearance on the face, while beneath it remains flat, as in poplins, repps and cords. A plan and a longitudinal section of a repp cloth are shown in fig. 2. Colour may also be employed to ornament plain fabrics, and its simplest application produces stripes and checks. But colour may convert these fabrics into the most artistic productions. Tapestries only differ from simple plain cloth in having each horizontal line of weft made up of numerous short lengths of parti-coloured thread. Many fine specimens of this art have been recovered from ancient Egyptian and Peruvian tombs, and many are still produced in the Gobelins and manufactories of Europe.

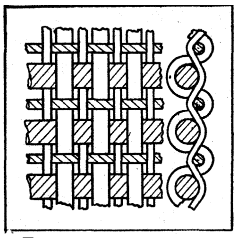


FIG. 2.—REPP CLOTH

Twills are next in importance to plain cloth on account of their wide range of application and great variety of effects; in elaborately figured goods their use is as extensive as where they provide the only ornament. Twills invariably form diagonal ribs in fabrics, and these are due to the intervals at which the warp and weft are intersected; thus two or more warp threads are passed over or under one or more than one weft thread in regular succession. Twills are said to be equal when similar quantities of warp and weft are upon the face of a fabric, unequal when one set of threads greatly preponderates over the other set. Fig. 3 shows the design for an equal, and fig. 4 that for an unequal twill, each of which requires four warp and weft threads to complete the scheme of intersections. If the ribs form angles of 45 degrees, the warp and weft threads per inch are about equal in number, but for an unequal twill the material most in evidence should be closest and finest. The angle formed may be greater or less than 45 degrees, as in figs. 5, 6, which are both derived as shown from the same base weave.

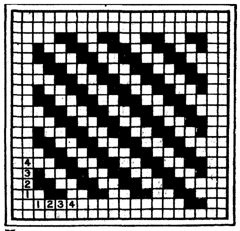


FIG. 3.—FOUR-THREAD 2/2 TWILL

Twills are *simple* and *fancy;* both terms refer to the schemes of intersecting. In the former the same number of warp threads are placed successively above or below each weft thread, and the ribs are of uniform width, as in figs. 3, 4. In the latter more warp threads may be above one pick than another, the ribs may vary in width and small ornament may be introduced befween the ribs, as in figs. 5, 6 and 7. Twills may be broken up into zig-zags, lozenges, squares and other geometrical designs, all of which may be produced by reversings in the diagonal lines, or by reversing the weave of an unequal twill. Fig. 8 is a zigzag, nameiy, a twill reversed in one direction. Fig. 9 is a diamond, or a twill reversed in two directions, and fig. 10 is a diaper, which gives a warp face in one place and a weft face in another.

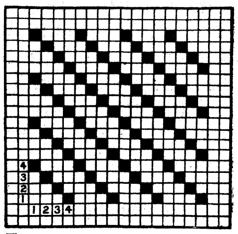


FIG. 4.—FOUR-THREAD 1/3 TWILL

Satins and *sateens* form another important section of Group 1. In a satin the bulk of the warp, and in a sateen the bulk of the weft, is on the face of a fabric. If perfect in construction both present a smooth, patternless appearance, which is due in part to the scheme of intersections, in part to using fine material for the surface threads and placing it close enough together to render the points of intersection invisible; the threads of the other set being coarser and fewer in number. Satins differ from twills in having each warp thread lifted, or depressed, separately, but not successively. From five to upwards of 30 threads of warp and weft are required to complete the various schemes of intersecting. If the intervals between the intersections are equal the weave is said to be perfect, as in fig. 11, but if the intervals are irregular it is said to be imperfect, as in fig. 12. In *Damasks* a satin is combined with a sateen weave, and since any desired size and shape of either weave may be produced, great facilities are offered for ornamentation. But in combination neither the satin nor the sateen can be perfect in construction, for one requires a preponderance of warp, the other a preponderance of weft; it follows that every point of intersection is distinctly visible on both surfaces.

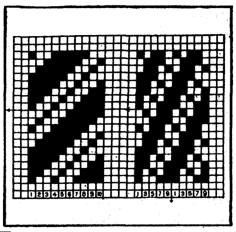


FIG. 5.—UPRIGHT TWILL

Brocades are fabrics in which both sets of threads may be floated irregularly upon the surface to produce ornamental effects, and they may be taken as typical of all one, warp and one weft fabrics that are figured by irregularly floated materials, whether the threads are uniformly or irregularly distributed, and whether one weave or several weaves be employed.

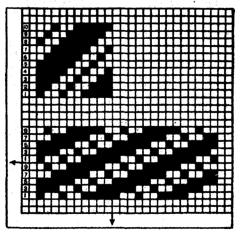


FIG. 6.—RECLINING TWILL

Group 2.—This group includes all backed and reversible fabrics, as well as those ornamented with extra material and compounded. Cloths intended for men's wear are often *backed,* the object of which is to give weight and bulk to a thin texture without interfering with the face effects. Either warp or weft may be used as backing; in the former there are two series of warp to one series of weft threads, while in the latter there are two series of weft to one series of warp threads. The face material is superposed upon that of the back, but the ratio of face threads may be one or two to one of back.

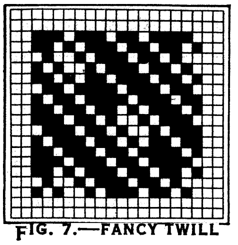


FIG. 7.—FANCY TWILL

In order to avoid disturbing the face weave, only those threads are used to bind the backing that are hidden by the face, as in fig. 13, which gives the design and a transverse section of a backed fabric. A is face weft, B back weft, and the circles are warp threads; of the latter C, D are beneath both B and A. This diagram will serve equally as a longitudinal section of a warpbacked fabric, if **A** represents a thread of face warp, B a thread of back warp and the circles are weft threads. Weft backing is capable of giving a more spongy feel to a fabric than warp, because softer materials may be used, but in these fabrics the length output of the loom is reduced by reason of the wefts being superposed.

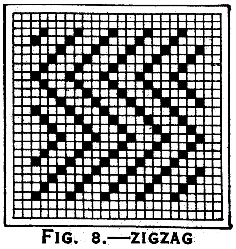


FIG. 8.—ZIGZAG

Warp-backed fabrics, whether uniformly coloured or striped, do not materially reduce the output of a loom, for every weft thread adds to the cloth length. *Reversible* fabrics may have either two series of differently coloured wefts or warps to one of the other series, in which event they may be similarly figured on both sides by causing the threads of the double series to change places, as in the design and transverse section, fig. 14; or, by allowing one series to remain constantly above the other, as in backed cloths, both sides may be similar or dissimilar in colour and pattern.

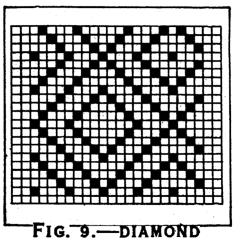


FIG. 9.—DIAMOND

Fabrics figured with extra material may have two series of warp or weft threads to one series of the other set, and they may yield reversible or one-sided cloths. The figuring may be done entirely by the extra material placed above or below a ground texture, as in fig. 15, or ordinary and extra materials may be used conjointly for figuring. In fig. 15 the waved lines and circles represent a section of the plain cloth ground which shows a thread of extra material.

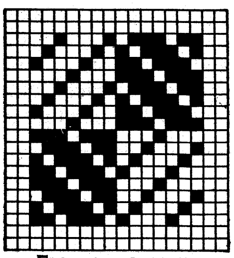


FIG. 10.—DIAPER

Compound cloths must have at least two textures, both as distinct in character as if woven in separate looms. They have many advantages over backed cloths, thus: the same design and colouring may be produced on both sides; where bulk and weight are required a fine surface texture may be formed over a ground of inferior material, and soft weft be passed between the upper and lower textures; the fabric is more perfect and admits of either simple or elaborate patterns being wrought upon the surface, with simple ones beneath, as in piqués and matelassés. One texture may be constantly above the other and connected at the selvages only, as in hose pipes and pillow slips; or at intervals a thread may pass from one texture into the other, in which event both are united, as in many styles of bedcovers and vestings. As many as from three to twelve textures may be woven simultaneously and united, as in woven beltings. It differently coloured, the textures may change places at pleasure, as in Kidderminster carpets.

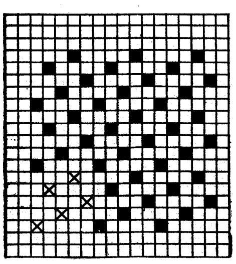


FIG. 11.—FIVE-THREAD SATEEN

There may be from one to three threads of face warp to one of back, and the wefting may or may not correspond with the warping. Fig. 16 shows the face and back weaves, the design, and a transverse section of a compound cloth with two threads of face warp and weft to one of back, and both are stitched together. The circles in the upper and lower lines represent face and back warps respectively, and **A**, B, C are weft threads placed in the upper and lower textures. In the design, filled squares show face warp lifted above face picks, crosses show back warp lifted over back picks, dots indicate face warp lifted over back picks, and the oblique marks show the binding of the two fabrics by back warp lifted over a face pick.

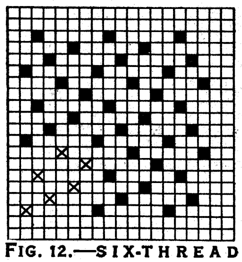


FIG. 12.—SIX-THREAD SATEEN

Loom-made tapestries and figured repps form another section of Group 2. As compared with true tapestries, the loom-made articles have more limited colour schemes, and their figured effects may be obtained from warp as well as weft, whether interlaced to form a plain face or left floating more or less loosely. Every weft thread, in passing from selvage to selvage, is taken to the surface where required, the other portions being bound at the back. Some specimens are reversible, others are one-sided, but, however numerous the warps and wefts, only one texture is produced. When an extra warp of fine material is used to bind the wefts firmly together a plain or twill weave shows on both sides.

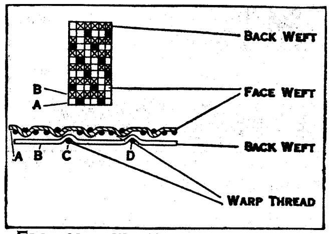


FIG. 13.—WEFT BACKED FABRIC

If a single warp is employed, two or more wefts form the figure, and the warp seldom floats upon the surface. Where warps do assist to form figure it rarely happens that more than three can be used without overcrowding the reed. Fig. 17 gives the design, and a transverse section of a reversible tapestry in four colours, two of which are warps and two wefts. If either warp or weft is on the surface, corresponding threads are beneath. The bent lines represent weft and the circles warp. In this design the marks indicate the colours showing on the surface of the cloth, and *not* the lifting of the warp. Thus, crosses show No. 1 warp on the surface, filled squares show No. 2 warp, dots show No. 1 weft and oblique marks No. 2 weft on the face of the fabric.

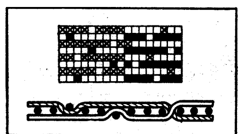


FIG. 14.—WEFT REVERSIBLE FABRIC

Each vertical line of squares represents one thread of each warp and each horizontal line represents one thread of each weft. *Figured repps* differ from plain ones in having threads of one, or more than one, thick warp floated over thick and thin weft alike; or in having several differently coloured warps from which a fixed number of threads are lifted over each thick weft thread; the figure is due to colour.

Group **3. Piled** Fabrics.—In all methods of weaving hitherto dealt with the warp and weft threads have been laid in longitudinal and transverse parallel lines. In piled fabrics, however, portions of the weft or warp assume a position at right angles to the surface of the cloth.

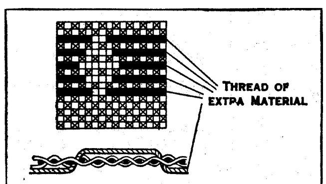


FIG. 15.—FIGURING WITH EXTRA WEFT

If the former there are two series of weft threads, one being intersected with the warp to form a firm ground texture, the other being bound into the ground at regular intervals, as in the design and transverse section of a velveteen, fig. 18; the circles and waved lines form plain cloth, and the loose thread **A** is a pile pick. After leaving the loom all threads A are cut by pushing a knife lengthwise between the plain cloth and the pile. As each pick is severed both pieces rise vertically and the fibres open out as at B. Since the pile threads are from two to six times as numerous as those of the ground, and rise from an immense number of places, a uniform brush-like surface is formed. Raised figures are produced by carrying the threads **A** beneath the ground cloth, where no figure is required, so that the knife shall only cut those portions of the pile weft that remain on the surface. The effect upon the face varies with the distribution of the binding points, and the length of pile is determined by the distance separating one point from another. When *chenille* is used in the construction of figured weft-pile fabrics, it is necessary to employ two weaving operations, namely, one to furnish the chenille, the other to place it in the final fabric. Chenille is made from groups of warp threads that are separated from each other by considerable intervals; then, multi-coloured wefts are passed from side to side in accordance with a predetermined scheme. This fabric is next cut midway between the groups of warp into longitudinal strips, and, if reversible fabrics such as table-covers and curtains are required, each strip is twisted axially until the protruding ends of weft radiate from the core of warp, and form a cylinder of pile. In the second weaving this chenille is folded backward and forward in a second warp to lay the colours in their appointed places and pile projects on both sides of the fabric. If chenille is intended for carpets, the ends of pile weft are bent in one direction and then woven into the upper surface of a strong ground texture. *Warp-piled fabrics* have at least two series of warp threads to one of weft, and are more varied in structure than weft-piled fabrics, because they may be either plain or figured, and have their surfaces cut, looped or both. *Velvets and plushes* are woven single and double. In the former case both ground and pile warps are intersected with the weft, but at intervals of two or three picks the pile threads are lifted over a wire, which is subsequently withdrawn; if the wire is furnished with a knife at its outer extremity, in withdrawing it the pile threads are cut, but if the wire is pointed a line of loops remains, as in terry velvet. Fig. 19 is the design and two longitudinal sections of a Utrecht velvet. The circles are weft threads, and the bent line is a pile thread, part of which is shown cut, another part being looped over a wire. The circles are repeated to show how the groundwarp intersects the weft. In the design the filled squares show the pile warp lifted over the wires. *Double plushes* consist of two distinct ground textures which are kept far enough apart to ensure the requisite length of pile. As weaving proceeds the pile threads are interlaced with each series of weft threads, and passed from one to the other. The uniting pile material is next severed midway between the upper and lower textures, and two equal fabrics result. Fig. 20 gives three longitudinal sections of a double pile fabric. The circles A, B are weft threads in the upper and lower fabrics respectively; the lines that interlace with these wefts are pile warp threads which pass vertically from one fabric to the other. At C, D the circles are repeated to show how the ground warps intersect the wefts, and at E the arrows indicate the cutting point. *Figured warp-pile fabrics* are made with regular and irregular cut and looped surfaces. If regular, the effect is due to colour, and this again may be accomplished in various ways, such as *(a)* by knotting tufts of coloured threads upon a warp, as in Eastern carpets; *(b)* by printing a fabric after it leaves the loom; (c) by printing each pile thread before placing it in a loom, so that a pattern shall be formed simultaneously with a pile surface, as in tapestry carpets; *(d)* by providing several sets of pile threads, no two of which are similar in colour; then, if five sets are available, one-fifth of all the pile warp must be lifted over each wire, but any one of five colours may be selected at any place, as in Brussels and Wilton carpets. Fig. 21 is a longitudinal section of a Brussels carpet. The circles represent two tiers of weft, and the lines of pile threads, when not lifted over a wire to form loops, are laid between the wefts; the ground warp interlaces with the weft to bind the whole together. When the surface of a piled fabric is irregular, also when cut and looped pile are used in combination, design is no longer dependent upon colour, for in the former case pile threads are only lifted over wires where required, at other places a flat texture is formed. In the latter case the entire surface of a fabric is covered with pile, but if the figure is cut and the ground looped the pattern will be distinct.

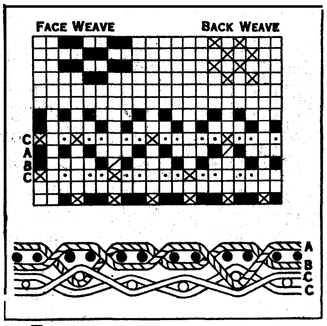


FIG. 16.—COMPOUND FABRIC

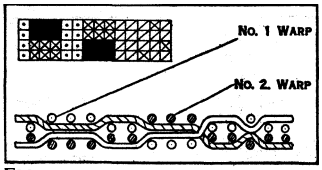


FIG. 17.—TAPESTRY WITH TWO WARPS AND TWO WEFTS

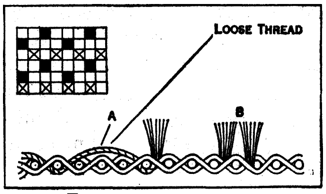


FIG. 18.— VELVETEEN

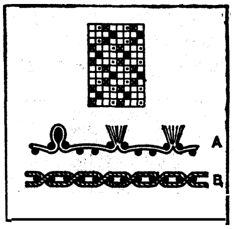


FIG. 19.—UTRECHT VELVET

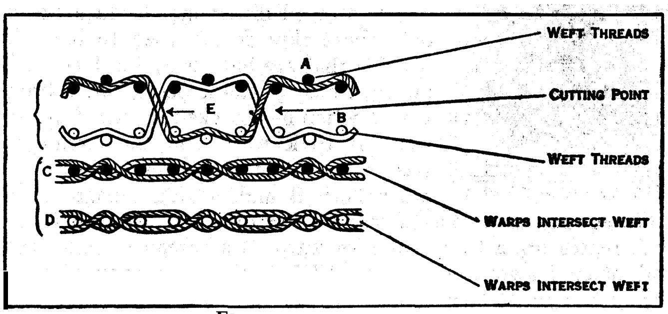


FIG. 20.— DOUBLE PLUSH

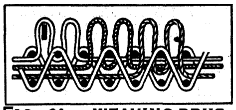


FIG. 21.—WEAVING BRUSSELS CARPET

Group 4. **Crossed** Weaving. — This group includes all fabrics, such as gauzes, in which the warp threads intertwist amongst themselves to give intermediate effects between ordinary weaving and lace. Also those, such as Lappets, in which some warp threads are laid transversely in a piece to imitate embroidery. *Plain gauze* embodies the principles that underlie the construction of all crossed woven textiles. In these fabrics the twisting of two warp threads together leaves large interstices between both warp and weft. But although light and open in texture, gauze fabrics are the firmest that can be made from a given quantity and quality of material. One warp thread from each pair is made to cross the other at every pick, to the right and to the left alternately, therefore the same threads are above every pick, but since in crossing from side to side they pass below the remaining threads, all are bound securely together, as in fig. 22, which shows a longitudinal section and also a plan of gauze. *Leno* is a muslin composed of an odd number of picks of a plain weave followed by one pick of gauze. In texture it is heavier than gauze, and the cracks are farther apart transversely. *Fancy gauze* may be made in many ways, such as *(a)* by using crossing threads that differ in colour or count from the remaining threads, provided they are subjected to slight tensile strain; *(b)* by causing some to twist to the right, others to the left simultaneously; (c) by combining gauze with another weave, as plain, twill, satin, brocade or pile;

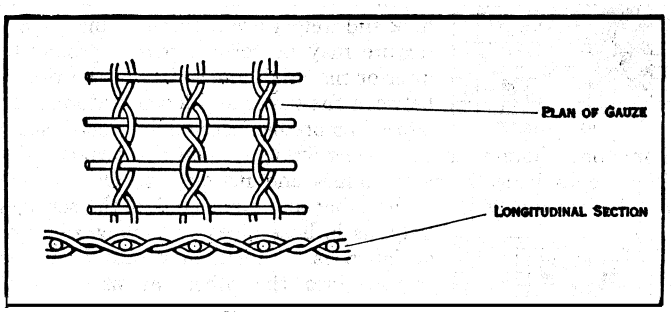


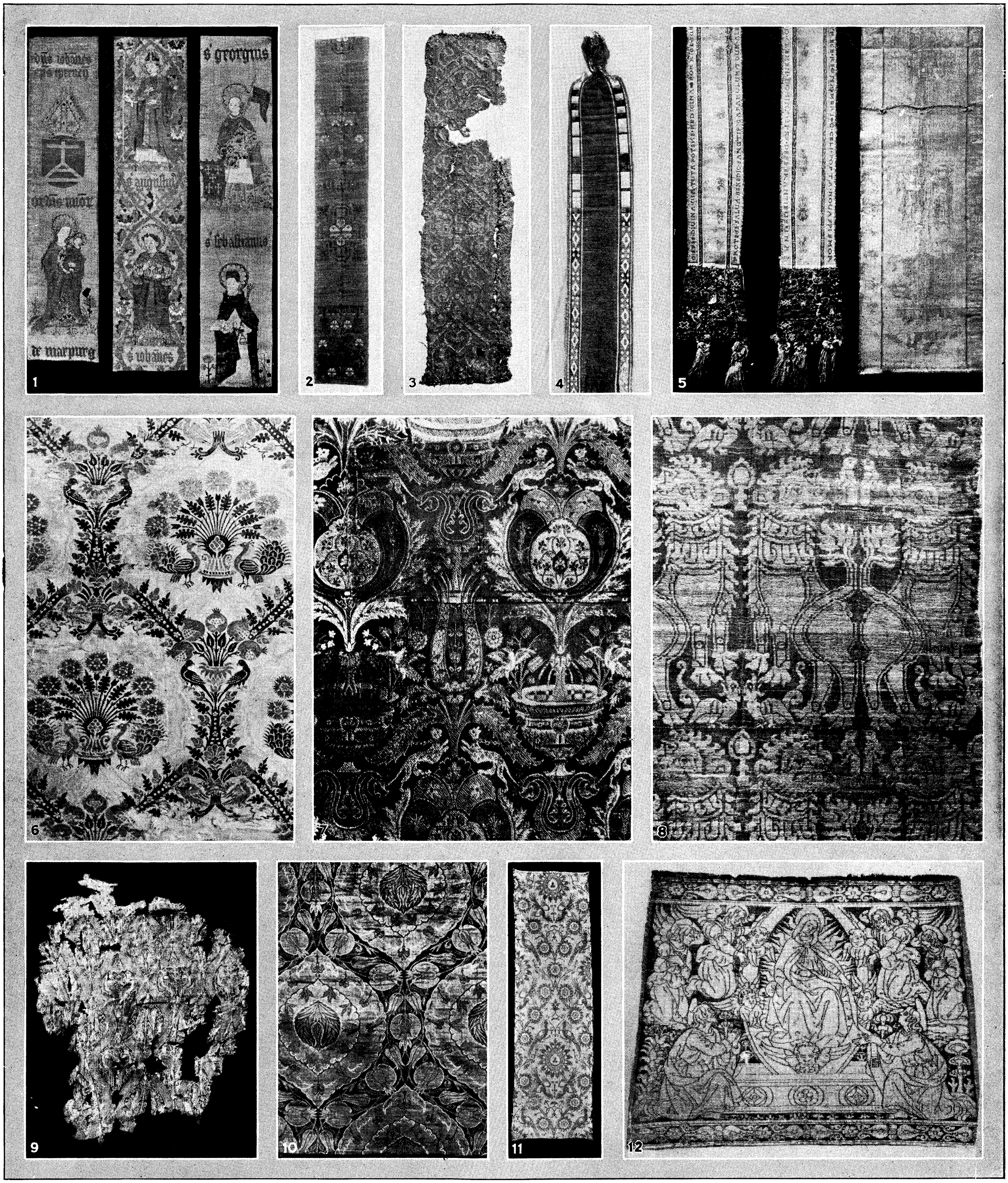
FIG. 22.— PLAIN GAUZE

BY COURTESY OF (1, 4, 7, 8) THE MUSEUM OF THE AMERICAN INDIAN, HEYE FOUNDATION, (2, 3, 5, 6) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM

SPECIMENS OF ANCIENT WEAVING

1. Fragment of fabric woven by the Incas. Taken from a grave in Pachacamac, Peru. 2. Portion of the silk wrapping of tomb of Charlemagne with fanciful elephant and sacred tree device in a roundel. Possibly of Baghdad manufacture, 9th century. 3. Syrian or Anatolian silk weaving of the 5th century depicting Samson slaying the lion. 4. Inca woven fabric with figures of persons. Discovered in an ancient grave in Ancon, Peru. 5. Syrian or Persian silk weaving of the 5th oentury, showing mounted hunters engaged in the chase. 6. Syrian and Coptic flax weaving of the 5th or 6th century. Discovered at Akhmin, upper Egypt. 7. Long narrow strip of Inca fabric with typical design found in a grave in the Nasca valley. 8. A wider strip of Inca woven fabric that was also discovered in one of the Nasca valley graves

WEAVING



BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM, LONDON

EXAMPLES OF MEDIAEVAL WEAVING

1. Cologne orphreys woven in silk and gold threads. Faces of the Virgin and Child are embroidered, (1425–1450). 2. Another specimen of Cologne orphrey also woven with gold and silk threads and bearing Latin inscriptions, late 15th century. 3. Part of a narrow band with chevron spaces filled with delicate scroll ornament. Woven in silk and gold thread, 13th century. 4. Portion of Clavus or narrow band from a Coptic tunic of the 9th or 10th century. 5. (Left) German late 12th or early 13th century orphrey woven in gold and silk threads with Latin inscription along the edges. (Right) part of broad band or orphrey woven in gold and silk threads and bearing figures of the Crucifixion and Annunciation. German work of the 13th century. 6. Italian damask or brocade silk fabric of 15th century manufacture. 7. Example of Venetian silk weaving. Design shows Ottoman influence, 16th century. 8. Byzantine weaving, 11th century. Red silk and gold thread used. 9. Fragment of Byzantine silk of the 12th century. 10. Ottoman silk and gold thread weaving of the 16th century, with ogival framed ornament. 11. Piece of north Italian silk weaving, 14th century, pattern planned on original basis with fantastic birds. Cone forms contain sham Arabic inscriptions. 12. Apparel of a Dalmatic woven in Venice late in 15th century. The pattern depicts the Virgin in glory

(d) by varying the number of threads that cross, and by causing those threads to entwine several ordinary threads; (e) by passing two or more weft threads into each crossing, and operating any assortment of crossing threads at pleasure.

Lappet weaving consists in diapering the surface of a plain or gauze fabric with simple figures This is done by drawing certain warp threads into a transverse position and then lifting them over a thread of weft to fix them in the texture, after which they are moved in the opposite direction and lifted over the following pick, the cloth being generally woven with the face side down. The material between one binding point and another must float loosely, and this limits the usefulness of lappet figuring. In fig. 23 the thick lines show a lappet spot upon a plain texture.

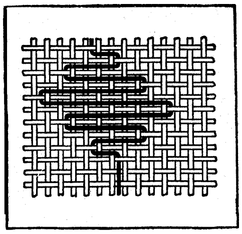


FIG. 23.—LAPPET FABRIC

Notwithstanding diverse structure, intricate machines are not essential to the production of either simple or complex textures; the most elaborate and beautiful specimens of the weaver's art have been manufactured upon simple machinery.

WEAVING MACHINERY

The longitudinal threads of a fabric are called warp, caine, twist and organzine, and the transverse threads are weft, shoot, woof, filling and tram. A loom for weaving these threads into cloth must provide for: *(1)* Shedding, *i.e.,* raising and lowering the warp threads in a predetermined sequence so as to form two lines between which the weft may be passed. *(2)* Picking, or placing lines of weft between the divided warp. *(3)* Beating-up, or striking each weft thread into its appointed position in the fabric. *(4)* Letting-off, or holding the warp tense and delivering it as weaving proceeds. (5) Taking-up, or drawing away the cloth as manufactured. (6) Temples, for stretching the fabric widthwise in order to prevent the edge threads of a warp from injuring the reed, and from breaking. Fig. *24* illustrates these operations. Shedding is generally done by controlling the warp threads by eyed healds, which are lifted or lowered to form the shed. The weft is inserted by the shuttle after the shed has been formed, and beating-up is done by the reed which is moved forward by the slay or batten. Intermittently driven rollers take up the cloth and a frictional drag, applied to the warp beam by a weighted rope or chain, regulates the let-off and warp tension. Power looms require the above-named contrivances to act automatically; and, in addition, (7) a weft-fork, to stop the loom when the weft

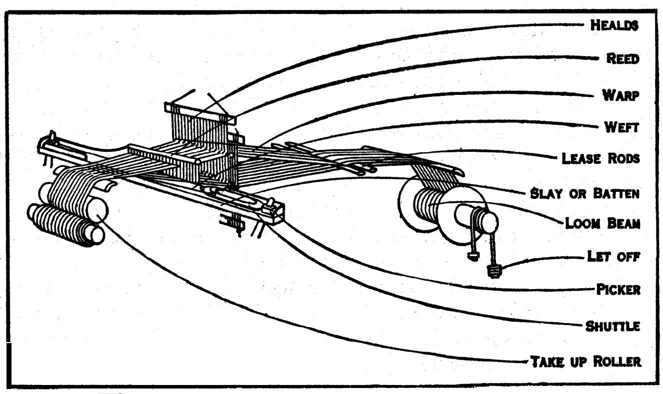


FIG. 24.— DIAGRAM OF VARIOUS PARTS OF A LOOM

becomes exhausted or breaks. (8) Mechanism for stopping the loom when the shuttle fails to reach its appointed box. (9) For weaving cross stripes, multiple shuttle boxes are needed to bring different colours, or counts of weft, into use at the proper time. (10) In some looms a device for automatically ejecting a spent cop, pirn or shuttle, and inserting a full one is requisite. (11) If a weaver has to attend to a greater number of looms than usual, a device for stopping the loom when a warp thread fails is essential. In addition to the loom itself, weaving machinery includes preparatory machines required to get the warp and sometimes the weft threads ready for the loom. Warp thread—or rather yarn—generally requires re-winding from the spinning frame bobbins or cops on to larger bobbins; warping a number of these yarns side by side on to a beam or into an untwisted rope; sizing the yarn to lay projecting fibres and to strengthen the

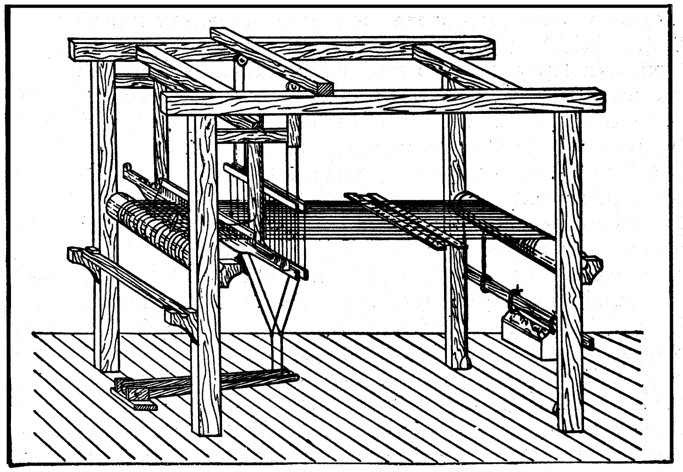


FIG. 25.— DIAGRAM OF HAND LOOM

yarn for weaving; finally, winding the sized yarn on to the loom beam and getting it ready for weaving in the loom.

The Hand-loom.— During the 17th and the first half of the 18th century it was observed that wherever any branch of the textile industry had been carried to a high state of excellence the looms used to manufacture a given fabric were similar in essentials, although in structural details they differed greatly. Prior to the invention of the fly shuttle by John Kay, in 1733, no far-reaching invention had for generations been applied to the hand-loom, and subsequently the Jacquard machine and multiple shuttle boxes represent the chief changes. A hand-loom as used in Europe at the present time *(see* fig. *25)* has the warp coiled evenly upon a beam whose gudgeons are laid in open steps formed in the loom framing. Two ropes are coiled round this beam, and weighted to prevent the warp from being given off too freely. From the beam the threads pass alternately over and under two lease rods, then separately through the eyes of the shedding harness, in pairs between the dents of a reed, and finally they are attached to a cloth roller. For small patterns healds are used to form sheds, but for large ones a Jacquard machine is required. Healds may be made of twine, of wire or of twine loops into which metal eyes, called mails, are threaded. But they usually consist of a number of strings which are secured above and below upon wooden laths called shafts, and each string is knotted near the middle to form a small eye. From two to *24* pairs of shafts may be employed, but the healds they carry must collectively

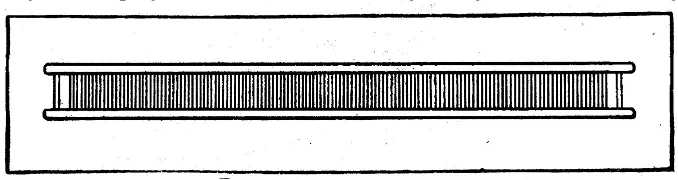


FIG. 26.— WEAVER'S REED

The warp threads are passed, generally in pairs or threes, through the dents or spaces between the reed wires

equal the number of threads in the warp. These healds will be equally or unequally distributed upon the shafts according to the nature of the pattern to be woven, and the threads will be drawn through the eyes in a predetermined order. The upper shafts are suspended from pulleys or levers, and the lower ones are attached directly or indirectly to treadles placed near the floor. The weaver depresses these treadles with his feet in a sequence suited to the pattern and the scheme of drawing the warp through the healds. When the treadle is pressed down, at least one pair of shafts will be lifted above the others, and the warp threads will ascend or descend with the healds to form a shed for the shuttle to be passed through. The reed (fig. 26) is the instrument by which weft is beaten into position in the cloth; it also determines the closeness of the warp threads, and guides a moving shuttle from side to side. It is made by placing strips of flattened wire between two half round ribs of wood, and binding the whole together by passing tarred twine between the wires and round the ribs. Such a reed is placed in the lower portion of a batten, which is suspended from the upper framework of the loom. In front of the reed, and immediately below the warp, the projecting batten forms a race for the shuttle to travel upon from side to side. Before Kay's invention a shuttle was thrown between the divided warp and caught at the opposite selvage, but Kay continued the projecting batten on both sides of the warp space and constructed boxes at each end. Over each box he mounted a spindle and upon it a driver, or picker. Bands connected both pickers to a stick which the weaver held in his right hand, while with the left hand he controlled the batten. A treadle is pressed down by one foot to form a shed; the batten is pushed back till a sufficient portion of the shed is brought in front of the reed and the depressed threads lie upon the shuttle race; a clear way is thus provided for the shuttle. A quick movement of the stick tightens the cord attached to a picker and projects the shuttle from one hox to the other. The batten is now drawn

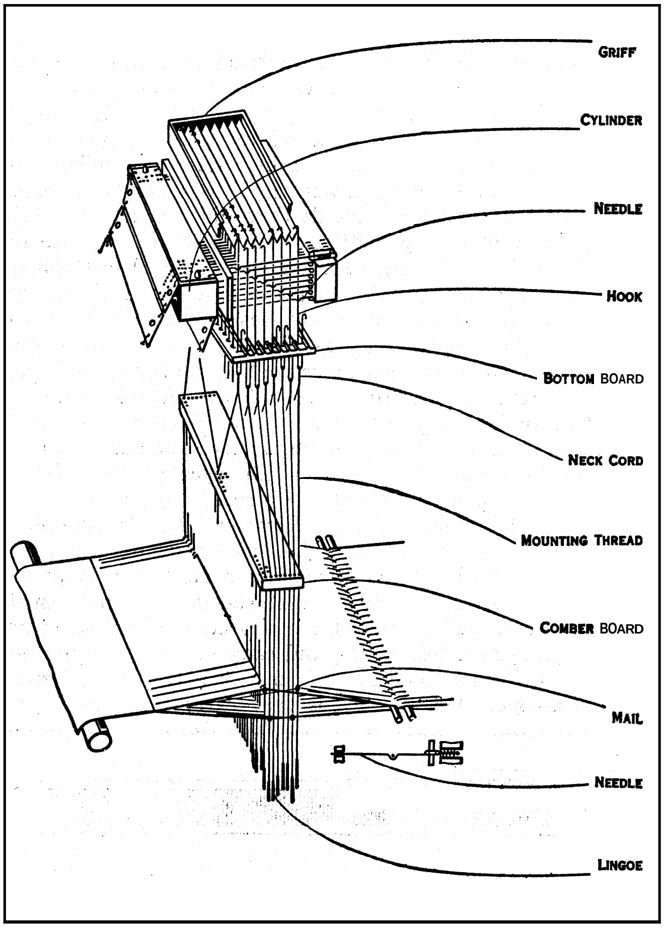


FIG. 27.—JACQUARD MACHINE AND HARNESS
This method of shedding is required for the production of all fabrics ornamented by woven floral designs

forward, and the reed beats up the weft left by the shuttle. As the next treadle is depressed to form another division of the warp for the return movement of the shuttle, the last length of weft is enwrapped between intersecting warp threads, and the remaining movements follow in regular succession.

In cases where the weft forms parti-coloured stripes across a fabric, also where different counts of weft are used, shuttles, equal in number to the colours, counts or materials, must be provided. By Robert Kay's invention of multiple shuttle boxes, in 1760, much of the time lost through changing shuttles by hand was prevented. His drop boxes consist of trays formed in tiers and fitted into the ordinary shuttle boxes. Each tray is capable of holding a shuttle, and by operating a lever and plug with the forefinger and thumb of the left hand the trays may be raised and lowered at pleasure to bring that shuttle containing the colour next needed into line with the picker.

The **Draw** Loom.—Large figured effects were formerly produced in draw looms, where the warp threads were so controlled by separate strings that any assortment could be lifted when required. To the lower end of each string a dead weight, called a lingoe, was attached, and a few inches above the lingoe a mail was fixed for the control of a warp thread. The strings passed through a comber board which held the mails and warp threads facing the proper reed dents. Still higher up, groups of strings were connected to neck cords; each group consisted of all strings required to rise and fall together constantly If, for example, in the breadth of a fabric there were 12 repeats of a design, 12 strings would be tied to the same neck cord, but taken to their respective places in the comber board These parts of a draw loom harness are clearly shown in fig. 27 which represents a Jacquard machine and harness. Each neck cord, after being led through the perforated bottom board and over a grooved pulley, was threaded through a ring on the top of a vertical cord called the simple, and passed horizontally to, and tied upon, a bar rigidly fixed near the ceiling of the weaving room. The simple cords were similarly attached to a bar placed near the flbor. From one hundred to several thousands of neck and simple cords could be used in one harness. The design to be reproduced in cloth was read into the parallel lines of the simple by looping a piece of string round each cord that governed warp threads to be lifted for a given shed; after which all the loops were bunched together. By pulling at a bunch of loops the simple cords were deflected and they caused all warp threads controlled by them to be lifted above the level of those undisturbed. Similar bunches of loops were formed for every shed required for one repeat of a design, and they were pulled in succession by the draw-boy, while the weaver attended to the batten and picking.

The Jacquard Machine.—This is the most important invention ever applied to the hand-loom, but it is not the work of one man; it represents the efforts of several inventors whose labours extended over three-quarters of a century. This apparatus has taken the places of the simple, the loops, the pulleys and the draw-boy of the older shedding motion, but other parts of the harness remain unchanged. In 1725 Basile Bouchon substituted for the bunches of looped string an endless band of perforated paper by which the simples for any shed could be selected. In 1728 M. Falcon constructed the machine since known as the Jacquard and operated it through the medium of perforated cards, but it was attached to the simple cords and required a draw-boy to manipulate it. In 1745 Jacques de Vaucanson united in one machine Bouchon's band of paper and the mechanism of Falcon. He placed this machine where the pulley box previously stood, and invented mechanism for operating it from one centre.

In a Jacquard machine the warp threads are raised by rows of upright wires called hooks (fig. 27). These are bent at both extremities and are normally supported upon a bottom board which is perforated to permit the neck cords from the harness beneath to be attached to the hooks. Each of a series of horizontal needles—one of which is shown enlarged and detached at the foot of the drawing—is provided with a loop and a crank; the former to permit of a to-and-fro movement, the latter to receive a hook. The straight ends of the needles protrude about one-quarter of an inch through a perforated needle board, but the looped ends rest upon bars placed in tiers. A wire passed through all the loops of the needles which form one vertical line limits the extent of their lateral movement, and small helical springs impinge upon the loops of the needles with sufficient force to press them and their hooks forward. A frame called a griff, is made to rise and fall vertically by a treadle which the weaver actuates with one foot. This frame contains a blade for each line of hooks, and when the blades are in their lowest position the hooks are free and vertical with their heads immediately over the blades, hence an upward movement given to the griff would lift all the hooks and thereby all the warp threads. Only certain hooks, however, must be lifted with the griff, and the selection is made by a quadrangular block of wood, called a cylinder. and cards which are placed upon it. Each face of the cylinder has a perforation opposite each needle, so that if the cylinder be pressed close to the needle board the needle points will enter the holes in the cylinder and remain undisturbed. But if a card, which is not perforated in every possible place, is interposed between the cylinder and the needles, the unpunctured parts of the card close up some of the holes in the cylinder and prevent corresponding needles from entering them. Each needle so arrested is thrust back by the advancing card; its spiral spring is contracted and its hook is tilted. If at this instant the griff ascends, its blades will engage the heads of all vertical hooks and lift them, but those that are tilted will remain unlifted. So soon as the pressing force of a card is removed from the needles the springs restore both needles and hooks to their normal positions. Cards are perforated by special machinery from a painted design, after which they are laced into a chain and passed over conical pegs upon the cylinder; the number required to weave any pattern equals the number of weft threads in that pattern The cylinder is generally drawn out and turned by each upward movement of the griff, and restored to the needles by each downward movement, so that each face in succession is presented to the needles, and each rotatory movement brings forward a fresh card. As the griffe rises with vertical hooks a shed is formed, and a thread of weft is passed across the warp. The griff then descends and the operation is repeated but with a new combination of lifted threads for each card. A Jacquard may contain from 100 to 1,200 hooks and needles, and two or more machines may be mounted upon the same loom.

The Power-loom. — Little is known of the attempts made before the beginning of the 17th century to control all parts of a loom from one centre, but it is certain the practical outcome was inconsiderable In the year 1661 a loom was set up in Danzig, for which a claim was made that it could weave four or six webs at a time without human aid, and be worked night and day; this was probably a ribbon loom. In order to prevent such a machine from injuring the poor people the authorities in Poland suppressed it, and privately strangled or drowned the inventor. M. de Gennes, a French naval officer, in 1678 invented a machine whose chief features consisted in controlling the healds by cams, the batten by cams and springs and the shuttle by a carrier. From 1678 to 1745 little of importance appears to have been done for the mechanical weaving of broadcloth, but in the last-named year M. Vaucanson constructed a very ingenious, self-acting loom, on which the forerunner of the Jacquard machine was mounted; he also adopted de Gennes' shuttle carrier.

During the last quarter of the 18th century it was generally believed that, on the expiry of Arkwright's patents, so many spinning mills would be erected as to render it impossible to consume at home the yarns thus produced, and to export them would destroy the weaving industry. Many manufacturers also maintained it to be impossible to devise machinery which would bring the production of cloth up to that of yarn. It was as a protest against the last-named assertions that Dr. Edmund Cartwright, a clergyman of the Church of England, turned his attention to mechanical weaving. More fortunate than his predecessors, he attacked the problem after much initial work had been done, especially that relating to mechanical spinning and the factory system, for without these no power-loom could succeed. In 1785 Dr. Cartwright patented his first power-loom, but it proved to be valueless. In the following year, however, he patented another loom which has served as the model for later inventors to work upon. He was conscious that for a mechanically driven loom to become a commercial success either one person would have to attend several machines or each machine must have a greater productive capacity than one manually controlled. The thought and ingenuity bestowed by Dr Cartwright upon the realization of his ideal were remarkable. He added parts which no loom, whether worked manually or mechanically, had previously been provided with, namely, a positive let-off motion and warp and weft stop motions; and he planned to size the warp while the loom was in action. With this machine he commenced to manufacture fabrics at Doncaster, and by so doing discovered many of its shortcomings, and these he attempted to remedy: by introducing a crank and eccentrical wheels to actuate the batten differentially; by improving the picking mechanism; by a device for stopping the loom when a shuttle failed to enter a shuttle box; by preventing a shuttle from rebounding when in a box; and by stretching the cioth with temples that acted automatically. In 1792 Dr. Cartwright obtained his last patent for weaving machinery. This provided the loom with multiple shuttle boxes for weaving checks and cross-stripes. But all his efforts were unavailing, and it became apparent that no mechanism, however perfect, could succeed so long as warps continued to be sized while a loom was stationary. His plans for sizing them while a loom was in operation, and also before being placed in a loom, both failed. Still, provided continuity of action could be attained, the position of the power-loom was assured, and means for the attainment of this end were supplied in 1803 by William Radcliffe and his assistant, Thomas Johnson, by their inventions of the beam warper and the dressing sizing machine.

For upwards of 30 years the power-loom was worked under numerous difficulties. The mechanism of the loom itself, the preparatory processes and the organization of the industry were all imperfect. Textile workers were unused to automatic machinery, and many who had been accustomed to labour in their own homes refused employment in mills, owing to dislike of the factory system and the long hours of toil which it entailed. Yet improvements in every branch of the textile industry followed each other in quick succession, and the loom slowly assumed its present shape. By using iron instead of wood in its construction, and centring the batten, or slay, below instead of above the warp line, the power loom became more compact than the hand-loom.

In the modern power-loom (figs 28 and 29), motion is communicated to all the working parts from a main shaft A, upon which two cranks are bent to cause the slay to oscillate; by toothed wheels this shaft drives a second shaft, C, at half its own speed. For plain weaving four tappets are fixed upon the second shaft— two, D, for moving the shuttle to and fro, and two others, E, for moving the healds, L, up and down through the medium of treadles M, M. For other schemes of weaving shedding tappets

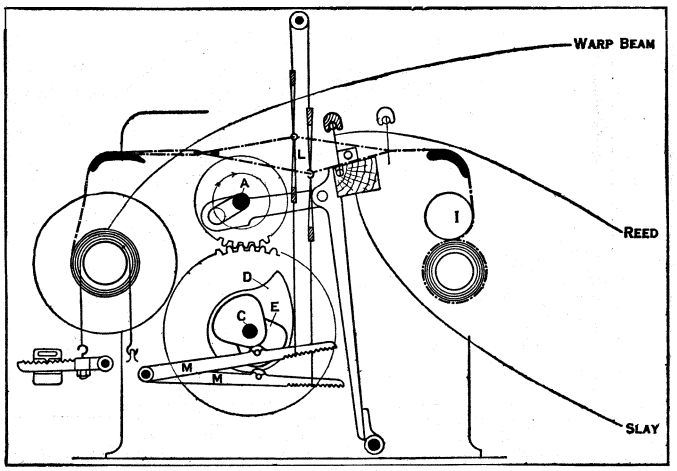


FIG. 28.—VERTICAL SECTION OF A POWER LOOM

are more numerous, and are either loosely mounted upon the second shaft or fixed upon a separate one. In either event they are driven by additional gearing, for the revolutions of the tappets to those of the crank shaft must be as one is to the number of picks in the repeat of the pattern to be woven. The warp beam is often put under the control of chains instead of ropes, as used in hand looms, and the chains are attached to adjustably weighted levers, whereby the effectiveness of the weights may be varied at pleasure. In the manufacture of heavy fabrics, however, it may be necessary to deliver the warp by positive. gearing, which is either connected, or otherwise, to the taking-up motion. The cloth is drawn forward regularly as it is manufactured by passing it over the rough surface of a roller, I, and imparting to the roller an intermittent motion each time a pick of weft is beaten home. This motion is derived from the oscillating slay, and is communicated through a train of wheels. The loom is stopped when the weft fails by a fork-and-grid stop motion, which depends for its action on the lightly balanced prongs of a fork, N. These prongs come in contact with the weft, between the selvage of the web and the shuttle box each time the shuttle is shot to the side at which the apparatus is fixed. If the prongs meet no thread they are not depressed, and being unmoved a connection is formed with a vibrating lever by which the loom is stopped. On the other hand, if the prongs are tilted, the loom continues in action. If more than one shuttle is used it may be necessary to feel for each, instead of alternate threads of weft. In such cases a fork is placed beneath the centre of the cloth and lifted above a moving shuttle; if in falling it meets with weft it is arrested and the loom continues in motion, but if the weft is absent the prongs fall far enough beneath the shuttle race for a stop to act upon a lever and bring the loom to a stand. To prevent a complete wreck of the warp it is essential to arrest the loom when a shuttle fails to reach its appointed box. For this purpose there are two devices, which are known respectively as fast and loose reed stop motions. The first was invented in 1796 by Robert Miller, and its action depends upon the shuttle, as it enters a box, raising two blades, K, which if left down would strike against stops and so disengage the driving gear. The second was invented in 1834 by W. H. Hornby and William Kenworthy; it is an appliance for liberating the lower part of a reed when a shuttle remains in the warp, thus relieving it, for the time being, of its function of beating up the weft. On the release of a reed from the motion of the slay a dagger stops the loom. Temples must keep a fabric distended to the breadth of

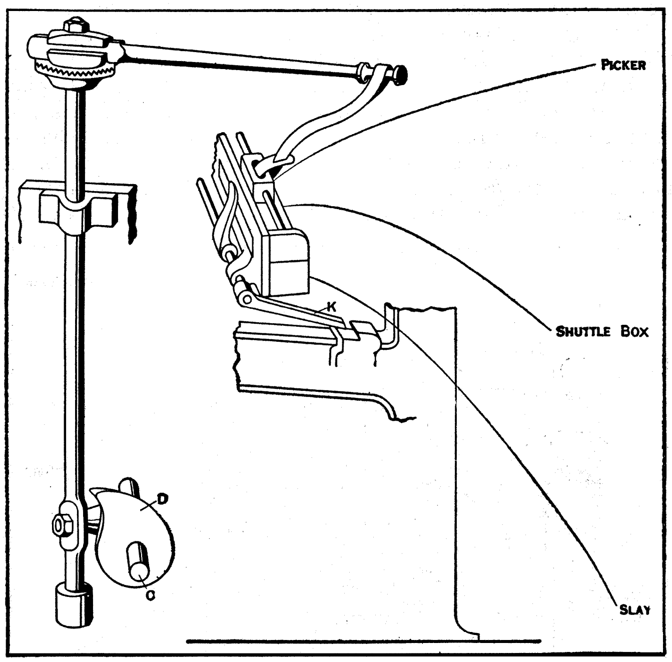


FIG. 29.— PICKING PARTS OF POWER LOOM
The illustration shows the cone overpick motion, the type generally used on the cotton looms of Lancashire and the jute looms of Dundee

the warp in the reed, and be self-adjusting. This is usually accomplished by small, rollers whose surfaces are covered with fine, closely set points. The rollers are placed near the selvages of a web which is prevented from contracting widthwise by being drawn tightly over the points.

Looms are varied in details to suit different kinds of work, but as a rule fabrics figured with small patterns are provided with healds for shedding as at L, while those with large patterns are provided with the Jacquard and its harness. Healds may be operated either by tappets or dobbies, but the range of usefulness in tappets is generally reached with 12 shafts of healds and with patterns having 16 picks to a repeat; where they are unsuitable for heald shedding a dobby is used. A dobby may resemble, in construction and action, a small Jacquard; if so the selection of healds that rise and fall for any pick is made by cards. In other types of dobbies the selection is frequently made by lags, into which pegs are inserted to pattern in the same manner that cards

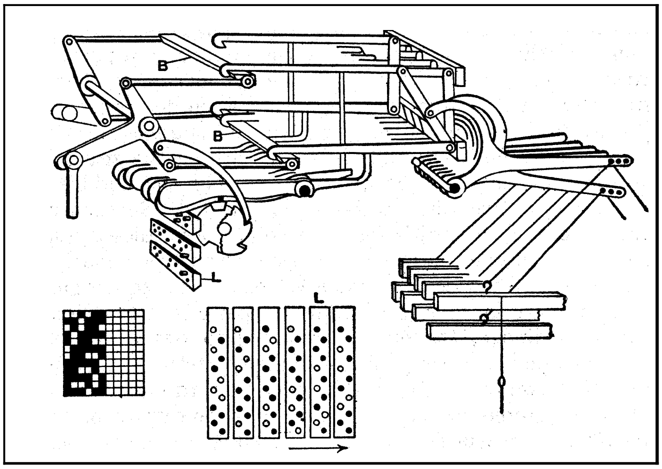


FIG. 30.— DOBBY SHEDDING MOTION. WIDELY USED FOR LIGHT CLOTHS REQUIRING SMALL PATTERNS. AS STRIPED SHIRTINGS AND DRESS FABRICS

are perforated. A dobby of this type is illustrated in fig. 30, which shows detached the pegging of the pattern lags for a small design, filled in circles representing pegs. The pattern lags, L, act on levers which lower hooks into contact with the oscillating griff bars B, and these lift the required heald shafts. The figure shows a double acting dobby, one lag, with two rows of pegs, serving for two picks. Some dobbies are made single acting and some have rollers instead of pegs to form a pattern. When multiple shuttles are required for power looms one of two types is selected, namely, drop or rotating boxes; the former are applicable to either light or heavy looms, but the latter are chiefly confined to light looms. As previously stated, Robert Kay invented drop boxes in 1760, but they were not successfully applied to the power-loom until 1845, when Squire Diggle patented a simple device for operating them automatically. Since his time many other methods have been introduced, the most successful of these being operated indirectly from the shedding motion. Revolving boxes were patented in 1843 by Luke Smith.

Many devices have been added to power looms with a view to reduce stoppages, among which those for the automatic supply of weft are probably the most important. These efforts originated with Charles Parker, who in 1840 obtained the first patent, but no marked success was achieved until 1894, when J. H. Northrop patented a cop changer. By his plan a cylindrical magazine, placed over one shuttle box, is charged with cops or pirns. When fresh weft becomes necessary the lowest cop in the hopper is pressed into a shuttle from above, the spent one is pressed out from beneath and the new weft is led into the shuttle eye, while the loom is moving at its normal speed. The mechanism is controlled by the weft fork, or by a feeler which acts when only a predetermined quantity of weft remains inside a shuttle. Many inventions are designed to eject an empty shuttle and introduce a full one; others change a cop, but differ in construction and action from the Northrop. By relieving a weaver of the labour of withdrawing, filling, threading and inserting shuttles it was seen that a large increase might be made in the number of looms allotted to one weaver, provided suitable mechanism could be devised for stopping a loom on the failure of a warp thread and for automatically maintaining a constant tension on the warp. With these devices as many as 100 looms have been supervised by one weaver.

Warp stop motions date from 1786, when Dr. Cartwright suspended an Independent detector from each warp thread until a fracture occurred, at which time a detector fell into the path of a vibrator and the loom was stopped. The demand for warp stop motions was, however, small until automatic weft supply mechanisms were introduced, and the majority of those devices now in use are constructed upon similar lines to the invention of Dr. Cartwright.

Smallware Looms.—A loom, which was for a long period operated manually, but to which mechanical power could be applied, was brought into use more than a century before Dr. Cartwright's invention. It was known as the Dutch engine loom, and was designed to weave from eight to upwards of 40 tapes or ribbons simultaneously. This machine may be regarded as a series of looms mounted in one frame, each having a complete set of parts, and as the first practical effort to connect and control all the motions of weaving from one centre. The place and date of its invention are uncertain, but it is known that in some districts its use was entirely prohibited, that in others it was strictly limited, and that it was worked in Holland about 1620. In England the first patent was obtained by John Kay and John Snell, in 1745, for additions which enabled it to be worked by hand, by water, or other force, and in 1760 John Snell appears to have added the draw harness for weaving flowered ribbons. In 1765 a factory in Manchester was filled with ribbon looms which were either invented by M. Vaucanson, or Kay and Snell, but one weaver could only attend to one machine. When worked by hand it was known as the bar-loom, because the weaver oscillated by hand a horizontal bar that set in motion all parts of the machine. The shuttles and reeds are actuated from the batten, the former originally by pegs, but later by a rack and pinion arrangement, which in action shoots the shuttles simultaneously across a web, to the right and left alternately, each into the place vacated by its next neighbour. One small warp beam is required for each web, but tappets, dobbies, or Jacquards are available for dividing the threads. Where differently coloured wefts are needed in one web the shuttles are mounted in tiers and all raised or lowered at once to bring the proper colour in line with the shed.

In *Swivel weaving,* shuttles, similar to those described above, are added to the battens of broad looms in order to diaper small figure effects, in different colours or materials, over the surface of broad webs. Weft from an ordinary shuttle forms the ground texture with the warp, and after the passage of this shuttle the small swivel shuttles place the figuring weft where required on the surface of the fabric.

Pile Weaving.— Looms for weaving piled fabrics differ in certain important respects from those employed for ordinary weaving; they are also made to differ from each other to suit the type of fabric to be manufactured, as, for example, double and single, plain and figured, textures. In *Double pile looms* the special features are those that control the pile threads and those that sever the vertical lines of pile. Two ground warps are required, and unless they are kept a uniform distance apart the piled effects will be irregular. For plain goods the pile threads are wound upon two or more beams, and as they move from web to web cloth-covered rollers deliver them in fixed lengths. Meanwhile, a shuttle passes twice in succession through each ground warp, and the pile threads in moving above or beneath the wefts are bound securely. Both fabrics are furnished with taking-up rollers which draw the pieces apart and so stretch the uniting pile in front of a knife, which severs it, thus forming two pieces at once.

The chief feature which renders most *single pile looms* dissimilar from others is the mechanism by which wires are woven upon, and withdrawn automatically from, a ground texture. Wires are of two kinds, namely, without and with knives. The former, being flattened and somewhat pointed, are woven above the weft of a ground texture, but beneath the pile, so that by withdrawing them looped pile is formed. A wire terminating in a knife with a sloping blade, on being withdrawn, cuts the pile and produces a brush-like surface. The mechanism for operating the wires is placed at one end of a loom and consists of an arm which moves in and out; at each inward movement a wire is inserted, and at each outward movement one is withdrawn. In weaving tapestry carpets, and certain other fabrics, a wire and a shuttle move simultaneously, but the shuttle passes through the ground warp, while the wire passes beneath the pile. After several wires have been woven upon the ground texture the one first inserted is withdrawn by the vibrating arm, and at the next inward movement the same wire enters the warp near the reed, where it is beaten up with the weft, and from this point the operation is continuous. Tapestry carpets require three warps, one for the ground texture, a second, or stuffing warp, to give bulk and elasticity to the tread, and a third to form the pile. The last named is printed upon a large drum, thread by thread to the colour-scheme of the design, then, when the colours have been fixed and the threads accurately placed, they are wound upon a beam, and all the warps are operated by healds. For figured velvets, and Brussels and Wilton carpets, the pile warp beam is replaced by a creel, in order that each thread of pile may be wound upon a bobbin and separately tensioned. This is essential, because, in the weaving of a design, it is probable that no two threads of pile will be required in equal lengths. Creels are made in sections called frames, each of which usually carries as many bobbins as there are loops of pile across a web, and the number of sections is the same as the number of colours. In weaving these fabrics healds are used to govern the ground warp, but a Jacquard is needed for the pile. It must form two sheds, the lower one to receive a shuttle, the upper one to make a selection of threads beneath which the wire is to pass.

Terry looms for weaving piled textures, of the Turkish towel type, have the reed placed under the control of parts that prevent it from advancing its full distance for two picks out of every series that separate one line of loops from another. At such times the weft is not beaten home but a broad crack is formed. So soon as the reed again moves through its normal space three picks of weft are simultaneously driven home, thus closing the gap and causing part of the pile to loop upward, the remainder downward. The system is available for plain and figured effects.

Gauze textures are woven in looms having a modified shedding harness, which, at predetermined intervals, draws certain warp threads crosswise beneath others and lifts them while crossed. There is also a tensioning device to slacken the crossed threads and thus prevent breakages due to excessive strain. At other times the shedding is normal.

Lappet looms have a series of needles fixed upright in laths, and placed in a groove cut in the slay, in front of the reed. Each needle carries a thread which does not pass through the reed. The needles are lifted for each pick and lowered after the passage of the shuttle, which is guided, not by the reed but by a series of pins in front of the needles and lifted and lowered along with the latter. After being lowered the needles are moved sideways the width of the figure and again lifted for the next pick. The edges of the figure are bound in this way to the ground texture by the weft.

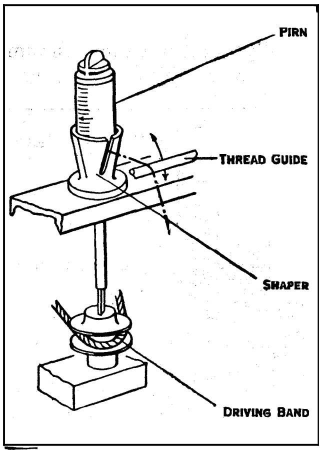


FIG. 31.—PIRN WINDING MACHINE, FOR WINDING COLOURED, AND SOMETIMES GREY, WEFT YARNS ON PIRNS FOR THE LOOM SHUTTLE

Preparing Warp and Weft for Weaving. — The power loom is only one of a series of machines which revolutionized weaving. Although early inventors of the power loom did much to perfect its various movements, the commercial results were disappointing> chiefly because means had not been devised for preparing warp and weft in a suitable manner for such a machine. William Radcliffe, of Stockport, perceived these shortcomings, and concluded that, by division of labour, weaving could be brought into line with spinning machinery, then recently invented. He therefore set himself the task of solving the problems involved, and by inventing the beam warper, the dressing sizing machine, the shuttle tongue, and the pin cop, he enabled the power loom to become a factor in the textile industry.

Weft yarns invariably receive simpler treatment than warp yarns; in many cases none at all. Cops and ring spools pass direct to the loom unless their dimensions are unsuited to the shuttles, in which case they, together with wefts bleached or dyed in hanks or used in a saturated condition, require winding upon pirns, or into cops of suitable sizes. Weft for use with automatic weft supply mechanism is frequently re-wound on to pirns, which hold much more than the cops or ring spools. This reduces the number of changes, lengthens the life of the changing mechanism and makes less work for the magazine fillers.

Pirn winders differ greatly in construction but a common type is illustrated in fig. 31. The spindles are driven at constant speed and the pirn is built up by the accumulation of yarn inside the shaper cup. The rubbing of the yarn against the cup is a disadvantage, and many winders have shapers which reduce rubbing to a minimum. These machines generally have horizontal spindles, running at constant speed, but often the speed is varied to keep constant rate of winding on to the varying diameter of the pirn.

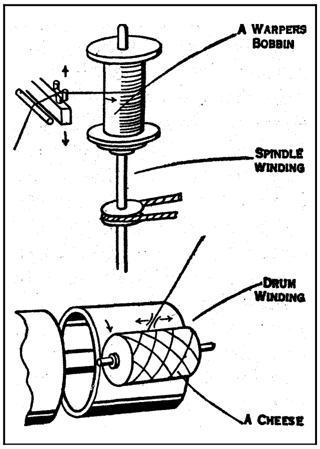


FIG. 32.— DIAGRAM OF WARP WINDING PROCESS

Warp winding consists in transferring yarn from cops, ring spools or hanks, either to warpers, bobbins or cheeses. Machines for this purpose are of two kinds, which are known respectively as spindle and drum winders (fig. 32). In the former each bobbin is placed upon a vertical spindle and rotated by frictional contact; a yarn guider meanwhile rises and falls far enough to lay the threads in even coils between the bobbin flanges. In the latter each bobbin, or tube, is laid upon a rotating drum and a thread guide moves laterally to and fro, slowly for a bobbin but quickly for a tube.

Warping. — Number of longitudinal threads in a web varies according to their closeness and its breadth. It is the function of a warper to provide a sufficient number of parallel threads for a web, all of equal length, and to retain their parallelism. Warpers are of three types, viz., mill, beam and sectional.

Mill *warping* (fig. 33) is the oldest type now in extensive use. A mill warper has a creel in which from 50 to upwards of 300 bobbins or cheeses are supported horizontally upon pegs, and the mill has a vertical axis which carries a reel from 5 to upwards of 20yd.

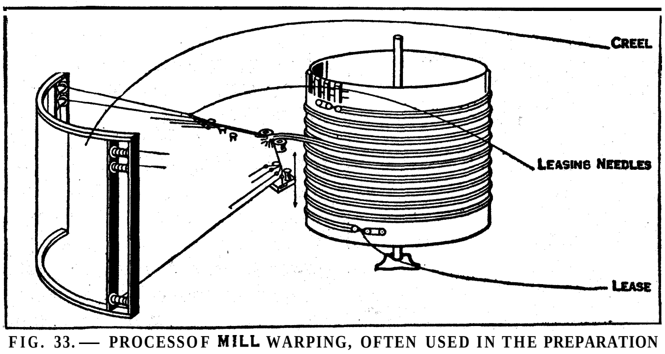


FIG. 33.— PROCESS OF MILL WARPING, OFTEN USED IN THE PREPARATION OF STRIPED COLOURED WARPS

in circumference. The threads from the creel are threaded in succession through leasing needles, then passed in groups of four to 20 threads between runners, and finally fastened by a peg to the mill staves. The needles are mounted alternately in two frames which may be lifted separately, one to elevate odd threads, the other even ones, and both separations thus formed are retained upon separate pegs; this is the lease which enables a weaver to fix readily the position of a broken thread. As the mill rotates the threads form a tape about 1in. wide, and the leasing appsratus slides down a post to coil the threads spirally upon the reel. When the full length of warp has been made the mill is stopped, a lease known as a half-beer lease is picked by hand from the divisions formed by the runners and is also retained upon pegs. The mill next reverses its direction of rotation, and as the leasing apparatus ascends the threads are folded back upon themselves. Hence, if a reel is 20yd. in circumference, and 200 threads are in use to make a warp 600yd. long, and containing 2,000 threads, the reel will

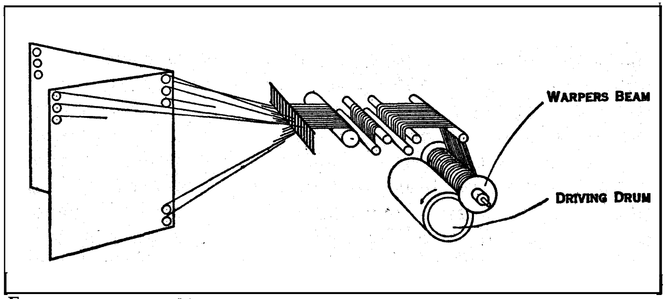


FIG. 34.— BEAM WARPING MACHINE. THE USUAL PROCESS FOR PREPARING THE WARP YARN FOR THE SLACKER SIZING MACHINE

make 30 revolutions (600÷20=30) and ten reversals, for at each reversal 200 additional threads will be added (2,000÷200=10).

Beam *warping* is the system most extensively used in the cotton trade. The creels for these machines have an average, capacity of about 600 bobbins, and are often V-shaped in plan. In each leg of the V the bobbins are arranged in tiers of 16 to 20, and row behind row. The threads are drawn separately between the dents of an adjustable reed, then under and over a series of rollers; from here they are dropped amongst the teeth of an adjustable comb and led down to a warper's beam, which rests upon the surface of a drum. As the drum rotates the threads are drawn from the bobbins and wrapped in even coils upon the beam. On most of these machines mechanism is attached for arresting motion on the breaking of a thread, and also for accurately measuring and recording the lengths of warp made. When full, a warpers beam holds threads of much greater length than are needed for any warp, but they are insufficient in number. Thus, if 500 threads are in use, and warps of the above-named particulars are required, four similar beams must be filled (2,000÷500=4) and the threads from all are subsequently united. The chief parts of a beam warper may be used as a substitute for a mill warper, provided that mechanism be employed to contract the threads to the form of a loose rope and coil them into a cylindrical ball, which will be subsequently treated as a mill warp. Or, one of these warpers may be furnished with parts which link the roped threads loosely into a chain.

Sectional warping is chiefly employed for coloured threads and its outstanding features consist in contracting the threads to form a ribbon of from 3in. to 12in. wide. This ribbon is coiled upon a block placed between flanges, and when completed is set aside until a sufficient number of similar sections have been made; after which they are slipped upon a shaft and by endlong pressure converted into a compact mass. All the threads are then collected and transferred in the form of a sheet to a loom beam, each section contributing its own width to that of the warp. Sectional warps are also made upon horizontal mills by superposing the coils of a ribbon of yarn upon a portion of the staves. When the first section is formed a second is wound against it, and the operation continued until all the sections have been made; after which the yam is run upon a loom beam.

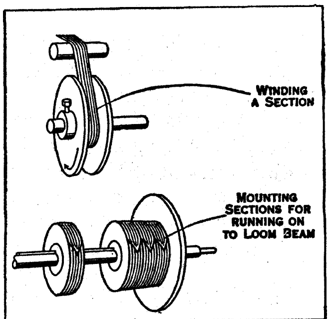


FIG. 35.—SECTION WARPING, SHOWING WARP YARN WOUND INTO SECTIONS (TOP), AND SECTIONS MOUNTED SIDE BY SIDE TO RUN YARN OFF ON LOOM BEAM (BOTTOM)

Yorkshire Dressing and Scotch Dressing — These systems are used to make striped warps from balled warps which have been dyed in different colours. The operation of Yorkshire dressing is as follows: The requisite number of threads of any colour is split from a uniformly dyed ball and set aside until warps of the remaining colours have been similarly treated. The split sections from the several balls collectively contain as many threads as are needed for a warp, but those threads have still to be placed in their proper sequence. This is done by drawing them in groups of two or four between the dents of a reed to a predetermined colour-scheme, then all are attached to a loom beam which is supported in a frame. The beam is rotated and winds the threads upon itself, but in order to hold the threads taut they are passed between weighted rollers and deflected by bars arranged ladder-wise, whilst in passing from one part of the machine to another they are gradually opened out to the width of the beam. Scotch dressing is an alternative system of making striped warps from dyed balled warps. Here, instead of being taken direct to the dressing frame, the required number of threads of each colour are first wound on to a beam. The threads from these differently coloured beams are then combined at the dressing frame and wound on to the loom beam according to the colour pattern, the yarn being wound on under considerable tension and the beam consolidated by a presser roller. This method gives a firmer beam than Yorkshire dressing, and the system is well suited to the preparation of several similar loom beams which can all be run from one set of coloured beams.

Sizing.—In cases where single yarns are made from short fibrous materials, smooth surfaces are obtained by laying outstanding ends of fibres upon the thread and fastening the fibres together to impart sufficient strength to resist the strains of weaving. This is accomplished either by coating the threads or by saturating them with an adhesive paste. In hand-loom days the paste was applied by brushes to successive stretches of warp while in a loom. But with the advent of mechanical weaving it was found necessary to size a warp before placing it in a loom. Two systems were evolved. One, invented by William Radcliffe, sizes, dries and beams a warp in one operation, the yarn being made to pass in the form of a sheet between a pair of rollers, the lower one being partly immersed in warm size. This roller carries upon its surface a film of size which it deposits upon the threads, while, by pressure, the upper roller distributes the size evenly, Brushes, acting automatically, smooth down the loose fibres and complete the distribution of size. As the yarn advances it is separated by reeds and lease rods, so that in passing over steam-chests and fans the moisture contained in the threads may be quickly evaporated. This machine is a duplex one, for the warpers beams are divided into two sets and placed at opposite ends of the machine, both sets receiving similar treatment as they move to the centre, where the loom beam is placed.

While efforts were being made to perfect Radcliffe's dressing machine a system of sizing ball warps was being gradually evolved and this system is still largely employed. The machine consists of a long trough, inside which a series of rollers are fitted, either in one horizontal plane or alternately in two horizontal planes, whilst over the front of the trough a pair of squeezing rollers are mounted. The trough contains size, which is maintained at a boiling temperature and in sufficient quantity to submerge the rollers. Two warps, in the form of loose tapes, may be simultaneously led over, under and between the rollers. As the warps advance, the threads become saturated with size, and the squeezing rollers press out all but a predetermined percentage, the latter being regulated by varying the pressure of the upper roller upon the lower one If more size be required than can be put into the threads during one passage through the machine, they may be similarly treated a second time. This process does not lay all the loose fibres, but the threads remain elastic. After sizing, the warps are passed round a set of steam-heated cylinders by which the moisture contained in the threads is evaporated; they are next either reballed or wound upon a loom beam.

For sizing cotton yarns Radcliffe's dressing machine has to a large extent been displaced by the slasher, but in some branches of the textile industry it is still retained under various modifications. In a slasher the threads from a number of warping beams are first combined into one sheet, then plunged into a trough filled with size which is kept at a boiling temperature by perforated steam pipes. The threads are next squeezed between two pairs of rollers mounted in the trough. The under surfaces of the sizing rollers are in the size, and the upper squeezing rollers, which are covered with flannel, rest by gravitation upon the lower ones. On leaving the size trough the sheet of yarn almost encircles two steam-heated cylinders which quickly expel moisture

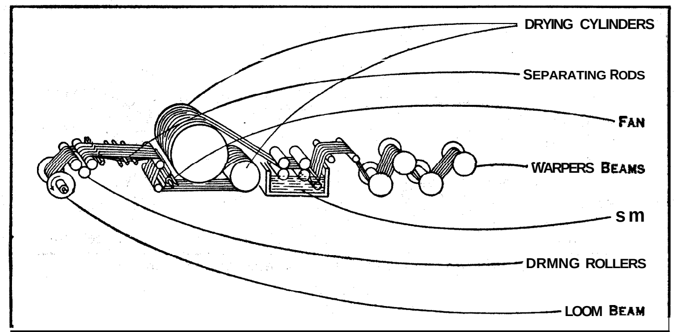


FIG. 36 —SLASHER SIZING MACHINE, FOR APPLYING SIZE TO THE WARP YARN AND FOR WINDING IT ON THE LOOM BEAM, ESPECIALLY IF CLOTH IS TO BE GREY OR ALL OF ONE COLOUR

from the yarn, but so much heat is retained that fans have to be employed to throw cool air amongst the threads. The yarn is next measured, passed above and below rods which separate threads that have been fastened together by size, smeared with piece marks, and coiled upon a loom beam.

Hank sizing is chiefly, but not exclusively, employed for bleached and coloured yarns. Machines for doing this work consist of a tank which contains size, flanged revolving rollers and two hooks. One hook is made to rotate a definite number of times in one direction, then an equal number the reverse way; the other has a weight suspended from its outer end and can be made to slide in and out. Size in the tank is kept at the required temperature by steam pipes, and "doles" of hanks are suspended from the rollers with about one-third their length immersed in size. As the hanks rotate all parts of the yarn enter the size, and when sufficiently treated they are removed from the rollers to the hooks where they are twisted to cause the size to penetrate the yarn and to wring out excess size. If sufficient size has not been added by one treatment, the wrung-out hanks are passed to a similar machine containing paste of greater density than the first and are treated a second time; if necessary this may be followed by a third passage. On the completion of sizing the hanks are removed either to a drying stove or a drying machine.

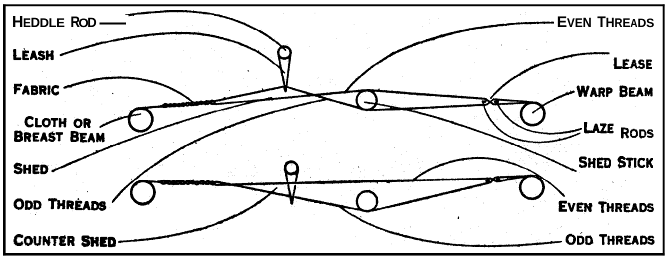
Drawing-in, or *entering,* is the operation of passing warp threads through the eyes of a shedding harness, in a sequence determined by the nature of the pattern to be produced, and the order of lifting the several parts. It is effected by passing a hook through each harness eye in succession, and each time a thread is placed in the hook by an attendant it is drawn into an eye by the withdrawal of the hook. The operation is generally done by hand, but for the simpler cloths, and particularly for repetition work, mechanical drawing-in is often used.

Twisting consists in twisting, between the finger and thumb, the ends of a new warp separately upon those of an old one, the remains of which are still in the eyes of the shedding harness. The twisted portions adhere sufficiently to permit of all being drawn through the eyes simultaneously.

BIBLIOGRAPHY.—For fabric structure and designing *see* T. Woodhouse and T. Milne, *Textile Design, Pure and Applied* (1912); W. Watson, *Advanced Textile Design* (1913) and *Textile Design and Colour* (1921); H. Nisbet, *Grammar of Textile Design* (1919). For weaving machinery *see* F. Bradbury, *Jacquard Mechanism and Harness Mounting* (Halifax, 1912); T. Woodhouse and T. Milne, *Jute and Linen Weaving* (1914); T. W. Fox, *Mechanzsm of Weaving* (5th ed. 1922). For preparatory processes *see* H. Nesbit, *Preliminary Operations of Weaving* (vol. i. 1914; vol. ii., 1924); P. Bean, *Chemistry and Practice of Sizing* (Manchester, 10th ed. 1921). *See* also F. Bradbury, *Carpet Manufacture* (Halifax, 1904); L. Hooper, *Weaving for Beginners* (1920) and *Weaving with Small Appliances* (1922). (T. W. F.: W. A. H.)

PRIMITIVE

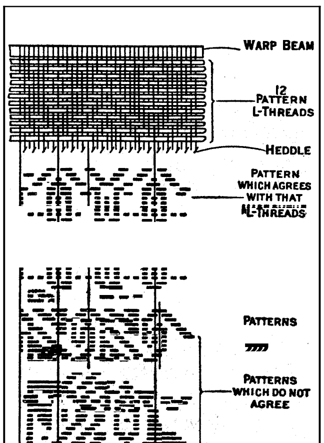
True weaving consists "of the interlacing at right angles by one series of filaments or threads, known as the *weft* or *woof,* of another series known as the *warp,* both being in the same plane." The *warp* threads are stretched from a *cloth-* or *breast-beam* to another beam known as the *warp-beam.* The process of weaving is then carried out by raising the odd threads, leaving the even ones



FROM ROTH, "STUDIES IN PRIMITIVE LOOMS" (ROYAL ANTHROPOLOGICAL SOCIETY)

FIG. 37

in position and passing the *woof* through the opening thus made. The odd threads are then lowered, the even ones raised, and the woof again passed between them. This is continued until the warp is full. The space between the odd and even threads when the former are raised is known as a *shed,* when the latter are raised as a *counter-shed.* The passing of the woof through either is termed *making* a *pick.* After each *pick* is made the woof is pressed home into position by a *beater-in* or *sword* usually a flat slat of wood. In some primitive looms the odd and even threads are laboriously raised by hand, but more commonly a *heddle* and *shed stick* are used. The simplest heddle consists of a bar of wood to which the odd warp threads are attached—this, the *rod heddle,* is always worked by hand. The *frame heddle* is composed of two parallel rods connected by a number of thin bars or strands, each with an eye or loop in the centre through which the odd warp threads pass (fig. 37). In Africa and Indo-China this is worked with the feet by means of treadles. The *shed stick* is a rod, usually of some thickness, which passes over the odd and under the even threads. When the heddle is not raised the thickness and weight of the shed-stick depresses the odd threads and so makes the *counter-shed* (fig. 38). *A* more efficient form of shed-stick is a lath which is set on edge to form the counter-shed. To prevent the warp threads from becoming entangled, either two slender laths are passed close to the warp-beam, one over the even and under the odd, the other over the odd and under the even threads; this prevents the warp threads from moving laterally or a *warp-spacer* is employed, *i.e.,* two parallel rods united by a number of rigid bars between which the warp-threads are passed in varying quantities. In many Indonesian and some African looms this is placed on the cloth-beam side of the heddles and serves as a *beater-in* as well. It is similar to the *reed* of a European hand-loom. An appliance which is sometimes used is the *temple,* usually a slender rod with a point at either end, inserted in the fabric horizontally close to the portion under construction, serving to keep the width of the web even. Except where the weft threads are discontinuous, as in the raffia looms of West Africa, the weft is wound upon a *spool.* The arrangement is either as on a European bobbin or the threads may pass lengthwise as on a netting needle. Where the former method is employed, the bobbin is usually encased in a shuttle, but among primitive peoples the latter is the more common. In Indonesia and Indo-China the material used in weaving is generally cotton, and this is also



FROM ROTH, "STUDIES IN PRIMITIVE LOOMS" (ROYAL ANTHROPOLOGICAL SOCIETY)

FIG. 38

widely used in Africa; but here and in the west Pacific vegetable fibre and the filaments of shredded leaves are utilized.

Variants.—Outside Africa the *horizontal loom* is most common. In this the warp beam is fixed a short distance off the ground. The cloth-beam is then either similarly fixed (as in the African specimens) or to it is fastened a girdle which passes behind the back of the weaver as she sits at work. By adjusting the position of her body she is able to regulate the tension on the warp threads. The looms of ancient Mexico and modern West Africa differ from other horizontal looms in that they lack a warp beam; instead the warp-threads are bunched together and anchored to a pole or to the ground.

The *vertical loom* is now found among primitive peoples in Africa, India and parts of North America. It was used in ancient Egypt and a special variety, with weights instead of a warp beam, in classical Greece. The African vertical loom has two varieties, that for weaving cotton and that for working raffia. They are probably related historically, possibly to the ancient Egyptian form. In them the warp-beam is the upper, the cloth-beam the lower; that is, the weaver begins his work at the bottom. A sloping loom is used by the Bushongo, wherein the warp is stretched at an angle of about 60° and the weaver sits underneath it, working from the bottom upwards.

Distribution. — The art of weaving occurs sporadically among primitive peoples. The vertical loom is found in Africa, India and among the Zuni, Navaho and kindred tribes of North America. The horizontal loom with fixed cloth-beam is mainly African; that with a back-strap is found in Farther India, Indo-China, in parts of Indonesia, Micronesia and north, central and south America, among the Ainu of Japan and in a few islands of Melanesia. In this last area its presence is almost undoubtedly due to Micronesian influence. In some islands, such as the Banks group and Santo (New Hebrides), it appears to have become a lost art, since there is evidence of its having been practised there formerly.

Sociological and Religious Aspect of **Weaving.**—Weaving is often the prerogative of one or other of the sexes. In Africa all the weavers are men, and though women may spin they are often prohibited from touching a loom. With the exception of Oceania the horizontal loom with the back-strap is worked mainly by women. Weaving may be restricted to villages or families, and among the Tangkhul Nagas of Assam, if a woman of a weaving village marries and goes to live elsewhere, she usually ceases to ply her craft. Even certain designs may be owned. In olden days in Ashanti the king appeared to hold "copyright" of all new designs, which were treated as a "tartan." Among the Sema Sagas a woman may not weave while her husband is away hunting, trading or fighting. The Ashanti hold it wrong to break or burn any part of a loom, and they therefore throw those which are past service into a stream. If a man weaver commits adultery with the wife of a weaver a sheep must be sacrificed in atonement to the loom as well as to the ancestral stools.

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WEAVING, HAND. One of the most ancient crafts, hand weaving is a method of forming a pliable plane of threads by interlacing them rectangularly. Invented in a preceramic age, it has remained essentially unchanged to this day. Even the final mechanization of the craft through introduction of power machinery has not changed the basic principle of weaving.

Other techniques had been devised to the same end: single element techniques—looping, netting, knitting, crocheting—and mul-

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, FLETCHER FUND, 1931

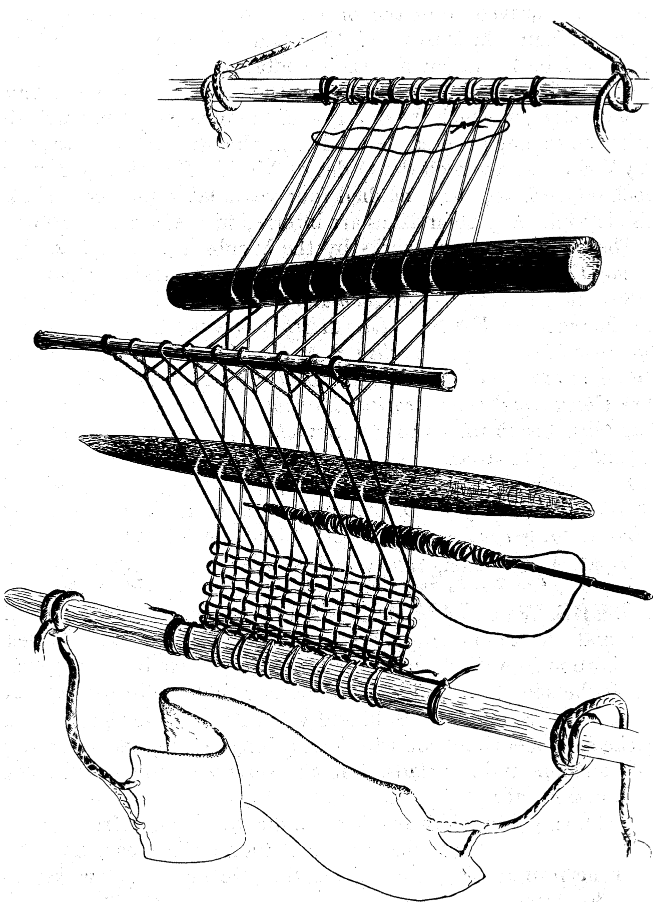
WOMEN WEAVING WOOL ON WARP-WEIGHT LOOM AS SHOWN BY A PAINTING ON LEKYTHOS (SCENT BOTTLE); ATHENIAN. ABOUT 560 B.C.

tiple element techniques—knotting, coiling, twining, braiding. In weaving, in the latter group, one system of threads, the warp, crosses another one, the weft, at right angles and the manner of intersecting forms the different weaves.

Gradually the various phases of manipulating warp and weft were mechanized until the technique of weaving surpassed all others in efficiency.

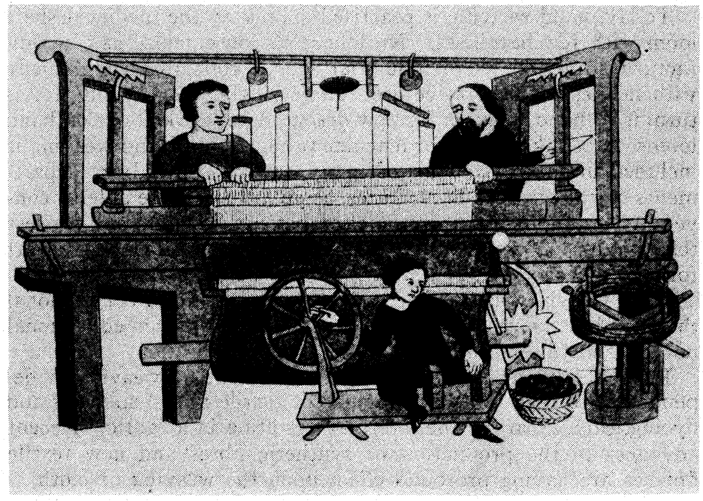
Whereas single-thread methods can be handled with few tools, weaving needs more complicated equipment since the warp has to be given tension. The device giving such tension is the loom. Weaving, then, is the process of passing the weft between taut, alternately raised warps, as in the basic plain weave, or between other combinations of selected warps, and pressing it into place.

Earliest weaving was done on the warp-weight loom where warps were suspended from an upper bar and weighted at bottom. Weaving here progressed downward, unlike other weaving. It was used in ancient Greece and, more recently, by Indians of the North Pacific American coast. Next came the two-bar loom, with warp stretched from bar to bar, or, for extended length, wound onto the bars. Used either vertically or horizontally, the warp was held taut by a framework or stakes in the ground. Early Egyptian records show weaving on such a loom which, in vertical position, is also the tapestry loom of today.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

PRE-COLUMBIAN BACK-STRAP LOOM



FROM CIBA REVIEW NO. 14, "CLOTH-MAKING IN FLANDERS" (SEPT., 1938); REPRODUCED BY COURTESY OF CIBA LIMITED, BASLE, SWITZ.

FAMILY OF FLEMISH WEAVERS USING SHAFT LOOM; FROM "BOOK OF **TRADES," YPRES, BELG.; 14TH CENTURY**

Another loom, allowing for subtly adjustable tension, therefore finer weaving, is the back-strap loom, in which the lower bar is attached to a belt around the waist of the weaver, who, leaning forward or backward can tighten or slacken the warp. This loom made possible the extraordinary textile achievements of pre-Columbian Peru and is still found in remote regions of Asia and parts of Central and South America.

The intersecting weft, crossing between raised and lowered warps, was first inserted without tool, the extra length being wound into little bundles, as today in tapestry weaving; *i.e.*, pictorial weaving. Later the weft was wound onto sticks and released as it traversed the warp. Finally, to introduce the weft faster and in greater length, it was wound on bobbins, inserted into boat-like shuttles, and thrust across the opened warp (the shed) in hand as well as in power looms.

To beat the weft into place, a weaver's sword of wood was an early instrument. Later a comblike "reed" was introduced, combining warp spacing with pounding of the weft. Suspended from the loom framework, the reed swings against the woven fabric pressing successive wefts against it.

A first device for speeding up the selection of warps between which the weft passes was the shed-rod, carrying raised warps. To raise the opposite warps, an ingenious device, called a heddle, was introduced. The warps running under the shed-rod were tied with string-loops to a second rod! the heddle-rod, and they now could be raised past those on the shed-rod with one upward motion. Later, series of heddle-rods replacing the shed-rod facilitated the production of weaves based on more complex warp operation than that demanded for the plain weave, based on the principle of opposites.

In the medieval loom the heddle-rods! now called shafts or harnesses, were suspended from the framework, similar to the pounding device, and were attached to foot treadles, as they are on hand looms today. They are still found on power looms. Though of incalculable value in saving time, this invention limited the thus far unlimited, primitive, warp selection.

To regain some of the early freedom, the highly developed draw-loom was devised. Chinese in origin, developed for elaborate pattern weaving, such as brocades and damasks, it was later adopted in Europe. It was superceded by a further mechanized warp-selection method, Jacquard weaving, still in use today, though transferred during the past century to power-driven machinery.

Among high achievements in hand weaving, Coptic as well as early Peruvian weaving must be recognized, the latter surpassing perhaps in inventiveness of weave structure, formal treatment, and use of colour, other great textile periods. In fact practically all known methods of weaving had been employed in ancient Peru, and also some types now discontinued.

Today, hand weaving is practised mainly on the medieval shaft loom with few harnesses. No longer of consequence as a manufacturing method in an industrial age, it concerns itself chiefly with fabrics for decorative use. Increasingly, though, industry is turning to hand weavers for new design ideas, worked out on hand looms, to be taken over for machine production. Hand weaving is included in the curriculum of many art schools and art departments of colleges and universities, as an art discipline able to convey understanding of the interaction between medium and process that results in form. It has survived through the ages as an art form in tapestry.

Hand weaving has also been taken up in the field of occupational therapy, having, though, as its aim there neither an educational nor an artistic end but solely that of rehabilitation.

It should be realized that the development of weaving is dependent also upon the development of textile fibres, spinning and dyeing, each a part of the interplay resulting in a fabric. Recent advances in the production of synthetic fibres and new textile finishes are having profound effect upon the weaving of cloth. (AN. A.)

WEBB, MATTHEW (1848–1883), English endurance swimmer popularly known as "Captain Webb," was the first person to swim the English channel. Born at Dawley, Shropshire, Jan. 18, 1848, he first attracted international attention when, on July 3, 1875, he swam the Thames from Blackwall pier, East London, to Gravesend, Kent (20 mi.) in 4 hr. 45 min., a record which stood for 24 years. Seven weeks later, on Aug. 24–25, he swam the channel, from Dover to Calais, in 21 hr. 45 min.

Captain Webb died on July 24, 1883, attempting to swim the whirlpool rapids below Niagara falls. *See* also SWIMMING: *Channel Swimming.* (J. D. McC.)

WEBB, PHILIP SPEAKMAN (1831–1915), British architect of the Gothic school, was born at Oxford on Jan. 12, 1831. He was educated at Aynho, Northamptonshire, and entered the office of G. E. Street, Oxford, where he met William Morris. In 1856 he set up for himself in London and after the establishment of the firm founded by Morris produced for them many designs for varied purposes. house decoration, tiles, jewelry, furniture, etc. Webb designed many country houses and one church, at Brampton, Cumberland (1875). His first house was built for William Morris (Red house, Upton, 1859). He also made additions to old houses; for example, Berkeley castle and Pusey house, Berkshire. Webb was the inventor of a method by which old buildings were strengthened by filling the interior of the walls with new material. This procedure was often used by the Society for the Protection of Ancient Buildings, which Webb and Morris jointly organized and founded in 1877. Webb died at Worth, Sussex, on April 17, 1915.

WEBB, SIDNEY JAMES, 1ST BARON PASSFIELD (1859–1947), and **BEATRICE** (née POTTER) (1858–1943), English leaders of social and economic reform, for half a century exercised far-reaching influence on the outlook of their time. Their books had world-wide circulation; the effect of their joint action was not less notable.

Sidney Webb was born on July 13, 1859, in London, of East Anglian stock. His father was an accountant; his mother carried on a hairdressing business. Educated on the continent and at the City of London and Birkbeck colleges, he left school at 16 and in 1878, after a brief period of commercial employment, won a place in the war office. Successful in a series of competitive open examinations, he passed from the clerical to the administrative grade in 1881 and spent ten years in the colonial office. In 1885 he was called to the bar; in the same year he joined the Fabian society (*q.v.*), where Bernard Shaw was a lifelong friend. His contribution to *Fabian Essays* (1889) was read by Beatrice, one of the nine daughters of Richard Potter, a wealthy and enterprising industrial magnate in Tadcaster. Born in Gloucester, Jan. 22, 1858, and privately educated, Beatrice shared her father's work, traveled widely with him and acted as his London hostess. In 1887 she entered the field of social work as assistant to her cousin Charles Booth (*q.v.*), in the inquiry published as *Life and Labour of the People in London* (17 vol., 1891–1903). At the time of her first meeting with Sidney Webb, she was engaged on *The Co-operative Movement in Great Britain* (1891). In 1892 they married. Henceforward, resources and talents were fused. Their London home—41 Grosvenor road—became a workshop for a long series of books, a hive of intellectual activity and a serious social centre of a unique kind.

Leaving the civil service in 1891, Sidney was elected, on a forthright Fabian program, as a Progressive member of the new London county council (L.C.C.). He held his seat at Deptford, with increasing majorities at each election, until he resigned in 1910. Much of his L.C.C. activity was devoted to education; he has been called the parent of London's educational system *(see* EDUCATION, HISTORY OF). The Webbs were the power behind the Balfour Education acts of 1902 and 1903; they did much to give London a teaching university; and they promoted the development of the London School of Economics. Sidney served on many royal commissions, including that of 1903–06 on trade unions; Beatrice was a member of the commission on the poor law.

Its famous minority report (1909) challenging the basis of the entire poor-law system, signed by Beatrice, was written, as usual, jointly by herself and her husband *(see* POOR LAW: *Reports of the Royal Commissions, 1909).* They organized a great crusade in favour of the minority report; its failure, at the time, brought them into party politics, hitherto eschewed. In 1913 they founded the *New Statesman;* in 1914 Sidney became a member of the war emergency committee set up by the Labour party and largely directed its domestic policies. He wrote the manifesto *Labour and the New Social Order,* on which the party fought the elections of 1918, 1922 and 1924; he was, from 1915 to 1925, a member of the party's national executive. In 1918 he stood as member of parliament for London university; in 1922 he was elected M.P. for Seaham Harbour. In the 1924 Labour government he was an adequate president of the board of trade. He resigned his seat in 1928, but in the government of 1929 he came back, under strong pressure, to be secretary of state for the colonies, with a seat in the house of lords as Baron Passfield—a title his wife never used. The name was derived from the pleasant house, Passfield Corner, in Liphook, Hampshire, to which they had retired in 1928, giving up their London home but not their contacts. In 1932 they visited the U.S.S.R. and in 1935 published their last major book, *Soviet Communism,* in which the doctrine of "gradualism," to which they had been so long devoted, seemed to be thrown over. In 1944 Sidney Webb was awarded the Order of Merit. Beatrice died in Liphook on April 30, 1943; he died four years later, on Oct. 13, 1947, also in Liphook. Their ashes are interred in Westminster abbey.

The most important works by the Webbs are: *The History of Trade Unionism* (1894; rev. ed., 1920); *Industrial Democracy* (1897; new ed., 1920); *English Local Government,* 9 vol. (1906–29; includes *English Poor Law History,* 3 vol.); *The Break-up of the Poor Law* (1909); *English Poor Law Policy* (1910); *A Constitution for the Socialist Commonwealth of Great Britain* (1920); *The Consumers' Co-operative Movement* (1921); *The Decay of Capitalist Civilization* (1923); *Soviet Communism: a New Civilisation?* (1935; 3rd ed., 1945).

Beatrice Webb also wrote *My Apprenticeship* (1926) and *Our Partnership* (ed. by B. Drake and Margaret I. Cole, 1948). Her *Diaries, 1912–1924* were also edited by Cole (1952).

See M. A. Hamilton, *Sidney and Beatrice Webb* (1933); M. I. P. Cole (ed.), *The Webbs and Their Work* (1949). (M. A. H.; X.)

WEBB, WILLIAM HENRY (1816–1899), U.S. naval architect and the leading shipbuilder in New York for over 30 years, was born in New York city on June 19, 1816. He began shipbuilding at the age of 20, and by 1869 he had built more tonnage than any other U.S. builder. Bold and versatile in his designs, he built packets, clippers and side-wheelers, sailing vessels and steamships, wooden ships and ironclads. He also built war vessels for Russia, Italy and France.

Webb closed his shipyard in 1869, due to the shift from wood to iron construction, but continued his shipping interests until 1872 when he retired because of ill-health. He died in New York on Oct. 30, 1899.

Webb's most permanent and important contribution was the founding, building and endowing of Webb Institute of Naval Architecture at Glen Cove, N.Y., in 1889. (F. E. HA.)

WEBER, ALBRECHT (1825–1901), German orientalist, one of the most outstanding Sanskrit scholars of his generation, who contributed greatly to the development of European knowledge in ancient Indian studies, was born at Breslau on Feb. 17, 1825. In 1856 he was appointed teacher of Sanskrit at the University of Berlin and in 1867 he became professor of ancient Indian languages and literature, which appointment he held until his death in Berlin on Nov. 30, 1901. It was chiefly in the field of Vedic literature, especially in the old Vedic ritual texts, that he excelled as a scholar. He contributed largely to the Vedic portions of the great Sanskrit dictionary of O. von Bohtlingk and R. Roth. Although his principal work was on Sanskrit, he also took a keen interest in Prakrit: his edition of the Prakrit poems ascribed to Hala and his study of the Jaina Prakrit manuscripts in the Berlin Royal library are his most important works in this field.

Among Weber's important publications are: *White Yajurveda* (1849–59); *Akademische Vorlesungen über indische Literaturgeschichte* (1852); *Indische Studien* (1849–98), a review which Weber started and edited and to which he largely contributed; and *Verzeichnis der Sanskrithandschriften der kgl. Bibliothek zu Berlin* (1853–92). (J. BR.)

WEBER, CARL MARIA FRIEDRICH ERNEST VON (1786–1826), German composer, was born at Eutin, near Lubeck, on Dec. 18, 1786, of a family long devoted to art. His father, Baron Franz Anton von Weber, a military officer in the service of the palgrave Karl Theodor, was an excellent violinist, and his mother once sang on the stage. In 1778 Franz Anton was appointed director of the opera at Liibeck. In 1779 the prince-bishop of Eutin made him his *Kapellmeister,* and five years later he went to Vienna. placed two of his sons under Michael Haydn, and in 1785 married the young Viennese singer Genovefa von Brenner. In the following year Carl Maria was born—a delicate child, afflicted with congenital disease of the hipjoint.

Carl Maria von Weber became familiarized with the stage from his earliest infancy. Franz Anton hoped to see him develop into an infant prodigy, like his cousin Mozart. The child was taught to sing and place his fingers upon the pianoforte almost as soon as he could speak, though he was unable to walk until he was four years old. Happily his powers of observation and aptitude for general learning were so precocious that he seems, in spite of all these disadvantages, to have instinctively educated himself. In 1798 Michael Haydn taught him gratuitously at Salzburg. In April the family visited Vienna, moving in the autumn to Munich. There the child's first composition—a set of "Six Fughettas"—was published, with a pompous dedication to his half-brother Edmund; and there also he took lessons in singing and in composition. Soon afterward he began to play successfully in public, and his father compelled him to write incessantly. Among the compositions of this period were a mass and an opera—Die *Macht der Liebe und des Weins*—now destroyed. A set of "Variations for the Pianoforte," composed a little later, was lithographed by Carl Maria himself, under the guidance of Alois Senefelder, the inventor of the process. In 1800 the family moved to Freiburg. where Ritter von Steinsberg gave Carl Maria the libretto of an opera. *Das Waldmädchen,* which the boy (not yet 14) at once set to music, and produced in the following November at Freiburg.

Carl Maria returned with his father to Salzburg in 1801, resuming his studies under Michael Haydn. There he composed his second opera, *Peter Schmoll und seine Nachbarn,* which was unsuccessfully produced at Nuremberg in 1803. In that year he again visited Vienna, where, though Joseph Haydn and Albrechtsberger were both receiving pupils, his father preferred placing him under Abt Vogler. Through Vogler's instrumentality Carl Maria was appointed conductor of the opera at Breslau, before he had completed his eighteenth year. He began a new opera called *Riibezahl,* the libretto of which was "romantic" to the last degree, and Weber worked at it enthusiastically, but it mas never completed, and little of it has been preserved beyond a quintet and the masterly overture, which was rewritten in 1811 under the title of *Der Beherrschcr der Geister.* Quitting Breslau in 1806, Weber removed in the following year to Stuttgart, where he had been offered the post of private secretary to Duke Ludwig, brother of Frederick. king of Wiirttemberg. He worked hard, and in 1809 remodeled *Das Waldmadchen,* under the title of *Sylvana.* Weber removed to Darmstadt in order to be near his old master Abt Vogler. and his fellow-pupils Meyerbeer and Gänsbacher. On Sept. 16. 1810, he reproduced *Sylvana* at Frankfort, but with very doubtful success. His new comic opera *Abu Hassan* was completed at Darmstadt in January 1811.

Weber started in February 1811 on an extended artistic tour, during which he made many influential friends, and on June 4 brought out *Abu Hassan* with marked success at Munich. His father died at Mannheim in 1812. In 1813 Carl Weber's wanderings were brought to an end by the unexpected offer of an appointment as *Kapellmeister* at Prague, coupled with the duty of entirely remodeling the performances at the opera house. He retained this post till 1816. He composed no new operas. but he had already written much of his best pianoforte music, and played it with never-failing success, while the disturbed state of Europe inspired him with some of the finest patriotic melodies in existence. First among these stand ten songs from Körner's *Leyer und Schwerdt,* including "Vater. ich rufe dich," and "Lützow's wilde Jagd"; and in no respect inferior to these are the splendid choruses in his cantata *Kampf und Sieg,* which was first performed at Prague. on Dec. 22. 1815.

Weber resigned his office at Prague on Sept. 30, 1816. and on Dec. 21, Frederick Augustus, king of Saxony, appointed him *Kapellmeister* at the German opera at Dresden. Weber had previously meditated turning *Der Freischiitz* into an opera, and, with the assistance of Friedrich Kind, he produced an admirable libretto, under the title of *Des Jagers Braut.* He had dealt with the supernatural in *Riibezahl,* and in *Sylvana* with the pomp and circumstance of chivalry; but the shadowy impersonations in *Riibezahl* are scarcely less human than the heroine who invokes them; and the music of *Sylvana* might easily have been adapted to a story of the 19th century. But Weber now knew better than to let the fiend in *Der Freischiitz* sing; with three soft strokes of a drum below an unchanging dismal chord he brings him straight to us from the nether world

Weber wrote the first note of the music of *Der Freischiitz* on July a—beginning with the duet which opens the second act. But nearly three years elapsed before the piece was completed. In the meantime the performances at the opera house were no less successfully remodeled at Dresden than they had already been at Prague, though the work of reformation was far more difficult. Having, after much difficulty, broken off his liaison with Margarethe Land, Weber married the singer Carolina Brandt, a consummate artist. The new opera was completed on May 13, 1820. He had engaged to compose the music to Wolff's gypsy drama, *Preciosa.* Two months later this also was finished, and both pieces ready for the stage.

It had been arranged that both *Preciosa* and *Der Freischütz*—no longer known by its original title, *Des Jagers* Braut—should be produced at Berlin. *Preciosa* was produced with great success at the old Berlin opera house on June 14, 1821. On June 18, the anniversary of the battle of Waterloo, the opening of the new *Schauspielhaus* was celebrated by the production of *Der Freischütz.* Its success was triumphant, and it was received with equal enthusiasm at Vienna on Oct. 3 and at Dresden on Jan. 26, 1822. Yet Weber's position as *Kapellmeister* was not much improved by his success. For his next opera Weber accepted a libretto based, by Frau Wilhelmine von Chezy, on the story of *Euryanthe,* as originally told in the 13th century, in Gilbert de Montreuil's *Roman de la Violette,* and repeated with alterations in the *Decameron,* in Shakespeare's *Cymbeline,* and in several later forms. The work was produced at the Karntnerthor theatre in Vienna, on Oct. 25. 1823. and received with enthusiasm.

Weber's third and last dramatic masterpiece was an English opera. written for Covent Garden theatre. upon a libretto adapted by Planché from Wieland's *Oberon.* It was disfigured by the spoken dialogue abandoned in *Euryanthe;* but in musical beauty it is quite equal to it, while its fairies and mermaids are as vividly real as the spectres in *Der Freischiitz.* Though dying of tuberculosis Weber began to compose the music on Jan. 23, 1825. Charles Kemble had offered him £1,000 for the work, and he could not affordto rest. He finished the overture in London, at the house of Sir George Smart, soon after his arrival, in March 1826; and on April *12*, the work was produced with triumphant success. Weber was found dead in his bed on the morning of June 5, 1826. Besides his three great dramatic masterpieces and the other works already mentioned, Weber wrote two masses, two symphonies, eight cantatas, and a large number of songs, orchestral and pianoforte pieces, and music of other kinds, amounting altogether to more than 250 compositions.

Weber's style rises, in his three greatest works, to heights which show his kinship with the great classics and the great moderns. His intellect was quick and clear; but yet finer was the force of character with which he overcame the disadvantages of his feeble health, desultory education and the mistakes of his youth. With such intellect and character, every moment of his short life was precious; and it is impossible not to regret the placing of his training in the hands of Vogler.

Weber's master was an amiable charlatan, whose weakness as a teacher was exposed, in perfect innocence, by his two illustrious pupils Meyerbeer wished to be famous as the maker of a new epoch in opera. Weber could not help being so in reality. But all his determination could not quite repair the defects of his purely musical training, and though his weaknesses are not of glaring effect in opera, still there are moments when even the stage cannot explain them away. Thus the finale of *Der Freischütz* breaks down so obviously that no one thinks of it as anything but a perfunctory minding-up of the story, though it really might have made quite a fine subject for musical treatment.

In *Euryanthe* Weber attained his full power, and his inspiration did not leave him when this work needed large musical designs. But the libretto was full of absurdities; especially in the last act, which not even nine remodelings under Weber's direction could redeem. Yet it is easy to see why it fascinated him, for, whatever may be said against it in regard to probability and literary merit, its emotional contrasts are highly musical: it is through them that the defects invite criticism.

WEBER, ERNST HEINRICH (1795–1878), German anatomist and physiologist, a pioneer in the field of psychophysiology, was born in Wittenberg. June 24, 1795, the oldest of three brothers, all of whom achieved distinction in science *(see* WEBER, WILHELM EDUARD) From 1818 until his death Weber held a chair at Leipzig. Though he conducted many investigations on the internal organs, he is known chiefly for his work on touch, a field in which he conducted many original experiments and published two books: *De tactu: annotationices et physiologicae* (1834); and *Der Tastsinn und das Gemeingefühl,* first as a section of Rudolf Wagner's *Handwörterbuch der Physiologie* (1846) and later as a separate book (1851). Weber died in Leipzig on Jan. 26, 1878.

Weber's experiments on cutaneous localization and the two-point threshold led to his theory of sensory circles—small regions of common innervation that are projected upon the brain—a forerunner of R H Lotze's theory of local sign and of the doctrine of isomorphism of Gestalt psychology

From the localization of touch Weber went to the localization of sound. but these experiments attracted little attention. His measurement of sensibility—the just noticeable difference between sensations—might also have been neglected had his results not attracted the attention of G. T Fechner (*q.v*), who made them the basis of psychophysics Weber discovered the principle that ratios. not absolute differences, are required for the discrimination of least perceptible differences. Fechner saw the significance of these results for his own theory, gave mathematical form to the empirical relationship and called the formulation Weber's law. (K. M. D.)

WEBER, MAX (1864–1920), influential German sociologist and political economist, was born at Erfurt on April 21, 1864, and died in Munich on June 14. 1920. He was a professor at the universities of Berlin (1893), Freiburg (1894), Heidelberg (1897) and Munich (1919). As a student of legal and economic history, his first important work in this field was *Dze romische Agrargeschichte in ihrer Bedeutung fur das Staats- und Privatrecht* (1891). Later he turned to the study of sociology; the main challenge to his mind was the Marxist idea of economic determinism. In a thorough historical study *Die protestantische Ethik und der Geist des Kapitelismus* (1904–05; Eng. trans.. *The Protestant Ethic and the Spirit of Capitalism,* 1930), he tried to prove that, in this case at least, religious and ethical ideas were of overwhelming significance. The problem of historical causation developed into an even broader question: in view of the failure of other cultures to produce a capitalized economy. what factor in the spiritual history of the western world is responsible for capitalism? *(See* CAPITALISM) Weber found an answer only by thoroughly studying the religious and social history of India, China and the Jews His results were published in three volumes, *Gesammelte Aufsatze zur Religionssoziologie* (1920–21; Eng. trans., "The Religions of the East Series," 1952–58) His *Wirtschaft* und *Gesellschaft* (1921; Eng. trans.. *On Law in Economy and Society,* 1954) is a systematic presentation of the sociological factors (economic and noneconomic) that shaped history—a grandiose attempt to show that world history lends itself to systematic treatment. *(See* ECONOMICS: *The Critical Schools.)* In his contribution to scientific methodology, *Gesammelte Aufsatze zur Wissenschaftslehre* (1922; Eng. trans.. *Methodology of the Social Sciences,* 1949), Weber argued that human studies are different in nature from science because sympathetic understanding *(Verstchen)* and valuations play a decisive role, and the elaboration of the typical leads to the creation of specific concepts (*Idealtypus*). The great political thinker of the Weimar republic, he was a firm believer in the democratic ideals of the west.

Weber also wrote *Gesammelte Aufsatze zur Sozial- und Wirtschaftsgeschichte* (1924; Eng trans., *Theory of Social and Economic Organization,* 1947); *Gesammelte Aufsätze zur Soziologie und Sozialpolitik* (1924); *Gesammelte politische Schriften* (1921); *Wirtschaftsgeschichte* (lecture notes), ed by S. Hellman and M Palyi (1923; Eng trans., 1927). *From Max Weber: Essays in Sociology* was translated and edited by Hans H. Gerth and C. Wright Mills (1946).

See Marianne Weber, *Max* Weber: *ein* Lebensbild (1926), with a full bibliography (K. MM.)

WEBER, WILHELM EDUARD (1804–1891), German physicist noted for his contributions to the study of electricity and electromagnetism, was born at Wittenberg on Oct 24, 1804, a younger brother of Ernst Heinrich Weber, author of Weber's law. He studied at Halle and Gottingen, was one of the seven professors who were expelled for protesting against the action of the king of Hanover (Ernest Augustus, the duke of Cumberland) in suspending the constitution (1837). He was professor at Leipzig (1843) and in 1849 returned as professor at Göttingen.

There was at that time no system either of stating or measuring electrical quantities; but Weber showed, as his colleague C. F. Gauss did for magnetic quantities, that it is both theoretically and practically possible to define them, not merely by reference to other arbitrary quantities of the same kind, but in terms in which the units of length. time and mass are involved. Weber's theory of electricity was founded on the views of Gustav T Fechner, who considered that positive and negative charges move in a conductor with equal and opposite velocities. From this he worked out the law of forces between charges. Weber's work on electricity did much to stimulate mathematical physicists. He also carried on extensive researches in the theory of magnetism and developed Michael Faraday's ideas regarding the explanation of diamagnetic phenomena. In his observations in terrestrial magnetism he not only employed an early form of mirror galvanometer but, about 1833. devised a system of electromagnetic telegraphy, by which a distance of about 9,000 ft. was worked over. In conjunction with his brother Ernst h e published in 1825 a well-know: treatise on waves, *Die Wellenlehre auf Experimente gegründet;* and in 1836 he collaborated with his younger brother. the physiologist Eduard Friedrich Weber (1806–71), in an investigation into the mechanism of walking.

He died at Gottingen on June 23, 1891.

WEBER AND FIELDS, U.S comedians and theatrical managers. JOSEPH M. WEBER was born Aug. 11,1867, and LEW (Lewis Maurice) FIELDS, Jan. 1, 1867, both in New York city. In 1877 they made their first appearance in public, enacting together a juvenile sketch. They perfected their comedy teamwork over the next eight years, appearing chiefly in Dutch sketches. In 1885 they formed their own company and ten years later took over management of the Broadway Music hall, which thereafter was popularly called "the Weber and Fields." Their shows consisted chiefly of informal song, dance and comedy routines; and their burlesques of popular plays of the period, under such titles as *The Great Decide* and *Without the Law*, were featured. In 1904 Fields left the partnership and opened Fields' theatre. The team reunited in 1912 to produce *Hokey-Pokey* at the Broadway theatre, which Weber had continued to manage. Fields died in Los Angeles, Calif., July 20, 1941; Weber, May 10, 1942, also in Los Angeles. (S. W. H.)

WEBERN, ANTON (1883–1945), Austrian composer, was born in Vienna on Dec. 3, 1883. He studied at Vienna university, taking the degree of Ph.D. in musicology, and was one of the first disciples of Arnold Schönberg, whose principles he adopted in his own works. In concentration and intensity he even exceeds Schönberg, and fragmentariness and almost complete absence of tangible melody or effective rhythm are characteristics of his later compositions. A typical feature is his use of pianissimo. Webern died on Sept. 15,1945, near Salzburg.

His works include: choral cantatas; two string quartets, op. 5 and 9; pieces for violin and piano, op. 7; *passacaglia,* symphony and variations for orchestra; *Geistliche Lieder* for soprano with five instruments, op. 17; other vocal and instrumental chamber music; and five sets of songs.

WEBER'S LAW: *see* PSYCHOPHYSICAL METHODS.

WEBSTER, DANIEL (1782–1852), American statesman and lawyer, was born in Salisbury (area now in Franklin), N.H., Jan. 18, 1782. His parents were rugged New England farming people. Daniel was the delicate one of the family, and not particularly inclined to farm work. From childhood, however, he loved out-of-door life, was exceedingly fond of hunting and fishing, and unusually skilful at them, and this taste, which became strong in his youth, clung to him through all his long career.

His early schooling was primitive. But he had a passion for books of all sorts. Bits of the poets and illustrations from the great historians were always ready to his hand when he needed them and came out with singular appropriateness in later years. It has been urged that he was indolent. So was Sir Walter Scott. But Scott could do more work in a day than other men in a week; and so could Webster. His mind seized the essence of things.

These intellectual gifts were so manifest that Webster's father made great sacrifices to send the boy to Phillips academy, Exeter, and then to Dartmouth college. His college record was good, but not remarkable; like many men of genius, he preferred other things to the appointed task. It is said that in early days he was reluctant to speak in public, but toward the end of his college career he was known as something of an orator and debater, and when he was 18, a year before his graduation in 1801, he was invited to deliver the Fourth of July address for the town of Hanover. Some of these early speeches have been preserved, and while crude, they suggest what was to come.

With a mind like Webster's the law seemed the inevitable vocation, and the little teaching he did was merely a means to an end. As was the custom in those days, he went into the office of a practising lawyer in Boston, and the invaluable training of Christopher Gore no doubt went far in making his pupil the great lawyer that he afterwards became. He was admitted to the bar in 1805, and in 1807 settled himself to practise in Portsmouth. His reputation in law is quite as great as, perhaps more unclouded than, in statesmanship. His clear, massive, gorgeous, overwhelming eloquence carried juries with him as well as parliaments, and no estimate of his eloquence is complete that does not allow for the superb personality that gave it weight and vigour. He was a notable presence, even to those who passed him unknown in the street. The dignity of his solid figure, the rich and varied music of his voice, above all the penetrating splendour of his eyes, gave his spoken words a glory which we cannot recover, effective as his speeches often are in print. Of his jury triumphs the best known is that in the White murder case. His most celebrated plea before the Supreme Court in Washington is that for Dartmouth college, in 1818, when the personal touches, notably, "It is, as I have said, a small college, and yet there are those who love it," so affected all present that it was said of Chief Justice Marshall that "the deep furrows of his cheek expanded with emotion and his eyes suffused with tears."

Party passions, together with the power of his tongue, naturally took Webster into politics. It is said that even in childhood he began to study the Constitution as printed on a cotton handkerchief. From 1813 to 1817 he was a member of the House of Representatives. New England at that time was bitterly opposed to the Madison Administration, to the Democratic Party, and especially to the war with England, and Webster's eloquence was used unsparingly to express these New England prejudices, though he cannot be connected with the more or less disloyal Hartford Convention. At this early period, in curious contrast to his later views and arguments, he was hostile to a protective tariff, feeling that it would complete the ruin of the New England shipping interests, already sufficiently imperilled by the cost of the war.

While he was out of politics, from 1817 to 1823, Webster devoted himself energetically and profitably to the practise of law. During these years he was making his great reputation as a historical orator. In 1820 he delivered the bi-centennial speech at Plymouth, celebrating the landing of the Pilgrims, and it is probable that in the line of general eloquence he never reached a greater height than this. The significance of America, the political, social and religious principles that America stood for, and the splendid development and prospects of the Anglo-Saxon race, were portrayed with a dignity and amplitude which good judges consider worthy to be compared with Demosthenes or Burke. Webster's impressive delivery, his intense, magnetic hold upon his audience, were never more fully manifested than upon this occasion. Ticknor, who was present, gives a vivid account of his own experience: "I was never so excited by public speaking before in my life. Three or four times I thought my temples would burst with the gush of blood. . . . When I came out I was almost afraid to come near to him. It seemed to me as if he was like the mount that might not be touched and that burned with fire. I was beside myself, and am so still." The address delivered on the anniversary of the battle of Bunker Hill, in 1825, was another of these historical tributes, equally successful and well known. On Aug. 2, 1826, Webster gave, in Faneuil hall, Boston, the eulogy on John Adams and Thomas Jefferson, who had both died on the Fourth of July previous. This speech contains the famous words, attributed to John Adams, "Sink or swim, live or die," etc., which have probably been repeated in school declamations as often as any piece of rhetoric in the English language. In 1823 Webster again appeared in the House of Representatives, and in 1827 in the Senate, in which he was to play so great a part for many years. The Missouri Compromise (*q.v.*) of 1820 had for the time apparently settled the question of slavery, but in reality the rift between the two sections of the country had been opened, and it was not ever really to be closed again until after the Civil War.

Webster's position with regard to slavery was taken at this time, and in spite of his conduct in later years, it cannot be said that his theoretical attitude was ever altered. He believed, as did so many good men and leaders, both North and South, that slavery was an evil, disastrous to the white race as much as to the black. The earlier great men of the South in the main held this view, and it was left for Calhoun and Jefferson Davis, under the controlling influence of cotton, to discover that the enslavement of the blacks was ordained by God for the benefit of everybody. But Webster believed first of all in the Constitution. The Constitution recognized slavery, and therefore it was impossible to meddle with it, except to see that its increase and spread were discouraged by every means that the Constitution would permit.

On the other sectional issue, that of the tariff, which some persons consider even more vital than slavery, inasmuch as it meant the growing triumph of the industrial North over the agricultural South, Webster was more aggressive, and distinctly advocated the high protection which the Southern leaders felt to be fatal to their prosperity. But above all Webster ranged himself on the side of those who opposed sectional division and disunion tendencies altogether. In 1830 a comparatively minor debate as to the public lands brought on the Southern attack upon New England, and Webster, in defending his native state, replied to Hayne with the, glorification of the Union, which probably did more to unify the country than any single utterance of any man. Hayne and his followers often had the technical interpretation of the Constitution on their side, but Webster had common sense behind him, he was himself the incarnation of common sense, and he gave the common sense of a united country a superb, an enduring dignity of expression which has never been forgotten and never can be. In his arguments with Calhoun over nullification, in 1833, there is the same striking contrast. Calhoun was perhaps more sound as regards mere technical logic, but Webster had the weight and the enduring substance of human truth.

In this nullification quarrel with South Carolina Webster heartily supported Andrew Jackson. But there was no sympathy between the two. Webster was an aristocratic Whig of the old school, Jackson an aggressive Democrat of the America to come, and over the bank and other things they came into violent conflict. It should be added that Webster's most serious contributions to political thought are to be found in his discussion of strictly financial matters. Moreover, when Jackson went out, in 1836, Webster would have liked to come in, and this was one of the acute crises in the fever of his presidential desires. It is amusing to see how many of his biographers deny his ambition. He wanted to serve his country, they say; he wanted to be where he could be of the greatest use. It is the old story, and no one has ever yet succeeded in disentangling the personal from the patriotic motive in these matters. The Presidency is the final seal of success in American politics, and no man who has given his life to those politics has ever been willing to see the Presidency slip from him without a sigh of despair. "I would rather be right than be President," said Henry Clay. But Clay and Webster and many another have persuaded themselves that the road to being President was the road to being right. Where will you find a more ingenuous avowal of ambition than in Webster's words to his friend Plumer: "I have done absolutely nothing. At 30 Alexander had conquered the world; and I am 40."

But Van Buren was elected, and Webster passed by, and for a time he turned his thoughts to private life. His affairs needed more attention than he could give them. He had been twice married, first in 1808, to Grace Fletcher, a love-match; second in 1829, to Caroline Le Roy. He had an expensive family, and his own tastes were expensive. He liked social life of all sorts, and social life was costly. He liked eating and drinking, especially the latter. He was happy on his great farms, in Franklin and at Marshfield.

But the farms and the country life were almost as ruinous as dissipation, perhaps more so. And the trouble was aggravated by Webster's business habits, or lack of them. He was a master of theoretical finance, but he could not keep his own private accounts, did not even try to keep them systematically. In consequence, he was always in trouble, always borrowing and renewing. When such business methods get mixed up with politics, there may not be corruption, but there is terrible danger of it. Webster's biographers insist that he was never personally dishonest. But there is a profound remark of Webster himself, which is worth remembering: "There are means of influence not generally esteemed positively corrupt, which are competent to produce great effects."

With the failure of his immediate political ambitions, Webster turned his attention to more general matters, and grew anxious to see something of Europe. The embassy to England had always tempted him, and it was even said that he had manoeuvred to get his friend Everett out of the position so as to succeed him. This came to nothing, but in 1839 Webster arranged a trip across the water and he was received by his English friends with every possible attention and courtesy. He wrote rather extensive letters home, but it is curious to note, with these, as with all his correspondence, the singular lack of intimate personal revelation. In reading these lengthy epistles, we may be driven to wonderwhether Webster's external life was so active and varied that it left the inner life somewhat jejune and bare.

Returning from abroad, Webster found the election of 1840 impending, but his own hopes and aspirations were completely submerged in the spectacular success of Harrison, with the log-cabin and hard cider and Tippecanoe campaign furore. Again it was evident that, widely as Webster was esteemed and respected, he had not the faculty of personal leadership. Men praised him, but they did not vote for him. Instead of the Presidency, he was forced to put up with the secretaryship of State, which was given him by Harrison, and at first continued by Harrison's successor, Vice-president Tyler. Tyler soon got into trouble with his Whig cabinet, and they all left him but Webster, who incurred some odium by remaining. His plea was that he wished to complete the negotiation with England about the north-eastern boundary. This was settled with Lord Ashburton by the treaty of 1842, an arrangement which was entirely satisfactory to neither party, and was therefore probably as fair a compromise as could have been devised. This is notable as being almost the only great constructive achievement of Webster's career. With all his intellectual and oratorical powers, the working of circumstances was such that he was almost always in opposition, and had no opportunity to show how well he could build for permanence, though the sure logical action of his genius would seem to have adapted him peculiarly for such work.

After the treaty was disposed of, Webster retired from the cabinet and for a time again disappeared into private life. The clouds seemed to be gathering about him in many ways. The deaths of his children, culminating in that of his daughter Julia, were a terrible grief to him. His money complications increased, and though his earning power was as great as ever, his gift for spending more than kept pace with it.

When he returned to the Senate in 1845, the political world was as dark as his own surroundings. He was personally attacked by Ingersoll, with charges of dishonesty during his secretaryship. Congressional investigation cleared him of all but carelessness, yet men always spoke of him with a slur or an apology from the financial point of view. The menace of the Mexican War was confusing everything, and making the issue of slavery more threatening and more difficult to deal with. Webster, like Clay and Calhoun, opposed the war, but he sent his son to fight and die, as did Clay also.

The vast accession of territory that resulted from the defeat of Mexico brought all sorts of slavery complications with it. Webster took an active part in these, being in the main anxious to have slavery repressed and limited, so far as this was compatible with the Constitution. But when, in 1850, Clay brought forward his compromise measures, in the desperate attempt to avert actual civil conflict, Webster joined him, and the combined influence of the two, after months of heated debate, prevailed to have the compromise accepted. Webster's course was abused with the utmost violence by the anti-slavery section of the North, and Whittier's wail over Ichabod gave the abuse literary dignity and permanence. The senator was accused of having betrayed every high principle, in the vain hope of getting the South to support him for the Presidency. Recent historians have come more and more to reject this view. They argue that without the compromise, the Civil War would have been precipitated at that time, and that by postponing it for ten years, until the North was strengthened by the immense accession of the growing West, the whole course of American history was changed. In this view Webster became, not the destroyer but the saviour of his country, and it must at least be believed that such salvation was mainly what he aimed at.

Under Fillmore, he had to be content with the secretaryship of State, and he filled this office until the condition of his health became so critical that work of any kind was out of the question. Perhaps the most notable of his later official acts was his sharp correspondence with the Austrian *chargé* Hulsemann in regard to the affairs of Hungary. Webster died on Oct. 24, 1852.

The details of Webster's death have been recorded with curious minuteness by his biographer, Curtis. The dying statesman first delivered a senatorial oration on religious matters, perhaps, like most of his talk on such subjects, more eloquent than convincing. The exhaustion of this prostrated him for the moment. When he again came to himself, his words were: "Have I—wife, son, doctor, friends, are you all here?—have I, on this occasion, said anything unworthy of Daniel Webster?" And the audience unanimously answered, "no." It would be hard to find a more fitting final utterance for a man who had lived for 50 years in the statuesque pose.

Yet it is fair also to remember that Webster's last preoccupation on the less personal side was with his country, and he directed that the American flag should be kept flying at the masthead of his little yacht, with a light cast upon it at night, so that he could see it as long as he could see anything.

Webster's writings are best studied in the complete edition, 18 vols., 1903. This includes the two volumes of correspondence published earlier by his son. A large amount of further correspondence was published by Van Tyne in 1902. The two-volume Life, by Curtis (1869), is a storehouse of material, but is eminently partial to the subject. H. C. Lodge's "Life," in the American Statesman series, is brilliantly written, but under strong Republican and anti-slavery prejudices. *The* True Daniel *Webster,* by Fisher (1911) is sympathetic, and defends Webster where he most needs it. The Life by Ogg (1914), is critical and dispassionate. The Reminiscences of Lanman and Harvey are suggestive, but not always reliable. The writer of this article, whose grandfather was Webster's law partner, possesses a desk and a dispatch box which belonged to Webster. In the desk are a number of unpublished documents tending to support the statements made above as to Webster's financial habits. *See* also Allan L. Benson, *Daniel* Webster (1929). (G. B.)

WEBSTER, JOHN (fl. 1602–1624), one of the greatest tragic writers in English literature. Of his life almost nothing is known. It is said that he was the son of a London tailor; and we learn from his own Preface to the pageant called Monuments of Honour that he was a member of the Merchant Taylors' Company and "born free" of it. But this does not prove that either he or his father ever actually plied the needle. It might be gathered from the ambiguous classical knowledge exhibited in his writings that he was educated at some school of repute; but his close association with so good a scholar as Heywood gave him many opportunities of picking up the scraps of Martial and Horace which adorn his pages. Reasons have been given for placing his birth about 1580; and, as we hear nothing of him after 1625, he may have died in that year. These uncertainties are intensified by the fact that several persons of that time are known to have borne his name.

At what date he "commenced playwright" is uncertain. We learn from Henslowe's diary that he collaborated with Drayton and others in Caesar's Fate, 1602, and with Chettle, Dekker and Heywood in Christmas comes but once a year. Somewhat later his name appears with that of Dekker as part-author of Westward Hoe and Northward Hoe and in 1604 he contributed the induction to Marston's Malcontent. In 1607 "Mr. Dickers and Mr. Webster" appear on the title-page of The Famous History of Sir Thomas *Wyat,* a play which had no fewer than five authors and at least two titles (it is an abridgment of Lady Jane).

This habit of collaboration perplexes the critic who endeavours to appraise merit or mark progress in style. One collaborator may easily fall into the manner of the other, and it is not impossible that the authors themselves, after a few years, would be unable to name their own portions. Unerringly to trace the hand of Webster through Elizabethan drama is now impossible, though students still essay the task. Mr. Sykes thinks he had a share in Anything for a Quiet Life, usually ascribed to Middleton, and in the Fair *Maid* of the Inn, perhaps by Massinger and Ford but printed as Beaumont and Fletcher's. Mr. Sykes may be right, and has the weighty support of Mr. Lucas; but it is certain that others have been wrong. Thus in 1661 *A* Cure for a Cuckold and *A Thracian* Wonder were ascribed by the publisher Kirkman, probably without the slightest traditional justification, to Webster and Rowley. The former, as a whole, seems to bear rather the mark of Heywood than of either of the assigned authors; but there is in it an episode easily detachable from the rest and of some merit, which Gosse and Spring Rice, in 1885, printed separately under the title of Love's Graduate, with the wish rather than the assurance that it might be "a piece of silver-work by the sculptor whose other groups are all of bronze." As The Guise and The Late Murther of the Sonne upon the Mother (this latter partially by Ford) are alike lost, conjecture may here disport itself without danger either of proof or of confutation.

The case of *Appius* and Virginia is more important, for on the decision as to its genuineness must rest our idea of the width and range of Webster's genius. Except for a few remarkable passages, this excellent play differs in every way from Webster's certain work. The only external evidence is the statement of an unknown publisher in 1654, repeated by Humphrey Moseley in 1659; but Webster's authorship was never doubted till in 1911 Rupert Brooke submitted the play to a careful analysis and finally, on grounds of style and vocabulary, ascribed it to Heywood. The present writer, after carefully considering Brooke's arguments, and comparing the play with Heywood's undoubted works (especially with the Rape of Lucrece) is inclined to believe that Brooke has made out his case. If so, we are, in forming our judgment on Webster's powers, limited to the three undoubtedly genuine works, The White Devil, the Duchess of Malfy, and the Devil's Law Case.

The last, though considerably the latest of the three—it is dated 1619 or 1620—may be taken first, and can be easily dismissed. It is a clumsy, involved, inartistic tragicomedy, in which the happy ending is brought about by the violation of all probability. With many reminiscences of the older and better time, it marks the transition to the later and worse fashion of the Caroline drama. Its chief merits lie in occasional flashes of Webster's characteristic murky imagery and daemonic forcefulness of phrase. There are also some touches of a shrewd satirical observation which, though not always dramatic, is in itself exceedingly striking.

But it is on the two great tragedies that Webster's fame must always rest. The White Devil, based on actual events of then recent date, was published in 1612, with a preface that interests by its tersely-worded appreciations of contemporary writers; and, although we know Webster was a slow worker, may be dated 1611–12. The Duchess of Malfy, founded ultimately on a novel of Bandello's, cannot be later than 1614; for the researches of Charles Wallace have shown that William Osteler, who acted in it, died that year. The two plays, therefore, were written with the combined daring of youth and solid strength of manhood. They have been said to belong to the "Tragedy of Blood," and they certainly have much in common with Kyd's Spanish Tragedy on the one hand and with Hamlet on the other. But perhaps it would be better—if classify we must—to regard them as a fusion of the Blood-Tragedy with the "Machiavellian" type of which Othello is the supreme example—that type in which further use is made of the Elizabethan conception of a contemporary Italy, rich in all the resources of culture, and permeated with all the vices of decadence. In it the essential element is the villain, endowed with matchless cunning, a hatred of good for its own sake, and a plentiful lack of conscience. To the exhibition of this conception Webster brought a certain Juvenalian indignatio which informs the work from beginning to end. The dramatic technique, coldly considered, is often lamentable; whole scenes are irrelevant, characters start up at random, and description too often takes the place of action. With every allowance for the fact that the plays were greatly shortened for the stage, these defects are serious, and go far to explain the repugnance of such critics as William Archer. But they are far outweighed by stupendous merits—in fact by the irresistible power of genius, often it is true "sufflaminandus," but conquering every obstacle like a rushing torrent. There is nothing of the icily regular about Webster. He dares all, and either vanquishes or fails. The main secret of his lasting appeal (an appeal perhaps stronger than ever to-day, to a generation that has supped full of the horrors of war) is his accumulation of catastrophe on catastrophe, his sense of the ghastly in little things, his power of symbolic hinting, and what we may call his sublimation of the pathetic into the portentous. To convey all this he has, when at white heat, a gift of brief expression, charged with the fullest meaning, unmatched except in Shakespeare. The famous "Cover her face, mine eyes dazzle, she died young," is only a supreme instance out of scores. In the face of this, criticism has to hold its peace; or, if it speaks at all, takes the form of such imitation as Shelley gives us in the Cenci.

Webster's works were edited by Dyce (4 vols., 1830) and inaccurately; W. C. Hazlitt (4 vols., 1857), but all previous editions are superseded by that of F. L. Lucas (4 vols., 1927, bibliog. in vol. i). *The White Devil* and *The Duchess of Malfy*, Symonds (1888) and Sampson (1904).

Criticism, Lamb, *Specimens* (1808); Swinburne, *Age of Shakespeare* (1908); Sidney Lee, *Dict. Nat. Biog.* (1899) (needs correction as to facts); Gosse, *Seventeenth Cent. Studies* (1883); Symonds, *Italian By-Ways* (1883). On the story of Vittoria Accoramboni *see* Trollope in *All the Year Round*, 1860. (E. E. K.)

WEBSTER, NOAH (1758–1843), U.S. lexicographer whose name became a virtual synonym for the word "dictionary," was born at West Hartford, Conn., Oct. 16, 1758. He entered Yale college in 1774 and, though his third year was interrupted by Revolutionary War service, graduated in 1778. He taught school, did clerical work and studied law, being admitted to the bar in 1781.

While teaching school in Goshen, N.Y., in 1782, he began his work on the English language, publishing in 1783 as part one of A *Grammatical* Institute of the English *Language*, a speller, *The* American *Spelling* Book, which ultimately sold more than 70,000,000 copies and provided much of his income throughout his life. To protect his copyright, he traveled through the states, lobbying at the legislatures for copyright laws, teaching, giving singing lessons and lecturing. Part two of the Institute, a grammar (1784), was based on a principle later enunciated in his famous American Dictionary of the English Language, 2 vol. (1828): "... grammar is formed on language, and not language on grammar." Part three, a reader (1785), was made up mainly of American selections. In 1789 he published his lectures as Dissertations on the English *Language*, stating "Customs, habits and language, as well as government, should be national." He spoke of American English as "Federal English."

He founded the short-lived *American Magazine* in New York city in 1788. After his marriage in 1789 he practised law successfully in Hartford until 1793, when he founded in New York the pro-Federalist daily newspaper, the American *Minerva*, and a semiweekly newspaper, the *Herald*. He went to New Haven, Conn., in 1798 and sold the papers in 1803.

Though his *Compendious Dictionary of the English Language* (1806) contained 5,000 more words than Dr. Johnson's (1755), it was merely a preparation for his later one, on which he started work in 1807. In 1824–25 he traveled to France and England to find sources unavailable to him in the U.S. The dictionary, attacked for its "Americanisms," its unconventional preference for U.S. usage and pronunciation to British and its inclusion of nonliterary words, contained about 70,000 entries and between 30,000 and 40,000 definitions that had not appeared in any earlier dictionary. The first edition (U.S., 2,500 copies; England, 3,000) sold out in little more than a year. Subsequent revised editions appeared in 1841, 1847 (including Webster's revised appendix finished a few days before his death in New Haven, May 28, 1843), 1856, 1864, 1879 and throughout the 20th century, those after his death being under the ownership of G. & C. Merriam Co.

Webster wrote on many subjects: politics (*Sketches of American Policy*, 1785, sometimes described as the first statement of the principles of the U.S. constitution), economics, medicine, physical science, in addition to writings on language. He noted the living language as he traveled. Early enthusiasm for spelling reform was modified somewhat in his later works, but he is largely responsible for the differences between British and U.S. spelling forms.

See also DICTIONARY.

See Harry R. Warfel, *Noah Webster, Schoolmaster to America* (1936), and his edition of the *Letters* (1953).

WEBSTER, a town of central Massachusetts, U.S., in Worcester county, is situated on the French river about 16 mi. S.W. of Worcester. Nearby, to the southeast, is Lake Chaubunagungamaug (full name, Chargoggagoggmanchaugagoggchaubunagungamaug), a three mile-long resort on the Connecticut line. Settlement began about 1713; the town was incorporated in 1832 and named for Daniel Webster. It was noted for its early textile mills built by Samuel Slater (1768–1835), regarded as the founder of the U.S. textile industry. Modern manufactures include textiles, shoes, machine tools, optical goods, paper goods and chemicals. Webster, like several other towns in the state, was still governed by town meeting in the second half of the 20th century. For comparative population figures see table in MASSACHUSETTS: Population. (A. B. So.)

WEBSTER GROVES, a suburb of St. Louis, Mo. (*q.v.*).

WEDDING: see MARRIAGE.

WEDEKIND, FRANK (1864–1918), German dramatist, was born in Hanover on July 24, 1864. In 1883 he took up journalism. Afterward he became an advertising manager and then, in 1890, secretary of a circus. In 1897 he set up as an actor and producer acting in his own dramas. His dramatic works include: *Frühlings Erwachen* (1891), *Erdgeist* (1895), Der *Marquis von Keith* and *Die Kammersänger* (1900), *Die Büchse der Pandora* (1903), *Schloss Wetterstein* (1910) and *Franziska* (1911). Wedekind's plays are written in a difficult symbolic style. Their preoccupation with erotic themes awoke much opposition, and he served a term of imprisonment in Munich for lese majesty. Wedekind also wrote poetry (Die Vier *Jahreszeiten*), novels, Mine-Haha (1906), etc., and essays. He died in Munich on March 9, 1918.

His *Works* were published in 8 vol. (1912–19). Certain plays were translated into English by S. A. Eliot, Jr.

See A. Kutscher, *Frank Wedekind* (1922–24).

WEDGWOOD, JOSIAH (1730–1795), British pottery manufacturer, whose most lasting influence resides in his scientific approach to pottery making, was the youngest child of Thomas Wedgwood, a potter of Burslem, Staffordshire, and came of a family whose members had been potters since the 17th century. After his father's death in 1739 Josiah was put to work in the family business, becoming exceptionally skillful at the potter's wheel. In 1744 he was apprenticed to his eldest brother, but an attack of smallpox seriously curtailed his work. The consequent inactivity, however, enabled him to devote thought to other aspects of his craft. After brief participation in a pottery at Stoke he entered into partnership in 1754 with Thomas Whieldon of Fenton, probably the leading potter of his day. These two experiences made Wedgwood master of current pottery techniques, while his experimental turn of mind led him to new discoveries. After inventing an improved green glaze, in 1759 he set up for himself at Burslem, first at the Ivy House pottery and subsequently also at the Brick House (or Bell works). There he perfected a cream-coloured earthenware which, because of Queen Charlotte's patronage in 1765, was called "Queen's ware." This, by virtue of its durable material and serviceable forms, became the standard domestic pottery and enjoyed a world-wide market.

In 1762 Wedgwood met Thomas Bentley, a Liverpool merchant, who in 1768 became his partner in the manufacture of ornamental wares. These were primarily unglazed stonewares in various colours, formed and decorated in the then resurgent classical style, to which Wedgwood's wares lent great impetus. Chief among these "dry bodies" were "black basaltes," which by the addition of red encaustic painting could be used to imitate Greek red-figure vases, and jasper ware, a fine-grained stoneware for copying classical cameos. For his ornamental wares Wedgwood built near Hanley a factory called Etruria (Greek vases were currently thought to be Etruscan), to which the manufacture of useful wares was also transferred (*c.* 1771–73). There his descendants carried on the business until 1940, when the factory was relocated at Barlaston, near Stoke.

Wedgwood's exhaustive researches into materials, his logical deployment of labour, his business organization and his promotion of improved communications make him one of the great leaders of the Industrial Revolution. He died at Etruria, Jan. 3, 1795. His daughter Susannah was the mother of Charles Darwin.

See also POTTERY AND PORCELAIN.

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WEDNESBURY, a municipal and parliamentary borough of Staffordshire, Eng., 8 mi. N.W. of Birmingham. Pop. (1951) 34,-

759. Area 3.2 sq.mi. The borough includes the urban district of Darlaston (pop. 1951, 22.012). Wednesbury is an ancient market and industrial town. The foundation of modern Wednesbury was the rich "ten-yard" coal seam close to the surface and having near it ironstone, lime and fire clay. Pits are no longer worked in the borough but industries are still mainly metallurgical. It is the traditional centre of the manufacture of tubes The Church of St. Bartholomew is supposed to occupy the site of a place of the worship of Woden or Odin—hence Wednesbury (Wodensbeorgh). There Aethelflaed in 916 constructed a castle. After the Conquest it became a demesne of the crown, and was bestowed by Henry II on the Heronvilles. It became a parliamentary borough (1867) returning one member and a municipal borough (1886).

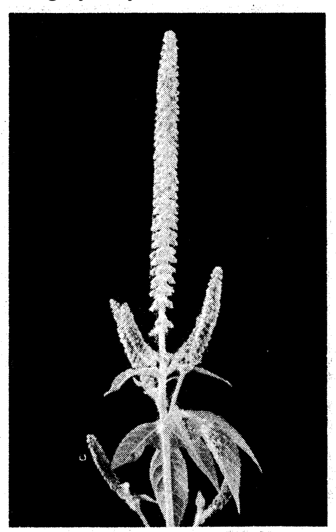
WEED, THURLOW (1797–1882), U.S. journalist and politician, was born at Cairo. N.Y., on Nov. 15, 1797, and began learning the printer's trade at the age of 12. As a member of the New York legislature, he was influential in placing his state behind John Quincy Adams in the 1824 presidential canvass.

He became a leader in the Anti-Masonic party (*q.v.*) in 1828; when the Masons forced him out of his management of the Rochester Telegraph, he started an anti-Masonic campaign paper. Soon convinced that anti-Masonry was an inadequate issue for a national party, Weed uas active in forming the Whig organization in New York. His paper, the Albany Evening Journal, founded in 1830 to support anti-Masonry, then became a chief Whig spokesman and Weed the leading political manipulator of the new party. Weed's alliance uith William H. Seward (q v.) was a strong factor in the latter's election to the governorship, and he was Seward's chief manager in his unsuccessful campaign for the Republican presidential nomination in 1860. As secretary of state, Seward in 1861 sent Weed as a special agent to England, where he was a successful propagandist for the United States. But his wish to compromise the war issues put him out of step with his party; and in 1863, tired and discouraged. he sold his paper and retired from politics. He later wielded some political influence, however, and was briefly editor of the *New* York Commercial Advertiser.

Weed's *Autobiography* (1883) and Thurlow Weed Barnes' *Memoir of Thurlow Weed* (1884) were published together as *The Life of Thurlow Weed* in 2 vol. *See* also Glyndon G. Van Deusen, *Thurlow Weed, Wizard of the Lobby* (1947). (F. L. MT.)

WEED. A weed is an unuanted plant. Ever since man first attempted the cultivation of plants he has had to fight the invasion by weeds of areas he has chosen for crops. Some unwanted plants later were found to have virtues not originally suspected and so were removed from the category of weeds and taken under cultivation. Other cultivated plants. when transplanted to new climates, escaped cultivation and became weeds. The category of meeds thus is ever changing, and the term is a relative one.

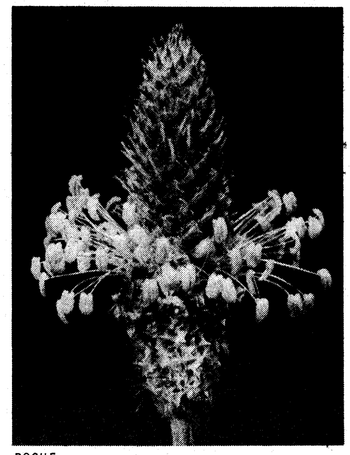
It has been estimated that the average yearly loss due to weeds in meadow and crop lands is greater than that due to animal and plant diseases. A large proportion of the farmer's work goes into the struggle with weeds. If he falters they gain control, and only through a much greater effort is he able to regain it. According to the adage. "one year's seeding means seven years' weeding." The reason is that agriculture disturbs the natural association of plants and sets in motion the ecological succession. This is the ever-present tendency of vegetation to return by ascending steps to the climax stage, which is its culmination. The climax is characterized by great permanence; if destroyed, whether by fire, floods or human agency, it always tends to return. The farmer seeks to replace this balanced natural vegetation with plants that for the most part do not belong to the climate and that in themselves have little power to impede the climb back to the climax association; hence his never-ending battle with weeds.



BY COURTESY OF ROGER P. WODEHOUSE

GIANT RAGWEED (AMBROSIA TRIFIDA)

When a piece of land has been denuded of vegetation and left unprotected against the sun, wind and rain, it is in jeopardy. Unless it is quickly covered, the soil is likely to be washed or blown away long before grass, shrubs or trees can become re-established. This provides an opportunity for the nearby weeds; they move in and auicklv clothe the soil. protecting it against destruction by rain and wind. (See below, Value *of* Weeds.) However, cultivated fields, with domesticated plants in rows three or four feet apart, similarly present open territory, which weeds attempt to pioneer. In this they are much more efficient than the cultivated plants, which struggle with an alien soil and climate and are assailed by an endless variety of insects and fungus and virus diseases. In this hostile environment cultivated plants would succumb promptly without constant attention from man.



ROCHE

BUCKHORN PLANTAIN (PLANTAGO LANCEOLATA)

The cost of maintaining cultivated fields against the onslaught of weeds and their concomitant effects is generally reckoned as the loss to agriculture from weeds. It represents the burden that agriculture assumes in arresting, in its earliest and most unbalanced stages, the ecological succession.

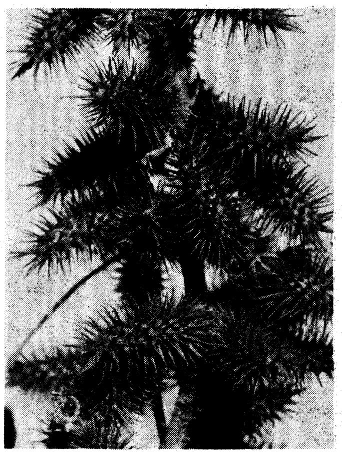
Pioneer Plants. — In spite of the fact that no plants are always weeds, many habitually are so classified. These are plants that in the climax association occupy a subservient position and almost go unnoticed, but that in the early pioneer stage of the ecological succession are dominant. Most are annuals, fast-growing and shallow-rooted, capable of quickly occupying denuded areas. Familiar examples are the weedy grasses such as foxtail (Setaria), barnyard grass, crabgrass, cheat (Bromus secalinus) and sandbur (Cenchrus). Also familiar are the short, tall and slender ragweeds, pigweed, lambs-quarters, marsh elder weed, cocklebur, Indian hemp (Cannabis), purslane, Russian thistle, wild sunflower and Galinsoga.

Most weeds, including all except the last four of the examples cited above, are wind pollinated. This is more than a matter of chance, for outside this ecological group wind pollination is relatively uncommon among the flowering plants. In fact, most of the wind-pollinated nonwoody flowering plants are pioneers. Wind pollination enables them to invade new areas in enormous numbers without the limitations imposed by an unreliable fluctuating population of pollinating insects. Wind pollination, however, is no assurance of success.

These plants must also be able to survive in the stable climax in scattered distribution, and thus enormous quantities of pollen per individual plant are required to bridge the gaps between the members of a species.

The ragweeds, false ragweeds, marsh elders, careless weeds, water hemps and some of the weedy grasses also belong to the pioneering group. These are not aggressive invaders, are easily crowded out by more permanent vegetation and so are relatively easily controlled The most obvious method of control is clean cultivation — preventing them from seeding. If, however. they are allowed to go to seed, a large proportion of their seeds are likely to become dormant. germinating at intervals, as opportunity arises, for 40 years or more. Once well in, therefore. they are likely never to be eradicated except by nature's way or at least some compromise with it.

In addition to the annuals, a large number of perennials also participate in the pioneer stages. Familiar examples are the field



JOHN H. GERARD

COCKLEBUR (XANTHIUM)

and hedge bindweeds of the morning glory family, in many places reckoned as the worst of all weeds; and Johnson grass, quack grass, Bermuda grass. curly dock, sorrel dock, nild onion. several species of plantain, nut grass. bur ragweed. western ragweed, knapweed, Canada thistle, horse nettle and common mallow. These are generally deep rooted and spread both by seeds and by runners above and belon ground. They belong to the next higher stage in the ecological succession and are more permanent than the annuals and more difficult to eradicate.

Origins of Weeds.—It is generally believed that weeds are introduced plants; in fact, this characteristic is often cited as their first qualification. It is not strictly true. however; so far as the number of different kinds is concerned. more weeds are native than introduced. All the ragweeds, false ragweeds, cockleburs and marsh elders. which are the most troublesome hay fever plants in North America, are native Americans. Some of these have been introduced into Europe and Australia. where they have failed to become weeds of any importance. Quack grass and Bermuda grass. troublesome weeds throughout much of North America. are both native. So also are Galinsoga and nut grass, poison ivy and poison sumac. On the other hand, the commonest and most pernicious American weeds are introductions from Europe. so that the impression based on numbers of individuals is most decidedly in favour of introduced species. The reason why the flora of America is so strongly tinged with that of Europe is, of course, that Americans came originally from Europe and brought their weeds with them or had them sent over later together with various European commodities.

When a plant or animal is transplanted into a new and favourable locality. it is likely to spread with great rapidity because of the absence of competition and its accustomed enemies. This was especially true of America, where large areas were made available to weeds by the heedless activities of men, who destroyed the native vegetation by plowing and overgrazing. The invasion of the western American ranges by Russian thistle was a result of such careless treatment. The American prickly pear, introduced into Australia, became a pestiferous weed there in overgrazed areas: as indeed it has become in America to a lesser degree.

Competition.— The harm that weeds do lies in their competition with more desirable plants for space. water, sunlight and nutrients. Under natural conditions the development of plants is closely related to the degree of competition that they have to endure, whether with each other or with other species. For example, it was shown by J. E. Weaver and F. E. Clements that 12 ragweed plants growing per square metre reach a height of 11.3 ft. with a stem diameter of 19.0 mm.; growing 64 to the square metre the figures are 8.4 ft. and 7.4 mm.; and growing at 154 plants, they are 5 ft. and 3.4 mm. Likewise corn that averaged 46 bu. per acre when weeds were kept down yielded only 7 bu. where weeds were allowed to grow.

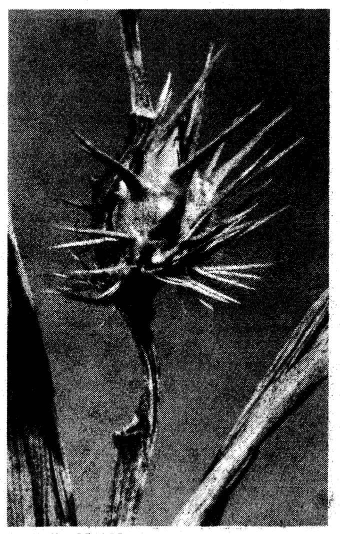
In an experimental competitive culture of tall panic grass (genus *Panicum*) and evening primrose (genus *Oenothera*) it was found that the evening primrose, being slightly taller than and extending its roots deeper than those of the grass, soon gained the ascendancy. The grass became attenuated and yellowish as a result of shading by the broad leaves of the evening primroses. By autumn. 25% of the panic grass had died. Only a few of the grass leaves ever managed to overtop the competitor and receive enough sunlight to perform full photosynthesis. By the end of the second season the evening primrose had seeded and died. which is normal. since its life cycle is biennial. It failed to reproduce in the area the following spring, however; the few starved grasses that remained tillered abundantly and soon had complete and permanent possession of the area. It is important to note that although this contest was very nearly fatal to the panic grass, this perennial weed finally won over the biennial evening primrose because the latter had to start again from seed. This it could not do in competition nith the grass, which had the advantage of starting from its tough perennial rhizomes. The outcome of the contest could have been made more certain for the grass by a single mowing or possibly grazing during the first or second year, for this is always much more injurious to broad-leaved annuals or biennials than it is to perennial grasses. This method is the easiest nay to convert a weed patch into grassy turf; land may be maintained indefinitely in this desirable condition, yielding a sustaining crop of hay or forage until the plot is needed for something else.

Value of Weeds.—Although needs should be replaced wherever possible by more desirable plants, they afford valuable service in the control of erosion, especially on abandoned or temporarily idle land. In controlled experiments a volunteer cover of miscellaneous weeds has been shown to be one-third more effective in reducing aater runoff and twice as effective in reducing the accompanying soil erosion as an ordinary stand of corn in the same kind of soil. Russian thistle as a volunteer cover crop is even more effective in conserving water and protecting the soil. Wild sunflouers are sometimes seeded in regions of low rainfall as an aid to restoring grass in a windswept soil. Wild mustard is sometimes sown from airplanes after destructive fires have removed all soil cover. This makes a dense stand the first year and then is gradually replaced by more permanent vegetation. Weeds. like true pioneers of the human race, do not thrive under crowded conditions, even of their onn making. and readily give way to more tolerant plants.

Control of Weeds.——Weeds are best controlled by good cultivation Experimental evidence shows that among both field and garden crops the only value of tillage is in weed control. Indeed, tillage generally results in some injury to the crop plants, but of course this is more than offsetby the removal of need competition.

Chemical herbicides offer a substitute for tillage in controlling weeds. These are of two kinds, nonselective and selective Examples of the former are common salt, iron sulfate, copper sulfate and sodium chlorate These are generally used at high concentration and sterilize the soil against all plant growth so that no plants can be grown on it for several or many years.

With the introduction of selective herbicides. weed control is rapidly being developed into an exact science. Many selective herbicides are in use, and more are continually being developed They are contact poisons of the nature of hormones and depend for their success upon the principle of selectivity. That is to say. in proper concentrations they destroy certain weeds without permanently injuring the desirable plants associated with them. The first of these to be developed were 2.4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). The former kills herbaceous (soft-stemmed) and the latter woody plants, without injuring grasses. Used separately or in combination. they are particularly valuable in controlling weeds along roadsides; herbicide spraying may reduce necessary mowings to one per season. thus eliminating two or three mowings and reducing the cost of roadside maintenance by as much as 90%. Selective herbicides also give excellent control of ragweed and poison ivy From lawns and turf they remove such undesirable weeds as plantains and dandelions without injuring the grass; they must be used with discretion, however, if clovers are compo-



JOHN H. GERARD

MAT SANDBUR (CENCHRUS PAUCIFLORUS)

nents of the lawn, for these are very susceptible to such herbicides.

For the control of weeds in vegetable crops and among ornamentals the choice of herbicides depends on the plants grown and on the weeds to be killed.

Furthermore, the concentrations to be used must be carefully adjusted, because there is often only a small differential between lethal doses for the weed and the crop. Since the more refined methods of weed control vary widely with locality, it is advisable that the farmer or gardener consult his agricultural college or county agent for local recommendations.

Proper weed control always means replacing weeds by more desirable plants without leaving the soil unprotected against erosion. Without the protective soil-binding influence of the weeds or their substitutes, the life span of human civilization would be greatly shortened.

See also articles on the individual plants mentioned.

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WEEK, the name given to periods of time, varying in length in different parts of the world, but shorter than a "month" (from A.S. *wicu,* Germanic *wikôn,* probably "change," "turn"). The month may be divided in two ways: a fractional part may be taken (decad or pentad), as in east Africa or ancient Egypt (moon-week), or the week may be settled without regard to the length of the month (market-week, etc.).

The seven-day week (see CALENDAR) originated in west Asia, spread to Europe and later to north Africa (Mohammedan). In other parts of Africa three, four (especially in the Congo), five, six and eight (double four) day weeks are found, and always in association with the market.

In ancient Scandinavia a five-day period was in use, but markets were probably unknown. That the recurrence of the market determined the length of the week seems clear from the Wajagga custom of naming the days after the markets they visit, as well as from the fact that on the Congo the word for week is the same as the word for market.

Among agricultural tribes in Africa one day of the week, which varies from place to place, is often a rest-day, visiting the market being the only work allowed.

WEELKES, THOMAS (1577?–1623), English composer, was one of the best and most individual of the English composers who took up the Italian madrigal form so eagerly in the closing years of the 16th century. An allusion to his "yeeres yet unripened" in Weelkes's book of *Balletts* and *Madrigals,* published in 1598, is the only evidence for the date of his birth. He had already published a set of madrigals for three, four. five and six voices in the previous year, and two more books of madrigals, one for five and the other for six voices: followed in 1600. For a brief period Weelkes had been organist of Winchester college, and in July 1602 he took the degree of Mus.B. at New college, Oxford. Shortly after, he was appointed organist of Chichester cathedral, which post he appears to have held until his death.

Although his madrigal publications had established his reputation, Weelkes produced only one more volume, the *Ayeres or Phantasticke Spirites* (1608) for three voices. There is no sign of any further secular music dating from later than 1608, but numerous scattered fragments (and some complete works) suggest that Weelkes composed a considerable amount of church music, including at least ten Anglican services. He died in London, about Nov. 30, 1623.

Weelkes's madrigals have all been edited and printed by E. H. Fellowes in *The English Madrigal School,* vol. ix–xiii (London, 1913–24). Fellowes and others have also printed a number of Weelkes's sacred works, and the surviving keyboard works have been edited by Margaret Glyn. The most complete studies of Weelkes's compositions occur in Fellowes's *English Madrigal Composers* (Oxford, 1921) and *English Cathedral Music* (London, 1941). (J. J. N.)

WEENIX, JAN BAPTIST (1621–1660), Dutch painter, whose paintings show great diversity, in quality as well as in subject matter, though at his best he was a fine artist, was born in Amsterdam, where Jan Micker was his first master. He later studied under Abraham Bloemart in Utrecht and Nicolaes Moeyaert in Amsterdam. He married Josina d'Hondecoeter in 1639 and had two sons, Jan (see below) and Gillis.

In 1643 Weenix traveled to Italy and stayed there four years, mostly in Rome. While there he was much employed by Giovanni Battista Cardinal Pamphili, who became Pope Innocent X in 1644.

After returning to Amsterdam in 1647 Weenix soon settled in Utrecht, where he was elected a commissioner of the painters' guild in 1649.

Before his Italian period Weenix seems to have used the single Christian name of Jan or Johannes, and he probably adopted the second in honour of his patron. In signing his pictures he always used the Italian form—Gio[vanni] Batt[ist]a Weenix. Characteristic subjects are landscapes (usually italianate) with peasants and animals, seaports, still-life compositions with dead game; he also painted a number of competent portraits. His pupils included, besides his son Jan, his nephew Melchior d'Hondecoeter and Nicolaes Berchem.

His son JAN WEENIX (1640?–1719) was born in Amsterdam, where he worked for most of his life, though he appears in the Utrecht painters' guild in 1664 and 1668. He specialized in large still-life paintings of dead game, which, with the elaborate bird paintings of Melchior d'Hondecoeter, were in great demand for the decoration of private houses in Amsterdam and elsewhere. (R. E. W. J.)

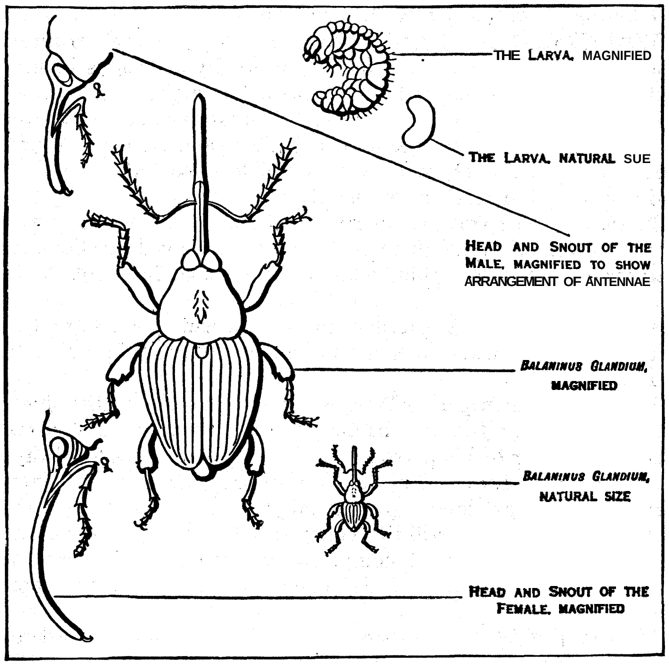
WEEVER, or WEAVER. The weevers (*Trachinus*) are small marine fishes common on the coasts of Europe. They belong to a family of spiny-rayed fishes (Trachinidae), and are distinguished by a long low body with two dorsal fins. the anterior of which is composed of six or seven spines only, the posterior being long and many-rayed. The ventral fins are placed in advance of the pectorals. The upper surface of the head is bony, without skin.

Several species are known, but two only occur on the British coasts, viz., the Greater Weever (*Trachinus* draco) and the Lesser Weever (T. *vipera*); the former is frequently found of a length of 12 in., while the latter grows only to about half that length. The coloration of both is plain, but the short first dorsal fin is always deep black. The weevers are bottom fish, burying and hiding themselves in the sand or shingle—the lesser species living close inshore and the greater preferring deeper water. They inflict wounds by their dorsal and opercular spines. The spines are deeply grooved, and the poisonous fluid lodged in the grooves is secreted by glands at their base. The flesh is not bad eating.

See Jordan, *Guide to the Study of Fishes.*

WEEVIL, the name applied to beetles of the division Rhynchophora of the order Coleoptera. They are characterized by the prolongation of the head into a rostrum or snout which bears the mouth-parts at the apex. The antennae are usually elbowed and clubbed, with the basal portion frequently lodged in a depression on each side of the rostrum. The tarsi have four evident segments and there is a single median or gular suture beneath the head. Their larvae are usually white, curved, fleshy grubs, generally without legs; the head is darker and well developed, with strong jaws; eyes are absent or very rudimentary. Both the adults and the larvae are exclusively vegetable feeders.

The true weevils or Curculionidae form the largest natural family in the animal kingdom and include over 35,000 known species, but probably several times that number still await discovery. More than 400 species occur in the British Isles, and upwards of 2,500 species inhabit America N. of Mexico. Their most characteristic organ is the rostrum: its function in the female is often that of a boring instrument, a hole being drilled by it for placing the eggs, but its significance in the male is not understood. As a rule the rostrum is better developed in the female than in the male, a feature that is well seen in the nut weevils. The majority of weevils are sombrely coloured but



ACORN-WEEVIL (BALANINUS GLANDIUM), ADULT AND LARVA

A nut-weevil closely allied to the common nut-weevil (Balaninus nucum) of Great Britain. The female of the various species drills holes in green hazel-nuts acorns or similar nuts and deposits eggs singly within the kernels upon which the larvae later feed

others are attractive objects. In the brilliant green Phyllobius and *Polydrusus,* so common among herbage in Britain, the colour lies in the covering scales. The Papuan *Eupholus* is sky blue. and the diamond-beetles (*Entimus*) of Brazil are probably the most resplendent of all. In their larval stages weevils may feed upon any part of a plant from the roots to the seed: the vast majority are internal or subterranean feeders, but some feed openly and a few live in tunnels formed of rolled leaves. A large number of species are highly injurious either as larvae or as adults also. The granary weevil (*Sitophilus granarius*) destroys the grains of corn (maize), wheat and barley, and has become widely distributed through commerce. The cosmopolitan rice-weevil (S. *oryza*) affects, besides rice, a great variety of other dry food products. The cotton-boll weevil (*Anthonomus grandis*) is the most serious enemy of the American cotton crop, causing immense damage to the bolls. The allied apple-blossom weevil (*A. pomorum*) is very destructive to unopened blossom buds in England and other parts of Europe. The palm-weevil (*Rhynchophorus ferrugineus*) affects toddy and coco-nut palms, and the pine-weevil (*Hylobius* abietis) is a European enemy of young conifers. The alfalfa-weevil (*Phytônomus posticus*) entered the U.S. from Europe in 1904 and is' a serious enemy of alfalfa and clovers. Mention must be made of the North American plum curculio (*Conotrachelus nenuphar*), a most destructive pest of stone fruits, of the nut-weevils (Balaninus) and of species of *Sitona* which attack leguminous crops. In addition to the Curculionidae, the Rhynchophora include the families Scolytidae, Platypodidae, Anthribidae and Brentidae.

See BOLL WEEVIL; BEETLE; COTTON: Pests and Diseases; ENTOMOLOGY: Agricultural and Forest Entomology; PINE BEETLE.

(A. D. I.; R. L. WL.)

WEFT: see WARP AND WEFT.

WEIDENREICH, FRANZ (1873–1948), German anatomist and physical anthropologist, an expert on the reconstruction of prehistoric human remains, well known for his work on *Sinanthropus* (Peking man) and for his studies in human evolution. Born June 7, 1873, at Edenkoben, in the Rhineland-Palatinate, he received a medical degree from the Cniversity of Strasbourg in 1899, where he became professor of anatomy in 1903. His publications reflected a growing interest in skeletal anatomy that eventually found expression in studies of locomotion, posture and bone structure as related to problems in primate evolution. He became professor of anatomy at the University of Heidelburg (1919); he was professor of anthropology at Frankfurt (1928–33) and visiting professor at The University of Chicago (1934). His most valuable contributions were made after his appointment (1935) as professor of anatomy at Peking Union Medical college, China, uhere he carried on investigations begun by D. Black on the Sinanthropus fossils (also termed Peking man or Pithecanthropus *pekinensis*)—one of the earliest known groups of human fossils. Weidenreich's classic descriptions. of Sinanthropus gained in importance when the fossils were lost during the Japanese invasion of Peking. In 1941 he went to the American Museum of Natural History, New York city. where he concentrated on the newly found Pithecanthropus (Java man) fossils and "giant" teeth discovered by G. H. R. von Koenigswald. (See also MAN, EVOLUTION OF.) His last project, a major study of Solo man (a later fossil from Java), was interrupted by his death on July 11, 1948, in New York city.

Among his works are *Apes,* Giants and Man (1946), a collection of scholarly but popular lectures; and Anthropological Papers, published posthumously (1949).

See also W K. Gregory, "Franz Weidenreich," Amer. Anthro., vol. 51, no. 1, pp 85–90 (Jan.–March 1949). (H. L So)

WEIERSTRASS, KARL THEODOR WILHELM (1815–1897), German mathematician, one of the founders of the modern theory of functions, was born at Ostenfelde on Oct. 31, 1815. He studied jurisprudence at Bonn and later went to Miinster to study under C Gudermann, who was interested in the theory of functions. Weierstrass wrote a paper on the development of modular functions for his teacher's examination and so started the aork in mathematics with which his name is associated. He became a teacher of mathematics at the gymnasium at Deutsche-Krone (1842–48) and then at the Collegium Hoseanum in Braunsberg (1848–56). In 1856 he was appointed extraordinary professor of mathematics at Berlin and lecturer at the school of technology. He was appointed ordinary professor in 1864. He died in Berlin on Feb. 19. 1897.

Weierstrass' work on the theory of functions was the most notable work on this subject since that of N. H. Abel and K. Jacobi. He published relatively little himself, but embodied his works in his lectures, which were collected in *Gesammelte Abhandlungen* (1894–1927); vol. i, ii and iii contained his lectures, vol. iv (1902) on Abelian functions, vol. v and vi (1915) on elliptic functions, vol. vii on the calculus of variations and vol. viii on analytic functions. He worked on the functions of real variables, devised tests for the convergence of series and dealt with converging infinite products. All his mathematical work is characterized by his emphasis on clarity and logical stringency. His example of a continuous function without a derivative at any point is famous in the history of mathematics. He also dealt with the theory of bilinear and quadratic forms.

Weierstrass developed the theory of functions of a complex variable to such an extent that he put his subject on a fresh basis. He also made notable contributions to the theory of periodic functions, elliptic functions, Abelian functions and the calculus of variations. Although his work was on pure mathematics, he was interested in its applications and influenced a number of his students to work on applied mathematics. He edited J. Steiner's *Gesammelte Werke* (2 vol, 1881–82) and was co-editor with E. Kummer of *Crelle's* Journal. See also FUNCTION. (O. OE.)

WEIGALL, ARTHUR EDWARD PEARSE BROME (1880–1934), British Egyptologist and author, was born on Nov. 20, 1880, and educated at Hillside school, Malvern. and at Wellington college. After a short time at New College, Oxford (1900), he joined the Egypt Exploration fund as assistant to Prof. Flinders Petrie, and later (1905) was appointed inspector general of antiquities under the Egyptian government He retired in 1914, hut continued to write on archaeological subjects. He received several foreign decorations for his archaeological work.

His many publications include A Report on the Antiquities of Lower *Nubia* (1907); *Travels* in the Upper Egyptian Deserts (1909); The Life of Akhnaton, Pharaoh of Egypt (1910, revised 1922); The Life of *Cleopatra,* Queen of Egypt (1914, revised

1924); *Egypt from 1798 to 1914* (1915); *Ancient Egyptian Works of Art* (1924); *A History of the Pharaohs*, vol i (1925), vol. ii (1926); *Wanderings in Roman Britain* (1926); *The Grand Tour of Norman England* (1927).

WEIGHING MACHINES. This article deals with mechanisms used for weighing goods and commodities, or used for technical purposes other than those for which the fine balance is constructed. The latter instrument is fully dealt with in the article BALANCE. and to that article the reader is also referred for a discussion of the principles which underlie the construction of the balance beam and determine its accuracy, sensitivity, period of vibration and so forth. The beam scale. or simple balance is, however, used for commercial as nell as for scientific purposes; hence a brief account of the principal forms is given.

The Beam Scale: Its History.—It seems certain that the balance originated in predynastic Egypt. and in the opinion of some Egyptologists its invention dates back to over 5,000 years before the Christian era.

The earliest balances of which we have knowledge were of the cord pivot type, the beam being suspended at its centre by a cord attached to a fixed support and the scale pans similarly suspended from the ends of the beam. At first. to effect these attachments, holes were drilled diametrically through the beam, but at a period which may be as early as 2000 B.C., a great improvement was initiated which enabled balances of considerable precision to be constructed. The end pivot was formed by drilling a hole into the upper surface of the beam and connecting it with one drilled longitudinally into the end. The suspension cord issuing from the latter and secured above the former hole was always held by the weight of the scalepan in definite contact with the end of the beam. Any inequality of arm length could be quickly corrected. The central pivot. or fulcrum. was either constructed by drilling diametrically through the beam, or by wrapping the suspension cord round the beam. or by attaching the cord to a metal ring secured to the upper surface of the beam. The better type of Egyptian balance, as early as 1500 B.C., and possibly much earlier. was always suspended from a bracket projecting from a substantial standard. From this bracket a plumb line was hung, the heart-shaped plumb bob of which was placed immediately below the tip of a downward depending tongue (finger or pointer) of triangular shape, secured to the bear- at its centre.

At a later date. and for ordinary commercial purposes, a more portable type of beam was used, like that depicted on the *kylix* of Arcesilas, a Spartan vase dating from about 550 B C. The lotus-shaped ends of the beam are here retained, but the beam is depicted as hung, by a simple sailors' device, from the lowered yard of the ship, on the deck of which the king is seated superintending the weighing and loading of a cargo of silphium. This balance is equipped with neither tongue nor plummet. The ancient method of constructing the cord pivot beam has survived in India and China to the present day.

The balance used in classical times was often constructed on Egyptian lines. but those examples nhich have survived are almost entirely of bronze, and are of a quite different type nhich possibly originated at Alexandria in Ptolemaic times. The pivots in these instruments may best be described as hole or ring pivots, and were formed by linking hooks or rings through holes pierced through the beam. These ring pivot instruments stand for a gain in portability and convenience, but for a retrograde step in accuracy of weighing.

At first no fork (gallon-s, shears, or cheeks) was used, as this device had not been invented. In its place a metal hook or loop of cord was attached to a ring linked through a central hole.

Later. probably about the beginning of the Christian era—but the date is quite uncertain—the fork was invented, and, being itself suspended, enabled an upward pointing tongue to be fitted. In all these classical balances the middle, or fulcrum pin, was apparently never secured to the beam. but to the fork. The beam turned loosely on a pin attached to the fork.

It is a remarkable fact that in the case of the steelyard in some surviving examples (of which one is now in the British Museum) we find a fixed fulcrum pin secured between lugs shaped in the body of the beam. It would appear that it was not till towards the close of the middle ages that such a pin, approximating to the modern knife-edge, was used in equal-armed balances.

Bullion Balances.—The finest type of large balance constructed in 1929 is used for weighing gold and silver. It is really a large precision balance and the principles of its construction need not here be detailed. Great care in design is necessary because of the magnitude of the stresses to which the parts are subjected. In particular, the design of the relieving cam and the whole of its connected parts demands technical skill of a high order.

In the modern form of bullion balance care is taken to preserve the structural rigidity of the beam by causing the continuous plane bearing piece to pass through an aperture in the framework of the open trussed beam. and thus give support to the continuous fulcrum knife-edge. This means that the bearing piece has to bridge over a space between tno supporting columns, and, in order to ensure freedom from distortion under load, great transverse rigidity is necessary.

For ordinary commercial purposes, box end, Dutch end. and "brass agate" beams are still often used. but the continuous knife-edge with continuous bearing is gradually displacing less accurate forms of pivot.

Counter Machines, or Small Linked Mechanisms.—It is convenient for most commercial purposes to use scales in which the scalepans are placed above the beam. In the United States such machines are known as counter trip scales. To effect this end. linked mechanisms have had to be devised which maintain the pans always in a horizontal position, and give accurate neighing irrespective of the position thereon of the load and weights. This means that each pan must be supported so that a load, wherever it is placed, will exert the same turning moment round the centre of oscillation of the main beam. This may be effected in various ways, the object in all cases being to give to every part of a pan or platform the same virtual velocity.

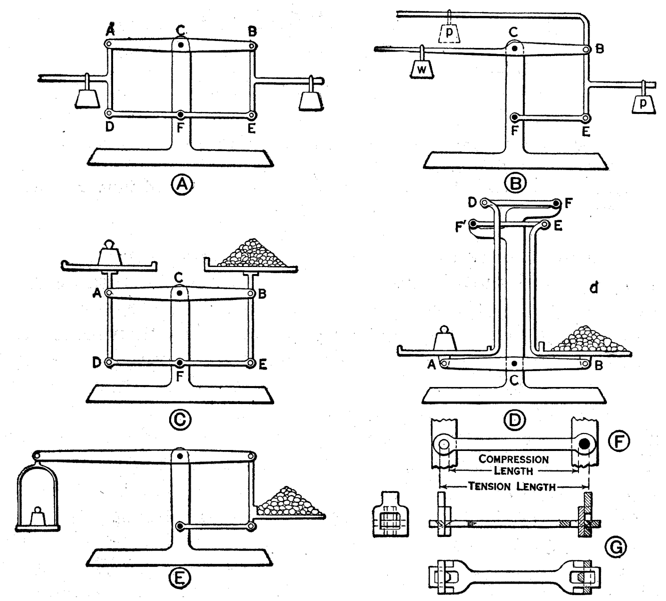


FIG. I.—THE ROBERVAL ENIGMA AND DERIVED MECHANISMS
(A) The Roberval Enigma; (B) Modified form; (C) Ordinary Roberval Counter Machine; (D) Inverted type of Roberval Balance; (E) Balance designed to avoid reversal of stress in stay; (F) Diagram showing change in stay length due to reversal of stress; (G) French stay designed to maintain constant length in tension or compression

Two chief groups of mechanisms may be recognized: (1) Those directly derived from the *énigme statique* (fig. 1*a*) of the French mathematician. Gilles Personne de Roberval, and (2) those consisting of a combination of load carrying levers adapted to support the scalepans in such a manner as to comply with the specified conditions (fig. 2). Roberval invented his static enigma in 1669, but no completely satisfactory explanation of its action appears to have been formulated until Louis Poinsot published the 3rd edition of his *Éléments de Statique* in 1821. His explanation is based on the theory of couples, and has the advantage of being immediate and self-contained.

J. d'Alembert, in his article on the lever in the *Encyclopédie* of 1750, had attempted a similar type of solution without complete success. On the other hand, Isaac Newton had long previously, by the enunciation of his principle of virtual velocities, provided all the data for solving the problem, though he left no note on the subject. J. T. Desaguliers applied Newton's principle to the enigma in his Course of Experimental Philosophy (2nd ed., London, 1745), and showed that in such a balance the turning moments exerted by the weights on each side of the centre are proportional to their virtual velocities multiplied by their mass, and not proportional to their distance from the centre of rotation. The original form of the enigma is shown in fig. 1*a,* while b shows a modified form using one parallelogram only.

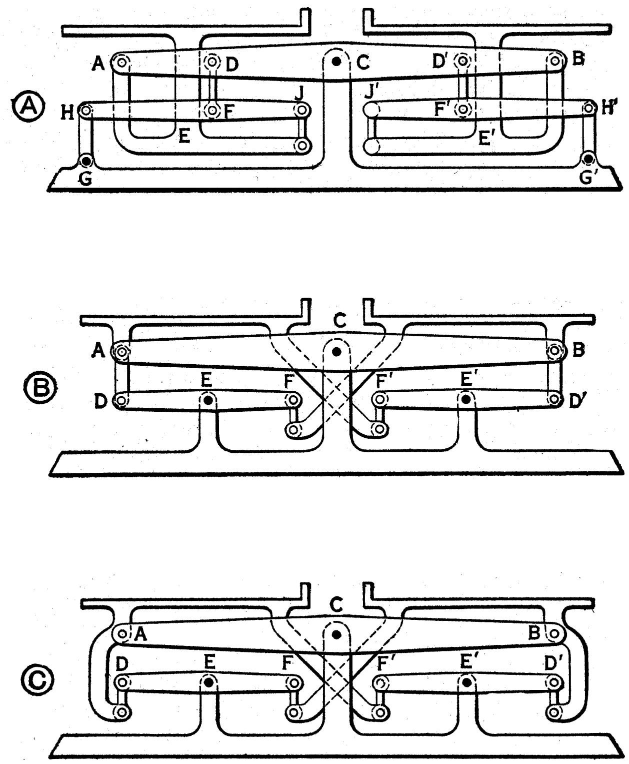


FIG. 2.— OUTLINE DIAGRAMS OF COUNTER MACHINES HAVING MORE THAN ONE WEIGHING LEVEL
(A) Béranger Balance; (B) Phanzeder Balance; (C) Modified form of Phanzeder Balance in which the links are all in tension

In fig. 1*a,* AB is an equal-armed beam pivoted on a knife-edge at C. AD and BE are vertical members pivoted with as little friction as possible to the beam and also to the link DFE, which latter is pivoted to the frame at F, the whole linkage forming two parallelograms. To the vertical legs are rigidly secured two bars from which equal weights are adapted to hang. These bars need not be fastened to the middle of the legs, nor need they project horizontally. If the parallelograms are truly equal. the balance will remain in equilibrium no matter what the position of the equal weights on the bars. It is obvious that, since the legs rise and fall vertically, the virtual velocities of the weights for any given change of inclination of the beam AB are independent of the distance of the weights from C, and are equal to each other; and it can be shown that, this being so, the balance of the system must remain undisturbed when the positions of the weights are changed. Considering the problem in the light of the principle of work, it is clear that, for a given inclination of the beam the vertical displacement of the weights is irrespective of their distance from the fulcrum C of the beam. Under such conditions equilibrium is not disturbed by moving the weights along the bars.

Any divergence of the linkage from perfect parallelism destroys the characteristics of the balance; and it is important to observe that the susceptibility to derangement through lack of equality in the lengths of the parallel members is much greater as regards the vertical legs than as regards the horizontal lever arms and links.

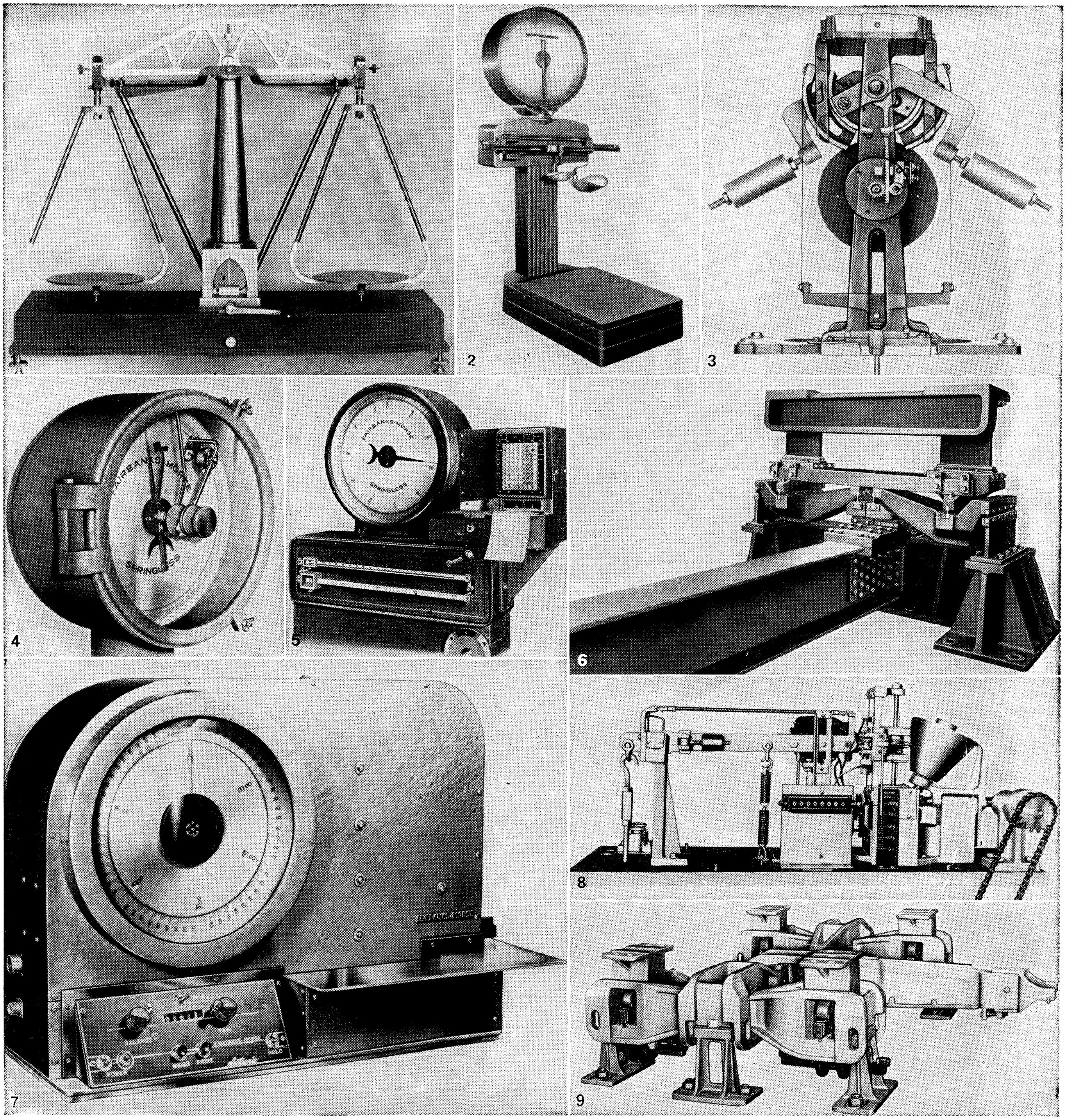
Fig. 1*b* shows a form of the device in which both weights may be placed spatially on the same side of C, though kinematically *p* is on the opposite side to *w.* A balance based on this form was made by Phitzer of Oschatz. The two principal counter machines which have been constructed on the basis of the Roberval enigma are indicated in outline in figs. 1*c* and 1*d,* and do not require detailed description. Type 1*d*—the inverted Roberval—is the better form, as the long vertical legs reduce the magnitude of the alternating tensional and compressive stresses in the stays or links DF and EF'.

In order to ensure that the parallelograms retain their true shape under load it is important that the attachment of the leg to the scalepan supports should be very rigid. In fact, good weighing with this type of balance depends on thoroughly sound design and construction.

Reference has been made to the alternation of stress in the stays or checks caused by varying positions of the load or weights. Unless a special type of pivot is employed, providing line contact on one and the same line irrespective of whether the stay is in tension or compression, a reversal of stress will always be accompanied by a change in the effective length of the stay, and, consequently, by a distortion of the parallelogram in question. This is shown in fig. 1*f.* The beautiful kinematic pivot by which this distortion is prevented is shown in diagram in fig 1*g.* Such stays require to be made with great accuracy to give satisfactory service in modern self-indicating balances, where any minute differences of load effect caused by variation in the position of the load are directly visible on the chart. To avoid reversal of stress in the stays the form of balance shown in fig. 1*e* has been devised and occasionally manufactured. Other forms have been constructed. A pointer attached to the beam to indicate over or under is useful as an aid in proportioning the weighed material for balance. U.S. counter machines are also generally equipped with a graduated steelyard, called a side beam, placed parallel to the scale beam and carrying a suitable poise. By moving this poise to the appropriate notch a balance may be obtained without the use of small fractional weights. A 16-lb. capacity scale would have a side beam of 1 lb. capacity graduated in $\frac{1}{4}$-oz. subdivisions. The use in retail trade of such counter scales is not allowed in England.

Of counter machines in which more than one load carrying lever is employed to keep a scalepan always parallel to itself throughout its permitted range of movement, the most typical is probably that of Joseph Béranger, a French scale manufacturer, who patented his device in the United Kingdom in 1849. This beautiful linkage is represented diagrammatically in fig. 2*a,* where ACB is the main beam, of which, as in all these diagrams, only one of the two side members is shown. At D and D' are pivots equally spaced from the fulcrum C. To the links DF and D'F' are suspended the subsidiary levers HFJ and H'F'J', anchored to the base plate respectively by links HG and H'G', and serving to support, by means of the links hanging from J and J', the cradles E and E', which latter are also suspended from pivots A and B of the main beam. By pillars rigidly attached to the cradles the scalepans are conveniently supported above the levers. Considering the left half of the beam, the short arm DC bears the same ratio to the long arm AC, as the short arm HF of the subsidiary lever HFJ does to the long arm HJ of the same. Hence it follows that, when the balance vibrates, if D falls 1 in, and A 2 in., J will also fall 2 in.; consequently, the cradle E, together with its scalepan, will move parallel to itself, and the load, or any part thereof, will produce the same turning moment about C whether it be transmitted directly to the main beam through A or indirectly through J, F and D. Precisely the same considerations hold in respect of the other half of the mechanism.

Another type of balance, very similar in principle to the Béranger, and much used in European countries, is the Phanzeder. In fig. 2*b* the earlier type, using compression links AD and BD'. is shown. The subsidiary levers DEF and D'E'F' are equal-armed, and it will be observed that each scalepan has one leg



BY COURTESY OF FAIRBANKS, MORSE AND COMPANY

VARIOUS TYPES OF WEIGHING MACHINES

1. Bullion and testing balance, a sensitive beam weighing machine used for precious stones and metal
2. Portable unit counting scale used to count the number of uniform pieces in an unknown quantity or to count a predetermined number of pieces
3. Phantom view of the load compensating and indicating mechanism found inside a dial scale. (The scale is shown at three-fourths capacity)
4. Dial with adjustable photoelectric control which provides an impulse at any desired weight to control material flow in any sort of batching operation
5. Dial scale and weight printer which indicates the weight and then prints on tape or tickets, or both, the weight plus any combination of numbers or symbols as set up on the keys, as well as the time, date and consecutive numbering of items weighed
6. Plate fulcrum track scale showing movable end section
7. Electric instrument which interprets and indicates weights received in the form of an electric current from the load cells of an eiectrical scale
8. Conveyor scale indicating mechanism which records the accumulated weight of material passing along a conveyor belt. The chain couples the speed of the moving belt with load being applied at the left through the rod and hook
9. Understructure or lever system of a heavy-duty two-section industrial scale

supported by a pivot, A or B, of the main beam, and the other leg supported by a link from a pivot of the subsidiary lever on the opposite side of the fulcrum.

Obviously, to avoid friction. since the arcs described by A and D, or B and D′ are of different radii. AD and BD' must be pivoted links, and not rigid projections from the scalepans. Obviously, too. they are in compression. British practice, as also in the U S., is generally opposed to the use of such compression links, which, nevertheless. when correctly designed and constructed. are quite reliable. A form of the Phanzeder balance in which only links in tension are used is shown in fig. *2c*.

The Steelyard.—This instrument. designed as a portable weighing device dispensing with the necessity for using a large number of weights, must be regarded as in all respects of a secondary or derivative nature when compared with the balance. The English word has probably nothing whatever to do with either steel or yard, being derived from the M.L.German word *stâlhof,* sample courtyard, the name for the London depot of the Hanseatic merchants. where they displayed samples of their goods, and where numbers of such instruments were in use. In the U.S., and in the British commonwealth, steelyards, especially when suspended from a tripod, are often known as weighmaster beams.

The principle of operation of the modern or Roman steelyard may be gathered from the diagram, fig. 3. AB is the steelyard freely suspended by its fulcrum knife-edge C from the fixed support D. E is the load knife-edge, and *p* the poise. shown suspended at a point F, such that the turning moments about the pivot C due to the weight of the steelyard and its parts, together with those due to the poise and the load (not sho n). are of equal magnitude on each side of C. Under these conditions the yard is in equilibrium. Supposing then, with the poise in zero graduation G. and no load except the shackle and its parts depending from E, the instrument is in equilibrium. then it is clear that the centre of gravity of the unloaded steelyard is under the suspension knife-edge C. The weight of the steelyard and its parts, under such conditions. exerts no turning moment about C. If, then, a load L be suspended from E. it will exert a turning moment $L\times CE$, and obviously this can only be balanced by moving the poise *p* away from the centre until, at a point F, the turning moment $p\times CF=L\times CE$. Since CE and *p* are constants the load varies directly as CF. Hence the graduations of the steelyard mill be of equal magnitude for equal increments of load. It is desirable that steelyards should be constructed so that the unloaded beam is in balance when the poise is in zero graduation.

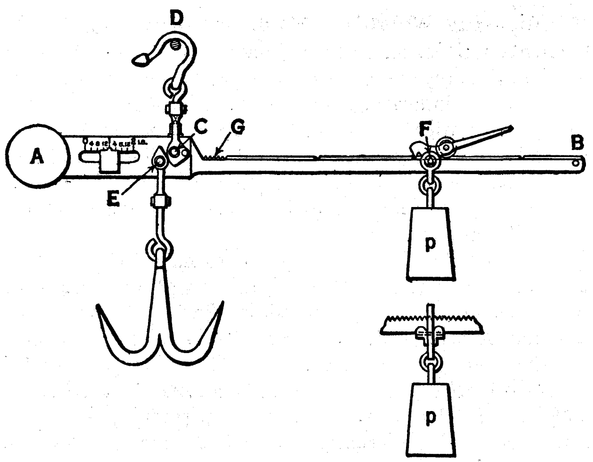


FIG. 3.— MODERN TYPE OF BUTCHERS' STEELYARD

A more primitive method of suspending the poise from the graduated yard is also shown

The Roman steelyard is an Italian invention, and probably originated about zoo B.C. in Campania, or in Magna Graecia. It was apparently unknown to Xristotle, who. in his "Mechanics," describes the so-called Danish steelyard, which we now know preceded the Roman type in classical antiquity, as also throughout the greater part of Europe and western Asia. The Danish steelyard consisted of a beam heavily weighted at one end, and provided at the other with a hook or pivot to which the load

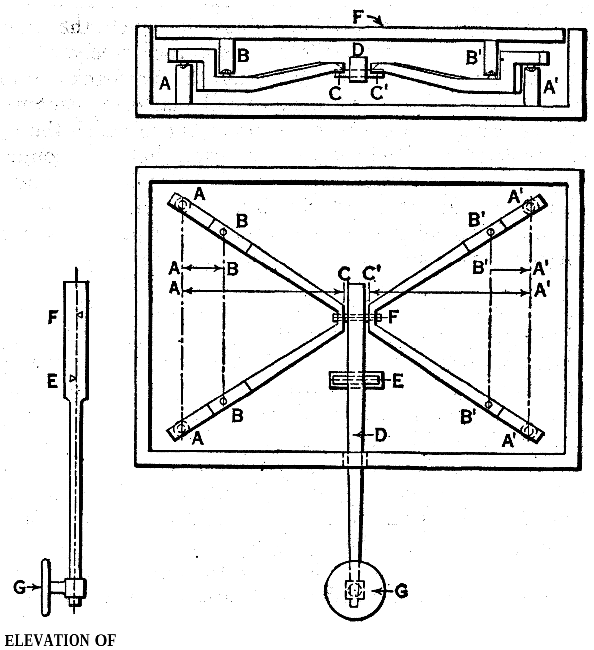


FIG. 4.— WYATT'S WEIGHBRIDGE

This first compound lever platform scale (about 1744) was the brilliant invention of John Wyatt of Birmingham

could be suspended. A loop of cord generally constituted the fulcrum. the graduated beam being moved through the loop until the load was balanced. The graduations were not equal, but formed a harmonic series. The Shetland *bismar,* the Indian *dhari,* and other instruments found throughout the east, conform to this type. The device was probably a Wiro invention, and was carried by those invaders into western and southern Europe, just as by the Aryans proper it was taken into India.

The modern Roman steelyard, still largely used by butchers, is a reliable and accurate instrument. The best makes are provided with devices to prevent undue wear of the graduation notches, and the yard proper, or blade, is made of noncorrosive steel. The notches are cut by a specially constructed dividing engine to a degree of accuracy quite unattainable by other means.

Compound Lever Platform Machine.—The usual method of weighing heavy loads is on some form of platform machine. Before John Wyatt's brilliant invention of the compound lever, about the year 1744, it was necessary to use immensely heavy and inconvenient steelyards for the weighing of loaded carts, and the operation, even in the case of a small two-wheeled hay cart, was a laborious one. Wyatt was a master carpenter or mechanic. Apparently most of his weighbridges were built when he was in the employ of the great Matthew Boulton. He died in 1766. Fig. 4 is a drawing, necessarily somewhat diagrammatic and lacking in detail, which probably represents rather closely the original scheme of Wyatt's mechanism. It has been constructed from early descriptions and illustrations. (See the 3rd edition of the Ency. Brit. [1797], under STEELYARD; John *Wyatt, Master* Carpenter and *Inventor* [1885, published anonymously, but compiled by Henry Pooley. of Liverpool], and the Wyatt manuscripts in the Birmingham reference library.)

The two triangular levers are pivoted at **A** and A', and receive the load transmitted by the stool legs of the platform F on pivots B and B'. The arms AB and X'B' are equal, as are also the arms AC and A′C′. The pivots C and C' transmit the load to the first order transfer lever D at the same distance FE from its fulcrum E. G is a table for weights to counterbalance the load. Such a combination of levers—crude as it is in construction, being devoid of links and originally having conical points instead of knife-edges —ensures the transmission to the counterpoising lever or steelyard of the same load effect by the same load, irrespective of its position on the platform. Before the close of the 18th century English builders were making machines of which the transfer levers pulled down on the ends of first order steelyards, very much in the modern manner. Whether the Fairbanks brothers of Vermont were the first to make small platform machines in which no separate transfer lever was used, but in which the upper triangular lever was provided with an extension arm connected to a steelyard, is difficult to ascertain; but their platform machines dating from the year 1831, undoubtedly marked an advance in construction and convenience of operation, and had a far-reaching effect on the development of platform machines throughout the world.

A medium capacity weighbridge of British design is shown in fig. j. The linkage consists of two triangular levers, link suspended from the framework, and connected by a central link to the upper lever, which has an extended arm. knife-edge connected to the counterbalancing and indicating device—a steelyard or automatic indicator. U.S. practice is to use a lever system composed of straight levers, with possibly some torsion levers. A torsion lever is a pipelike member with a fitting on each end which contains a load pivot and a fulcrum pivot. The load transmitted through these offset pivots twists the pipe, which is balanced at the end of a member extending perpendicular to the pipe. Thus a section composed of one torsion member and extension at each end of a

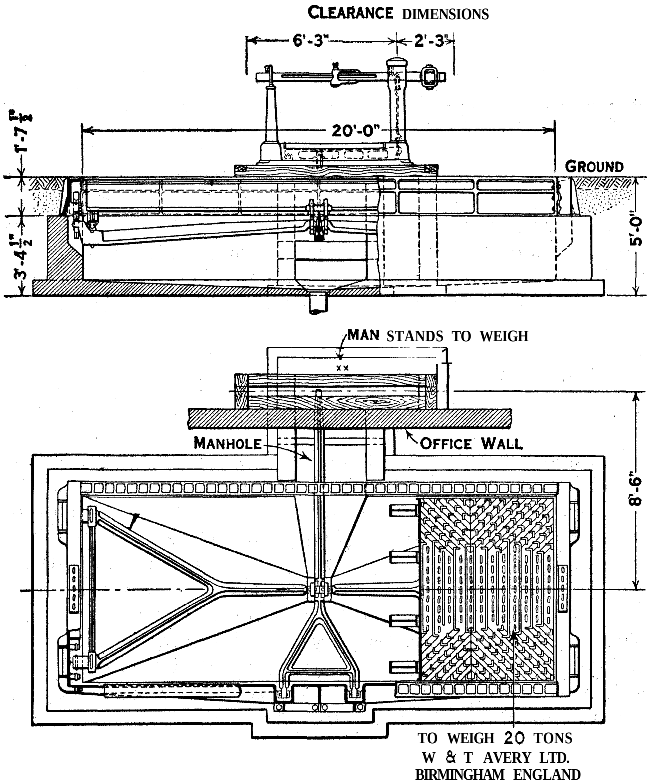


FIG. 5.— PLAN AND ELEVATION OF A BRITISH WEIGHBRIDGE CONNECTED TO A "NO-LOOSE-WEIGHT" STEELYARD

These bridges are sometimes connected to automatic dials, the load capacity of which can be multiplied several times by the use of counterpoise weights

weighbridge serves the same purpose as a section of two main straight and one extension levers, but requires one less fulcrum support. U.S. practice is to support fulcrums on pedestals from the concrete foundation. Vehicle scale linkages consist of two or four sections, depending on the length of platform and capacity of scale. Motor truck platforms 10 ft. wide and up to 60 ft. long, with weighing capacities to 50 tons, use four sections, all connected to one transverse extension lever for carrying the load to steelyard or other indicator. Railroad linkages are similar to those of motor truck scales and are made up to 110 ft. long, usually with four sections of capacities to 200 tons per section. Railroad track scales can weigh moving cars at the rate of about 5 per minute, whereas spotting for stationary weighing would allow about 18 per hour. The minimum indicator graduations may be 20 lb. The accuracy of such scales in heavy exposed service should be 0.1% to 0.2%. The use of long levers tends to minimize loss of accuracy by dulling pivots from heavy shock loads. Automatic printing devices attached to vehicle scales give quick proof of reading. Three seconds after the wheels of the freight car are on the scale a printed ticket is available. Heavy scales provided for weighing vehicles are subjected to considerable shock by approaching and suddenly stopping loads, and hence must have generous excess capacity. Suspensions to allow motion of the aeighbridge and checks to limit travel are built in, allowing horizontal motion and protecting the pivots. Another suspension system uses steel balls between cups on the weighbridge and loading pivot, providing freedom of motion and restoring action as well. The weight of railroad cars is transmitted to the weighbridge through sections of track isolated from the connecting track. If locomotive passage over this section transmits forces too great for the capacity of the system dead rails may be provided. These rails parallel the live rails and are supported by transverse beams bearing directly on the foundation, thus protecting the pivots of the weighing machine.

Plate Pivot Machines.—Of recent years there has been developed, in the United States, a type of weighbridge in which knife-edges are replaced by thin plates or laminae used in compression. These are all derived from the work of A. H. Emery, who, in the year 1875, successfully applied this type of pivot to the construction of a remarkably fine testing machine. There is no doubt that some admirably reliable and sensitive weighbridges have been constructed with plate fulcrums; but their cost at present prevents their general adoption. It is claimed that weighbridges built on this principle remain in accurate and sensitive adjustment even if subjected to severe conditions of use. The plate fulcrums and load pivots are made of chrome-vanadium steel, and their cross sectional area is sufficient to provide an ample margin of safety. The amount of flexure to which they are subjected in use is extremely small. The platform is restrained from horizontal movements by the tension of horizontal plates or rods sufficiently flexible to permit the minute vertical movement required for weighing. The lever system is similar to that of knife-edge lever machines. E. and T. Fairbanks and company, of St. Johnsbury, Vermont, constructed the first plate fulcrum railway track scale in 1915.

Self-indicating Weighing Machines.—The most important developments in the science of weighing instruments in recent years have, unquestionably, been associated with the evolution of the modern automatic indicating weighing machine. In these machines the load is automatically balanced by a resistant counterforce accompanied by a means of indicating the load. The variable counterforce is applied by helical springs or a pendulum (a bent lever with a large mass at the free end) whose effective moment arm varies with its displacement.

The first self-indicating scales appear to have been invented by Leonardo da Vinci (1452–1519). They are described and drawn in one of his notebooks preserved at Paris. (Manuscripts in Bibliothèque de l'Institut. See *Les Manuscrits de Léonard de Vinci, publiés en fac-simile,* etc., par C. Ravaisson Mollien, 6 vol. [1881–91]. *See* also *The Mechanical Inventions of Leonardo da Vinci,* by I. B. Hart [1925].) His description appears to make it certain that he had actually constructed one of these instruments. A semicircular dial, suitably weighted, is suspended, at the middle of its diameter, on a pivot from which also hangs a plumb line, situated so as to serve as an indicator. A scalepan hangs from one end of the diameter. The design has a remarkable characteristic not shared by many modern instruments, *i.e.,* the accuracy of the indications is not affected by any divergence from horizontality of the surface on which the instrument is placed.

A pendulum or bent lever resistant does not give equal chart divisions on a circular or segmental chart unless a cam or other equivalent device is used in the application of the load to the resistant, so as to counteract what has been called the circular error of the pendulum.

4s the pendulous mass is raised by the fall of the load, its resistance increases as the sine of the angle of displacement from the vertical. At the same time, unless the load has been applied by a strap passing around a circular arc concentric with the centre of rotation. the effective length of the arm to which the load is applied will vary. Supposing, in the most simple case. that when the instrument is unloaded the load arm is horizontal and the centre of gravity of the pendulous mass vertically beneath its pivot then the application of a load will deflect the system until a position of equilibrium is attained. During this movement the effective load arm will become shorter in the ratio of the cosine of the angle of deflection. and the resistant arm will increase from zero in the ratio of the sine of the angle. Hence, the load in all balanced positions will vary as the tangent of the angle of deflection, and a pointer attached to the pendulum will not indicate equal chart graduations for equal load increments Generally if the load arm makes an angle ϕ with the horizontal. and the pendulum an angle θ with the vertical, the applied load being L, the following relationship will hold:

$$\mathbf{L} \propto \frac{\sin\theta}{\cos\phi}.$$

Obviously, with a small angle of deflection the graduations will be approximately equal to each other, for the arc traversed will be nearly proportional to the trigonometrical function of its angle. Weighing machines have been constructed using such small angles of rotation in order to get virtual equality of subdivisions. as is required by the regulations of the various national weights and measures authorities. Where a machine is permanently and securely positioned, and extreme sensitivity is not required, little exception can be taken to this method of construction, which has the great advantage of extreme simplicity and robustness of design.

The sensitivity of a pendulum resistant is, however, within limits imposed by technical considerations, a function of the amplitude of the angle of rotation; and furthermore, the larger the angle the less the derangement that will result from such minute differences of level as may supervene after installation. Hence has arisen a multitude of designs for utilizing a considerable angle of rotation, as 55° for instance, while still obtaining equality of subdivisions. Various parallel motion and tangent bar devices have been constructed, but the most generally employed method makes use of a cam formed by eccentrically displacing a circular arc in respect of the axis of rotation. To the periphery of this cam the load is applied by means of a flexible metallic strap. *(See* fig. 6. *a* and b.) A close approximation to absolute equality of subdivisions is possible if the best geometrical configuration is adopted. Fig 6a is a diagram of the mechanism of the well-known fan type of self-indicating counter machine. The combined counterbalancing and indicating unit is pivoted on a knife-edge housed in V-shaped bearings. Fig. 6b is a diagram designed to show that the rate of change of the products of the "circular cam" arm lengths and their respective loads closely approximates to the rate of change of the pendulum moment arms, nhich latter, as has been stated above, conform to a sine law. The two rates of change are made to counteract each other in just the measure necessary to permit of the use of equally divided charts. The dimension d indicates the linear displacement of the cam circle from the centre of oscillation.

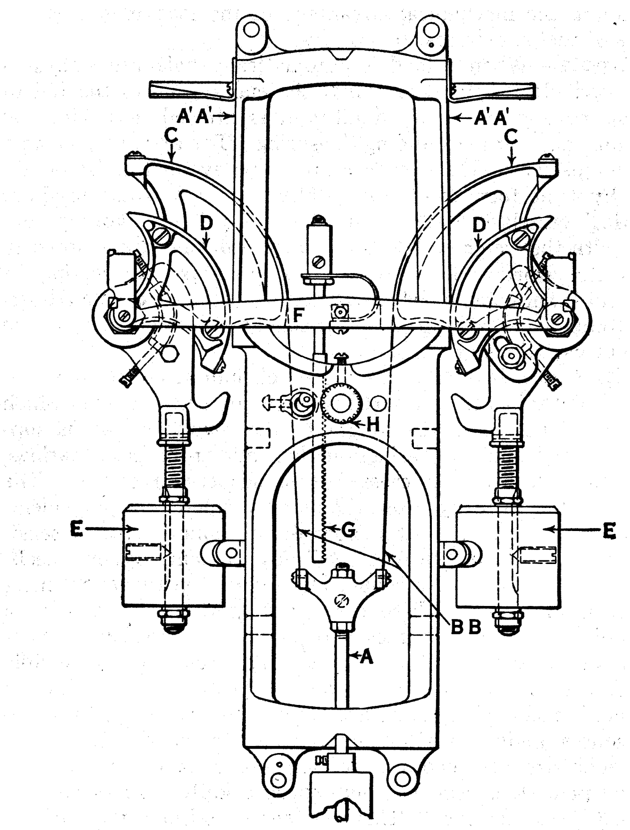


FIG. 7.— MECHANISM OF THE "TOLEDO" SELF-INDICATING PLATFORM MACHINE

(A) Connecting rod attached to weighing levers. Yoke connected by steel straps (BB) to the cams (CC), which are attached to segments (DD) and to pendulums (EE). Segments are suspended from the frame by straps (A'A'). The bar (F) sensitively pivoted to the centres of the circular segments (DD) is raised together with the elastically supported rack (G) which rotates the pinion (H)

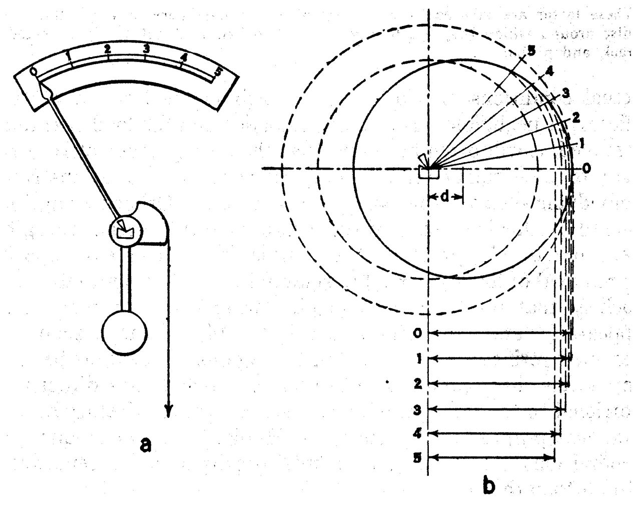


FIG. 6.— THE PENDULUM RESISTANT

(a) Diagram of the mechanism of the Fan Scale used for weighing small quantities in retail shops; (b) Diagram showing how the arm lengths of the cam vary with the angle through which the pendulum moves

The well knonn cylindrical computing scale embodies a resistant of this type, the cylinder itself being carried on antifriction uheels. and rotated by a pinion engaging with a vertically moving rack connected pivotally with the neighing lever. Some types of dial mechanism employ a resistant consisting of two pendulums rotating in opposite senses, thus eliminating the effects of out-of-level disturbances In a nell known U.S. type of mechanism. floating fulcrums replace stationary knife-edges. *(See* fig. 7.) The load is transmitted by straps to the load cams to which are attached cams supported from the frame by straps As the load is applied through tapes, the suspension cams roll about their strap contacts at the frame producing an upuard advancing pivot as the pendulum arms rotate outward. The use of two weights offsets the effect of uneven setting of base. The upward movement of the pendulum cam centres is transmitted through a rack meshing with a pinion to sneep the pointer around an indicator dial. Accuracy is dependent upon carefully cut gear teeth, good tooth contact and freedom from wear. The rack may be held in controlled mesh with the pinion by means of spring, roller or magnet. One redesigned scale dispensed with the rack pinion drive by substituting straps around multiplying drums.

A three-cam system whereby the leverage of the weight is varied by cam contour is illustrated in fig. 8. The load is transmitted by straps to the load cam and rotates the cam system about the suspension cam pivot at its tape contact point. This has the effect of diminishing the mechanical advantage of the load in raising the weights of the pivoted resistant levers.

Dashpots. — When a load is automatically balanced against a simple variable resistant, only half the energy due to the fall of the load to a position of equilibrium is utilized in raising the pendulous mass, or in extending the spring. The remaining energy, if violent oscillations and shocks are to be avoided, must be absorbed by some form of dashpot. The devices generally used are cylindrical vessels containing oil. in which pistons pivotally connected with the weighing levers by suitable linkage are adapted to reciprocate. Ports, in the piston, or in a tubular part connecting the upper and lower ends of the oil-containing chamber, enable adjustments to be made to compensate for changes in the viscosity of the oil due to variations of temperature.

Antifriction Devices. — In those self-indicating machines in which a pointer has to be rotated round a circular dial, or in which a moving dial is used, the weight of the revolving part is supported on frictionless bearings — either miniature ball bearings, antifriction wheels, or a crossed-strap suspension device. The first of these is, in many cases, the most commercially convenient, but does not permit the attainment of the same degree of sensitivity that is possible with really well-designed antifriction wheels.

Crossed-strap Device, introduced by Avery, constitutes the most frictionless method yet discovered of supporting and rotating a large indicating unit. No rack and pinion is necessary. A rotational angle of about 300° is possible. The weight of the spindle carrying the rotating part is entirely supported by two pairs of thin steel bands. These pairs are secured to, and wrapped in opposed senses about, a small drum attached to the spindle. Their upper ends are attached to the opposite ends of an inverted weighted pendulous segment, pivoted on a knife-edge working in V-shaped agate bearings. This segment constitutes the variable resistant, and carries a cam or displaced circular arc so disposed eccentrically to the fulcrum as to give equal chart subdivisions for equal fractions of the total load. The load effect or pull is transmitted from the main weighing lever to this cam by means of a long flexible steel strap. As the segment rotates on its knife-edge it unwinds one pair of straps and winds up the other pair at exactly the same rate, thus rotating the drum mounted on the floating chart-carrying spindle, while maintaining it in exactly the same position.

Other resistants beside the bent lever or pendulum have been and are used in weighing mechanisms. Of these the chief is the spring. The most commonly used form is the helical spring. For some purposes its employment is quite legitimate; nevertheless, the chief constructors of self-indicating weighers throughout the world have, with few exceptions, abandoned it as a resistant in entirely automatic weighing mechanisms. It has three outstanding defects, two of which result from its susceptibility to changes of external temperature. The substance of all steel springs expands or contracts in length with variations of temperature, and this generally affects the zero indication of the balance. It can be shown that, in the case of a properly proportioned helical spring in the unloaded state, the change in length of the wire caused by temperature change makes practically no difference in the actual length of the helix; but in a weighing instrument such a condition of no-load never occurs in practice. Temperature also affects the specific elasticity of springs. When a spring is warm it extends more under a given load than when cold. Hence, even if the scalepan is empty, the greater extension of the spring under its initial load resulting from the weight of necessary parts, displaces the zero indication. To a still greater extent the whole range of indications is affected. In a large measure this defect can be compensated for by means of a thermostatic device made of two dissimilar metals, so disposed that the transmitted load-effect can, by means of a change of leverage, be given a greater or less mechanical advantage before its application to the spring resistant or by using a special metal alloy unaffected by temperature.

The third source of error is more serious and cannot be completely eliminated, though it is proper to note that, under the actual conditions in which many weighing machines operate, its effects are negligible. If a spring is loaded and the load is gradually removed, it will often be found that the spring does not return exactly to its original conformation; hence. the zero of an instrument embodying such a spring will not be constant. Other derangements caused by this hysteresis of the elastic material of the spring have been noted. In practice, the gradual and shockless deposition or removal of loads referred to seldom takes place, and vibration—such as that resulting from neighbouring traffic or machinery—appears generally to eliminate this trouble in the case of well-designed spring-operated machines. Against these drawbacks the spring has the great advantage of giving deflections directly proportional to the load, thereby producing without alteration. for all practical purposes, conformity to Hooke's law, *i.e.,* equal chart subdivisions. Moreover, it is intrinsically a more sensitive resistant than the pendulum.

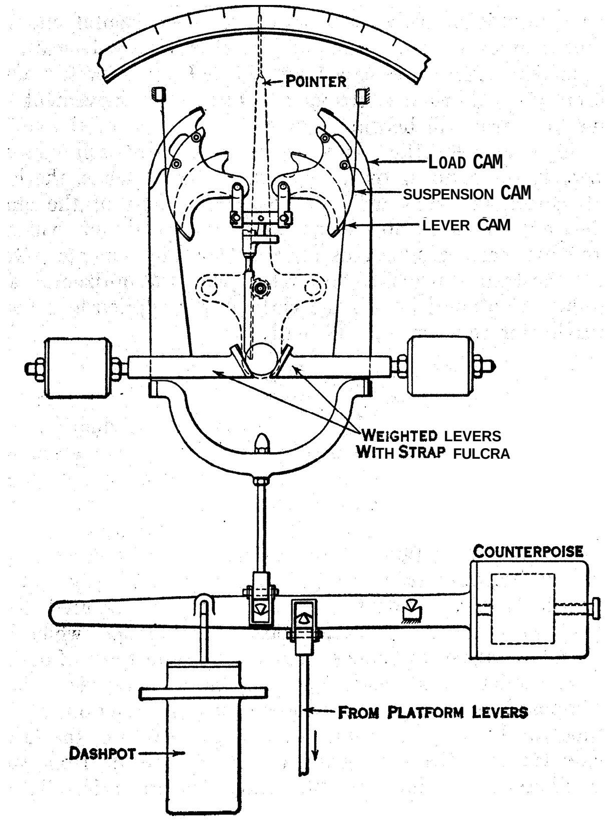


FIG. 8.—AVERY CAM-RESISTANT MECHANISM

A variable resistant is obtained without the use of pendulums, two sets of suspended triple cam contours so designed as to give to an increasing load a diminishing mechanical advantage in its efforts to raise the weighted levers. These latter are pivoted by steel straps to the periphery of a small circular disc around which they are free to roll. The balanced pointer is operated by rack and pinion

The hydrostatic resistant has been made in various forms. It depends on the buoyancy of a float and its resistance to vertical displacement. A mercury resistant embodying the same principle has also been extensively used.

Computing Scales. — Entirely automatic self-indicating counter scales are very generally adapted to indicate, not only the weight of the goods, but the particular value of the weight corresponding to a large number of different unitary prices. Collinear with each weight graduation is a series of price indications — the respective unitary prices, as, for instance, prices per pound avoirdupois being marked either on the pointer, if the dial is of the stationary type, or on the revolving chart itself.

Automatic Feed Scales.—This name is given to a large class of mechanisms by means of which granular and liquid materials may be automatically weighed off in predetermined amounts. It is possible to weigh in this manner practically all materials which can be induced to flow through a port or valve of reasonable dimensions. Thus modifications of the same general type of scale will weigh flour and the most finely ground cement, while others will weigh coal and ores broken up in lumps not exceeding say 2 or 3 in. in diameter. In general terms such a machine—one form of which is illustrated in fig. 9—may be defined as consisting of a hopper I, or box terminating a feeding spout, and equipped at its lower end with a pivoted gate D, or gates, adapted, when opened, to permit a flow of material into a scale hopper C, placed immediately beneath it. This receptacle depends from one end of an equal-armed balance beam A. the other end of which carries a weight box B. When the scale is empty the weighted end of the beam causes the hopper end to rise, and by contacting with a part pivotally connected by links to the above mentioned gate or gates, forces them to open, thus causing the rapid filling of the receptacle with the material being weighed. The bottom of the scale hopper is closed by a large discharge valve E, to which is connected linkage so designed that, when this door is closed, the linkage forms a locked dead centre. This device, often called a toggle, is indicated at the right of the receptacle in the illustration. Other and different devices, as detent mechanisms, are sometimes used to keep the bottom door securely fastened until the receptacle has received its proper load.

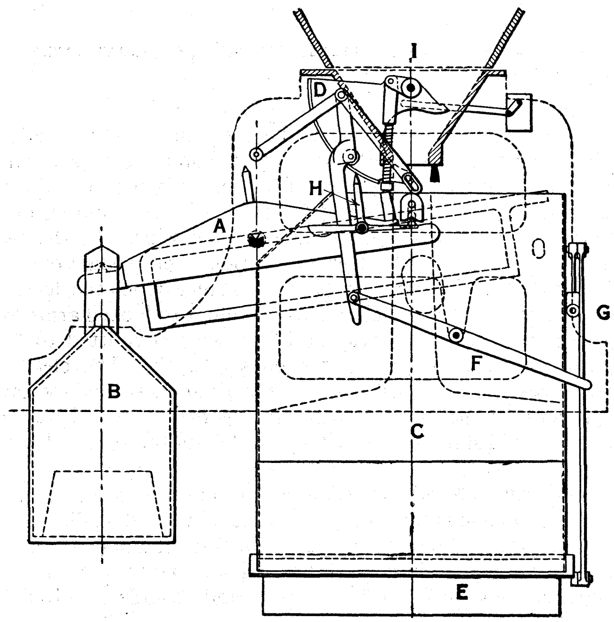


FIG. 9 — AUTOMATIC FEED SCALE

A diagram of a grain weigher for automatically weighing wheat and other grains. The material is stored in the hopper I, the gate D being opened by the upward pressure of the empty receptacle C due to the weights in the scale-pan B. When the load in the receptacle balances the weights the receptacle falls, closes the supply gate and 'opens the discharge valve E

As a state of equilibrium is approached, the weights no longer hold up the receptacle forcibly against the device which controls the opening of the hopper valve. Consequently. this valve gradually closes, and the final cutoff is arranged to take place just when a balance has been obtained. In some types of this mechanism the balanced beam, in falling aaay from the gate-opening mechanism, causes contact to be made between a lug or peg attached to the framework, and the linkage or detent system controlling the discharge valve; or, alternatively, as in fig. 9, a part connected with the feed gate is adapted to break the dead centre or toggle mechanism of the discharge valve linkage. at the moment when the hopper valve has completely closed. A small force, properly applied, suffices to effect this release. The moment this takes place the discharge valve E opens, and the weighed material falls into another receptacle, generally connected with a conveyor or elevator.

Such, in brief outline, is the principle on which practically all automatic feed weighers act. Many refinements are, however, necessary in practice. and to the chief of these some reference must be made. At the moment when the receptacle has received its true weight of material, and the beam is moving to the balanced position, there is a considerable weight of material in the act of falling from the closed feed port to the receptacle. To compensate for this amount, which would otherwise overload the balance: a compensating lever is employed. This lever is shown outlined in the illustration as lying parallel to the scale beam. It is pivoted to the frame, and adapted by means of an adjustable poise. not shown, to press upon the load receptacle: or some connected part, while the receptacle is being filled. Consequently, the receptacle tends to fall to the balanced position before it has obtained its full load, thus closing the feed port. The weight of material in the air at the moment of cutoff exactly compensates for this deficiency. If desired, the accuracy of the weighing can be immediately checked by raising the compensating lever before the hopper has had time to fall sufficiently far to cause discharge to ensue, or by preventing discharge in some other convenient manner. If the adjustments have been properly made, the beam will be found in perfect balance. In order to render the cutoff still more precise, in practically all larger weighers a small valve called a dribble valve is used in addition to the main valve or valves. The main valves are closed before the weighing is complete, but the dribble port continues open until closed by the release of a detent, or, in some mechanisms—as in the grain weigher illustrated in fig. 9—by the continued movement of the main valve. In some makes of machine, especially those used for weighing grain, the edge of the feed valve port is rimmed with a brush in close proximity to which the closing valve moves very smoothly and without risk of jamming.

The action of the particular type of weigher illustrated may be followed in a little greater detail. F is a lever connected to the feed valve linkage. When this valve is nearly closed, the little wheel shown on the vertical link is resting on the steel pin H, attached to a pivoted counterbalanced lever. Later, when the loaded receptacle falls to the balanced position, a pin contacts with the counterbalanced lever and throws H over to the right. The valve then closes completely, and the free end of the lever F rises and contacts with the pin G, thus breaking the dead centre and causing the discharge valve E to open.

Small automatic feed weighers, used for filling packets with standard quantities of material, are often operated electrically, as this enables great accuracy to be attained. In such devices, the instantaneous and energetic shutting of the feed port is actuated by the indicator through either a mercoid-magnetic switch, a high-voltage gap, or a photoelectric cell. Several adjustable cutoff positions are provided. A stepped interceptor of light to a photoelectric cell can give controlled dribble before cutoff.

Conveyor **Weighers.**—Of recent years various conveyor weighers have been developed, and have filled a useful place in the bulk weighing of materials where no great accuracy is required. The principle of operation of one form may be briefly outlined. If a conveyor belt is made to pass over rollers supported by a system of weighing levers, which system is in turn suitably connected to a variable resistant, the resistant will respond to the varying weight of material on the belt. If this weighing device, as regards its load indications, is connected with a device responding to the velocity of linear movement of the conveyor belt in such a manner that the one numerical magnitude is multiplied by the other, it is obvious the product may be evaluated to represent the weight of material passing along the conveyor in a given time. Various methods, some mechanical and others electrical, have been designed to effect this multiplication.

Totalizer. — This weighing machine is of the automatic moving poise type, and is generally used for the automatic weighing and recording of the total of the separate loads contained in a series of receptacles or trucks placed successively on the weighing platform. As each load is imposed an electrically propelled poise moves out along a steelyard connected to the weighing machine, and effects a balance, at the same time operating a counting device which records and adds on to the total of previous weighments the weight of the newly imposed load. Such mechanisms are capable of accurate and reliable adjustment. The divergence of the weight indications of the mechanical counters, when such a machine is working under reasonably good conditions, from the true weight of the total loads should not exceed about one-fifth of 1%. About the same standard of accuracy is often attainable with high-class automatic feed weighers.

Weighing as a Means of Counting.— A great extension of this convenient method of counting things of uniform weight has taken place in recent years. Immense numbers of small parts and finished articles are produced by modern methods of machining and fabrication under conditions which ensure that the weight of each piece will be approximately the same. Hence, if a balanced system of linked levers is constructed having two receptacles connected therewith, one large and one small, at points at which the mechanical advantage of a weight deposited in the small pan is 100 times greater than that of the same weight if deposited in the larger pan, it is obvious that equilibrium can only be obtained by placing 100 such weights in the large pan for every one deposited in the small pan. Hence if, for instance, it is desired to count bolts of uniform pattern in hundreds, one bolt is placed in the small pan and a quantity in the other, the number being rapidly adjusted until a balance is obtained.

Load Cells.—Where large beam machines are not suitable for weighing heavy or bulky objects, load cells are convenient. These are small, portable units that operate on electric, hydraulic or pneumatic principles. The electric cell consists of a load-carrying bar to which are attached four matched wire gauges electrically connected in a Wheatstone bridge circuit subjected to a direct current voltage. When the bar is loaded in tension or compression its deformation changes the resistance of the two loaded grids so that the circuit is electrically unbalanced proportionally to the load. The unbalance is amplified and transmitted to an indicating motor. Electric cells are available in sizes 0 to 200 lb. and up to 1,000,000 lb. Small size, excellent sensitivity and accuracy (better than 0.25%), small deflection and indifference to vibration along with high capacity and remote indication make it suitable for many applications, particularly automatic process control. Hydraulic cells utilize a thin film of oil between a piston and diaphragm. Pressure is generated by a short stroke and transmitted to an indicator with an accuracy of about 0.1%. Cells are extremely sensitive but are unsuitable for oscillating loads. Capacities are up to 5,000,000 lb. Pneumatic cells are supplied with air under pressure from an outside source to balance load applied on a piston. Principally used for light to medium loads over a limited range, these cells are more popular for control than for weight measurement.

Developments in transmitting readings electrically over long distances, optically magnifying and projecting readings for clear viewing, and refined automatic printing of weight recordings rapidly were being made in the mid-1950s. Application of dynamic weight control with prompt response and small movement are a requisite in the development of automation.

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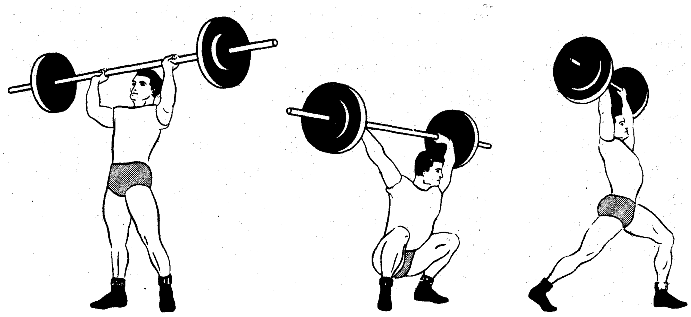
WEIGHT LIFTING. Weight lifting is a competitive sport, which is included in the Olympic games and governed by rules established by the International Weight Lifting federation. Champion weight lifters, like all champion athletes, must have co-ordinated speed and agility and a will to win. More than other sports, however, weight lifting requires strength.

Exercise similar to weight lifting, called weight training, is also practised by those who exercise with a bar bell (and dumbbells) to develop strength, to improve physical appearance, to increase power in order to succeed in other sports or to rehabilitate parts of the body weakened by illness or injury.

A bar bell is a steel rod handle to which removable cast-iron disks



A B C

AFTER J. A. MURRAY

THE THREE BASIC LIFTS: (A) PRESS. (B) SNATCH (SQUAT STYLE), (C) CLEAN AND JERK

are attached at the ends to vary the resistance. Dumbbells are simply short bar bells, used one in each hand. Competition involves a bar bell and three lifts. The winner is the one who lifts the highest total weight on the (A) press, (B) snatch and (C) clean and jerk. In case of a tie, the lighter man wins. In the press, the bar bell is lifted to the chest in one pull, then pushed overhead by the arms and shoulders without assistance from the legs. In the snatch, the bar bell is pulled from the floor to locked arms overhead in a single motion, with the lifter being permitted to lunge or squat under the weight as it travels upward. The clean and jerk is a two-movement lift, one to the chest and a second overhead, but leg action is not restricted, as in the press. The lifter may lunge, squat and start the bar bell upward from the chest with a leg drive.

Weights can be lifted for exercise in an infinite variety of ways. The main principle is that when a muscle is worked against gradually increasing resistance over a period of time. it becomes stronger (and to some extent larger). Pressing a weight overhead from the shoulders adds strength to the arms and shoulders. Holding a weight on the shoulders and doing knee bends strengthens the legs. Such basic exercises are usually done with five to ten repetitions. Scientific studies have shown that weight lifting does not slow the speed of muscular contraction and has a low incidence of injury.

For Olympic champions. see OLYMPIC GAMES.

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WEIGHTS AND MEASURES. The U.S. customary system of weights and measures, the British imperial system and the metric system are treated in detail in this article, and the systems and units used in some other countries are briefly considered.

Some consideration is given to the materials used as standards, to the conditions necessary to specify in order that standards may correctly define the units, and to weights and measures administration. Reference should be made to the articles on METROLOGY and PHYSICAL UNITS for additional information about units and standards, and to the article on TIME MEASUREMENT for information about units of time.

Other related articles are those on GRADUATION AND CALIBRATION; DIMENSIONAL ANALYSIS.

The **U.S.** Customary System.—The weights and measures in common use in the American colonies at the time of the American Revolution were all of English origin and were the same as those then in use in Great Britain. As the system of weights and measures in Great Britain at that time was far from being on any scientific basis, it is not surprising that there was considerable lack of uniformity in the units in the colonies. The need for fixing the standards was recognized by the framers of the Articles of Confederation and of the constitution. The subject was often discussed but no definite action was taken for many years. On May 29, 1830, the senate passed a resolution directing the secretary of the treasury to cause a comparison to be made of the weights and measures in use in the principal customhouses and to report to the senate at its next session. The investigation was made and large discrepancies were found in the weights and measures in use. The average values of the several units were, however, all reasonably close to the corresponding values in the British system in 1776. Real progress was made toward the unification of weights and measures in the United States by the subsequent distribution of uniform standards to the customhouses based on the following: (1) the yard of 36 in., (2) the avoirdupois pound of 7,000 gr., (3) the wine gallon of 231 cu.in. and (4) the Winchester bushel of 2,150.42 cu.in. These units are still in use in the United States. The wine gallon, usually referred to as "the gallon" or "the U.S. gallon," is used only for liquid measures; and the Winchester bushel, usually referred to as "the bushel," or "the U.S. bushel," is used only for dry measures.

The yard is subdivided into three feet of 12 in. each. Five and one-half yards ($16\frac{1}{2}$ ft.) make a rod, pole or perch; 40 rods make a furlong; and eight furlongs (5,280 ft.) make a statute mile. Units of area and volume are simply the squares and cubes, respectively, of the units of length, except for the insertion of the acre, which consists of 43,560 sq.ft.

The avoirdupois pound is subdivided into 16 oz., or 256 drams or 7,000 gr. It should be noted that the grain is the same whether it is avoirdupois, troy or apothecaries' weight and that the avoirdupois ounce contains $437\frac{1}{2}$ gr. whereas the troy ounce and the apothecaries' ounce each contains 480 gr. One hundred pounds equals a hundredweight and 2,000 lb. equals one ton—designated as "net ton" or "short ton" to distinguish it from the "gross ton" or "long ton" of 2,240 lb.

The U.S. gallon is divided into four liquid quarts, or eight liquid pints or 32 gills. The gallon, quart and pint of the apothecaries' fluid measure are, respectively, the same as the corresponding unit of the ordinary liquid measure. The pint is subdivided in the apothecaries' fluid measure system into 16 fluid oz., or 128 fluid drams or 7,680 minims. The U.S. bushel is subdivided into four pecks, or 32 qt. or 64 pt.

For more complete information on units of the U.S. customary system reference is made to miscellaneous publication M233 of the national bureau of standards, entitled *Units of Weight and Measures (United States Customary and Metric)—Definitions and Tables of Equivalents,* and to Circular 570 of that bureau, entitled *Units and Systems of Weights and Measures—Their Origin, Development, and Present Status.*

It was not sufficient, however, that a decision was made in 1832 as to the units and measures for the United States; it was also necessary to adopt physical standards embodying those units. For the yard the length at 62° F. of the interval between the 27th and 63rd inch of a certain 82-in. brass bar known as the Troughton scale was adopted; for the pound, the troy pound of the mint was used, the avoirdupois pound being defined as $\frac{7{,}000}{5{,}760}$ troy lb. As already stated, the gallon and the bushel were defined in terms of the inch. For more than half a century those having the custody of U.S. weights and measures tried to keep the U.S. pound equal to the British pound and the U.S. yard equal to the British yard. But in 1893. after receipt of the metric standards, it was decided that a more stable basis for the system of customary weights and measures in the United States would be obtained by defining the yard in terms of the metre and the pound in terms of the kilogram using the U.S. prototype metre and the U.S. prototype kilogram, respectively, with their certified corrections as the primary standards of length and mass in this country. This is the present basis of the units. The U.S. yard was defined as $\frac{3{,}600}{3{,}937}$ m. and the U.S. pound as 0.4535924277 kg.

Effective July 1, 1959, the following exact equivalents were adopted by the national standards laboratories of Australia, Canada, New Zealand, South Africa, the United Kingdom and the United States: 1 yd. = 0.9144 m.; 1 lb. (avoirdupois) = 0.45359237 kg. From the first of these equivalents it follows that 1 in. = 25.4 mm. In the U.S. the survey foot, defined as $\frac{1{,}200}{3{,}937}$ m., will be used in connection with geodetic surveys for values expressed in feet.

It is to be noted that although the *mass* of a body, often defined as the quantity of matter in a body, remains constant everywhere and under all conditions as long as no portion of the body is taken away and no matter added to it, its *weight,* being a force equal to the product of mass of the body by the acceleration of gravity, varies with the locality in which it is measured *(see* MECHANICS: *Newton's Laws).* Where a standard or normal value for the acceleration of gravity is wanted in weights and measures work the value used is 980.665 cm./sec.^{2} (or 32.1740 ft./sec.^{2}) as adopted in 1913 by the fifth General (international) Conference on Weights and Measures.

The international prototype kilogram is defined as a standard of mass, and the U.S. pound is therefore regarded in weights and measures work as a unit of mass. The word *weight* has often been used in the sense of *mass* and critical reading is often necessary to determine in what sense this word has been used. This remark also applies to the French word *poid.*

The British Imperial System.—The British system of weights and measures evolved from units having many origins, many of the units having been introduced into Britain at the time of the Roman conquest. Some rather old standards are still in existence, as, for example, the Winchester bushel of Henry VII and the standard hundredweight of Elizabeth I. These and other standards are deposited in the Jewel tower at Westminster, London. At the council chambers at Edinburgh and Linlithgow there are some interesting standards of Scotland, including the Stirling jug or Scots pint, 1618; the choppin or half pint, 1555; the Lanark troy and trone weights of the same period.

By the beginning of the 19th century the units of length and mass for Great Britain had been fixed more or less approximately at their present values. Two different gallons were, however, in use: the wine gallon of Queen Anne containing 231 cu.in., and the ale gallon of 282 cu.in. Both these gallons were abandoned by the British in 1824 when the present British gallon (277.42 cu.in.) was adopted. When the houses of parliament were burned on Oct. 16, 1834, the standard pound and the standard yard were destroyed. The scientific studies and investigations in weights and measures which followed, the construction of new standards, the passage of weights and measures acts and the establishment of scientific laboratories, first the standards department of the board of trade, established in 1870, and later the National Physical laboratory in 1900, brought about a unified system of weights and measures.

The basic units of the British imperial system are the yard, the pound and the gallon.

The British imperial yard is defined (Weights and Measures act, 1878) as the distance, at 62 00° F., between two fine lines engraved on gold studs sunk in a specified bronze bar known as "no. 1 standard yard." This bar was cast by Troughton and Simms in 1845.

The British imperial pound is defined as the mass ("the weight *in vacuo*") of a cylinder of pure platinum about 1.35 in. high and

1.15 in. diameter. This is the only pound legal for use in Great Britain and is sometimes called the avoirdupois pound, the troy pound having been abolished with other troy weights from Jan. 1, 1879, by the Weights and Measures act of 1878, with the exception only of the troy ounce, its decimal parts and multiples, legalized in 1853 by the act of 16 Vict. c29, to be used for the sale of gold and silver articles, platinum and precious stones.

The British imperial gallon is the volume of ten pounds avoirdupois of pure water as weighed in air against brass weights, the temperature of the air and the water being 62° F. and the barometric pressure 30 in. of mercury. This legal definition is incomplete; for instance it does not state the density of the brass weights, but in official comparisons this density is taken as 8.143 g. per cm.[3]

The multiples and submultiples of the British yard are similar to the corresponding units of the U.S. customary system. The British pound is subdivided into 16 oz., or 256 drams or 7,000 gr. Fourteen pounds equals one stone; two stones = one quarter (28 lb.); eight stones = one hundredweight = 112 lb.; and 20 cwt. = one ton = 2,240 Ib. In the apothecaries' weight system 20 gr. make one scruple; three scruples make one drachm; and eight drachms make an apothecaries' ounce, the grain being the same as in the avoirdupois system.

The British gallon, as defined above, is by calculation equivalent to 277.42 cu.in. It is used as a unit of capacity, both liquid and dry. The British gallon is divided into four quarts. or eight pints, or 32 gills or 160 fluid oz. (the U.S. gallon being divided into 128 fluid oz., the result is that the British fluid ounce is smaller than the U.S. fluid ounce, whereas the other British units of capacity are larger than the corresponding U.S. units). Two gallons make a peck, eight gallons make a bushel and eight bushels make a quarter. In the British apothecaries' liquid measure system the fluid ounce is divided into eight fluid drachms, or 24 fluid scruples or 480 minims.

The Metric System.—The metric system is the international decimal system of weights and measures based on the metre and the kilogram. The essentials of the system were embodied in a report made to the French national assembly by the Paris Academy of Sciences in 1791. The definitive action taken in 1791 was the outgrowth of recommendations made along similar lines in the last half of the 17th century and the early part of the 18th century. Gabriel Mouton, vicar of St. Paul's church, Lyons, in 1670 first proposed a comprehensive decimal system having as a basis the length of an arc of one minute of a great circle of the earth. Jean Picard in 1671 and others made suggestions along similar lines.

The metric system as it was first set up by its founders differs in some details from the system as it exists today. The original scheme of the metric system will first be described and then the later changes will be discussed.

The metre, the unit of length, was to be the one ten-millionth part of meridional quadrant of the earth. Geodetic measurements for this purpose were made on an arc from Dunkirk, Fr., to Mont-Jouy, near Barcelona, Sp. A platinum end standard, the metre of the archives, was constructed and adjusted to be one metre in length as given by the above definition and measurements. This was the standard metre for most of the 19th century.

The gram, the unit of mass, was to be equal to the mass of a cubic centimetre (1 cm. = 0.01 m.) of pure water at the temperature of its maximum density (4° C.). A platinum cylinder known as the kilogram of the archives was made and declared to be the standard for 1,000 g.

The litre was defined as the volume equivalent to the volume of a cube, each side of which had a length of one decimetre (1 dm. = 0.1 m.).

The are was defined as the measure of area for land equal to a square ten metres on a side.

The stere was defined as the measure of volume, especially for cordwood, equal to a metre cube.

Names for multiples of the several units were to be formed by using Greek prefixes, and the names of subdivisions were to be formed by adding Latin prefixes. These prefixes are:

Prefix	**Signification**
deca	10
hecto	100
kilo	1,000
mega	1,000,000
giga	1,000,000,000
tera	1,000,000,000,000
deci	0.1
centi	0.01
milli	0.001
micro	0.000001
nano	0.000000001
pico	0.000000000001

The spelling of the metric prefixes as well as of the basic units is not uniform in all countries. In England the French forms *metre, kilogramme* and *litre* are retained, whereas in the United States the spellings *meter, kilogram* and *liter* are commoner. In Italy *kilo* becomes *chilo* and other similar changes are made to conform to the orthography of that country.

It took many years for the metric system to be adopted as the obligatory system for use in France. Its progress in most other countries has also been slow, but its desirability as an international system was recognized by geodesists and others. As a result of their efforts an international treaty was signed on May 20, 1875, providing for an International Bureau of Weights and Measures, thus assuring "the international unification and improvement of the metric system." This international bureau was established in Shvres, Fr., a suburb of Paris, on land ceded by the French government and declared to be international territory. An international conference, of a diplomatic nature, with the designation General Conference on Weights and Measures, meets nominally every six years. Between the meetings of the conference the general supervision of the international bureau is in the hands of an international committee. The treaty specifies the details as to the membership of the committee and the conference and also prescribes for the maintenance of the international bureau by the signatory nations.

The first task of the International Bureau of Weights and Measures was the construction of new standards for the metre and the kilogram, including the necessary measurements. As standards were constructed for distribution to the nations supporting the bureau, in addition to the international standards to be kept at Sèvres, the task was a large one. Since then important researches have been undertaken there. The scope of the work at the international bureau has been considerably broadened so that researches are carried on in the fields of electricity and photometry in addition to its former work in weights and measures with which were included such allied fields as thermometry and barometry.

At the first general conference in 1889 the work of the international bureau in constructing and comparing the standards was approved, new definitions of the metre and the kilogram in terms of the new standards were adopted, and the distribution of the national standards to the governments supporting the work was authorized.

The metre was redefined in terms of the bar of platinum-iridium, known as the international prototype metre, at the international bureau. This is a line standard of length made with a cross section known as the Tresca section, selected because of its great rigidity for a given weight, and having microscopic lines engraved on the plane of its neutral axis. The composition of the alloy is 90% platinum, 10% iridium. The distance between the central one of the group of three lines at each end when the bar, being subjected to normal atmospheric pressure, is supported on two rollers at least one centimetre in diameter placed symmetrically 572 mm. apart, and the bar is at a temperature of 0° C., is defined as one metre. Although measurements were made which showed the length of the bar to be equal to that of the metre of the archives, the metre is now defined in terms of the international prototype metre without reference to the metre of the archives or to the length of the earth's quadrant.

It was shown by Albert Abraham Michelson that a standard of length could be replaced by reference to the measurement of wave lengths of light (see INTERFEROMETER: The Michelson Interferometer) and measurements made by him in 1892–93 and later by Charles Fabry and Alfred Perot made this procedure possible. In 1927 the seventh General (international) Conference on Weights and Measures adopted provisionally a supplementary relation between the metre and the wave length of light. This relation for red cadmium light waves under specified conditions of temperature, pressure and humidity is

1 m. = 1,553,164.13 wave lengths.

The accuracy of this value is usually stated as being about 1 part in 10,000,000. A redefinition of the metre as 1,650,763.73 times the wave length of the orange light of isotopic krypton of mass 86 at 760 mm. pressure and 15° C. was adopted at an international conference in Paris in 1960.

The kilogram is the mass of a definite platinum-iridium standard, the international prototype kilogram, kept at the International Bureau of Weights and Measures. The composition of this cylinder, which has a height approximately equal to its diameter, is the same as that of the prototype metre, namely, 90% platinum and 10% iridium. When the first kilogram was constructed it was not possible to measure the volume of a cubic decimetre of water to 1 part in 1,000,000. Because of this there is not the simple relation between the metre, the kilogram and the litre that was originally intended, and if the volume of a quantity of water is found precisely by measuring linear dimensions and by weighing the water, using the assumption that one cubic decimetre of water at the temperature of its maximum density weighs exactly one kilogram, the two results are not exactly the same. According to the most precise determinations the difference is 28 parts in 1,000,000. For this reason the litre is a secondary or derived unit defined as the volume of a kilogram of pure water at the temperature of its maximum density and under standard pressure, and is equal to 1.000028 dm.3 Formerly the value 1.000027 cu.dm. was accepted as the best value. For most purposes the differences between the millilitre and the cubic centimetre can be safely neglected. In the graduation and test of volumetric apparatus and in the preparation of density tables for liquids, the unit employed is the millilitre (designated by the abbreviation ml.), the one one-thousandth part of the litre, even though it may be—and often is—incorrectly designated as c.c. If a volume is derived from linear measurements and is expressed in cubic centimetres, the correct abbreviation is $cm.^3$. The metric system is either obligatory or permissive in every civilized country. In the U.S. its use was legalized by the act of July 28, 1866. In Great Britain the Weights and Measures (Metric System) act of 1897 legalized its use in trade, although its use had previously been permitted from 1864 to 1878. In 1946 the metre-kilogram-second system of mechanical and electric units (m.k.s.), originally proposed by G. Giorgi in 1904, was adopted by the International Committee on Weights and Measures (see PHYSICAL UNITS: The M.K.S. *or* Giorgi System of *Units*).

Other Systems of Weights and Measures.—The Spanish, French and Portuguese systems of weights and measures were each somewhat analogous to the British and U.S. systems although there were many differences between these five systems. The Spanish, French and Portuguese systems were brought to America by the colonists and they survive to some extent, often in modified forms of the original, even where replaced by the metric system (South and Central America and Mexico) or by the British system (Canada).

In Europe prior to the 19th century each country had its own system or systems of weights and measures, and, although most if not all of these systems have given way to the metric system, use of the old systems often persists, at least in nomenclature.

Weights and Measures in General.—Materials for Standards.—It has already been stated that the international and national prototype metres and kilograms were made from an alloy of 90% platinum and 10% iridium. This alloy was chosen because it was believed to be the least liable to be affected by time or circumstance. Experience seems to have substantiated the wisdom of this choice. It is very costly, and therefore cannot be afforded for laboratory or shop use. It can be highly polished and fine lines can be ruled on it. Its coefficient of expansion is moderately high (8.7×10^{-6} per degree C.). Other materials are used for length standards in industry and in scientific laboratories. See METROLOGY.

Invar, an alloy of about 36% nickel and 64% iron discovered by Charles Edouard Guillaume, is often used for length standards where a low coefficient of expansion (about 1.0×10^{-6} per degree C.) is desired. A length standard made of this material needs to be checked against a more stable standard from time to time because invar is dimensionally unstable, so that the length of an invar bar changes with time. Although some improvement was expected in the use of so-called "stable invar" in which the small amounts of chromium have been added, there is instability even in this form of invar.

Fused quartz has been found to be very suitable for reference end standards of length. This material has a low coefficient of expansion (about 0.4×10^{-6} per degree C.), takes a high polish, and is very stable dimensionally.

The objection to platinum-iridium for use as a standard of mass, except as a primary standard where unusual precautions are always taken, is that because of its high density (21.57 g. per cm.3) the slightest abrasion will change its mass appreciably.

Brass weights, either lacquered or gold-plated are generally employed for the common sizes of commercial and laboratory weights. They frequently gain in weight for years without any visible alteration, and lacquered weights are liable to vary considerably with large variations in humidity (for example, by 0.2 mg. per 100 g.), Small weights are frequently made of platinum or aluminum.

Detailed information about materials for standards of weights and measures can be obtained from the national bureau of standards in the U.S. and other national standardizing institutions.

Effects of Temperature, Pressure and Gravity.—Because the dimensions of any standard change with temperature, it is necessary to state the temperature at which standards of length, area, volume, or capacity are to be used; if used at any other than standard temperature, then the coefficient of expansion must be stated. The standard temperatures most often used are: 0° C. (=32° F.), the standard temperature for the prototypes of the metric system, also used for some secondary metric standards and for some measurements; 20° C. (=68° F.), the internationally adopted standard temperature for gauges and the standard temperature which is being increasingly used for weights and measures work; 16.67" C. (=62° F.), the official temperature used in connection with the British imperial system; 4° C. (=39.20° F.), the temperature of maximum density of water, used in density and volumetric work in which water is directly or indirectly involved; 25" C. (=77" F.), a standard temperature used in some work in physical chemistry; and 15.56° C. (=60° F.), the standard temperature used in the petroleum industry for density and volume work.

If the expansion of the standard used in any measurements, a gauge for example, is the same as that of the piece being measured, it is only required that the standard and the object are both at the same temperature, not necessarily the standard temperature, the length of the gauge being known at the standard temperature.

Although the temperature of 62° F. used in the definition of the British units is numerically that used earlier, as for example, in 1845 in the construction of the imperial standards when Sheepshank's Fahrenheit thermometers were used, it is difficult to state how the true temperature then of 62" F. would compare with 62" F. of the present standard thermometric scale.

Changes in atmospheric pressure have very little effect on length standards, a change in pressure from 710 to 790 mm. causing a change in length of about 0.00005 mm. in the case of the prototype metre. Changes in atmospheric pressure are usually disregarded in measurements of length. Any changes in air pressure, as well as changes in the temperature and humidity of the air, are, however, of importance in any comparison of masses because these are factors affecting the buoyant effect of the air. Any definitions of weights that involve comparisons of the weights of bodies having different densities are incomplete unless the atmospheric conditions are specified together with the densities of the materials employed. In the United States most commercial weights are verified on the basis of apparent mass in air against brass standards of density 8.4 g./cm.^{3} at 0° C., no correction being made for the buoyant effect of the air, the values for the brass standards being their. true mass or weight in *vacuo*.

When weighing on an equal arm balance, if the body being weighed does not have the same density as the weights, a correction must be made.

The standard air pressure usually used in weights and measures work is 760 mm. mercury, at 20° C., mercury having a specified density of 13.5951 g. per cm.3, with gravity 980.665 cm./sec^2.

The effect of the force of gravity must be considered in precision length measurements because of the downward force acting on the standard and the resulting possible distortion of the standard. The length of the prototype metre bar would be slightly different if the supports were changed from the specified positions; this is because of the change in the deflections of the bar under the action of gravity. This difference has been made as small as possible first by the choice of the position for the two supports, and in the second place by the placing of the graduation lines in the plane of the neutral axis. If the graduation lines had been placed on the top of a rectangular bar, relatively large changes in length would be caused by a displacement of one or of both the supports.

Since a spring balance indicates weight and not mass, a constant mass suspended from a spring balance will produce different readings when measurements are made in a series of places having sufficient changes in the force of gravity, the indicated weights varying directly with the force of gravity, other conditions being equal. An equal arm balance likewise really compares weights rather than masses, but on the assumption that the two pans of the balance are acted upon by the same force of gravity, the result is an indirect comparison of masses. If other conditions remained constant. a balance would, on the same assumption, everywhere give the same balance between the same two bodies, no matter how the force of gravity varied from place to place.

Administration.—In the U.S., control of commercial weights and measures work, with the exception of a few special cases, is the function of state and local authorities. The organization of state and local work in weights and measures is not uniform in the several states. For information see National Bureau of Standards Handbook H26, Weights and Measures Administration.

In Great Britain the control of weights and measures is partly national and partly local. The Board of Trade regulates the denominations of weights and measures permissible for use, approves types of weighing and measuring devices as not being liable to facilitate fraud, and promulgates regulations for the guidance of the local inspectors of weights and measures. Local verification and inspection of weighing and measuring appliances in use in trade is undertaken by inspectors appointed by the local authorities, such as the county and county boroughs councils. An inspector is required to hold a certificate of qualification issued after examination by the Board of Trade and, to promote uniformity throughout the country, to follow the regulations prescribing the methods for testing weights, measures and weighing and measuring instruments. In most of the other important countries of the world, weights and measures control is either wholly government controlled or shared between central, state and local government in varying degrees.

Equivalents.—In the United States the following equivalents between the metric units and the customary units underlie all others:

1 yd. = 0.9144 m. (exactly)	1 m. = 1.093613 yd.
1 lb. = 0.45359237 kg. (exactly)	1 kg. = 2.204623 lb.
1 gal. = 3.785306 1.	1 1. = 0.264178 gal.
1 bu. = 35.2381 1.	1 1. = 0.028378 bu.

Detailed tables of equivalents are contained in national bureau of standards miscellaneous publication M233, Units of Weights *and Measures—Definitions* and Tables *of Equivalents*.

In Great Britain the equivalents corresponding to the above are:

1 yd. = 0.9144 m. (exactly)	1 m. = 1.093613 yd.
1 lb. = 0.45359237 kg. (exactly)	1 kg. = 2.204623 lb.
1 gal. = 4.5459631 1.	1 1. = 0.2200 gal.
1 bu. = 36.37 1,	1 1. = 0.02750 bu.

From these two sets of equivalents it will be seen that

1 U.S. yd. = 1 British yd.
1 U.S. lb. = 1 British lb.
1 U.S. gal. = 0.83267 British gal.
1 U.S. bu. = 0.9689 British bu.

or

1 British yd. = 1 U.S. yd.
1 British lb. = 1. U.S. lb.
1 British gal. = 1.20095 U.S. gal.
1 British bu. = 1.0321 U.S. bu.

However, when the National Physical laboratory, the national standards laboratory for Great Britain. adopted the above relations between the yard and the metre and between the pound and the kilogram, effective July 1, 1959, the British Board of Trade decided to retain the older equivalents for use in trade pending legislative action. These are: 1 British yd. = 0.914399 m.; 1 British lb. = 0.45359243 kg. The difierences are of legal implication but are not of practical importance in commerce.

Some selected equivalents between the units of other countries and the units of the U.S. system or the units of the metric system are given in a table appended to this article. The number of units of weights and measures used in modern times—as distinguished from ancient times—is very large, and the selection of the units to be included in a table is difficult. The purpose of such a table is taken to be that of giving the average reader some information about units with which he is not familiar, including the approximate size of units. For exact values one must necessarily resort to a source of more detailed information where exact values are given showing what changes have been made from time to time and how the values vary from place to place. Many of the units listed in the table are known to differ in these two ways, and the value shown is simply a representative one. A number of the units having simple relationships with the units of the metric system originally had values somewhat different.

Table of Selected Weights and *Measures*, Their Places of Use and Their Equivalents in *U.S. Customary* or in *Metric* Units

Acre	United States Great Britain	4,840 square yards = $\frac{1}{640}$ sq. mi.
Almude.	Portugal	16.7 litres.
	Spain.	4.625 litres = $\frac{1}{12}$ fanega (dry measure).
Ångström Unit (Spectroscopy)		10^{-10} metre = $\frac{1}{10,000}$ micron.
Anker	Latvia	38.256 litres, or 30 stoof.
Anoman (Ammomam, Amomam)	Ceylon	5.83 U.S. bushels.
Archin, or Arshin.	Turkey	1 new archin (Law 1881) = 1 metre (39.37 inches) = 10 parmaks (decimetres) = 100 khats (centimetres), 1 mill = 1,000 archins (kilometre). Pharoagh = 10 mills. hnothkr pharoagh = 2 hours' journey.
Archine, or chinne	U.S.S.R. (Estonia	28 inches, or 0.7112 metre.
Ardeb	Egypt	5.619 bushels (Customs).
Are		= 100 sq. metres = 119 6 sq.yds.
Arpent	France Canada	Legal arpent was equal to 100 sq. perches = 51 07 metric ares. In Quebec = 180 French feet.
hrroba	Portugal	14 68 to 15 kilograms.
	Spain	Wine = 16.14 litres; oil = 12.56 litres.
Artaba	Iran	66.0 litres.
Assay ton	United States	29 167 grams.
Aune	Belgium	1 metre. Formerly 1.2 metres.
	France	1.188 metres.
	Jersey	4 feet.
Barile	Rome	58.34 litres.
Bat, Baht, or Tical	Thailand	15 grams (= 231.5 grains).
Batman.	Iran	6½ lb. av.: varies locally.
	Turkestan.	125 kg. (variable).
Behar or Bahar	Arabia	450 lb. av.
Berri	Turkey	1.67 kilometres (1.04 miles) (old measure).
Boisseau	Belgium	15 litres.
Boutylka	U.S.S.R.	1.625 liquid pints (wine bottle).
Braça	Portugal	2.20 metres.

Braccio d'ara	Rome	0.7 metre.
Brasse	France	1.62 metres.
Braza	Argentina	1.732 metres.
Bu, or tsubo.	Japan	$\frac{100}{,0}$,, – 3.306 square metres (area). Also = $\frac{1}{100}$ shaku (length).
Bunder.	Netherlands	1 hectare.
Bushel	United States	2,150.42 cubic inches.
	Great Britain	1.032 U.S. bushels.
Cabot	Jersey	10 pots, or 19.75 litres.
Candy	Bombay	560 lb. av.
	Madras	500 lb. av.
Cantar or Kantar	Turkey	124.45 lb. av. (old weight).
Cantara	Spain	1 arroba.
Capicha.	Iran	2.63 litres.
Carat, metric		200 milligrams.
Catty	China	$1\frac{1}{3}$ lb. av. See Tael.
	Malaya	$1\frac{1}{3}$ lb. av.
	Thailand	2.67 lb. av.
Cawnie	Madras	1.322 acre.
Centigram		$=\frac{1}{100}$ gram.
Centilitre		$=\frac{1}{100}$ litre.
Centimetre		$=\frac{1}{100}$ metre.
Centimetre, cubic		0.061 cubic inch.
Centimetre, square		0.155 square inch.
Centner.	Austria	
	Denmark	50 kilograms.
	Switzerland	
Chain	Great Britain	66 feet.
Chain (Gunter's).	United States	66 feet.
Chang	China	10 ch'ih = 11 ft. 9 inches (*Treaty).
	Thailand	1,200 grams.
Chapah	N. Borneo.	1.8 lb. av.
Charka	U.S.S.R.	0.123 litre.
Chee. See *Tahil.*		
Chek	Hong Kong	14%inches.
Chenica.	Iran	1.359 litres.
Chetvert	U.S.S.R.	8 chetveriks, or 2.099 hectolitres.
Ch'ien	China	589 grains (silver weight).
Ch'ih	China	Varies throughout China from 11 to 15.8 inches. For Customs purposes the *Treaty ch'ih = 14.1 inches, and 5 ch'ih = 1 pu.
Chin or Catty	China	$1\frac{1}{3}$ lb. av. (*Treaty).
Ching	China	121 sq.ft. (*Treaty).
Ch'ing	China	72,600 sq.ft. (*Treaty).
Chittack	Bengal	5 tolas, or 900 grains.
Chô	Japan	As unit length = 360 shaku.
		As unit area = 3,000 bu. or tsubo.
Chuo	China	1,815 sq.ft. (*Treaty).
Chupah.	Singapore	3.125 lb. av. of water at 62° F., as a measure of capacity.
	Malacca	36 oz. av. of water.
Chupak.	Malaya	1 quart (British imperial).
Collothun	Iran	8.22 litres.
Cord (firewood)	United States	128 cubic feet.
Coss	India	1.829 kilometres.
Covado	Portugal	0.66 metre.
Covid, or Cubit	Madras	18 to 21 inches.
	Bombay	18 inches.
Covido	Arabia	19 inches.
Cuartillo	Spain	1.16 litre (dry); 0.504 litre (liquid).
Daktylos	Greece	25.39 millimetres.
Daribah	Egypt	15.84 hectolitres.
Decagram or dekagram		= 10 grams.
Decalitre or dekalitre		= 10 litres.
Decametre or dekametre.		= 10 metres.
Déçïatina	U.S.S.R.	= 2,400 square sagènes = 2.7 acres.
Decigram		=,dgram.
Decilitre		$=\frac{1}{10}$ litre.
Decimetre		$=\frac{1}{10}$ metre.
Decimetre, cubic		= 61.023 cu.in.
Decimetre, square		= 13.500 sq.in.
Denaro	Italy	1 gram.
Denaro	Rome	18.17 grains (old weight).
Deunam	Turkey	25 ares.
Diraa or Pik.	Egypt	0.58 metre.
	Turkey	0.7087 metre.
Dirhem	Egypt	1.761 dram av. (Customs).
		3.12 grams (Cairo).
Dito	Italy	1 centimetre.
Djerib	Turkey	1 hectare.
Dolïa, or Dola	U.S.S.R.	0.686 grain. 96 doli = 1 zolotnick.
Drachm	Great Britain	3 scruples (apothecaries' weight).
Drachm, fluid	Great Britain	0.961 U.S. fluid dram.
Drachma	Netherlands	3.906 grams (apothecaries' weight).
	Turkey	3.21 grams.
Drachma	Greece	3.2 grams.
Dram	Great Britain	$\frac{1}{16}$ avoirdupois ounce.
Dram	Iran	1 gram.
Dram, apothecaries'	United States	60 grains.
Dram, avoirdupois	United States	$27\frac{11}{32}$ grains.
Dram, fluid	United States	$\frac{1}{8}$ fluid ounce.
Ducat	Vienna	53.873 grains (gold weight).
Duim	hTetherlands	1 centimetre.
	U.S.S.R.	1 inch.
Eimer	Germany	29 to 307 litres.
El	Netherlands	1 metre. (Old el = 27.08 inches.)
Ell	Jersey	4 feet.
Ella	N. Borneo.	1 yard.
Elle	Latvia	0.537 metre.
	Switzerland	60 centimetres.
Estadio	Portugal (old)	258 metres.
Faden	Latvia	4.077 steres.
Faltche	Moldavia	143.22 ares.
Fanega	Argentina	137 litres.
	Portugal	55.364 litres.
	Spain	55.30 litres.
	Peru	55.50 litres.
		1.615 acre. but varies locallv.
Fass	Germany	1 hectolitr'e.
Fathom	United States	6 feet.
	Great Britain	
Feddan	Egypt	1.038 acre (Masri).
Fen	China	5.83 grains (silver weight).
Fjerding	Denmark	0.988 bushel.
Fod	Denmark	0.3138 metre = 1.0297 feet.
Foglietta	Rome	0.513 litre.
Foot	United States	$\frac{1}{3}$ yard.
	Great Britain	
	Canada	French foot = 12.8 inches.
	Amsterdam	11.147 in.)
	South Africa	12.356 in. old measure.
	Old Rhenish	
Fot.	Sweden	11.689 in. 10 fot = 1 stöng. 1 ref = 10 stänger. 1 mil = 360 ref.
	Norway	0.3137 metre.
Founte, or Funt	U.S.S.R.	0.90282 lb. av.
Foute, or Fut	U.S.S.R.	1 English foot.
Frasco	Argentina	$2\frac{3}{8}$ litres.
Funt	Poland	405.504 grams.
Furlong	United States	220 yards.
	Great Britain	
Fusz	Vienna	12 zolls = 1.037 feet.
	Switzerland	$3\frac{1}{3}$ fusz = 1 metre.
		See *Stab.*
Gallon	United States	231 cubic inches.
	Great Britain	1.201 U.S. gallon, or 0.129 U.S. bushel.
Gantang	Malaya	1 British imperial gallon.
	N. Borneo.	144 oz. av. weight of water as measure of capacity.
Garnetz.	U.S.S.R.	3.28 litres.
Gill	United States	$\frac{1}{4}$ pint.
	Great Britain	$\frac{1}{4}$ British pint.
Gin. See *Kati.*		
Gisla	Zanzibar	hfeasure of 360 lb. av. of rice.
Go	Japan	0.18 litre.
Grain	United States	$\frac{1}{7,000}$ avoirdupois pound = 0.065 gram.
	Great Britain	
	U.S.S.R.	0.960 grain (apothecaries').
Gram		15.432 grains.
		= 0.03215 oz. troy.
Grano	Rome	0.757 grain.
Grao	Portugal	0.769 grain; also measure 0.18 in.
Grein	Netherlands	= 0.065 gram.
Guz, or Gudge	India: Bengal	36 inches.
	" Bombay	27 inches.
	" Madras	33 inches.
	Iran	The guz, gueza or zer varies from 24 to 44 inches. A guz of 40.95 inches is common. By the law of 1925 the guz was made equal to the metre.
	Arabia	25 inches.
Hat'h, .or Moolum, or Cubit	India	18 inches.
Hectare.		= 100 ares, or 2.471 acres.
Hectolitre		26.418 gallons.

Hiyaka-me	Japan	5,797.198 grains.
Hiyak-kin	Japan	$132\frac{1}{2}$ lb. av.
Hoon. See *Tahil.*		
Hu.	China	51.77 litres.
Hulmit	Latvia	11.48 litres.
Hundredweight	Great Britain	112 lb.
Hundredweight, gross or long	United States	112 lb.
Hundredweight, net or short	United States	100 lb.
Immi	Switzerland	1.5 litre.
Inch	United States	$\frac{1}{36}$ yd.
	Great Britain	
Joch	Austria-Hungary	57.55 ares= 1.422 acre.
Kan	Ketherlands	1 litre.
	Hong Kong	$1\frac{1}{3}$ lb. av.
Kanne or Kanna.	Germany	1 litre, or formerly 1.06 liq. qt., or 0.91 dry qt.
	Sweden	2.62 litres.
Kantar; or Cantaro	Egypt	99.0492 lb. av.=100 rotls (Customs). 45 kilograms of cdtton. 44.5 kilograms other produce.
Karwar.	Iran.	100 batman.
Kassabah	Egypt	3.8824 yards (Customs).
Kati, Catty or Gin	Malaya	$1\frac{1}{3}$ lb. av.
Keddah.	Egypt	2.0625 litres.
Ken	Japan	1.82 metres=5.965 ft.
	Thailand	40 inches.
Kerbt	Turkey	$1\frac{1}{8}$ inch measure (old). 3.09 grains weight (old).
Kette, or Chain	Germany	10 metres.
Khat (New)	Turkey	1 centimetre.
Kileh	Turkey	1 bushel approx. (varies).
Kilogram		=1,000 grams=2.205 lb.
Kilometre		=1,000 metres=0.621 mile.
Kin	China	See Catty.
	Japan	0.600 kilogram= 1.323 lb.
Klafter	Austria	=2.0740 yards.
	Switzerland	1.9685 yard.
Koddi	Arabia	7.58 litres.
Koilon	Greece	33.17 litres.
Koku	Japan	180.39 litres=10 To.
Kon or Catty	Korea	$1\frac{1}{3}$ lb. av.
Korntonde	Norway	138.97 litres.
Korn-Topmaal	Norway	160 litres.
Korrel	Netherlands	0.1 gram.
Kouza	Cyprus	9 British imperial quarts.
Koyan	Malaya	$5,333\frac{1}{3}$ lb. av.
Krina	Bulgaria	20 litres.
Kung	China	78.96 inches (*Treaty).
Kup	Thailand	10 inches.
Kwan or Kuwan	Japan	3.75 kg.=8.267 lb. av.
Kwarta	Poland	1 litre.
Kyat	Burma	16.33 grams.
Last	Netherlands	30 hectolitres.
Latro	Czechoslovakia	1.917 metres.
League (land)	United States	3 statute miles.
Li	China	About $\frac{1}{3}$ mile=360 pu. Varies with length of ch'ih. 1 decigram.
Liang or Léang	China	1) oz. 16 liang=1 chin=$1\frac{1}{3}$ lb. avoirdupois.
Libbra	Italy	1 kilogram; 327 grams (old).
Libra	Argentina	1.0128 lb. av.
Libra (Castilian)	Spain, Mexico	1.0143 lb.
Libra, or Arratel	Portugal	1.012 lb. av.
Light Year (astronomy)		9.4627 × 10^{12} kilometres.
Line or Ligne	Paris	2.26 millimetres.
Liniya	U.S.S.R.	0.1 inch. 1 archine=280 liniyas.
Link, Gunter's or surveyors'.	United States	7.92 inches.
	Great Britain	
Litre		'0.908 dry quart, or 1.057 liquid quart.
Livre	Belgium	1 kilogram.
	France	0.4895 kilogram.
Loket	Czechoslovakia	0.593 metre (Prague); 0.594 metre (Moravia); 0.579 metre (Silesia).
Lot	Germany	New Lot=10 grams. Old lot, nearly $\frac{1}{2}$ oz. av.
	Switzerland	15.625 grams.
	Vienna	270.1 grains. Postal Lot 257.2 grains.
Maass	Germany	1.837 litres.
Maass	Switzerland	1.5 litres.
Maatze	Netherlands	0.1 litre.

Mace	China	58) grains.
	N. Borneo	$93\frac{1}{3}$ grains.
Mahud	Arabia	2.04 lb. av.
Marc, or Mark	France	0.2448 kilogram (old weight).
	Sweden	6.77 oz. troy.
	Vienna	9.02 oz. trov.
Marco	Portugal	=8 oncas=229.5 grams.
	Spain,	3,550 grains.
Maund	India	82.286 lb. av., Government. 28 Ib., Bombay. 25 lb.. Madras. Local maunds vary.
Metre		39.37 inches.
Metre, cubic		1.308 cubic yards.
Metre, square		1.196 square yards.
Metze	Austria	61.5 litres.
Microgram (y)		$\frac{1}{1,000,000}$ gram.
Micron (μ)		$\frac{1}{1\,000\,000}$ metre=$\frac{1}{1,000}$ mm.= 0 00004 inch.
Miglio	Rome	0.925 mile.
Mijle	Netherlands	1 kilometre.
Mil	United States	0.001 inch.
	Great Britain	
Mil, or Mill	Turkey	1,000 archins (new mil).
	Denmark	4.680 miles.
Mile, statute	United States	5,280 feet.
	Great Britain	
Mile, nautical	United States	6,080.20 feet (formerly).
Mile, nautical ("Admiralty").	Great Britain	6,080 feet.
Mile, nautical, International		1,852 metres.
Mile, square.	United States	640 acres.
	Great Britain	
Mile (postal)	Austria	4.714 miles.
Milha	Portugal	1.297 mile.
Milligram		=0.001 gram=0.015 grain.
Millilitre		=$\frac{1}{1,000}$ litre.
Millimetre		=$\frac{1}{1,000}$ metre=0.03937 inch.
Minim	United States	$\frac{1}{60}$-fluid dram.
	Great Britain	0.961 U.S. minim.
Miscal	Iran	10 grams, formerly 71 grains.
Mkono	East Africa	45.72 centimetres.
Mna	Greece	$1\frac{1}{2}$ kilogram= 1.172 oke.
Momme	Japan	$\frac{1}{1,000}$ kwan=10 fun, 3.75 grams.
Morgen.	Prussia	0.631 acre.
	Netherlands (Old)	2.1 acres.
	South Africa	2.117 acres.
Mou	China	Commonly 806.65 sq.yd. Varies locally. Shanghai= 6,600 sq.ft. (Municipal Council). By Customs Treaty=920.417 sq.yd., based on ch'ih of 14.1 inches.
Mud	Netherlands	1 hectolitre.
Nin	Thailand	$\frac{10}{12}$ inch.
Ock	Turkey	Legal ock (1881)=100 drachmas. New batman=10 ocks, and kantar=10 batmans; ock=1 kilogram.
Octavillo	Spain.	0.29 litre.
Oitavo	Portugal	1.730 litre.
Oke	Bulgaria	1.28 litre (for liquids). 1.282 kilograms (old).
	Cyprus	2.8 lb. av.=400 drams (Cyprus).
	Egypt	2.751 lb. av. (Customs). 2.805 lb. (Alexandria).
	Greece	2.82 lb.=1.280 kilograms.
	Turkey	1.28 pint. 2.83 lb. av. (old).
Onça	Portugal	28.688 grams.
Once	France	30.59 grams (old).
Oncia	Rome.	436.165 grains.
Onze	Netherlands	100 grams.
Ounce, avoirdupois	United States	437.5 grains.
	Great Britain	
Ounce, fluid	United States	$\frac{1}{16}$ liquid pint.
	Great Britain	0.961 U.S. ounce.
Ounce, troy or apothecaries'	United States	480 grains.
	Great Britain	
Packen	U.S.S.R.	1,083.38 lb. av.
Palamé	Greece	25.39 millimetres.
Palm	Netherlands	1 decimetre.
Palmo	Portugal	0.22 metre.
	Spain.	0.229 metre.
Para	N. Borneo.	90 Ib. av.
Parah	Ceylon	25.4 litres.
Parasang. See *Persakh.*		

Parmak. See *Archin.*		
Parsec (astronomy)		3.084 X 10^{13} km.
Passeree	Bengal	5 seers.
PC	Portugal	$\frac{1}{3}$ metre.
Pecheus.	Greece	0.648 metre.
Peck	United States	8 dry quarts.
	Great Britain	8 British quarts = 1.032 U.S. pecks.
Pennyweight	United States	24 grains.
	Great Britain	
Perch	United States	1 rod.
	Great Britain	$30\frac{1}{4}$ sq. yd.
Perche	France	22 square pieds de roi. In Quebec 18 French feet.
	Canada	
Persakh	Iran	Probably 3.88 miles = 6,000 guz.
Pfund	Germany	= 16 unzen = 32 Lot; 1.01 to 1.23 lb. av. old weight.
		Zollpfund (1872) = 500 grams.
	Latvia	419 grams.
	Switzerland	500 grams = 16 unze.
		Apoth. pf. = 375 grams.
	Vienna	Pfund = 560 grams.
		Zollpfund (1871) = 500 grams
Pharoagh. See *Archin.*		
Pic or Pik	Cyprus	2 feet.
Picki, Pik or Pic	Greece	0.64 to 0.67 metre.
Picul	Japan	132.3 lb. av.
	Malaya, Hong Kong	$133\frac{1}{3}$ lb. av.
	North Borneo	A measure of 180 lb. weight of water.
Pie	Rome	11.73 inches.
	Spain	10.97 inches.
Pied	Belgium	11.81 inches = 10 pouces.
	Canada	12.79 inches.
Pied de Roi	Paris	0.3248 metre.
Pik. See *Diraa.*		
Pint	Great Britain	1.032 U.S. dry pints, or 1.201 U.S. liquid pints.
Pint, dry	United States	$\frac{1}{64}$ bushel.
Pint, liquid	United States	$\frac{1}{8}$ gallon.
Pinte	France	0.931 litre.
Pipa	Portugal	500 litres; 429 litres (old value).
Poide de Marc	France	0.2448 kg. = 8 ounces.
Point (typography)	United States	0.013837 inch, about $\frac{1}{72}$ inch.
Pole. See Rod.		
Polegada	Portugal	27.77 millimetres.
Pond	Netherlands	1 kilogram.
Pot.	Denmark	0.966 litre.
	Switzerland	1.5 litre.
	Belgium	$1\frac{1}{2}$ litre (dry). $\frac{1}{2}$ litre (liquid).
	Norway	0.965 litre.
Pouce	France	27.07 mm. = 1.066 inch (old measure).
Poud, or Pood	U.S.S.R.	36.113 lb.
Pound	Great Britain	1 U.S. avoirdupois pound.
Pound, apothecaries'[3]	United States	5,760 grains.
Pound, avoirdupois	United States	7,000 grains = 0.454 kilograms.
Pound, troy	United States	5,760 grains.
Pu	China	70.5 inches = 5 ch'ih.
Puddee	Madras	1.64 litres. 100 cubic inches = Government puddee.
Pulgada.	Spain.	0.914 inch.
Pund	Denmark	500 grams.
	Norway	500 grams.
		0.4981 kilogram (old value).
	Sweden	425.1 grams.
Quart	Great Britain	$\frac{1}{4}$ gallon = 1.032 U.S. dry quarts = 1.201 U.S. liquid quarts.
Quart, dry	United States	$\frac{1}{32}$ bushel.
Quart, liquid	United States	$\frac{1}{4}$ gallon.
Quarter.	Great Britain	28 lb.; 8 bu. = 8.257 U.S. bu.
Quarto	Rome.	73.6 litres.
	Portugal	3.46 litres.
Quintal	Spain.	100 libras (Castilian) = 101.4 lb.
	Portugal	58.752 kilograms. $129\frac{1}{2}$ lb. av.
	Argentina	100 libras, or 101.28 lb. av.
Quintal (metric)		= 100 kilograms = 220.46 lb.
Ralte	Iran	1 litre.
Ratel	Iran	1.014 lb. av.
Rattel, or Rottle	Arabia	1.02 lb. av.
Ri	Japan	2.440 miles.
Rod	United States	$16\frac{1}{2}$ feet.
	Great Britain	
Rode	Denmark	3.138 metres.
Roede	Netherlands	1 dekametre.

Rood	Great Britain	40 perches = $\frac{1}{4}$ acre.
Rotl, Rottolo or Ratel	Egypt	0.9905 lb. av. (Customs).
Rottol	Turkey	1.6 litres (old measure).
Sagène	U.S.S.R.	7 feet.
Scheffel	Germany	50 litres, formerly 16 metzen (Prussia).
Schepel	Netherlands	1 decalitre.
Schoppen	Germany	$\frac{1}{2}$ litre.
	Switzerland	0.375 litre.
Scruple	United States	20 grains.
	Great Britain	
Scruple, fluid	Great Britain	0.320 U.S. fluid dram.
Se	Japan	118.615 square yards (.9918 are).
Seer	India	Government seer = 2.057 lb. av.
		Bengal, 80 tolas weight of rice (heaped measure), about 60 cubic inches (struck measure).
		Madras, 0.617 lb. av.
		Bombay, 0.72 lb. av.
	Ceylon	1.06 litres.
	Iran	16 miscals, or 1,136 grains weight (Sihr).
	Note.—In India the seer, like the maund, varies considerably; usually 40 seers go to a maund.	
Seidel	Austria	0.354 litre.
Sen.	Thailand	40.6 metres.
Ser, Seer	India	1 litre.
Shaku	Japan	$\frac{10}{33}$ m., also 9.18273 square decimetres; also 18.039 cubic centimetres ($\frac{1}{100}$ shô).
Sheng	China	1.035 litre.
Shih	China	157.89 lb.
Shô	Japan	1.804 litre.
Skaal-pund	Sweden	425.1 grams, or 0.937 lb. av.
	Norway	0.4981 kilogram, or officially $\frac{1}{2}$ kilogram.
Skeppe	Denmark	17.39 litres.
Skjeppe.	Norway	17.37 litres.
Stab	Germany	1 metre, or 38 old fuss. but varied.
Stere		= 1 cubic metre.
Stone	Great Britain	14 pounds.
Stopa	Poland	0.288 metre.
Streep	Netherlands	1 millimetre.
Stremma	Greece	12.70 ares.
Strich	Germany	1 millimetre.
	Switzerland	$3\frac{1}{3}$ strich = 1 millimetre.
Stunde	Switzerland	4.8 kilometres.
Sultchek	Turkey	Cubic measure (1881) whose sides equal a parmak (decimetre).
Tael	Thailand	$936\frac{1}{4}$ grains.
	Hong Kong	$1\frac{1}{3}$ oz. av.
	China	Silver weight, 18 oz. av.
	Japan	10 momme.
Tahil	Malaya	$1\frac{1}{3}$ oz. av. = 10 chee = 100 hoon.
Tan	China	$133\frac{1}{3}$ lb. av., 25 gallons.
Tank	Bombay	68.1 grains (72 tanks = 1 seer).
Teng	Burma	Burmese measures of capacity depend on the teng or basket. Officially a basket is 2,218.2 cubic inches, but the teng varies locally:—
		Akyab = 23 lb. of rice.
		Bassein = 51 lb. of rice.
		Moulmein = 48 lb. of rice.
		Rangoon = 48 to 50 lb. of rice.
Thanan or Fanan	Thailand	1 litre.
Thangsat	Thailand	21.3 litres.
To	Japan	18.0391 litres = 4.77 U.S. gal. or 1.98 pecks.
Toise	France	1.949 metres.
Tola	India	180 grains. Legal weight of rupee.
Tomand	Arabia	187.17 lb. av. of rice.
Ton	Great Britain	2,240 lb.
Ton, long	United States	2,240 pounds.
Ton, metric		= 1,000 kilograms = 1.102 U.S. short tons.
Ton, short	United States	2,000 pounds.
Tonde	Denmark	131.4 litres (liquid measure).
		139.1 litres (dry measure).
Tonnelada	Portugal	793.15 kilograms.
Tonos	Greece	3,307 lb. av.
Tou	China	10 litres.
Tovar	Bulgaria	128.2 kilograms.
Township	United States	36 square miles.
T'sun	China	1.41 inch (*Treaty).
Tu	China	100.142 miles = 25 li.

Vara	Mexico	83.8 cm. (32.99 inches).
	Chile, Peru, Spain, etc.	83.59 cm. (32.91 inches).
	Argentina	86.6 cm. (34.09 inches).
	Portugal	1.1 metre (43.31 inches).
	Texas (u.s.A.).	33 33 inches (84.67 cm.).
Vat	Netherlands	1 hectolitre. 768 mingelen (old value). 1 mingelen = 1.20 to 1.237 litres.
Vedro	U.S.S.R.	10 schtoffs, or 12.3 litres.
	Bulgaria	12.8 litres.
Verchok	U.S.S.R.	1.75 inch.
Versta, or Verst	U.S.S.R.	0.66288 mile.
Vierkante Roede	Netherlands	1 are.
Viertel	Denmark	7.73 litres.
	Switzerland	15 litres.
Viss	Burma	3.60 lb. av. (3.65 lb. av. old value).
Wa or Wah	Thailand	2 metres.
Wichtje.	Netherlands	1 gram.
Wisse	Netherlands	1 stere.
Yard	United States	0.9144 metre.
	Great Britain	1 U.S. yard (almost exactly).
	Mexico	83.8 centimetres.
Zak	Netherlands	1 hectolitre.
Zar (metric)	Iran	1 metre.
Zer (Iran). See *Guz*		
Zoll	Switzerland	3 centimetres. Old zoll nearly one inch. (See also *Pfund*.)
Zolotnik	U.S.S.R.	65.8306 grains, or 96 doli.

*Values agreed on by China in treaties (1842–44 and 1858–60) with England and France and thereafter accepted by the Chinese maritime customs as standard values for all tariff duties, but not in general otherwise used.

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(L. V. J.)

WEIGHTS AND MEASURES, ANCIENT.

WEIGHTS AND MEASURES, ANCIENT. The history of weights has been greatly extended by: (1) the discrimination of the ages of Egyptian weights by their forms; (2) the study of 3,400 weights and many capacity measures from Egypt; (3) the finding of the names and marks of four standards in Palestine which confirms their independent position; and (4) increased knowledge of prehistoric weights.

Such material supersedes most of the fragmentary and vague statements of ancient authors upon which we were formerly dependent.

The English standards of inches and grains are the most familiar and are here placed on the left side of the column; the equivalents in millimetres and grams are inset on the right side. Only the values actually found are here described without any theoretical amounts or assumed connections.

There is nothing easier than to frame systems of plausible relations between measures, but the exact amounts and the historic probability of descent must be ascertained before such theories can be valued.

LINEAL MEASURES. The units derived from 20.62 inches.

This standard of the cubit was used in Egypt

inches from the time of the predynastic royal tombs. mm.

20.62 The first accurate example yet published is in **524**

the size of the pyramid of Snefru (3rd dynasty) at 20.66, but still more exactly 20.62 in the pyramid of Khufu. The pure system of it was

n	100 = meh cubit	100 = khet
.206	20.62	2062 inches

But it was mixed with other systems as

zebo digit	4 = shep palm	7 = meh cubit	100 = khet reel	120 = ater or skhoinos
.737	2 947	20 62	2062	3.9 miles

This was termed the "royal cubit" throughout history. The Babylonian 20.89 of Gudea may be another form and probably the origin of this. It appears in Asia Minor as 20.55 to 20.94; in tombs at Jerusalem as 20.57; and in six English stone circles as 20.55. The eastern system was

uban	5 = qat	6 = ammat	6 = qanu	60 = sos	30 = parasang	2 = kaspu
.695	3.475	20.85	125.1	7506	225,180	450,360

The same cubit of 20.68 appears in stone buildings of New Mexico.

12.45 This foot is $\frac{3}{5}$ of the cubit of 20.75. It is found in Athens as 12.44; Aigina 12.40; Miletos **316**

12.51; Olympia 12.62; Etruria 12.45; and medieval England 12.47. The system was

foot	10 = akaina	10 = plethron	6 = stadion
12.45	124.5	1245	7470

From the foot was formed a cubit of 18.7 **474**

foot	$1\frac{1}{2}$ = cubit	4 = orguia	100 = stadion
12.45	18.7	74.7	7470

13.8 Another foot was formed of $\frac{2}{3}$ of the cubit adopted by Philetairos of Pergamon as a **350**

standard.

17.72 This was the short cubit of Egypt; actually found as a measuring rod and having 6 palms **450**

it was directly connected as $\frac{6}{7}$ of the 20.67 cubit. As 17.6 it is recognized as the early Jewish cubit.

The digit and derived measures.

inches This digit mas $\frac{1}{40}$ of the diagonal of the 20.62 mm.

.729 cubit. The diagonal of the cubit, 40 digits, is **18.51**

found as a wand of the middle prehistoric age, 29.1 long. Another multiple was the half of this, 20 digits, called the remen, used as a basis of land measure. By having two systems, one the diagonal of the other, it was possible to denote one square half the area of another.

digit	100 = orguia	10 = amma	10 = stadion: itinerary
.729	72.9	729	7290

inches mm.

18.23 25 digits = Greek cubit of 18.23 **463**

12.15 $\frac{2}{3}$ of 18.23 is the Greek foot of 12.15 from which was a decimal system. **309**

foot	10 = akaina	10 = plethron: agrarian
12.15	121.5	1215

This measure is rare in comparison with the 12.45 foot. It has been supposed to have been used for the Parthenon, but the 11.69 foot agrees more closely with that. The $\frac{2}{3}$ of 25 digits being a fractional amount was inconvenient, and the foot of 12.15 was divided binarily into 16 digits, of 96 to the orguia, or .759 inch. Such seems to have been the original connection of the different Greek systems, but much more dated material is needed.

11.613 From the digit of .729 on which the Greek measures were based, as for the Parthenon **294.9**

11.69, the Italic foot of 16 digits was formed of 11.66, or as it was later at Rome 11.613. The series was

digitus	4 = palmus	4 = pes	5 = passus	125 = stadium	8 = milliare
.726	2.90	11.61	58 06	7258	58,060

This was widely spread by Roman influence, varying up to 11.8. It has an earlier history, being used for the Parthenon and perhaps the Theseion as 11.69, as an Etruscan measure (**11.59**), in prehistoric times at Stonehenge **(11.68)** and probably in other stone circles and hill figures **(11.60).** Such are the linked systems of great extent from which have been derived many units.

13.3 This widespread measure is first found in Egypt as wooden cubit rods of 26.5 to 26.74 **338**

of the 12th dynasty: later a very accurate standard slab of this unit, divided in 7 palms, reaches 26.80. In Asia Minor it is found as 13.35 in buildings; in Greece 13.36; at Lachish 13.18 (900 B.C.); and in Syria (A.D. 620) as 13.22, carried on as the

Stambuli cubit of 26.6. Hultsch takes it as 13.1 and connects it with the Drusian foot of 2 digits longer than the Roman foot, or 13.10. This was the Belgic foot which Drusus had to adopt as a northern standard for the border settlements of the Agri Decumates. Hence it connects with the base of English land measure.

foot	6=fathom	10=chain	10=furlong	10=old mile
13 2	79.2	792	7920	79,200

It was the commonest building foot in medieval England (13.2), and its age is seen by its use as the measure for Silbury hill (13.0). It was also the basis for French architecture, the *canne* of 78.24, or six feet of 13.04. Unfortunately this old equivalent for the metre has now disappeared.

19.2 This unit is found in Persepolis (19.2) and modern Persia (2 × 19.3); the cubit of Gudea **488**
and of the tower of Babylon 119.5); in the west in Asia Minor (19.3); and as the Pythic foot (9.75, ½**19.5**). Two-thirds of this, a foot of 12.83, seems to bc a unit of buildings at Knossos.

20.0 The great U of 39.96 (Oppert) is possibly a variant of the preceding. found in some As- **507**
syrian buildings as 19.97.

21.6 By the recorded circuit of Khorsabad the U is 10.806, hence the series of multiples on the **549**
tablets is

susi	20=palm	3=U	6=qanu	2=sa	60=us	30=kasbu
18	3 6	10.8	64 8	129 6	7776	233,280

In Phrygia this mas 21.8 at Ushak; in Italy it was 21.86 in Lucania; and half of 21.7 or 21.9 as the Oscan foot. It may occur in square prehistoric earthworks in England. In Egypt there are late cubits of 21.11, 21.16 and 21 33 which may be the same. In Persia it was likewise a smaller form as

vitasti	2=arasni	360=asparsa	30=parathanha	2=gav.
10.7	21 4	7704	231,120	462,240

This important unit was used in Phoenicia; at
22.2 Byblos 11.10; for the Erechtheion 11.09; and 564
in Punic colonies, Carthage, Sardinia and the Hauran, 11.08–11.17. The double of 11.30 is the commonest unit of tombs at Jerusalem.

inches There are very few evidences of this measure. mm.
25.1 Divisions on a wall at Abydos give 25.13. The 638
contents of the brazen sea of Solomon taking the bath as 2380 c.c. would imply a cubit of 23.0 if cylindrical or 26.2 if hemispherical. This at least proves a cubit much longer than the Egyptian. Oppert concluded that Assyria had a cubit one-sixth longer than 21 6; *i.e.*, 25.2. Measures of buildings point to 25.28 in Palestine and 25.34 in Persia, where the *guerze* is 25 inches.

There are not included here some suggestive but debatable evidences of various units, such as the course heights of the pyramid of Khufu (*Anc.* Eg. **1925,39**) and the subsidiary marks of units on the standard cubits.

It may be noted how usually a stadium or furlong measure has been established. There are seven named above: 7258, 7290, 7470, 7506, 7704, 7776 and 7920 inches. These may result from convenient lengths for the plough furrow. It is easy to find coincidences with so many values to choose from.

Areas are passed by as they involve very uncertain factors of methods of cultivation, length of furrow, influence of measures of seed and varying ability of ploughing due to soil.

Capacity Measures

The approximate values of Egyptian capacities are anciently stated by the odd quantities that certain vases held, but as these were probably measured to some unknown point below the brim the result cannot be exactly defined. The standard vessels here described, intended for gauging, give better determinations than have been known before.

cubic inches The amount of the Egyptian hen by five regular measures (of metal or stone) averages c.c.
29.1 29.2 ± .5 cu.in., from ten bronze vessels 29.0 ± 477
.3, from eight marked vases 29.2 ± .6. So 29.1 may best be adopted. If it held 5 debens of water the deben weight would be 1,470 grains, which is nearly a middle value. The multiples are

ro	8=hen	4=hennu	10=apt	4=tama	25=sa
3.64	29.1	116.4	1164	4656	116,400

20.8 There is a double grouping of the Syrian kotyle 341
21.6 on 20.8 and on 21.6. This is supported by the 354
literary difference between the old Syrian 21 and Seleucidan 22 cu.in. (Hultscli). The cause for this change may have been that the old unit of 20.8 belonged to 25 beqa of water, and later it was raised so as to fall within the limit of 25 sela of water. The change would be caused by the sela superseding the beqa as a usual weight standard. In Egypt this was the commonest measure, of which there is a series of the 3rd dynasty and a stone cylinder standard from the 4th, of 20.8. The series of early and late values is

kotyle	2=xestes	18=sabitha or saton	3=bath, artaba
20 8	41 6	7488	22,161
21.6	43 2	7776	23,328

There was also the metretes of 5 saton, 37,440 to 38,880.

33.2 The Syrian log was not unusual in Egypt. Nearly in the midst of the values for it there 544
is a bronze cylinder measure with names of Ainenhetep III, of 33.26. If this log were to agree with 50 necef, the most usual Syrian weight, it would not be over 32.6 in early times and would only reach 33.2 in the 18th dynasty. The Phoenician, Babylonian and Jewish systems vary as follows, the Egyptian amounts being placed to the latter series.

P. log	4=kab		6=saton		30=kor	
31	123		740		22,200	
B. log	4=kapitha			18=epha	10=homer	6=akhane
33	132			2380'	23,800	142,800
J. log	4=kab	3=hin	2=seah	3=ephah	10=homer	
E. 33.2	132.8	398.4	796.8	2391	23,910	

17.4 The Attic kotyle is found in the size of six similar bronze bowls of late form in Egypt, **285**
from ½ to 2 kotyles. The mean is 17.15. This amount is too small for an Attic weight, for if the khous were 8 minae of water the largest bowl size would only agree with the lowest mina. But if the kotyle of water weighed half the mina of Chios or Persia (khoirine system), this would place it at 16.6 to 17.5. In this dilemma the Persian kapetis has some influence. According to Herodotus (1,192) the Attic kotyle: kapetis : : 12 : 51 or 4 : 17. The kapetis is shown by two bowls mentioned below to be 74.5 or 75.3; therefore, the kotyle would be 17.53 or 17.72. If we take 17.4 that would leave the 51 of Herodotus the nearest whole number, and the small difference would thus be divided among the three factors. The series is for

		Liquids			
kyathos	1½=oxybaphon	4=kotyle	12=khous	12=metretes	
2.9	4.35	17.4	208.8	25,056	
		Solids			
kpathos		6=kotyle	4=khoinix	8=hekteos	6=medimnos
2.9		17.4	696	5568	33,108

cu.in. Two bowls of Persian age from Egypt are of c.c.
74.5 74.5 and 75.26, clearly the Persian kapetis. 1221
Their relation to the kotyle value is stated above. The multiples were

kapetis	48=artaba	40= } akhane
74 5	3576	
	marıs	72= } 143,040
	1987	

58.5 A system found at Gythion (Rev. Arch., 1872) is based upon 58.5 cu.in., and seems to belong **958**
to the Egyptian hen, double of which is 58.2.

kotyle	4=hemihekton	4=khous	3=*n*
58.5	234	936	2808

1701 The most important Roman system is far from being established. The data are but few 27870
and discrepant.

	amphora	sextarius	amphora	sextarius
If amphora =cube ft.....	1569 cu.in.	32.7 cu.in.	25,709 c.c.	536 c.c.
Amphora 80 lib. water...	{1575	{32.8	{25,807	{538
	{1605	{33.4	{26,300	{548
By Farnese congius.....	1654	34.4	27,102	563
St. Genevieve congius...	1700	36.4	27,856	580

Naples measure........	1701 / 1703	35.44 / 35.48	27,872 / 27,905	581 / 581
Pompeian standard......	1732	36.1	28,377	623
Caervoran standard.....	1824	38.0	29,888	

There does not seem any course better than to accept the two accurately made measures in the Naples museum of 709.7 and 283.5 cu.in. as being 20 and 8 sextaria; this would give 1702 for the amphora, agreeing with the St. Geneviève congius. The Naples vessels are only measured by lineal gauging, but that cannot be far in error. The system was

quartarius	4 = sextarius	6 = congius	4 = urna	2 = amphora
8.86	35.44	212.6	850.5	1701

Of the above sources the first two may be only approximate, and the Farnese congius is not above suspicion of a Renaissance origin. The Pompeiian measures seem too rough internally and look as if they had held a beaten copper lining. The Caervoran measure is marked as $17\frac{1}{2}$ sextarii, and this yields 38.0 cu.in.

Weights

The whole subject of weights as treated here is based on Egyptian material as that is by far the earliest and best known historically, and in amount the largest published. The arrangement found in Egypt serves best to classify the standards of other countries. The broad view is that each people or tribe had a separate standard, and that these were brought into different countries by invasion or trade. Those standards which were most alike gradually approximated by errors of copying, and lost their individuality entirely before any of the literary records. Thus 17 standards in Egypt which had originally come from various foreign sources became simplified to 8. They are here described in the order of their amount.

grains 116, 121, 124 — grams 7.52, 7.86, 8.06

The peyem standard is marked P.Y.M. on three Palestine weights. The varieties named here were all known before the 6th dynasty; the two heavier were mixed at the 20th dynasty; the lighter one joined in the 26th. There are twelve weights known marked with numerals and the standard, called *shoti* in Egypt, is named on papyri as being 12 to the deben, or between 115 and 126 grains. The multiples were

n	4 = peyem	10 = noshem	10 = *r*	4 = *s*
30	120	1200	12,000	48,000 grains

The noshem was 1,225 grains according to a triply-inscribed weight, the shekel or peyem being 122.5.

grains 127.5, 131.5 — grams 8.26, 8.55

Two standards of the daric existed in the Old Kingdom, but they were blended in the 18th dynasty. The same separation is seen in the weights from Ur, with a light group at 126.1 and a heavy group at 129.4. The earliest in Egypt is of S.D.40, or the beginning of the eastern immigration of Gerzean age: these centre on 125.5. The early weight of Dungi is of 125.9. A maneh of 50 shekels at 126.0 was used in Syria and Knidos. In Italy it was divided into unciae and termed the litra. Italic bronze ingots of a talent are based on 126.0. On the heavier standard the Persian karasha was 10 shekels of 128.65. The coinage under the Persians (from which is taken the name daric) was of 129.2, and some coins reach 131. The heavy standard at Knossos is 131.8, 132.9. This daric standard spread over Asia Minor and across the Euxine, westward to Corinth, the Adriatic isles, south Italy and even to Ireland (gold work 128.0). The series is

um	60 = sikhir	6 = shekel	60 = maneh	60 = trade talanton
.36	21.5	129	7750	465,000

134.0, 135.8 — 8.68, 8.80

The Stater or Attic standard is the least prominent in Egypt. The forms are poor and only two examples bear numerals. The two standards were unified by the 18th dynasty, and the multiples are decimal. In Greece the system was

khalkous	8 = obelos	6 = drachma	100 = mina	60 = talanton
1.4	11.17	67	6700	402,000

In Greek use there was a lighter form for coinage, ,133, and a heavier form in trade, centring on 135. The names of obelos and drachma, or a dart and a handful (of darts), show how objects were used for weights in Greece. The names must have arisen in the use of iron or bronze weapons, and the silver coins were the exchange values. This standard passed into Italy where it was halved for the Etruscan and Sicilian libra, and divided into 12 unciae. It was the talanton of Antioch and the Ptolemies, and survived in Egypt as the rotl, divided duodecimally as in Italy and so producing the dirhem which was the standard coin of Arabic Egypt.

144 — 9.33

The qedet was the national standard of Egypt and was brought in by the dynastic people. There are very few marked weights because it was so usual. Though there were not distinct groups in early times, there were local differences, as weights "of Heliopolis" are on 140 unit, while one of Amasis is 150. Alabaster cones are the earliest, belonging to the 1st dynasty: they are multiples of a third of the qedet. From Ur are six small weights that are multiples of a twelfth of the qedet, so the division in thirds comes from Babylonia. There are many qedet weights from Gezer, Gerar, Knossos and Troy. A large knuckle-bone of bronze from Gela, inscribed "I am of the Gelonians," is 100 qedets. The unit, however, did not spread much in other countries nor start other standards.

b	4 = *c*	3 = qedet	2 = khenp deben	5 = deben	10 = sep	5 = *d*
12	48	144	288	1440	14,400	72,000

The deben a-as binarily divided in Ethiopia for the gold trade down to the *pek*, which was $\frac{1}{128}$. A set of measures for gold dust gives every stage of this division.

154.4, 162 — 10.0, 10.5

The necef is named on six Palestine weights; it may be the nusa weight mentioned in the Harris papyrus. It was first identified by the weight of Syrian tribute to Tehutmes III being in odd numbers of qedet but soluble as multiples of this amount. The two varieties of this unit did not blend till the 26th dynasty. The lighter was the Syrian standard of named weights and was the earlier one at Gezer. The system was decimal, multiplying up to 1,000 and halving down to $\frac{1}{8}$. By the tribute lists it was North Syrian and in later times is found at Berytus and Antioch, Cilicia (pre-Persian), Asia Minor and a bronze lion from Abydos of 2,500 necef. On going west there is a $\frac{1}{4}$ necef at Knossos. It appears in the jewelry of the 17th dynasty at Thebes, a collar of gold weighing 10 X 158.5, and bangles 2 $\times$ 161.3, 162.9. This collar is of the same form as the three Swedish collars weighing 60 $\times$ 158.2, 70 $\times$ 155.9 and 80 $\times$ 158.7, all on the necef basis. Where all this necef jewelry was made is unknown but it mas entirely foreign to both Egypt and Sweden. There are about 50 Irish gold objects on the heavy necef of 162 to 169. The Greek system was

stater	50 = mina	50 = talanton	60 = Greek talanton
160	8000	400,000	480,000

grains 171, 185 — grams 11.08, 12.00

A mark ♀ is often used for this unit but the name is not known in full. As many copies of cowry shells are on this (but on no other) standard, it is called the khoirine and perhaps the monogram is XO, as those letters were in use long before Greek writing. The bulk of the early examples is from 176 to 190; but there was a rarer form at 171–3, down to the 18th dynasty, and not blended with the majority till the 23rd. Three very fine numbered weights from Gerar closely agree in giving 179.3 to 179.8; the stone cowries are the same but rather more divergent, 177.7 to 180.0. The multiples in Egypt are decimal up to 1,000 and fractions down to $\frac{1}{10}$. In later times it became the Persian silver standard, but all the theories of the derivation of an 86 grain weight from the ratio of gold to silver, are blown away by the fact that this standard is thousands of years older. At Khorsabad silver plates are 40 khoirines in weight. As a monetary unit it is known at Arados, Cilicia, Lydia and Macedonia. It is known as the Chian standard, with a mina of 8,410 to 8,886. It was used on the Danube in Roman times and recognized as a mina of 20 unciae. The classical system was

obolos	6 = siglos	100 = mina	60 = talanton
14.3	86	8,600	516,000

196, 210 The oldest standard known is the beqa, found in early Amratian graves in Egypt (7000–8000 B.C.), and named upon three weights in 12.70, 13.61
Palestine. This is often called the gold standard because many of these weights bear the hieroglyph for gold. The names of kings are more frequent on this than on other standards. The lighter and heavier forms were not unified until the 23rd dynasty, though both were used before for royal weights. The system was decimal up to 2,000 beqa with fractions down to $\frac{1}{16}$. The earliest weights (Amratian) are short cylinders with domed ends; later (Gerzean) is a dome with convex base. From the marks, the variety of forms and fine work, this is the most attractive series of weights. Abroad the standard is often found at Gerar and there are several weights from Knossos (194–205); in the west are six double axes from Elbe and Rhine on a unit of 191, and 50 examples of Irish gold on 200 to 202. The iron currency bars found in Celtic England are stated to be on multiples of 191, though they vary rather widely. Some of these western forms are due to the Greek adoption of the beqa as the standard of Aigina (199) which was widely spread by trade in Asia Minor and Ionia, as well as in Greece (the old mina of Athens), and passed on to Italy. There as the Etruscan pound (it originated the Roman libra), which at its lightest was 25 X 187, divided into 12 unciae.

5050, 421 The heaviest value of the Roman libra is given by the early aurei as 5050, uncia 421. The influence of unification with other standards 327.24, 27.27
created many types of the libra, and it is instructive to see the groups at 393 (6 Attic coin drachma); 407 (6 Attic trade drachma); 412 (Roman trade); 417 (Roman solidi); 421 (Roman aurei); 427 (octodrachm Ptolemaic); and 435 (2 Phoenician staters). The Attic trade value was adopted for the average pigs of lead which are 250 librae of 4,900 grs.; the Attic coinage value influenced the Celtic weights; Mayence 4767, Glamorgan 4770. The system was

siliqua	6 = scripulum	4 = sextula	6 = uncia	12 = libra
2.9	17.5	70.1	421	5050

In later times the gold solidus, or sextula, was called the nomisma.

grains 220 The Phoenician or Alexandrian unit is best termed the sela which, though a later name, grams 14.26
serves to distinguish it from other shekels. It was a diffuse unit from the beginning, varying in the Old Kingdom from 214.7 to 227.0, and it gradually diminished to as low as 210. The multiples are decimal up to 4,000 and fractions to $\frac{1}{16}$. This is found as the unit of the Syro-Mesopotamian tribute under Tehutmes III, and later as one of the most usual coinage units, such as the Maccabaean shekel. It was carried by trade to Carthage and Spain and formed the Italic mina. Gold bars from Abukir of Roman age are each 25 shekels of 211.7, 212.9 and 213.0. The series is

drachma	4 = shekel	25 = mina	120 = talanton
55	220	5500	660,000

It extended widely into prehistoric Europe. At Knossos the great octopus weight shows a unit of 223.7, an ox-head from the Diktaian cave shows 227.2, a gold bar from Mykenai 233.1 and another irom Enkomi 222.6. The Vapheio cups are 20 sela of 213, and 216.5. Electrum jewelry from the temple of Ephesos is on a unit of 219.0. In Babylon the maneh of the age of Entemenna (2850 B.C.) is 50 of 210.1. The average of 19 ingots of bronze from Hagia Triada gives a talanton of 2,000 shekels of 226.0. Two double axes from the Rhine and four Ligurian ingots agree on 50 shekels of 225.4. The Irish gold has a large group agreeing with an average of 226.0. Thus there was a great spread of the unit, doubtless due to Phoenician trade.

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WEIGHT THROWING is the art, science and sport of throwing a weight for distance or height. Men of many nations have matched strength and skill at hurling objects of various weights for centuries. Such contests have always held particular appeal in what is now known as Ireland. As far back as 1829 B.C., the *roth cleas*, or wheel feat, was a major test of the Tailteann games. The competition involved various methods of throwing: irom shoulder or side; with one or two hands; and with or without run or follow. The implements used varied widely in weight and conformation. Early in the 20th century records nere listed for throwing weights of 14 lb., 28 lb., 35 Ib. and 56 lb., both for distance and height.

In 1904 at St. Louis, Mo., and in 1920 at Antwerp, Belg., 56-lb. weight-throwing contests for distance were held in the Olympic games. Etienne Desmarteau, a policeman from Montreal, Can., won the 1904 competition with a throw of 34 ft. 4 in. Pat McDonald, a New York policeman, won at Antwerp with a flip of 36 ft. $11\frac{1}{2}$ in.

By the second half of the 20th century there no longer was any international competition in weight throwing, and performances did not receive world-record listing by the International Amateur Athletic federation, the world governing body of track and field. The sport remained popular, however, in the northeastern United States. The 35-lb. weight throw is a standard event in the annual championship indoor meets of the Amateur Athletic union (A.A.U.) of the United States and the Intercollegiate Association of Amateur Athletes of America (I.C.4-A). Member I.C.4-A colleges include it in their dual meet programs. The A.A U. also had a 56-lb. weight throw on its list of outdoor championship events until 1959. when it was dropped.

The weight thrown today, either 35 lb. or 56 lb., is a ball molded of lead or a brass shell filled with lead. Affixed to it by an eye bolt or swivel coupling is a triangular handle of round iron or steel, $\frac{1}{2}$ in. in diameter. measuring no more than $7\frac{1}{4}$ in. a side, inside dimension. The throw must be completed from within a 7-ft. circle, without follow.

Top standards of performance in throwing for distance have risen to above 70 ft. nith the 35-lb. weight and 40 it. with the 56-lb. weight. Because there is little international competition, there no longer are listed world records for weight throwing but the A.A.U. publishes American records which, in effect, are world records since there are none better.

Method of Throwing.— Strength and bulk were once the main factors in weight throwing, but technique has been refined to a point nhere speed is now more important than mere weight and muscle. Because of their speed and perfection of technique, comparatively small men, such as Harold Connolly, have thrown the 35-lb. weight for distances undreamed of by the big men of earlier days. Connolly was the first thrower to exceed 70 ft.; the speed which he developed in training for the hammer throw, in which he has been a record-holder, more than compensated for his lack of size.

To throw for distance, the athlete takes a stance at the rear of the throwing circle with his feet well apart for balance and his back turned squarely toward the direction of the eventual throw. The weight is grasped by its triangular handle, palms up or donn or with the left palm down and right palm up. according to individual preference. The weight is lifted. swung to the right side and revolved around the head. With the completion of the revolution the thrower commences a tight-based, pivoting spin on his left foot. As he whirls nith arms fully extended the weight moves with him, square to his chest, in a wide arc. Another turn is taken with acceleration and then, at least by the good throwers, still another. On the completion of his third turn the throner should be in an approximation of his starting position, but in the forward portion of the throning circle. with the neight in rapid circular movement. With feet solidly planted he then whips all his strength into the release of the whirling ball, driving up with his legs, pivoting his whole torso and following through with his arms as he lets the ball fly over his left shoulder.

It has been well established through experimentation that there is no substitute for developing a high rate of speed on the turns. Weights as heavy as the 35-lb. or 56-lb. implements that are used must be moving at high speed at the release to travel long distances. Sheer strength or an explosive releasing snap is not enough to conquer the passive force of inertia.

While concentrating on attaining maximum spinning speed, the thrower must also maintain control and balance. The rules require that a competitor must not step from inside the circle until his throw has been measured and also that he must depart from the rear half of the ring. (J. M. Sh.)

WEI-HAI (formerly Wei-hai-wei), a city and port near the northern tip of the Shantung peninsula in Shantung province North China. The harbour faces eastward toward the Yellow sea but is protected on the east by 2-mi. long and 1-mi. wide Liukung Island which is urbanized along its south side. Wei-hai city on the mainland is backed by hills rising to 1,353 ft. The harbour takes vessels up to 33 ft. draft. Strong northwest winds in winter reduce safe depths by two feet. The southwest end of Liukung Island has a naval station with a number of piers, and Wei-hai is commonly linked with Port Arthur (*q.v.*) to form the naval gate ays guarding the entrance to the Gulf of Chihli (Po Hai). It was this strategic situation that caused Great Britain to lease the port from China as a naval base (Port Edward) in 1898, in part to counter Russia's lease of Port Arthur. The Wei-hai lease was surrendered voluntarily in 1930 when a special administrative area was established there by the Chinese government. Wei-hai was occupied by Japan from 1938–1945.

In 1949 following the Nationalist withdrawal, it was occupied by Chinese Communist forces, thereafter becoming a Communist naval base.

Wei-hai also is a secondary commercial and fishing port for Shantung. Small industries include vegetable oil pressing, silk and cotton weaving and ship repair, especially in the foundries and machine shops of the naval station. Highways connect Wei-hai with Chefoo (Yen-t'ai) in the west and Tsingtao (Ch'ing-tao) in the southwest. A submarine cable also provides communications with Chefoo. (H. J. Ws.)

WEILL, KURT (1900–1950), U.S. composer, was born in Dessau, Ger., March 2, 1900. He began to compose music while still in elementary school, prompted by his father, a cantor. At the age of 18 he began studying composition in Berlin with Engelbert Humperdinck. He moved to Ludenscheid in Westphalia, as operatic conductor, but shortly returned to Berlin to study with the pianist and composer Ferruccio Busoni until 1924. During these years Weill composed a variety of aorks, including symphonies and chamber music. He first adapted his composition to the theatre in the mid-1920s when he was commissioned to do a children's ballet for a Russian company visiting Berlin. In 1926 he collaborated with Georg Kaiser on the opera *The Protagonist,* and subsequently also collaborated with Kaiser, Ivan Goll and Bertolt Brecht on various operas including *Royal Palace, The Tsar Has Himself Photographed, The Three-Penny Opera* and *The Silver Lake.* The anti-Nazi overtones of *The Silver Lake* resulted in the banning of Weill's works in Germany, and he went to Paris where, in 1933, he composed the ballet *The Seven Deadly Sins.* In 1935 he went to the United States, where he was commissioned by producer Max Reinhardt to write the music for *The Eternal Road.* He also composed the music for *Knickerbocker Holiday* (1938), *Lady in the Dark* (1941), *One Touch of Venus* (1943), *Street Scene* (1946) and *Lost in the Stars* (1949). He died in New York city, April 3, 1950.

WEIMAR, a city of Germany, the chief town of the former *Land* of Thuringia, in the district of Erfurt. Pop. (1950) 64,452. It existed in the 9th century. Till 1140 it belonged to the counts of Orlamünde; it then fell to Albert the Bear. In 1247 Otto III founded a separate Weimar line of counts. In 1345 it became a fief of the landgraves of Thuringia, to whom it escheated in 1385. At the partition of Saxony in 1485 Weimar, with Thuringia, fell to the elder. Ernestine, branch of the Saxon house of Wettin. and was the continuous residence of the senior branch of the dukes of this line after 1572. Under Charles Augustus (1775–1828) and his successors, Weimar became a centre of liberalism as well as of German art. It was at Weimar, in July 1919, that the constitution of the new German republic was adopted by the national assembly.

Weimar still retains much of its medieval character because of the narrow winding streets of the older part of the town, the market place surrounded by houses with high-pitched gables and roofs, and the fragments of the walls, which still survive. Of the churches. the Stadtkirche is a Gothic building dating from about 1400, but much altered in detail under "classical" influences. The altarpiece is a triptych, the centrepiece representing the Crucifixion; beside the cross Luther is represented, with the open Bible in his hand, while the blood from the pierced side of the Saviour pours onto his head. The other church, the Jakobs- or Hofkirche (court church), is also ancient. The most important building in Weimar is the former palace, erected (1789–1803) under the superintendence of Goethe, on the site of one burned down in 1774. A remnant of the old palace, with a tower, survives. The interior is very fine, and in one of the wings is a series of rooms dedicated to the poets Goethe, Schiller, Herder and Wieland. Of more interest, however, is the house in which Goethe himself lived from 1782 to 1832. It is a complete example of a German nobleman's house at the beginning of the 19th century. Of more pathetic interest is the Schillerhaus, in the Schillerstrasse. containing the humble rooms in nhich Schiller lived and died. The theatre, built under Goethe's superintendence in 1825, memorable in the history of art not only for its associations with the golden age of German drama, but as having witnessed the first performances of many of Wagner's operas, was pulled down and replaced by a new building in 1907. The most beautiful monument of Goethe's genius in the town is, however, the park. Just outside the borders of the park, beyond the Ilm, is the "garden house," a simple wooden cottage with a high-pitched roof in which Goethe used to pass the greater part of the summer. Finally, in the cemetery is the grand ducal family vault, in which Goethe and Schiller also lie, side by side.

Among the other prominent buildings in Weimar are the Grunes Schloss (18th century), containing a library and a valuable collection of portraits, etc.; the old ducal dowerhouse (Wittumspalais); and the museum. In 1896 the Goethe-Schiller Archiv, on the height above the Ilm, containing manuscripts by Goethe, Schiller, Herder, Wieland, Immermann, Fritz Reuter, Mörike, Otto Ludwig and others, was opened. Weimar possesses also archaeological, ethnographical and natural science collections. About 2 mi. S. from the town is the château of Belvedere, with the open-air theatre, of interest because of its use in Goethe's day. A few miles northwest of Weimar was located the Nazi concentration camp of Buchenwald, where racial and political prisoners were confined from 1933 to 1945.

WEINGARTNER, FELIX (1863–1942), Austrian-born conductor and composer, was born in Zara, Dalmatia, on June 2, 1863. He studied music at the Leipzig conservatory and in 1883 went to work under Franz Liszt who arranged to have his first opera, *Sakuntala,* produced at the Weimar court theatre in 1884. He subsequently became *Kapellmeister* at the Konigsberg theatre. In 1891 he became *Kapellmeister* in the Berlin Royal Opera and conductor of the Berlin symphony orchestra. He first visited London in 1898, made his first appearance in the United States in 1905, as guest conductor of the New York Philharmonic orchestra, and toured the country the following year. His fame as a conductor grew steadily; he led the Vienna Opera (1908–10) and thereafter conducted the symphony concerts of the opera orchestra.

He became head of the Basel conservatory in Switzerland in 1927 and a naturalized Swiss citizen in 1931. He was director of the Vienna State Opera. 1935–36, but after 1937 lived in Switzerland. where he died. at Winterthur. on May 7, 1942.

His compositions included a number of operas and six symphonies and he edited many musical norks.

WEINHEIM, a town of Germany, in Baden-Württemberg, at the foot of the Odenwald, about 10 mi. N. of Heidelberg. Pop. (1950) 25,199. It is still in part surrounded by the ruins of its ancient walls. The Gothic town hall, the ruins of the castle of Windeck and the modern castle of the counts of Berckheim, the house of the Teutonic order, and three churches are the principal buildings. The town has various manufactures, notably leather, machinery and soap, and cultivates fruit and wine. It is a favourite climatic health resort and a great tourist centre for excursions in the Odenwald range. Weinheim is mentioned in chronicles as early as the 8th century, when it was a fief of the abbey of Lorsch. and it was fortified in the 14th century. In the Thirty Years' War it was several times taken and plundered, and its fortifications dismantled.

WEINMAN, ADOLPH ALEXANDER (1870–1952), C.S. sculptor, was born at Karlsruhe. Ger.. on Dec. 11, 1870. He emigrated as a child to New York city. where he studied sculpture under Augustus Saint-Gaudens. He opened his own studio in 1901 and first attracted notice for his group of American Indians at the St. Louis, Mo., world's fair of 1904. Well-known works oi his include a pediment of the national archives building. Washington, D.C.; a monumental frieze for the Elks National Memorial building, Chicago, Ill.; and figures for various state capitols. Weinman died at Port Chester, N.Y., on Aug. 8, 1952.

WEIR, J. (JULIAN) **ALDEN** (1852–1919), U.S. painter, who was among the earliest Americans to show the influence of Impressionism, was born on Aug. 30, 1852, in West Point. N.Y., the youngest of the 16 children of Robert Walter Weir (*q.v.*). After studying at the National Academy of Design in New York, he went to Paris to study with Gérôme. There he became a friend of Jules Bastien-Lepage, who was to become an important influence in his development. He became interested in the work of the Impressionists, particularly in their concern for light and colour, but he never fully adopted their manner. He helped form the Society of American Artists and was president of the National Academy of Design from 1915 to 1917. In 1898 he helped found the group known as the Ten American Painters, which consisted of J. H. Twachtman, F. W. Benson, Childe Hassam, E. C. Tarbell, W. L. Metcalf, E. Simmons. Robert Reid, Joseph De Camp. T. W. Dewing and, later. W. M. Chase. Weir died on Dec. 8, 1919, in New York city. His works are in the Metropolitan Museum of Art in New York, the Art Institute of Chicago, the Phillips collection in Washington. D.C.. and in several other galleries.

WEIR, ROBERT WALTER (1803–1889), G.S. portrait and historical painter, was born at New York, N.Y., on June 18, 1803. He was a pupil of John Wesley Jarvis, was elected to the National Academy of Design in 1829, and was teacher of drawing at the United States Military academy at West Point in 1834–46 and professor of drawing there in 1846–76. He died in New York city on May 1, 1889. Among his better known works are: "The Embarkation of the Pilgrims" (in the rotunda of the Capitol at Washington, D.C.); a portrait, "Red Jacket"; "Columbus Before the Council of Salamanca"; "Our Lord on the Mount of Olives"; "Virgil and Dante Crossing the Styx." Several portraits and "Peace and War" are at West Point.

His son, JOHN FERGUSON WEIR (1841–1926), painter and sculptor, became a member of the National Academy of Design in 1866, and was director of the Yale university art school in 1869–1913. Robert Weir was also the father of the painter J. Alden Weir (*q.v.*). (D. H. W.)

WEIR, WILLIAM DOUGLAS WEIR, 1ST VISCOUNT (1877–1959), British politician and businessman, was born May 12, 1877, the son of James Weir of Over Courance, Dumfriesshire. He was successively Scottish director of munitions (1915), member of the air board (1917), air minister (1918), and chairman of the advisory committee on civil aviation. He was director general of explosives and chemical supplies in 1939 and chairman of the tank board in 1942. He was knighted 1917, sworn P.C. and created a baron 1918. created G.C.B. 1934 and a viscount, 1938. He died July 2. 1959, in Eastwood Park, Scotland.

WEIR, a barrier of moderate height placed across a river or stream to control the flow of the water for navigation, irrigation, power or other purposes, discharging the water over its crest or through wide openings having movable gates. River weirs are frequently termed dams, particularly in the United States where the term weir is more generally applied to small barriers erected to measure the flow of water or to trap fish. The French term barrage is often applied to neirs. (See WATER SUPPLY AND PURIFICATION; IRRIGATION; DAM; RESERVOIRS; MECHANICS, FLUID.)

Rough neirs formed of stakes and brushwood were erected across English rivers in Saxon times for holding water and catching fish. Fish traps, with iron wire meshes and eel baskets, are still used sometimes at weirs. Similarly, weirs of brushwood weighted with stones are still being used in some parts of the world to divert the flon into a ditch leading to land to be irrigated or into a bucket-type water wheel that spills water into a flume leading to an irrigation ditch.

Weirs exhibit the greatest variety of form and construction in connection with the canalization of rivers. Navigation becomes impracticable at the shoals in many rivers during periods of low water. In early times boats had to be kept at such places until the discharge of storm water raised the river sufficiently to carry them over the shallows. An early method of remedying this trouble consisted in building low weirs upstream from the shallows to increase the depth of water. Openings in them could be temporarily closed by stanches usually consisting of planks supported by movable wooden beams. By removing these beams suddenly and thus releasing the stanch an artificial flood was produced which carried any boat waiting above the weir through the opening and over the shoals below. This process was called flashing. It remained in use on some rivers in England and France until the early 19th century. (N. G. G.; B. O. M.; X.)

WEIRTON, a city of Brooke and Hancock counties in extreme northern West Virginia, U.S.. and an important steel-producing centre, is situated on the Ohio river about 26 mi. N.N.E. of Wheeling and 39 mi. W. of Pittsburgh Incorporated in 1947. when several adjoining towns merged, the city sprawls across seven miles of the West Virginia panhandle from the river on the west to the Pennsylvania border on the east, and from King's creek on the north to Harmon creek on the south. Weirton is one of the largest cities in the state. (For comparative population figures see table in WEST VIRGINIA: *Population.*)

Originally settled by John Holliday and his family during the American Revolution, in the 1790s the area boasted one of the first iron manufactories west of the Alleghany mountains when Peter Tarr built a crude furnace on King's creek to smelt iron ore mined in the nearby hills. There were fashioned the cannon balls which the U S. fleet under Oliver Perry used to defeat the British in the battle of Put-in-Bay during the War of 1812.

Iron and steel have remained closely identified with the community's economic development. Both the city and its principal industry are named for Ernest Tener Weir, who, in 1909, with several associates, founded the Weirton Steel company. In addition to sheet steel and tin plate, Weirton is also noted for the production of Venetian blinds, steel furniture, automotive parts and electronic equipment. (P. R. S.)

WEISMANN, AUGUST (1834–1914), German biologist, whose outstanding contribution was the theory of the continuity of the germ plasm, was born in Frankfurt am Main on Jan 17, 1834. He studied medicine at Gottingen during 1852–56, and in 1863, after working for a short period under R Leuckart in Giessen, went to the University of Freiburg. where he later was professor of zoology until his retirement in 1912. He died in Freiburg on Nov. 5, 1914.

Weismann's early zoological work was in insect embryology. but as a result of deterioration of his eyesight he had to give up working with the microscope, and after 1864 he devoted himself mainly to theoretical problems. He proposed that living organisms contain a special hereditary substance (the germ plasm) which, unlike the perishable body of the individual (the somatoplasm), is transmitted from generation to generation. The germ plasm can never be formed anew, but is formed from pre-existing germ plasm It governs the development of every part of the organism, and is not, in Weismann's view. modified by the action of environment He vigorously opposed the doctrine of the inheritance of acquired characters, previously generally taken for granted.

Weismann saw that since the hereditary substances from the two parents became mixed together in the fertilized egg, there would be a progressive increase in amount of hereditary substances unless at some stage there was a compensating reduction. He therefore predicted that there must be a form of nuclear division at which each daughter nucleus receives only half the ancestral germ plasms contained in the original nucleus. The cytological work of E. Strasburger, O. Hertwig and others on meiosis proved the correctness of this prediction. and enabled Weismann, together with these others. to propose that the germ plasm was located in what were subsequently called the chromosomes of the egg nucleus. It should be remembered, however, that at this time (1885) no detailed information concerning the nature of the hereditary factors was available, since Mendel's work, though published, was lying in obscurity.

Many of Weismann's detailed speculations, such as his idea that cellular differentiation took place by some process of segregation of hereditary factors (ids). were not supported by later work. Moreover, his rigid distinction between germ plasm and somatoplasm could not be maintained once it was realized that both germ and somatic cells contain nuclei and chromosomes. Nevertheless, in broad outline his theory of the germ plasm remained the basis of much of modern genetics.

Weismann's writings include *Studien zur Descendenztheorie,* 2 vol. (1875–76), trans. as *Studies in the Theory of Descent,* with a preface by Charles Darwin (1882); *Aufsätze über Vererbung,* etc.. trans. as *Essays upon Heredity and Kindred Biological Problems,* 2 vol. (1889 and 1892); and *Das Keimplasma* (1892). trans. as *The Germ-Plasm, a Theory of Heredity* (1893). *See* also HEREDITY; LAMARCKISM.

See E. Gaupp, *August Weismann* (1917). (G. H. BE.)

WEISS, (CHARLES) ANDRÉ (1858–1928), French international lawyer, best known for his work in private international law. was born at Mulhouse on Sept. 30. 1858. He began as a lecturer at the University of Dijon. moving to the University of Paris in 1891, where he became professor in 1896. His wide range of interest embraced at various times civil, administrative. public and private international law. It was on the latter that he lectured at Dijon and published. in 1885. *Traité élémentaire de droit international privé,* expanded into the six volume *Traité théorique et pratique de droit international privé* (1907–13), a pioneering work which reflected a wide knowledge of foreign systems of law. In 1911. with Jules Roche and Louis Renault, he drafted the constitution of Monaco.

Weiss was legal adviser to the French foreign office (1908–22), was elected a judge of the Permanent Court of International Justice (1921) and served for a while as vice-president. He died at The Hague on Aug. 31, 1928.

See the tribute delivered by the president of the Permanent Court of International Justice. Sept. 13, 1928, in P.C.I.J. *Series* E, no. 5r.10; and E. Bartin in *Journal du Droit International Privé,* 55:849 (1928).

WEISSENBURG: *see* WISSEMBOURG.

WEISSENFELS, a town in the district of Halle, Ger. Pop. (1950) 47.967. It is a place of some antiquity, and from 1656–1746 was the capital of the small duchy of Saxe-Weissenfels. The body of Gustavus Adolphus mas embalmed at Weissenfels after the battle of Liitzen. The former palace, the Augustusburg (1664–90), lies on an eminence near the town. Manufactures include cardboard, rubber; boots, machinery, ironware and paper. In the area are large deposits of sandstone and lignite.

WEIZMANN, CHAIM (1874–1952), research chemist. Zionist leader and first president of Israel, was born Nov. 27, 1874, in the township of Motol in Russian Poland. After early upbringing in a traditional Jewish environment, he studied in Germany and Switzerland: becoming lecturer in biochemistry at the University of Geneva and in 1904 reader in the same subject in Manchester. His practical discoveries in organic chemistry gave him not only a wide reputation but also some degree of financial security. An eager Jewish nationalist, he was already prominent in the Zionist movement (*see* ZIONISM). In consequence, when World War I split Zionist leadership into two camps, he inevitably assumed the foremost role in England. In this he was aided by his engaging personality, his wide linguistic range and his important war work (1916–18) in the admiralty laboratories on acetone, which brought him into contact with some outstanding figures in national life. He was thus largely responsible for winning from the British government in 1917 the Balfour declaration favouring the establishment of a Jewish national home in Palestine.

Throughout the next generation Weizmann was the leading figure in the Zionist movement, being from 1920 almost without a break president of the World Zionist organization and from 1929 chairman of the extended Jewish Agency for Palestine. Convinced as he was of the reconcilability of British policy and interests in Palestine with the requirements of the Jewish national home. his influence was at all times moderating and conciliatory. This resulted in his temporary replacement as president from 1931 to 1935, when the emergency which resulted from the rise of Nazism made his return to office inevitable. He was the principal spokesman for the Jews before the successive British and international commissions of inquiry sent to Palestine in the following years. The tragic crisis which resulted from the Nazi persecutions and the necessity of finding a Jewish haven of refuge created a widening gap between the British and Jewish viewpoints on the Palestine situation. and Weizmann while condemning acts of violence could not condone the drastic restrictions now proposed by the British government.

Driven thus into resignation in 1946. Weizmann retired to Rehovoth in Palestine to work at the Institute of Science (later called the Weizmann institute) which he had helped to create. and to compose his vivid though somewhat idealized volume of memoirs, *Trial and Error* (1949).

When the state of Israel came into being in 1948 Weizmann was elected president of the provisional government, and in 1949 first president of the state. but largely owing to his poor health and failing eyesight took little part in active politics. He died at Rehovoth on Nov. 9, 1952.

See P. Goodman (ed.), *Chaim Weizmann, A Tribute on His 70th Birthday* (1945), containing appreciations and Eng. trans. of select speeches; O. K. Rahinowicz, *Fifty Years of Zionism: A Historiral Analysis of Dr. Weizmann's "Trial and Error"* (1932). (C. R.)

WELCH, WILLIAM HENRY (1850–1934), U.S. pathologist and educator. was born in Norfolk, Conn., on April 8. 1850. A graduate of Yale university (A.B., 1870), he studied medicine at the College of Physicians and Surgeons in New York city and graduated from that institution in 1875. After an internship at Bellevue hospital in New York he went to Germany in 1876 and spent two years there studying under well-known medical scientists. Returning to the United States in 1878, he was appointed professor of pathology and anatomy in Bellevue Hospital Medical college (later New York university), a post he held from 1879 to 1884, when he was called to the newly created professorship of pathology in the Johns Hopkins university in Baltimore. Md.

In his new post Welch had the opportunity to develop what was in reality the first true university department of pathology in the United States. When the school of medicine of the Johns Hopkins university was opened in 1893, Welch was appointed dean, a post which he held until 1898. He remained as professor of pathology in the university and pathologist to the Johns Hopkins hospital until 1916. when he was appointed director of the newly established school of hygiene and public health of the university. After organizing that school and seeing it operating successfully, he resigned to become the first professor of the history of medicine in the school of medicine (1926). He retired from that post in 1930.

Welch made a few original contributions to the sciences of pathology and bacteriology—notably the discovery, with G. H. F. Nuttall, of the so-called "gas bacillus," the cause of gas gangrene—but his chief contributions were to the development of medical science in general, of medical education and of public health. He was considered one of the foremost figures in U.S. medicine. He died at Baltimore on April 30, 1934. (A. M. CY.)

WELD *(Reseda luteola),* **a** herbaceous plant of the mignonette family (Resedaceae) formerly cultivated in France, Germany and Austria. It is the oldest European dyestuff known, and appears to have been used by the Gauls in the time of Julius

Caesar. Of all the natural yellow colouring matters, it yields the purest and fastest shades, but because of the small amount of dye which it contains, and its bulky nature, it has almost disappeared from the market. Weld contains the yellow colouring matter luteolin, which crystallizes in yellow needles and melts at 320° C. See ANTHOCYANINS AND ANTHOXANTHINS. (A. G. P.)

WELDING usually refers to a technique of joining metals by heating with or without the application of pressure and with or without a filler metal; cold welding is possible by means of high pressure or by hammering. The value of welding as a standard method of joining metals was not fully appreciated before World War I, when because of the need for speed of production in every metal-using and metal-fabricating industry, the older of the welding processes came into their own. During and after World War II new welding methods were developed, which further increased speed and facilitated the joining of the many special-purpose alloys that were developed during this period.

Limited in its early applications to small or less important parts, welding in the second half of the 20th century mas employed in fabrications too numerous to mention, such as ships, locomotives, railroad rails and cars. automobiles. pipelines. aircraft and household appliances. While all metal-using industries employ more or less nelding, some are completely dependent on this technique of joining metals. The petroleum industry is a classic example. The cutting edges of the bits used to drill oil wells consist of a hard weld metal fused to a tough backing. The oil is conducted to the surface through pipe sections fabricated from plate by welding, and these sections are in turn welded end-to-end to form a leak-proof casing. At the refinery the oil is processed in equipment of which every permanent joint is nelded. Transportation to and from the refinery is via all-welded pipelines, ships, tank trucks and drums And, ultimately, gasoline is pumped from nelded underground vessels into the nelded steel gas tank of the consumer's automobile, while heating oil is delivered into a welded tank in the consumer s basement.

Whenever a piece of apparatus is intended to contain a liquid or gas, melding is the logical method of fabrication. As such. it has almost completely replaced other methods. Water, fuel gas and a host of other fluids are, like petroleum and its products, stored, processed and transported in welded equipment. Poner boilers and other vessels built to contain fluid under high pressure are welded uith complete reliability.

Nuclear power reactors are of entirely nelded construction, from the small cans containing the' fuel elements to the huge envelopes designed to confine the radioactivity in the event of a leak. As a matter of fact, ease of nelding is one of the major criteria in the selection or development of construction materials for nuclear reactors.

Welding is of course by no means confined to applications where leak-tightness is involved. In the conventional body-on-frame automobile there are some 8,000 to 10.000 resistance welds and up to 40 ft of arc nelding. Even more nelding is employed in automobiles using the body as the primary load-carrying member. Arc welding is the basic means of fabrication of heavier vehicles such as trucks, locomotives and earth-moving equipment.

Welded construction is used in the aircraft industry to a somewhat lesser degree. Aluminum alloys used in airfoils and air frames derive their strength from a critical heat treatment, and the heat of welding causes some deterioration in properties. Turbine and rocket engines, however, are fabricated by welding. Further, trans-sonic aircraft develop skin and frame temperatures that preclude in many areas the use of aluminum. The alloys used in its stead are fabricated by welding.

Bridges and buildings can be erected by welding, with a saving of 10% to 20% in the amount of steel required. Erection costs and, particularly, design costs are somewhat higher than in riveted construction. The proportion of structures erected by welding was increasing in the second half of the 20th century and the trend appeared likely to continue. In the home, many thousands of welds can be found in such diverse places as refrigerators. washing machines, frying pans, heating plant, plumbing, window casings and vacuum cleaners. Frames of homes and similar small buildings have been erected by welding, and there are sound reasons to expect that this application will increase.

Processes. — The subject of welding may be divided into five

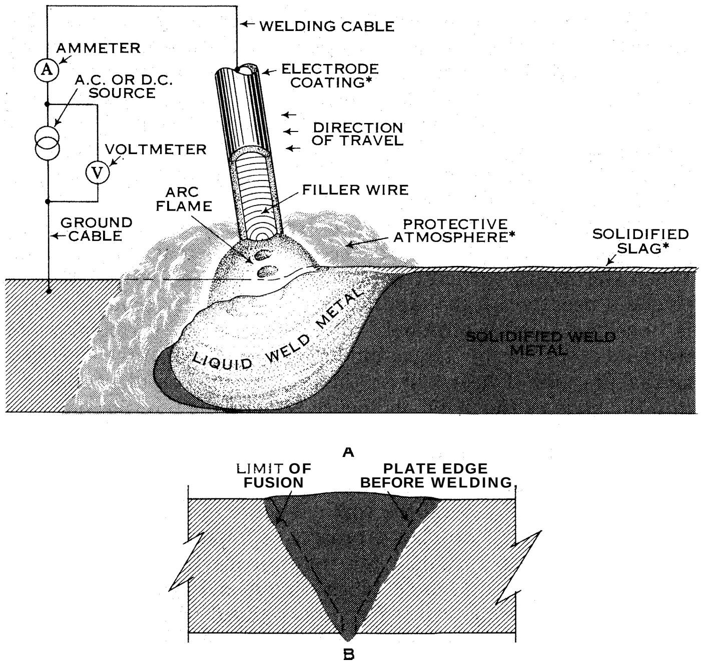

FIG. 1.—ARC WELDING WITH ROD ELECTRODES. (A) LONGITUDINAL SECTION THROUGH AN ARC WELD IN PROGRESS; (B) CROSS SECTION THROUGH COMPLETED WELD. COMPONENTS MARKED * ARE NOT PRESENT IN SOME ARC-WELDING PROCESSES

processes: (1) forge welding; (2) arc melding; (3) gas welding; (4) resistance welding: (5) aluminothermic welding.

Forge Welding. — From prehistoric times until about 1880 the only available method was forge welding. After properly shaping the two surfaces to be joined, the parts were heated to welding temperature in a forge or furnace and then hammered, rolled or pressed together, often with the aid of some fluxing material. In the manufacture of Damascan and samurai swords, wrought iron bars were hammered thin, then doubled back on themselves and forge welded. This procedure was repeated many times to ensure that all flaws in the original bar were drawn out in a longitudinal direction. The toughness of the neapon depended on how many times the bar was hammered out and nelded back on itself.

In modern practice, the heat is applied in *situ* by torches, induction coils or an aluminothermic mix (see *Aluminothermic Welding*, below). The parts are pressed rather than hammered to accomplish the weld. These modifications of forge welding are generally called pressure butt welding.

Cold nelding is the process by nhich ductile alloys can be welded at room temperature. if enough pressure and deformation are applied. Essentially, the process consists of drastically stretching the tno surfaces to be nelded together, while pressing them tightly in contact Strong joints in copper and the softer aluminum alloys can be made by this method.

Arc Welding may be divided as follows: (1) metal arc welding nith consumable rod electrodes; (2) inert-gas-shielded metal arc welding; (3) submerged melt nelding; (4) tungsten or carbon arc nelding; (5) atomic hydrogen welding. All of these methods can be automatized, and have been at one time or another. Important automatic installations are limited to (2), (3) and (4).

Metal Arc *Welding With* Rod Electrodes. — Tonnage-wise, this method is the most important. An arc burns between the electrode, a rod of suitable composition, generally coated nith a heavy cellulose or mineral coating and the parts to be welded. These should be properly shaped and are usually beveled on both edges when plates are to be joined in the same plane by a butt weld. The metal is fused at both ends of the arc and the fused electrode deposited in the joint in a series of layers until it is properly filled. After each layer the protective slag formed by the melting of the coating should be removed by chipping or peening. The arc should be as short as possible, particularly with bare wire welding, in order to avoid oxidation of the metal, the inclusion of harmful gases and to secure the proper penetration.

Welding may be done with direct or alternating current. The alternating current is usually supplied by a suitable transformer provided with taps to adjust the current. Several types of direct current arc welding equipment are available, An arc welding outfit consists of a welding generator or transformer, a control panel for varying the current, a voltmeter and ammeter, proper lengths of cable, an electrode holder and a suitable shield or helmet for protecting the eyes of the operator.

When direct current is used, one terminal remains positive and the greater portion of the total heat is liberated at this terminal. When alternating current is used, the terminals are alternately positive and negative so that approximately the same amount of heat is liberated at each terminal. Usually the piece of metal to be welded is considerably larger and has more mass than the electrode so that its loss of heat will be the greater because of conduction into the body of the metal and hence is made the positive side. In case very thin metal is being welded, it is frequently advisable to reverse the polarity to prevent the arc burning through the metal.

Coated electrodes have been used in some form since early in World War I. In general the coatings serve as a fluxing or deoxidizing medium and provide a protective vapour around the arc. They are used as a vehicle for transmitting desirable alloys in the deposited metal. Some types contain a large proportion of metallic iron. Components are always added which stabilize the arc by promoting ionization and thermionic emission. Low-hydrogen coatings, used on alloy steel rods, are compounded with a minimum of water or other hydrogen-producing substance. Some coated electrodes operate best with reversed polarity, *i.e.,* with electrode positive. Bare electrodes yield an inferior weld metal and are used only for tack welding and similar low-strength applications.

Inert Gas Metal Arc Welding.—The arc burns in a chemically inert atmosphere blown into the region of the weld. The electrode is fed automatically from a large spool of mire, through a tubular electrical contact, into the arc. The welding head, consisting of this contact, means for water or air cooling and means for conducting the inert gas to the weld, may be traversed either manually or automatically. Shielding gases commonly used are helium, argon and carbon dioxide. The last is not strictly inert to most engineering alloys.

The advantages of this process stem from its inherent high welding speed. A given size of wire can handle several times as much current as the same size of wire made into rod electrodes. Further, there is no need for the operator to stop frequently to change electrodes. The equipment costs more than that required for rod-electrode welding. The shielding gases, except where carbon dioxide can be used, are much costlier than rod-electrode coatings.

Submerged Melt Welding.—The apparatus is similar in many respects to that used in the last-described process. However, the wire is fed into a mound of flux rather than into a shielding atmosphere. Part of the flux melts, spreading over and protecting the molten weld metal. The flux is compounded to deoxidize and, if wanted, to add alloying elements to the weld metal.

Submerged melt welding is the most economical way to make long, straight seams in heavy steel plate in the flat position. In 1952 apparatus was introduced that makes possible submerged melt welding of horizontal and vertical seams in vertical plates.

Tungsten or *Carbon* Arc Welding.—The carbon arc was first applied to the welding of metals only a few years after its introduction as a smelting tool in 1881. The carbon resists the heat of the arc, but is gradually oxidized. The welding wire is fed into the arc, or into the molten pool formed on the work. The weld may be shielded against atmospheric contamination by means of granulated flux or an inert gas. However, submerged melt welding is a more satisfactory flux-shielded process.

Tungsten is nearly as resistant as carbon to the heat of an electric arc, but tungsten oxidizes more rapidly and is, of course. much more expensive. Of the two, tungsten is by far the better electrical conductor. Accordingly, tungsten has superseded carbon as a nonconsumable electrode for inert-gas-shielded arc welding. The shielding gas, argon or helium, is blown through an opening concentric with the electrode, thus serving to protect both the tungsten and the weld pool from oxidation.

Atomic Hydrogen Arc Welding.—A fine jet of hydrogen is forced through an arc formed between two tungsten electrodes. The high temperature of the arc breaks up the hydrogen molecules into hydrogen atoms, which recombine into molecules after passing through the arc, giving up the heat absorbed during dissociation in the arc. The result is a jet flame of hydrogen burning in a hydrogen atmosphere at a temperature higher than that of almost any other known flame, but lower than that of the arc. The welding mire is fused in this flame and deposited in the joint. The intensely reducing character of this hydrogen flame results in a nearly perfect weld practically as good as the parent metal, except in alloys that are embrittled or otherwise damaged by hydrogen absorption.

Gas Welding. — This process of fusion welding is generally carried out by the heat produced by the burning of acetylene in the presence of commercially pure oxygen, the flame temperature so attained being probably about 5,500' F, which, in view of the concentrated flame, is high enough to melt any metal locally, and so allows pieces to be easily fused together. It is necessary, when welding thick materials, to bevel the edges to be joined so they form a *v*, which is filled up by melting into it a rod of suitable composition, the weld metal also being fused to the base metal. The joint if well made is clean and sound, free from injurious defects. and usually as strong or stronger than the parts joined.

Torches. — Any oxyacetylene welding torch is an instrument that thoroughly mixes the two gases, oxygen and acetylene, in the proper amounts and that permits easy adjustment and regulation of the flame. A small flame and little heat are required for welding thin gauge metals and a large flame and much heat when welding heavy sections; thus interchangeable tips are furnished by the torch manufacturers. Broadly speaking, there are two types of torches—pressure and low pressure. In the pressure type of torch, both acetylene and oxygen are supplied to the torch under appreciable pressures, the pressures being increased for each larger size of tip used. In the low-pressure or injector type of torch, the oxygen only is under pressure. The mixing chamber is made on the same principle as an ordinary steam water injector so that the volume of acetylene going into the mixture is dependent upon the velocity, and not the volume of oxygen.

Flame Adjustment and *Manipulation.*—It is generally desirable that the welding flame be neutral, that is, that there be no excess of acetylene or oxygen. When there is an excess of acetylene the hot inner cone is ragged and poorly defined. When there is an excess of oxygen the inner cone is short and has a pale violet colour. The inner welding flame should not play directly on the welding rod but around it in a semicircular fashion, the rod being melted by the radiating heat of the flame. The heat should be evenly distributed on each side of the joint in order to melt down the walls and to secure thorough penetration and union of the adding material and parent metal. It is also essential that the torch oscillations be regular; otherwise fusion will be more thorough on one side of the joint than on the other.

Reinforcement.—As the weld proceeds, the rod metal should be added until the surface of the joint is built up a little above the edge of the plates. This reinforcement is customary in all welding on steel plate. The small amount of oxide that forms during welding and impurities remain on the surface as a scale and can be easily removed when cold, by grinding or machining.

Fluxes.—Except in the welding of wrought iron and steels, fluxes are usually required for satisfactory results. Impurities on the surface of the metal or impurities contained in the metal find their may into the weld and must be floated out as slag to prevent damage to the weld. The combination of a suitable flux with these impurities produces the slag.

Cutting.—The cutting torch differs from the welding torch in that in addition to having the oxyacetylene heating flame it also has another gas stream of pure oxygen under high pressure which does the cutting after the metal is raised to the ignition point by the heating flame. The iron and oxygen combine to form iron oxide, thus burning a narrow slit or kerf in the steel. It is a chemical process and should not be confused with melting. Sometimes hydrogen is used in welding and cutting operations instead of acetylene. Other fuel gases are sometimes used in conjunction with oxygen for cutting. The cutting torch may also be used for the beveling of plates and for machining operations.

Of the engineering alloys, only titanium, and the plain carbon and low-alloy steels. can be cut with a simple oxygen jet. Nickel- and copper-base alloys do not produce enough heat of combustion to maintain the cutting action. while highly alloyed steels yield too refractory a slag. To cut these alloys, iron powder is fed into the oxygen stream. The heat of combustion of the iron, plus the fluxing action of the oxide produced, makes possible the torch cutting of alloys that previously had to be sawed or sheared. The inert-gas-shielded tungsten arc is used for thermal cutting of aluminum alloys,

Resistance Welding.—In this method, invented in 1877 by Elihu Thomson, the parts to be joined, after proper shaping, are pressed together. A large current is then passed through the joint until it has reached welding temperature, when further pressure is applied, upsetting the joint and completing the weld. As the electrical resistance of the contact surface is much greater than that of the solid metal, most of the heat is generated at the joint surface where it is desired.

The voltage required is so low and the current so high that the only convenient source is a large-turns-ratio transformer built into the welder and as close as possible to the jaws, which hold the parts and transmit the current to them. For work of any considerable size, these machines are not readily portable; *i.e.*, the work must ordinarily be brought to the machine. The type of resistance welding described above is known as butt welding, and has been applied to join sections of widely varying shapes up to 36 sq.in. in a section.

Flush *Butt Welding.*—Parts to be welded are clamped, the primary circuit closed and the ends of parts brought together slowly. When these ends touch they will flash, that is, minute particles of molten metal will fly off; this flashing is continued until the entire faces of the abutting ends have reached a melding heat when heavy pressure is applied, forcing the ends together and completing the weld.

Spot *Welding.*—Where airtightness is not required, a lap seam may be welded in spots by clamping the seam overlap between two electrodes and passing the necessary current between them and through the overlapping edges of the plates. As the electrical resistance of the surface contact is least in the region under pressure, most of the current and therefore the weld is confined to a spot of about the same area as that of the electrodes. For relatively thin metal this method is much more rapid and economical than any other known method of making a joint where mechanical strength alone is the chief consideration. The mechanical strength obviously depends upon the number and size of the spots. Sometimes the spots are localized by raising one of the surfaces to be joined at convenient points or projections. Several spot welds may be made at one time by having one of the electrodes flat. This is called projection welding.

Seam Welding.—The overlapping edges of sheet metal are passed between two narrow roller electrodes, the speed, current and pressure being so adjusted as to produce a continuous seam or a series of overlapping spots. This method is usually limited to relatively thin sheets, but is readily applicable to straight seams or to circular seams. The process is widely used in manufacturing barrels. small transformer tanks and other containers.

Aluminothermic Welding.—Thermit and Exoweld are trade names for a mixture of finely divided aluminum and iron oxide, which when ignited reacts to produce a superheated liquid steel at 5,000" F. The underlying principle of the thermit process is the high chemical affinity of aluminum for oxygen. Up to a temperature of 2,800° F. thermit is an inert mixture. At that temperature however, the aluminum unites with the oxygen of the iron oxide, and the iron is set free and becomes a highly superheated liquid steel. It is obvious that if steel at this temperature is poured around the sections to be united, especially if the sections have previously been preheated to a bright red heat, it will melt those

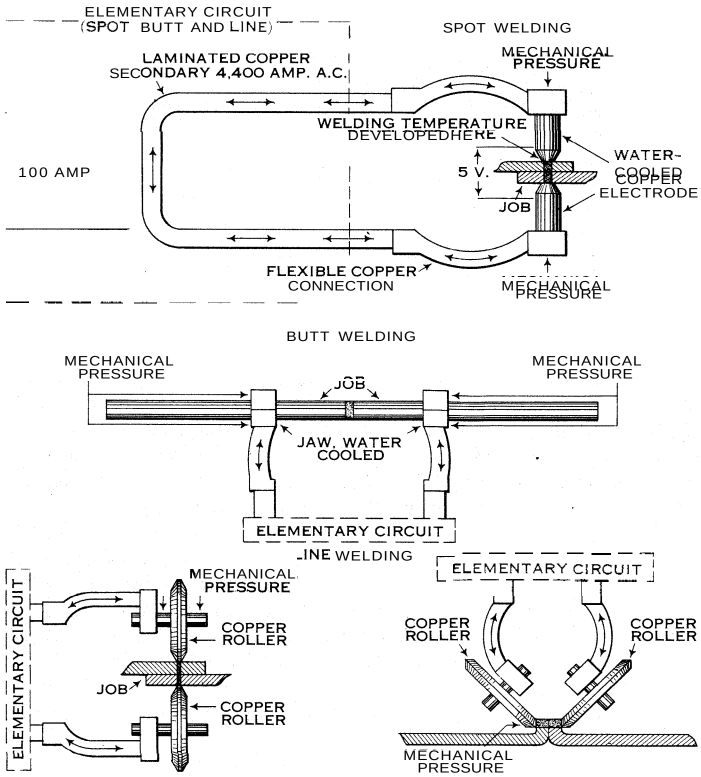

FIG. 2.—DIAGRAMS OF CIRCUITS OF VARIOUS WELDING MACHINES

sections and amalgamate with them so that the whole will cool to form a single homogeneous mass, or in other words a fusion weld.

Making a *Thermit Weld.*—In making a thermit weld, the parts to be united are first lined up with a space between the ends to be welded, the extent of which depends upon the size of the sections to be welded. The adjacent ends are then thoroughly cleaned by a sand blast or other suitable means. A wax pattern is then formed around the ends to be united of the exact shape of the thermit steel to be cast. A sand mold is next rammed around the wax pattern and inside a sheet iron box provided with pouring gates, heating gates and risers. A basin on the top of the mold serves to catch the slag when the pour is made.

The flame of a compressed air liquid fuel (gasoline or kerosene) heater. directed into the heating gate melts the wax pattern and leaves a space for the thermit steel. The heat is continued until the parts to be united have been brought to a good, red, workable heat. By that time the mold will have become dried out. In the meantime the charge of thermit is placed in a conical-shaped crucible supported over the pouring gate of the mold. When the sections are red hot and the mold dried. the application of heat is discontinued, the heating gate plugged up and the thermit charge in the crucible ignited. In 25 to 35 seconds the thermit reaction is completed and the thermit steel tapped from the bottom of the crucible into the mold where it flows around and between the sections to be welded, uniting them into one homogeneous mass.

APPLICATIONS

Every metal-using industry employs welding to a greater or lesser degree. Of the important families of engineering alloys. steel is welded by all the described processes. However, the tungsten arc and atomic hydrogen processes are rarely used on carbon and Ion-alloy steels, and stainless steel is seldom welded with the torch, and never with the carbon arc or aluminothermic process. Actually, the last process is used only on heavy sections of low-alloy and carbon steels. The accompanying table shows roughly

Applications of the Welding Processes

Process	Plain carbon and low-alloy steels	High-alloy and stainless steels	Nickel and cobalt alloys	Copper-base alloys	Aluminum-base alloys	Magnesium-base alloys	Titanium and zirconium alloys	Cast iron
Consumable rod electrode . .	A	A	A†	A†	B	C	D	A
Metal-inert-gas	A	A	D	A	A	D	D	B
Tungsten arc.	B	A	A	A	A	A	A†	B
Submerged melt	A	A†	D	D	D	D	D	D
Atomic hydrogen	C	B	B†	B	B	D	D	D
Oxyacetylene torch . . .	B	B†	B†	A†	A	B†	D	A
Aluminothermic	A	D	D	D	D	D	D	A†
Solid phase*	A	B†	B†	A‡	At:	C	D	D
Resistance flash	A	A	A	C	A	A†	A†	D
Spot, seam, projection . . .	A	A	A†	C	A	C	A†	D

*Includes modern forge welding and resistance butt welding. (A) preferred process. (B) yields sound melds, but is uneconomical except in special circumstances. (C) yields inferior welds unless special precautions are used. (D) not applicable. †Some members of the familv vield unsatisfactory welds by this process. ‡Only if the alloy can be cold welded. Otherwise (B)†.

to what extent each of the described processes is applied to the more important families of engineering alloys. Molybdenum, not included in the table, is used to some extent in jet aircraft and rocket-propelled missiles. It is joined by tungsten arc and resistance flash melding, but the welds are hrittle at room temperature. Zinc alloys and the precious metals are generally welded with the oxyacetylene torch. Lead is commonly welded with an air-hydrogen flame.

The welding of reactive and refractory metals and of those of ultra-high-strength steels which are sensitive to hydrogen can be accomplished in a high vacuum by use of an electron beam. A heated tungsten filament is the cathode from which electrons are emitted and accelerated toward the work by a potential of 5,000 to 150,000 volts.

See also Index references under "Welding" in the Index volume.

(WM. SP.; H. U.)

WELF or GUELPH, a German dynasty of princes. The 12th-century chronicler of the family recorded a tradition that its name was derived from the word meaning "whelp." The first member of the house of whom there is certain evidence was the Bavarian count Welf I, a contemporary of Charlemagne and of Louis the Pious. The kings of Burgundy who ruled until 1038 and the West Frankish magnate known as Hugh the Abbot (d. 886) were descended from him. The German line which had its chief seats at Altdorf and Ravensburg in Swabia died out with Welf III in 1055. Welf IV (d. 1101), a son of Welf III's sister Kuniza by Azzo of Este, was then summoned from Lombardy to take over the inheritance; he became the first Welf duke of Bavaria in 1070. Welf IV's son Henry the Black (d. 1126) married a coheiress of Magnus, the last Billung duke of Saxony. To the Saxon lands that she brought to her husband, their son Henry the Proud (d. 1139) added the entire fortune of the emperor Lothair of Supplinburg (see LOTHAIR II) by marrying his only child Gertrude. Henry the Proud's designs on the German crown were frustrated, but his son Henry the Lion (*q.v.*) kept the duchy of Saxony and regained Bavaria in 1156. Most of the family's south German lands passed to Henry the Proud's younger brother Welf VI (d. 1191), who was also enfeoffed with Tuscany, Spoleto and the Mathildine lands by his Hohenstaufen nephew, the emperor Frederick I Barbarossa; and Welf VI chose the house of Hohenstaufen to succeed him. When Henry the Lion had in 1180 forfeited his fiefs, only the Saxon patrimony round Brunswick and Liineburg remained to his descendants. In 1235 the emperor Frederick II turned these lands into a dukedom so that the Welfs should belong to the estate of princes. Later they frequently divided their reduced territories to endow new branches of their house. George Louis (1698–1727), elector of Hanover, who'came to the throne of Great Britain and Ireland as George I in 1714, belonged to the Liineburg line of the Welfs.

Otto IV (d. 1218), a son of Henry the Lion, fought against the Hohenstaufen for the imperial crown. His Italian supporters called themselves Guelphs, and this became the label of all who sided with the papacy against the adherents of the empire, or Ghibellines (see GUELPHS AND GHIBELLINES). The names of these factions long outlived their original meaning

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(K. J. L.)

WELHAVEN, JOHANN SEBASTIAN CAMMERMEYER (1807–1873), Norwegian poet and critic, was born at Rergen. He first studied theology, but from 1828 onward devoted himself to literature.

In 1840 he became reader and subsequently professor of philosophy at Christiania (Oslo), Nor., and delivered a series of impressive lectures on literary subjects. In 1836 he visited France and Germany; and in 1858 he went to Italy to study archaeology.

Welhaven died at Christiania on Oct. 21, 1873.

In a violent attack on Henrik A. Wergeland's poetry, he opposed the theories of the extreme nationalists. He desired to see the Norwegian culture brought into line with that of other European countries, and he himself followed the romantic tradition, being closely influenced by J. L. Heiberg (*q.v.*). He represented clearness and moderation against the extravagances of Wergeland.

Welhaven gave an admirable practical exposition of his aesthetic creed in the sonnet cycle *Norges* Daemring (1834). He published a volume of Digte in 1839; and in 1845 Nyere Digte. His descriptive poetry is admirable. but his best work was inspired by his poems on old Norse subjects, in which he gives himself unreservedly to patriotic enthusiasm.

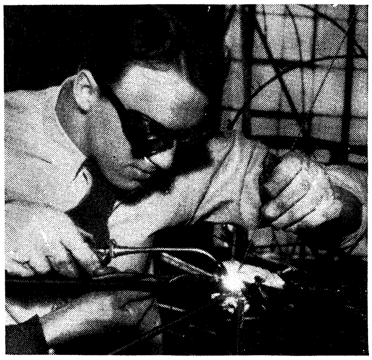
His critical work includes *Ewald og de norske Digtere* (1863), *On Ludwig Holberg* (1854). Welhaven's *Samlede Skrifter* were published in 8 vol. at Copenhagen (1867–69).

WELL, a pit or shaft generally excavated for the purpose of removing fluids from underground. In recent years some wells were constructed expressly for the purpose of putting fluids underground. In the U.S. (1960s) during a single year there were pumped from wells about 22,000,000,000,000 gal. of water, 2,600,000,000 bbl. of oil and about 15,000,000,000,000 cu ft. of natural gas. To maintain and increase these rates of extraction, about 500,000 water wells and 50,000 oil and gas wells were being drilled each year. It has been suggested that prehistoric man learned to dig for water by observing wild horses and wolves. It seems probable that the earliest wells were mere pits a few feet deep which, in times of progressive drought, were deepened as they became dry. By biblical times the digging of wells had become a common practice (Gen. xxvi, 17–23).

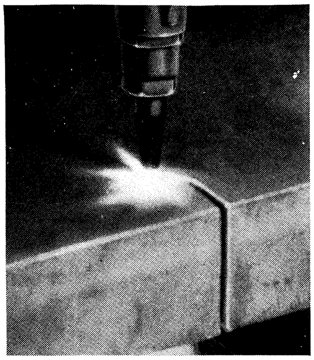
Types of Well.—Wells may be classified in many different ways according to purpose, method of construction, depth of excavation and depth to yield. The primary uses of wells are production, injection and observation.

Production Wells.—Although fresh water is the fluid produced in greatest quantity from wells, many other fluids are derived from underground sources. Wells drilled for oil are second in abundance only to fresh-water wells; such oil typically is mixed with natural gas and salt water. While the oil and gas are valuable products, the salt water is almost always a waste product. Rarely do oil-field brines contain sufficient concentrations of such valuable chemicals as iodine to justify extraction. Natural-gas wells mainly produce combustible gases, with only minor amounts of liquids. Other wells are drilled expressly to tap pools of highly concentrated and valuable brines. Such chemicals as table salt, magnesium salts, potassium salts, soda ash, bromine and iodine are extracted from these brines.

The recovery of sulfur by means of wells is a unique and espe-

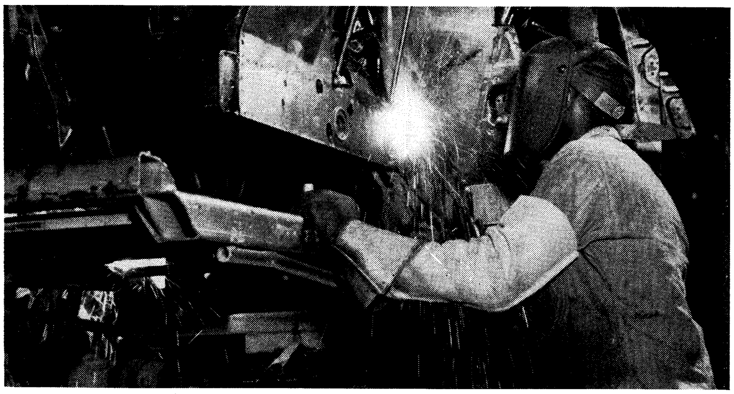


Gas welding of aircraft tubing

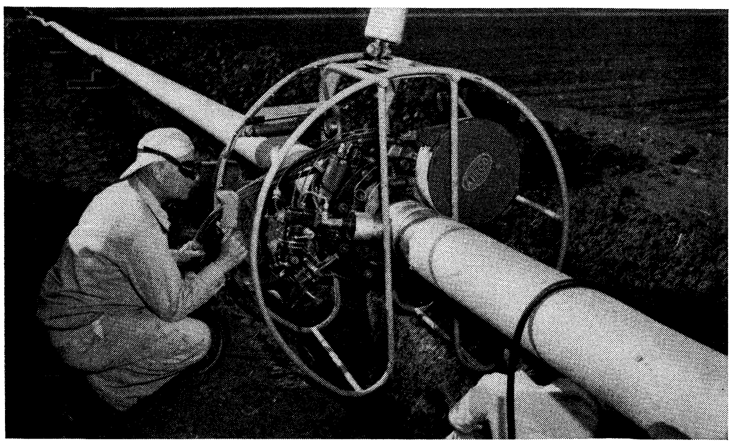


Gas cutting of heavy steel

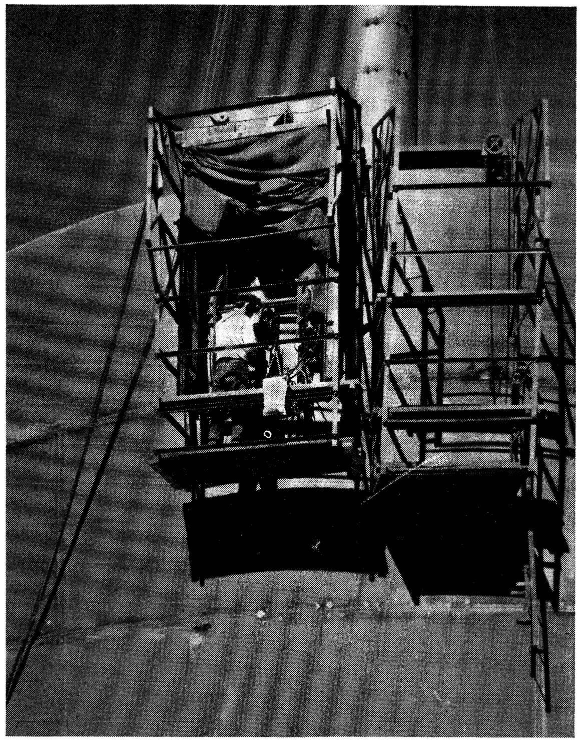
Tungsten arc welding of an aluminum pipe line



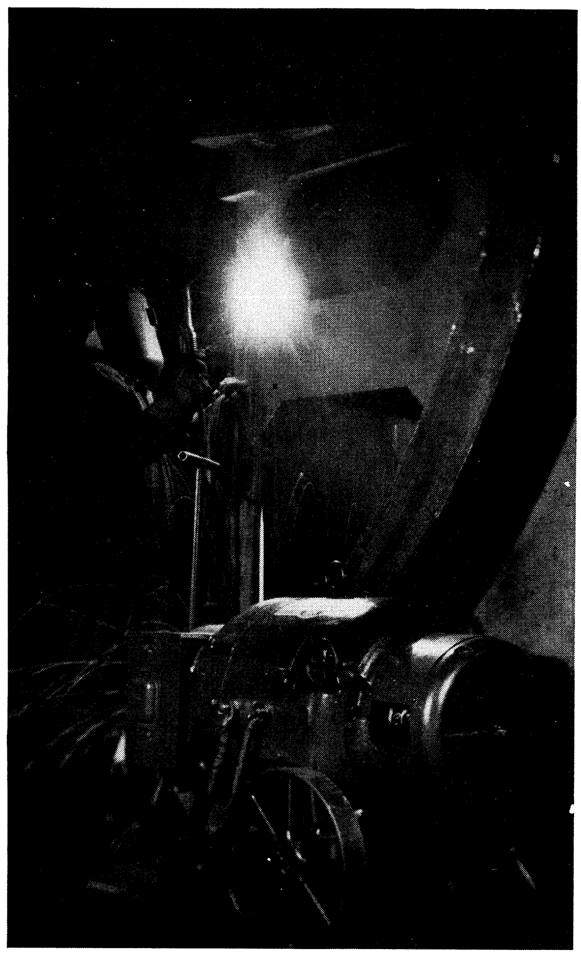
Rod-electrode welding of an automobile body frame



Inert-gas-shielded metal-arc welding of an aluminum pipe line



Automatic submerged melt welding of an oil storage tank



Portable welder being used for fabricating large machine frame

WELDING EQUIPMENT AND METHODS

BY COURTESY OF (TOP LEFT) THE LINDE AIR PRODUCTS COMPANY. (TOP CENTRE) AIR REDUCTION SALES COMPANY. (TOP RIGHT) CHICAGO BRIDGE AND IRON COMPANY. (SECOND ROW LEFT, BOTTOM LEFT) REYNOLDS METALS COMPANY, (THIRD ROW LEFT) AMERICAN MOTORS CORPORATION (BOTTOM RIGHT) WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

cially interesting procedure. Native sulfur in solid form is found in the cap rocks of certain salt domes along the coasts of Texas and Louisiana in the U.S. In the Frasch process (see SULFUR), hot water is pumped down a well containing several concentric pipes to melt the sulfur. The liquid mixture of sulfur and water returns to the surface and is discharged to bins where the sulfur is allowed to solidify.

In a few areas of the world, usually near recently active volcanoes, wells are drilled to exploit the thermal properties of underground fluids. The well may flow (or is pumped) to produce hot water that can be piped to homes for hot-water taps or circulated through radiators as a source of heat. More commonly, the hot water is delivered to bathhouses and swimming pools. Many of these hot waters contain high concentrations of dissolved minerals and are unsuitable for drinking. Where underground temperatures are higher, the fluid coming from the well may be steam that is circulated for heating or directed through turbines for generating electricity. Formerly even nonthermal waters flowing from wells were used for power. In the 1880s the water from one well, flowing under high pressure, was discharged to a Pelton water wheel and developed enough power to grind 125 bbl, of flour per day.

Injection Wells.—Some wells are used to inject liquids or gases into underground layers. These wells may have been former production wells, or they may have been drilled expressly for injection use. The major objectives of injection are waste disposal, repressuring and terminal storage. Waste-disposal wells are utilized to dispose of large volumes of undesirable liquids where surface disposal would contaminate fresh water supplies or otherwise constitute a hazard. Chief among these liquids are oil-field brines, which are produced in large volumes in most oil fields; in certain areas these brines are more salty than ocean water. After being cleaned thoroughly, the brines are pumped into an injection well and enter a geological layer deep enough to avoid contamination of the generally shallower fresh waters. In inland areas it was expected that increasingly large volumes of atomic wastes would be disposed of in this manner. The disposal of storm waters into wells has been practised in a few areas where the geologic layers have large openings. Normally such waters are very turbid and will quickly clog disposal wells. Although most modern practices involve careful planning prior to waste injection, this was not true in the past when wastes were poured indiscriminately in abandoned wells, with disastrous consequences to underground fresh waters.

In older oil fields, brine injection may be used for water flooding, a method of secondary recovery of oil in which water is injected into partially depleted wells to push the remaining oil toward production wells. Injection of brine for such repressuring occurs at the lower levels in the reservoir layer, usually at the edge of the producing area. Simultaneously, natural gas may be injected through wells near the top of the underground oil reservoir also to rebuild pressures that have dropped with removal of oil.

To maintain the yields of aquifers (underground layers containing fresh water), some areas have ordinances requiring return of air-conditioning water to the layer from which it was pumped. Thus, each air-conditioning system would require two wells—one for production and one for injection. In certain coastal areas where fresh-water levels have been depressed far below sea level by heavy pumping, lines of injection wells are used to create a continuous ridge of fresh water. If this ridge can be maintained above sea level, the wells inland from the ridge can be pumped without causing intrusion of sea water into the aquifer.

From such areas of large natural gas reserves as the Texas Panhandle in the U.S.; the Stavropol oil fields in the U.S.S.R.; and Alberta, Can., the natural gas is piped for long distances. Demand for the gas in distant cities is very seasonal. If a pipeline were built to carry all the gas needed during the cold months, it would require an excessive diameter; while during the warm months, the pipeline would be carrying only a small part of its capacity. This problem was solved by terminal storage of large volumes of gas close to the centres of demand. The volume of storage required is much larger than can be accommodated economically in tanks, and so natural underground formations are used. During warm months the excess gas from a narrower, less costly pipeline is pumped to a suitable geologic layer through injection wells. During peak demand the gas is removed from the layer to supplement pipeline flow.

Observation Wells.—Observation wells are used for continuous or periodic collection of data. In studies of aquifers, an observation well is commonly an unused production well, although some are drilled especially for observation purposes. The well may be used for measuring depths to water, or water samples may be taken for chemical analysis. Some wells may be equipped with devices to give continuous records of the fluctuations of water or fluid levels. Flowing wells or natural-gas wells may be equipped with pressure gauges.

Methods of Well Construction.—The excavation of a well involves (1) loosening or breaking the soil or rock: (2) removing this loosened or broken material; (3) keeping the sides of the excavation from caving; and (4) preventing the entry of unwanted fluids into the hole or keeping the fluids in the hole from draining away. Ingenious procedures have been devised to deal with these problems in the history of well-sinking techniques. In many instances either a means was found to develop underground water, or the land had to be abandoned.

Dug *Wells.*—Dug wells are probably the oldest type, since they require a minimum of equipment. They must be of sufficient diameter to accommodate the labourers. Minimum diameter is about 3 ft.. with many in the range of 4 to 8 ft., and a few dug wells as much as 30 or 40 ft. across. Although most such wells are circular, some are square or rectangular. The depths of dug wells may be as much as 400 or 500 ft., but the overwhelming majority are less than 100 ft. Prior to the installation of central water-supply systems, towns usually had one dug well to which all residents came for water. The well served not only as a source of water! but had important functions as a social centre.

Dug wells are most often excavated in soft materials. The soil, loosened by pick and shovel, is usually placed in a container and lifted by a rope to the surface. Caving of the walls may become a severe problem, especially after water level has been reached, and walls may be curbed with wood, stone, bricks. concrete, tile or large pipes. In hard rock, though caving is much less a problem, blasting may be required. Hand digging flourishes in areas and times of inexpensive labour. Modern practice in more prosperous countries employs mechanized digging equipment, for there are places where the large-diameter dug well is the most advantageous. Modern digging utilizes a clamshell (see EXCAVATION) or orange-peel bucket which scoops the soft materials out of the hole. Sections of cylindrical curbing are allowed to settle as the material is removed. Mechanized digging is usually much more effective than hand digging below the water level where continuous pumping may be required to allow men to work. An important advantage of the large-diameter dug well, if the materials yield water slowly, is the large wetted surface exposed. This gathering area can be further enlarged by extending horizontal laterals radially outward from the well. Dug wells have relatively large storage capacity and can be pumped more efficiently than small-diameter wells in poorly yielding materials.

Dug wells are commonly associated with low production! usually no more than a few gallons per minute: but in certain rocks very large yields are known. Prior to 1900 dug wells usually yielded water at a greater rate than the existing equipment could remove it. Primitive methods for removal employed such things as a bag of hides on the end of a rope, and later a bucket and windlass. Increasing demands for high-yielding wells were generated by an expanding agriculture and the development of piped water supplies in towns and cities. Prior to 1900 centrifugal pumps were about the only types available for lifting water efficiently and in large volume. Although centrifugal pumps can push water considerable distances vertically, the pump itself had to be within suction lift (25 ft. or so) of the water. As heavy pumping continued and water levels dropped, centrifugal pumps had to be placed progressively lower in large diameter wells. This procedure of using a centrifugal pump near the bottom of a dug well was gradually superseded following the development of deep-well pumps (see PUMP).

Bored Wells.—In soft, noncaving materials, wells may be excavated with augerlike devices. The renowned flowing well that was started in A.D. 1126 at Lilliers. France, in the northern province of Artois. may have been bored. Wells excavated by boring are often called artesian wells after Artesium, the ancient name for Artois. Popular usage tends to reserve the term to such wells that flow without pumping. In the boring method a cutter at the end of a rod is rotated at the surface. When the auger or cutter is full it is raised to the surface and emptied. Casing or tubing probably was used even in early wells, since boring is difficult in badly caving materials. Boring was widely practised in Europe from the 12th to the 19th centuries, and was introduced (about 1823) to the U.S. from England. Early bored 11-ells were of small diameter, perhaps four inches or so, and reached depths of several hundred feet. Few small-diameter bored wells were being constructed in the 1960s, and in many areas. large truck-mounted power augers were being used to bore holes one to six feet in diameter. This equipment is used mainly for boring utility pole holes, foundation footing holes and residential cesspools, but is also used for boring water wells.

Driven *Wells.*—Small-diameter wells (one inch to four inches) may be constructed in favourable localities merely by driving a pointed piece of pipe into the ground. Such wells have been employed extensively where the surficial material is soft sand and where water is within suction lift of the ground surface. A hardened drive point is fixed to the bottom of the string of pipe. and above this is a screened section to admit the water. After a pitcher pump is attached to the top of the pipe the well is ready for production. This method is used much more rarely than in the past because of difficulties in preventing contamination of the shallow waters. Formerly, homever, batteries of driven wells connected to a common suction were used as water supplies for small towns. Such well systems are still used extensively for dewatering excavations.

Jetted *Wells.*—The jetting method involves washing down a hole with a stream of water under pressure issuing from the end of a small-diameter pipe. The cuttings are washed up in the space between the pipe and the wall of the hole. The washing action is supplemented by alternately raising and dropping a chisel bit, and also by turning the pipe at the surface. Casing is usually lowered into the hole, closely following the bit, and may be pounded down from the surface. Jetted wells are commonly about four inches in diameter, and depth may be as much as 500 ft. The earliest known jetting rig was built in about 1884 and by the end of the 19th century jetting was the chief method of sinking tubular wells on the Atlantic and Gulf coastal plains of the U.S. This method was adapted mainly for drilling water wells that would flow. Such small-diameter deep wells that did not flow were considered uneconomic because relatively expensive pumps had to be installed. If the water rose almost to the surface, it was sometimes allowed to flow through a pipe below the surface into an adjacent dug well of large diameter, simplifying the pumping problem. Because jetting is effective only in small-diameter holes, this method no longer is used extensively for water wells. The method, however is still commonly used as an inexpensive means of installing shallow observation holes.

Drilled *Wells.*—Most modern wells are constructed by drilling. The various drilling methods may be classified as percussion, rotary-hydraulic, reverse-rotary-hydraulic, rotary-air or gas, and rotary-air-percussion.

In percussion drilling, rock is pounded to fragments by lifting a heavy tool and allowing it to drop. At intervals the tool or bit is withdrawn from the hole and a special bucket or bailer is lowered into the hole to remove the debris. If the materials tend to cave, the hole should be lined with casing. Very primitive percussion drilling was employed by the ancient Chinese on the edges of the Gobi desert. Depths of 5,000 ft. were attained with bamboo tools and casing. Such wells sometimes required several decades of patient labour.

Percussion drilling started in the U.S. about 1808 and was developed almost to its modern form by the end of the 19th century, spurred by the completion (1859) of the Drake well in Pennsylvania, the first productive U.S. oil well. The earliest pre-Drake wells were drilled for brine along the Kanawha river in what is now West Virginia. In those days brine was sought as a source of table salt and the petroleum that occasionally appeared in small quantities was considered a nuisance. After observing the West Virginia drilling. Levi Disbrow built a rig and became the first well-drilling contractor in the U.S. His methods and tools were covered by patents issued in 1825 and 1830. Although he employed chisel bits that were raised by a windlass and allowed to drop, he also used augers where suitable.

In the earliest percussion rigs, the bit was suspended on a string of wooden poles connected by iron screw fittings. Because the poles broke excessively the bit was later suspended on a Manila rope. Modern percussion (cable-tool) drilling utilizes steel cable instead of rope. In hard rocks. where cable-tool drilling is standard procedure, no casing is needed unless a caving zone is encountered or a zone with unwanted fluid is reached. In oil wells, if water is encountered, a string of casing is inserted and drilling is continued with a smaller bit. Several strings of successively smaller casing may be required before the oil zone is reached. Where the cable-tool method is used in softer materials, casing may be required from the very start and pushed or driven down continuously as the hole is deepened. In cable-tool drilling the heavy chisel bit hits the bottom of the hole about 25 to 30 times per minute. At intervals the bit is quickly removed irom the hole and the bailer is lowered on a different cable. In soft materials a special bit-bailer combination ("mudscow") speeds drilling considerably.

Rotary-hydraulic drilling may be thought of as a combination of augering and jetting. At the bottom of a string of pipe (drill stem) a cutter (bit) is made to rotate by power applied at the surface. At the same time a liquid (commonly a mud slurry) is pumped down through the drill stem and continuously washes the cuttings to the surface. Casing is usually not needed because the mud cakes on the wall of the hole and prevents caving. Casing is normally not set in a water well until the desired aquifer is reached. In oil wells a shallow string of casing may be set to avoid contamination of shallow aquifers by oil and brine. The rotary-hydraulic technique was developed in the oil fields of Louisiana about 1890 but was given its greatest impetus during the oil boom in 1901 when the Spindletop well was discovered near Port Arthur, Tex. Gradually, rotary-hydraulic drilling replaced cable-tool methods in drilling oil wells, and cable-tool drilling tends to be restricted to shallow wells and special completion procedures. The deepest oil wells are drilled a-ith rotary-hydraulic methods, sometimes to depths over 20.000 ft. Cable-tool methods are much more widespread in water-\yell drilling, although in some areas rotary-hydraulic techniques have become relatively more important, especially for the deeper holes. A special variation of the rotary-hydraulic method is diamond core-drilling (with a hollow cylindrical bit armed with commercial diamonds!. A solid core remains undrilled and may be removed for examination. Although primarily for exploration holes, diamond core-drilling is occasionally used for small (1.5 to 3 in.) water wells in hard rocks; inclined or even horizontal wells are drilled this way.

In reverse-rotary-hydraulic drilling the water moves down the hole outside of the drill stem and the cuttings move up the drill stem, from which they are removed by high-capacity pumps. These are typically large-diameter wells (up to five feet or more) but usually no more than a few hundred feet deep. Reverse-rotary-hydraulic drilling is suited to soft materials, may be especially advantageous where small boulders are encountered, and is an increasingly popular recent modification of the more standard rotary-hydraulic method.

An even more recent modification of the rotary methods involves circulating air instead of water or mud. In this type of drilling excellent penetration rates have been obtained. Drilling must be through materials dense enough to prevent excessive loss of air, and only relatively small-diameter holes can be drilled. Since large quantities of water would prevent air circulation, water wells only of small yield can be drilled in this manner. For special purposes, rotary-air techniques have been very effective, but for most geologic conditions they will not replace rotary-hydraulic methods. For drilling in natural gas zones it has been found advisable to remove the drilling mud and circulate natural gas to avoid sealing gas zones with mud; drilling rates have been increased also, and bit life has been lengthened.

The most recent development in the 1960s was the rotary-air-percussion rig, combining rotating action and circulation of air with an air hammer just above the bit that delivers about 600 strokes per minute. In extremely hard rocks record drilling rates have been obtained, but small hole diameter and the limited volumes of fluid that can be handled are disadvantages for general use in drilling for water.

Typically. modern wells are drilled by rotary-hydraulic or cable-tool methods. Hard-rock water wells may be uncased: other wells usually are cased with wrought-steel pipe in convenient lengths welded or screwed together. Casing is perforated at points where fluids are to be removed or injected. In water wells, screens with accurately controlled openings are used extensively instead of perforated casing. Selection from among the wide variety of methods for adapting a drill hole to production or injection should be based upon a thorough knowledge of the geologic layers penetrated — their caving characteristics, the volume and nature of the contained fluids, and the fluid pressures in the various zones. The main objective in a production well is to extract the maximum amount of the fluid or fluids desired, and to exclude unwanted fluids and such suspended materials as sand and silt. A further consideration is the cost of lifting the liquids to the surface if the well does not flow. In water wells lifting efficiency is often improved by a sleeve of gravel (gravel pack) poured between the well screen or perforated casing and the wall of the hole. Special construction problems are encountered if the well penetrates high-pressure oil or gas zones.

The strings of casing should be cemented in place and high-pressure seals should be installed at the top of the pipe. In water wells the casing should be sealed to prevent the entry of polluted surface waters. *See* also references under "Well" in the Index volume.

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WELLAND SHIP CANAL. This waterway provides for navigation of large vessels between lakes Erie and Ontario, and is an important link in the Great Lakes–St. Lawrence seaway. The difference in elevation between the two lakes is 326 ft. and the natural connection between them. the Niagara river (*q.v.*), is impassable because of its falls and rspids. The first canal. with a depth of 8 ft., was built by a private corporation, the Welland Canal company, at a cost of $7,700,000, and was opened to traffic in 1829. This n-as a ditch connecting Port Dalhousie. Ont. (3 mi. W. of the present canal outlet). with Port Robinson on Chippawa creek. which gave access to the Niagara river. In 1833 the canal was extended from Port Robinson to Port Colborne. Ont., on Lake Erie. The canal was enlarged by the government of Upper Canada (now Ontario) in 1871–87, at a cost of about $21.750.000. Further improveinents were begun by the Canadian government in 1912.and the official opening of the newer canal took place in 1932. This project cost about $130.000.000.

The modern Welland canal extends 27.6mi. from Port Colborne, Ont., on the north shore of Lake Erie. to Port Weller, Ont., on the south shore of Lake Ontario. It is 200 ft. wide at the bottom, 310 ft. at the water line with a lock width of 80 ft. and has a minimum depth of 27 ft. Eight locks provide for control of water level and flow. and they accommodate vessels 765 ft. long. The time required for transit of the canal generally is less than eight hours.

See GREAT LAKES. THE; ERIE. LAKE; ONTARIO. LAKE; ST. LAWRENCE SEAWAY.

See *Great Lakes Pilot,* vol. i, Canadian Hydrographic Service (annual); Hugh G. J. Aitken, The *Welland Canal Company* (1954).
(J. L. HH.)

WELLER, THOMAS HUCKLE (1915–), U.S. physician and parasitologist, shared with J. F. Enders and F. C. Robbins (*qq.v.*) the Nobel prize in physiology and medicine in 1954 for cultivation of the poliomyelitis viruses in tissue culture. Weller was born in Ann Arbor. Mich., and received his education at the University of Michigan (A.B.. 1936: M.S., 1937) and Harvard medical school (M.D., 1940). While a medical student he became interested in tissue culture techniques and with Enders' group studied the propagation of the parasite causing trichinosis and also vaccinia or cowpox virus in living tissue cells. During World War II he served in the army as chief of the bacteriology, virus and parasitology sections of the Antilles Department Medical laboratory, Puerto Rico, n-here he studied various tropical diseases. After the war he completed his hospital training in pediatrics and in 1947 joined Enders in establishing a research laboratory at the Children's Medical centre, Boston. There, with Robbins, the viruses of poliomyelitis were successfully cultivated, leading to the development of poliomyelitis vaccine, new diagnostic methods and the isolation of many new viruses. In 1954 W'eller became professor of tropical public health at the Harvard school of public health, Boston.

See *Les Prix Nobel en 1954,* pp. 100–118 (Stockholm, 1955).
(J. H. DE.)

WELLES, GIDEON (1802–1878), secretary of the navy in Lincoln's cabinet, was born at Glastonbury, Conn., July 1, 1802. He attended Episcopal academy. Cheshire. Conn., and spent three years at Norwich (Vt.) university. He then studied law for a time but. in 1826he became part owner and editor of the *Hartford Times*. For the next ten years his paper was the official spokesman for Jacksonian democracy in southern New England. He was elected to the Connecticut legislature in 1826 and served until 1835. He fathered legislation to end imprisonment for debt and to abolish property and religious requirements for voting. and was the author of the state's general incorporation law as part of the Jacksonian war against the Bank of the United States. Retiring from the legislature. Welles was three times elected state comptroller. served as postmaster of Hartford and then as chief of the bureau of provisions and clothing of the United States navy. He ran for congress in 1834and for the senate in 1850, but was defeated in each case.

Welles broke with the Democrats over slavery in 1854 and helped organize the Republican party. He also helped found the *Hartford Evening Press,* one of the first Republican papers in New England. In 1856 he was his party's candidate for governor. Although defeated, his activities led Abraham Lincoln to select him as New England's representative in the first Republican cabinet.

As secretary of the navy Welles proved efficient, loyal and honest. He increased the number of ships from 90 to 670, and the officers and seamen from 8,800 to 57,200. He made the blockade an effective factor in crushing the Confederacy and his support made possible the development of the ironclads which revolutionized naval warfare. Always a stickler for sound procedure, he opposed Lincoln's suspension of habeas corpus and the suspension of critical newspapers. He. however. backed the Emancipation Proclamation as a war measure and stood solidly behind Andrew Johnson in the impeachment proceedings. He supported the Liberal Republicans in 1872 but voted for Samuel Tilden in 1876. His diary is one of the most important documents of the Civil War period. He died at Hartford, Conn., on Feb. 11, 1878.

(AY. CN.)

WELLESLEY, RICHARD COLLEY WESLEY (or WELLESLEY). MARQUESS (1760–1842), eldest son of the 1st earl of Mornington an Irish peer. and brother of the famous duke of Wellington, nas born on June 20 1760 He nas sent to Eton and to Christ Church. Oxford By his fathers death in 1781 he became earl of Mornington, taking his seat in the Irish house of peers.

In 1784 Wellesley entered the English house of commons as member for Beeralston. Soon afternard he was appointed a lord of the treasury by Pitt. In 1793 he became a member of the board of control over Indian affairs and in 1797 accepted the office of governor general of India. Wellesley seems to have caught Pitt's large political spirit during his intercourse with him from 1793 to 1797. That both had consciously formed the design of acquiring empire in India is not proved, but the rivalry with France made Wellesley's rule in India an epoch of enormous and rapid extension of English power. Clive won and Warren Hastings consolidated the British ascendancy in India. but Wellesley extended it into an empire. For the details of Wellesley's Indian policy see INDIA: History.

He found the East India company a trading body, he left it an imperial power. He was an excellent administrator, and sought to provide, by the foundation of the college of Fort William, for the training of a class of men adequate to the great work of governing India. A firm free trader, like Pitt, he endeavoured to remove some of the restrictions on the trade between England and India.

Both the commercial policy of Wellesley and his educational projects brought him into hostility with the court of directors. and he more than once tendered his resignation, which, however. public necessities led him to postpone till the autumn of 1805. He reached England just in time to see his friend Pitt before his death. He had been created an English peer in 1797, and in 1799 an Irish marquess.

On the fall of the coalition ministry in 1807 Wellesley was invited by George III to join the duke of Portland's cabinet, but he declined, pending the discussion in parliament of certain charges brought against him in respect of his Indian administration. Resolutions condemning him for the abuse of power were moved in both the lords and commons, but defeated by large majorities.

In 1809 Wellesley was appointed ambassador to .Spain. He landed at Cádiz just after the battle of Talavera, and endeavoured, but without success, to bring the Spanish government into effective co-operation with his brother in Portugal. A few months later Wellesley became foreign secretary in Perceval's cabinet. He retired in Feb. 1812, partly from dissatisfaction at the inadequate support given to Wellington by the ministry, but also because he was convinced that the question of Catholic emancipation was urgent. With the claim of the Irish Catholics to justice he henceforward identified himself.

On Perceval's assassination he refused to join Lord Liverpool's administration, and he remained out of office till 1821, criticizing with severity the proceedings of the congress of Vienna and the European settlement of 1814. He was one of the peers who signed the protest against the enactment of the corn laws in 1815.

In 1821 he was appointed lord lieutenant of Ireland. Wellesley's acceptance of the vice-royalty was believed in Ireland to herald the immediate settlement of the Catholic claims. But the hope of the Catholics still remained unfulfilled. On the assumption of office by Wellington, who was opposed to Catholic emancipation, his brother resigned the lord lieutenancy. He had, however, the satisfaction of seeing the Catholic claims settled in the next year by the very statesmen who had declared against them. In 1833 he resumed the office of lord lieutenant under Earl Grey's brief ministry. He died on Sept. 26, 1842.

See Montgomery Martin, *Despatches of the Marquess Wellesley* (1840); W. M. Torrens, *The Marquess Wellesley* (1880); W. H. Hutton, *Lord Wellesley* in the "Rulers of India Series" (1893); G. B. Malleson, *Wellesley* in the "Statesmen Series" (1895); *The Wellesley Papers: Life and Correspondence of Richard Colley Wellesley by* the editor of "The Windham Papers," 2 vol. (1914).

WELLESLEY, a college town (township) of Massachusetts, U.S., in Norfolk county, lies on 10.5 sq.mi. of rolling terrain 15 mi. W. of Boston. The township population in the 1960s was about 26,000.

Originally a part of Dedham, the Wellesley area was included in Needham when that town was set off in 1711, and comprised its western precinct until 1881 when it was incorporated as a separate town. Its place name was an adaption of the family name of Samuel Welles, who settled in the area in 1763 and whose grandson-in-law H. Hollis Hunnewell purchased the Welles estate and named it Wellesley. The natural beauty of the area and its easy access to Boston led to a steady population growth in the late 19th and early 20th century although strict zoning restrictions have kept the nature of the town residential. The town is governed by representative town meeting.

The character of the town was greatly influenced by the existence of the liberal arts women's college which bears its name. The campus of more than 400 ac. bordering on Lake Waban was once the country estate of Mr. and Mrs. Henry Fowle Durant, who decided in 1860 to establish a female seminary that would "offer to young women opportunities for education equal to those usually provided in colleges for young men." The college received its charter from the state in 1870, and in 1875 mas opened to 314 students. Its resources and size grew steadily and by the 1960s more than 40 buildings provided facilities for the intellectual and community life of approximately 1,700 students and 170 faculty members. Fourteen buildings are residence halls for undergraduate students, who come from every state in the union and several foreign countries. In 1959 the Jewett Arts centre; containing facilities for fine arts, music and drama instruction., was opened.

Despite its large physical growth the essential nature of Wellesley college as a liberal arts institution has remained constant. Classes are kept small and programs of individual study based on a student's particular interests are encouraged.

Wellesley is also the site of the Babson Institute of Business Administration (1919), the Dana Hall schools and the Academy of the Assumption.

See Alice P. Hackett, *Wellesley, Part of the American Story* (1949); Florence Converse, *Wellesley College: a Chronicle of the Years 1875–1938* (1939). (M. R. M.)

WELLESLEY COLLEGE, a liberal arts college for women in Wellesley, Mass., chartered March 17, 1870, as Wellesley Female seminary. See WELLESLEY.

WELLHAUSEN, JULIUS (1844–1918), German Old Testament scholar, one of the most famous names in biblical criticism of the 19th century and promulgator of the Graf-Wellhausen theory, which after 1878 produced a revolution in Old Testament criticism, was born in Hameln, Westphalia, on May 17, 1844. He studied under G. H. A. von Ewald (*q.v.*) at Göttingen and began his teaching career there in 1870. He received a professorship at Greifswald in 1872, but in that stronghold of Lutheran conservatism his position became difficult after the appearance of critical works from his pen, and so he resigned in 1882. Beginning again as *Privatdocent,* this time in the field of Semitic languages, which freed him from ecclesiastical persecution, he became professor at Marburg in 1885 and at Göttingen in 1892. Sadly he thereby was robbed of the opportunity to draw large numbers of students. Nonetheless he gained a following almost without parallel by the convincing demonstration that the basic document of the Pentateuch (the Priestly Document or P, as he called it) was the youngest rather than the oldest element in that composite work. Only then did it become possible to understand the evolution of the Old Testament religion. His demonstration gave vast stimulus to Old Testament research, and a great number of younger scholars carried the task further.

Wellhausen was not only a master of literary criticism, he also contributed to textual criticism. He was a student of Islam and produced important works in that field. In pre-Islamic heathenism he saw the best parallel to Hebrew life and thought at the nomadic stage.

In his later years Wellhausen contributed important work to the New Testament field—to the criticism of the Gospels, Acts and Revelation. The search for Aramaisms in New-Testament Greek was begun by him. He wrote trenchantly and concisely, disdaining to set forth anew what others had dealt with sufficiently.

Perhaps the literary critical approach of Wellhausen's day and school was not the last word: it has subsequently been supplemented by other approaches; in detail many results formerly held secure have been softened; and the ancient orient was not resurrected until after his revolutionary works appeared. Nonetheless, Wellhausen may still be considered to occupy a place in biblical studies comparable with that of Darwin in biology. He died Jan. 7, 1918.

His major works included *Geschichte Israels* (1878), republished as *Prolegomena zur Geschichte Israels* (1882; Eng. trans. 1885); *Die*

Konzposition des Hexateuch und der historischen Bücher des Alten Testaments (1889); *Israelitische und jüdische Geschichte* (1894); ***Einleitung in die drei ersen Evangelien*** (1905). Wellhausen kept alive Friedrich Bleek's *Einleitung in das Alte Testament,* eds. 4–6 (1878–93), by extensive alterations and additions. (E. G. Kr.)

See E. G. Kraelinp, *The Old Testament Since the Reformation,* pp. 94 ff. (1955); W. Baumgartner, "Wellhausen und der heutige Stand der alttestamentlichen Wissenschaft," *Theologische Rundschau,* pp. 287 ff. (1930).

WELLINGBOROUGH, a market town and urban district in the Wellingborough parliamentary division of Northamptonshire, Eng., between the Nene and the Ise. 10 mi. N.E. of Northampton. Pop. (1961) 30,579. Area 13.7 sq.mi. In 1935 the area was extended to include the urban district of Finedon and other lands. In 948 Edred gave the church at Wellingborough to Crowland (or Croyland) abbey, and the grant was confirmed by King Edgar in 966. The town received the grant of a market in 1201. It was formerly famed for chalybeate springs. After a disastrous fire in 1738 on a "fry-day," the town was built on its present site on the hill. Wellingborough school, founded in 1595, was endowed with the revenues of a suppressed guild. The staple industry is leather, chiefly gloves, boots and shoes. Other industries are brewing, flour milling. iron smelting and founding and rubber, plastic and foodstuff manufacture. The name was said to come from the wells but, from forms such as Wendlingburgh in 1220, it has been shown that the name meant "burg of Wendel's people."

WELLINGTON, ARTHUR WELLESLEY, 1st Duke of (1769–1852), was the fourth son of Garrett (1735–1781) Wellesley or Wesley, 2nd baron and 1st earl of Mornington, now remembered only as a musician. He was descended from the family of Colley or Cowley, which had been settled in Ireland for two centuries. The duke's grandfather, Richard Colley, 1st Baron Mornington (d. 1758), assumed the name of Wesley on succeeding to the estates of Garrett Wesley, a distant relative of the famous divine. In Wellington's early letters the family name is spelled Wesley; the change to Wellesley seems to have been made about 1790.

Arthur (born in Ireland in 1769[1]) was sent to Eton, and subsequently to a military college at Angers. He entered the army as ensign in the 73rd Highlanders in 1787, passed rapidly through the lower ranks (in five ditierent regiments), became major of the 33rd (now the duke of Wellington's Regt.) and purchased the lieutenant-colonelcy of that regiment in 1793 with money advanced to him by his eldest brother. But in all these changes he did little regimental duty, for he was aide-de-camp to the lord-lieutenant of Ireland for practically the whole of these years. Before reaching full age he was returned to the Irish parliament by the family borough of Trim.

His first experience of active service was in the campaign of 1794–95. when the British force under the duke of York was driven out of Holland by Pichegru. In 1796 he was sent with his regiment to India, being promoted colonel by brevet about the same time. It was thus as a commanding officer that he learned for the first time the details of regimental duty. He mastered them thoroughly — it was to the completeness of his practical knowledge that Wellington ascribed in great part his later success. It is probable, moreover, that he at this time made a serious study of the science of war.

As soon as he landed in India he began to devote fixed hours to study, giving up cards and the violin. This study was directed chiefly to the political situation of India, and when on his advice his eldest brother, Lord Mornington, afterwards Marquess Wellesley. accepted the governor-generalship of India. he became his trusted though unofficial adviser. In the war with Tippoo Sahib the 33rd was attached to the Nizam's contingent. and Colonel Wellesley commanded this division in the army of General Harris. Though his military services in this short campaign were not of a striking character, he was appointed by his brother to the supreme military and political command in Mysore, in spite of the claims of his senior, Sir David Baird.

His great faculties now for the first time found opportunity for their exercise. In the settlement and administration of the conquered territory he rapidly acquired the habits and experience of a statesman, while his military operations against Doondiah, a robber chief, were conducted with extraordinary success.

When pressed in Mysore, Doondiah moved into Mahratta territory. whither Wellesley followed him. Here, negotiating and bargaining with the Mahratta chiefs, Wellesley acquired a knowledge of their affairs and an influence over them such as no other Englishman possessed.

Simple and honourable himself, he was shrewd and penetrating in his judgment of Orientals; and, unlike his great predecessor Clive. he rigidly adhered to the rule of good faith in his own actions, however depraved and however exasperating the conduct of those with whom he had to deal. The result of Wellesley's singular personal ascendancy among the Mahrattas came into full view when the Mahratta War broke out. In the meantime, however! his Indian career seemed likely to be sacrificed to the calls of warfare in another quarter. Wellesley was ordered with a body of troops to Egypt. But at Bombay he was attacked by fever, and prevented from going on. The troop-ship in which he was to have sailed went down with all on board.

He returned in May 1801 to Mysore, where he remained until the Mahratta War broke out. Wellesley, now a major-general, was placed in command of a division of the army charged with the task of restoring the Peshwa, overthrown by his rival, to power. Starting from Seringapatam, he crossed the frontier on March 12, 1803, and moved on Poona. The march was one unbroken success, thanks to Wellesley's forethought and sagacity in dealing with the physical conditions and his personal and diplomatic ascendancy among the chieftains of the district. A march of 600 m. was conducted without even a skirmish. The Peshwa was restored.

Sindhia and Holkar, with the raja of Berar, maintained a doubtful but threatening aspect farther north. It was uncertain whether or not a confederacy of the northern Mahrattas had been formed against the British Government. Wellesley was charged with "the general direction and control of military and political affairs in the territories of the Nizam, the Peshwa and the Mahratta states and chiefs." Armed with these powers, he required Sindhia, as a proof of good faith, to withdraw to the north of the Nerbudda. Sindhia not doing so, war was declared on Aug. 6, 1803, and Wellesley moved against the enemy. A second division was to converge from the east, but on Sept. 23 Wellesley suddenly found that the combined forces of Sindhia and the raja of Berar were close in front of him at Assaye. Weighing the dangers of delay, of retreat and of an attack with his single division of 4,500 men, supported only by 5,000 native levies of doubtful quality, Wellesley convinced himself that an immediate attack, though against greatly superior forces (30,000 horse, 10,000 European-drilled infantry and 100 well-served guns) in a strong position, was the wisest course. He threw himself upon the Mahratta host, and, carrying out a bold manoeuvre under an intense fire, ultimately gained a complete victory, though with heavy loss. In comparison with the battle of Assaye, all fighting that had hitherto taken place in India was child's play. Wellesley brought the war to a close by a second victory at Argaum on Nov. 29 and the storming of Gawilghur on Dec. 15. The treaties with Sindhia and the raja of Berar, which marked the downfall of the Mahratta power, were negotiated and signed by Wellesley—not yet 35 years old.

His ambitions now led him back to Europe, and in the spring of 1805 he quitted India. After being sent on the abortive expedition to Hanover, he was elected M.P. for Rye, in order to defend his brother in the House, and in the following year he was Irish secretary for a few months. He was then employed in the expedition against Copenhagen, in which he defeated the Danes in the action of Kjoge (Oct. 29). In 1808, however, began the war (*see* Peninsular War) in which his military renown was fully established. In April he was promoted lieutenant-general and placed in command of a division of the troops destined to operate against the French in Spain or Portugal. He landed at Mondego bay in the first week of August, moved southwards, and on the 21st won the battle of Vimeiro. In the midst of this

[1]At 24 Upper Merrion Street, Dublin, or at Dungan castle, Meath, on April 29 or on May 1; but both place and date are uncertain.

engagement, however, Sir Harry Burrard landed, and took over the command. Burrard was in turn superseded by Sir Hew Dalrymple, and the campaign ended with the convention of Cintra, which provided for the evacuation of Portugal by the French, but gave Junot's troops a free return to France. So great was the public displeasure in England at the escape of the enemy that a court of inquiry was held. After the battle of Corunna, Wellesley, who had in the meantime resumed his duties as Irish secretary, returned to the Peninsula as chief in command. He drove the French out of Oporto, and then prepared to march against Madrid. He had the support of a Spanish army, but his movements were delayed by the neglect of the Spanish Government, and Soult was able to collect a large force for the purpose of falling upon the English line of communication. Wellesley, unconscious of Soult's presence on his flank, advanced against Madrid, and defeated his immediate opponent, King Joseph, at Talavera de la Reina (*q.v*) on July 27–28. But within the next few days Soult's approach on the line of communication was discovered, and Wellesley, disgusted with his Spanish allies, had no choice but to withdraw into Portugal.

A peerage was conferred upon him for Talavera. He was also made marshal-general of the Portuguese army and a Spanish captain-general. But his conduct after the battle was sharply criticized in England, and its negative results were used as a weapon against the ministry. Even on the defensive, Wellington's task was exceedingly difficult. Austria having made peace, Napoleon was at liberty to throw heavy forces into the Peninsula. Wellington, foreseeing that Portugal would now be invaded by a very powerful army, began the fortification of the celebrated lines of Torres Vedras. (See FORTIFICATION.)

As summer approached Masséna moved against Portugal with 70.000 men. Wellington, unable to save Ciudad Rodrigo, retreated down the valley of the Mondego, devastating the country, and pausing to inflict a check on the French at Bussaco. Masséna continued to press forward but was held up definitely in front of the lines. It was with the utmost difficulty that he could keep his army from starving. At length, when the country mas exhausted. he fell back to Santarem. In the spring of 1811 Wellington received reinforcements and moved forward. Masséna retreated, but such were the sufferings of his army, both in the invasion and in the retreat, that the French, when they re-entered Spain, had lost 30,000 men. Public opinion in England, lately so hostile, now became confident, and Wellington, whose rewards for Talavera had been opposed in both Houses, began to be a hero.

In the meantime Soult, who was besieging Cadiz, had moved to support Masséna. But after capturing Badajoz, Soult learnt that Masséna was in retreat, and in consequence returned to the south. Wellington, freed from pressure on this side, and believing Masséna to be thoroughly disabled, considered that the time had come for an advance into Spain. The fortresses of Almeida, Ciudad Rodrigo and Badajoz barred the roads. Almeida was besieged, and Wellington was preparing to attack Badajoz when Masséna again took the field, and marched to the relief of Almeida. The battle of Fuentes d'Onoro followed, in which Wellington was only able to extricate the army from a dangerous predicament which "if Boney had been there" would have been a disaster. His attack on Badajoz and Ciudad Rodrigo failed.

Wellington had from the first seen that, whatever number of men Napoleon might send against him, it was impossible, owing to the poverty of the country, that any great mass of troops could long be held together, and that the French, used to "making war support war," would fare worse in such conditions than his own troops with their organized supply service. It was so at the end of 1811. Soult had to move southwards to live, and the English were again more than a match for the enemy in front of them. Wellington resumed the offensive early in 1812, took by storm Ciudad Rodrigo and Badajoz, although with terrible loss, and then advanced into Spain. Marmont, who had succeeded Masséna, fell back to the Donro, but there turned upon his assailant, and, by superior swiftness, threatened to cut the English off from Portugal. Wellington retreated as far as Salamanca (*q.v.*), and there extricated himself from his peril by a brilliant victory (July 22). Instead of immediately following the French, Wellington thought it wise to advance upon the Spanish capital. King Joseph retired, and the English entered Madrid in triumph. The political effect was great, but the delay gave the French northern army time to rally. "The vigorous following of a beaten enemy was not a prominent characteristic of Lord Wellington's warfare," as Napier says. Moreover, Soult, raising the siege of Cadiz, pressed towards Madrid. Wellington was compelled once more to retire into Portugal. During this retreat he announced in general orders that the demoralization and misconduct of the British army surpassed anything that he had ever witnessed. Such wholesale criticism was bitterly resented, but indeed throughout his career Wellington, cold and punctilious, never secured to himself the affections of officers and men as Marlborough or Napoleon did. He subjugated his army and gave it brilliant victories, but he inspired few disciples except the members of his own staff. For Salamanca his rewards included a marquessate.

He was now invested with the supreme command of the Spanish armies, and, after busying himself with preparations, in May 1813 the hour for his final and victorious advance arrived. The Russian disasters had compelled Napoleon to withdraw some of his best troops from the Peninsula. Against a weakened and discouraged adversary Wellington took the field with greatly increased numbers and with the utmost confidence. Position after position was evacuated by the French, until Wellington came up with the retreating enemy at Vittoria, and won an overwhelming victory (June 21). Soult's combats in the Pyrenees, and the desperate resistance of St. Sebastian, prolonged the struggle through the autumn, and cost the English thousands of men. But at length the frontier was passed, and Soult forced back into his entrenched camp at Bayonne. Both armies now rested for some weeks, during which interval Wellington gained the confidence of the inhabitants by his unsparing repression of marauding. his business-like payment for supplies. and the excellent discipline which he maintained. In Feb. 1814 the advance was renewed. The Adour was crossed, and Soult was defeated at Orthes. At Toulouse, after the allies had entered Paris, but before the abdication of Napoleon had become known, the last battle of the war was fought. Peace being proclaimed, Wellington took leave of his army at Bordeaux, and returned to England, where he was created duke of Wellington.

After the Treaty of Paris (May 30) Wellington was appointed British ambassador at the French capital. During the autumn and winter of 1814 he reported the mistakes of the restored Bourbon dynasty, and warned his Government of the growing hostility to it. His insight, however, did not extend beyond the circumstances immediately before and around him, and he failed to realize that the great mass of the French nation was still with Napoleon at heart. He remained in France until Feb. 1815, when he took part in the congress of Vienna. His imperfect acquaintance with French feeling was strikingly proved in the despatch which he sent home on learning of Napoleon's escape from Elba. "He has acted," he wrote, "upon false or no information, and the king (Louis XVIII.) will destroy him without difficulty and in a short time." Almost before Wellington's unfortunate prediction could reach London, Louis had fled, and France was at Napoleon's feet. The ban of the congress, however, went out against the common enemy, and the presence of Wellington at Vienna enabled the allies at once to decide upon their plans for the campaign. To Wellington and Blücher were committed the invasion of France from the north, while the Russians and Austrians entered it from the east. But Napoleon outstripped the preparations of his adversaries, concentrated his main army on the northern frontier, and on June 14 crossed the Sambre. The four days' campaign that followed, and the crowning victory of June 18, are described in the article WATERLOO CAMPAIGN. Wellington's reward was a fresh grant of £200,000 from parliament—he had already received £500,000 for the Peninsular War, the title of prince of Waterloo and great estates from the king of Holland, and the order of the Saint-Esprit from Louis XVIII.

Not only the prestige of his victories, but the chance circumstances of the moment, now made Wellington the most influential personality in Europe. The emperors of Russia and Austria were still far away at the time of Napoleon's second abdication, and it was with Wellington that the commissioners of the provisional Government opened negotiations preliminary to the surrender of Paris. The duke well knew the peril of delaying the decision as to the Government of France. The emperor Alexander was hostile to Louis XVIII. and the Bourbons generally; the emperor Francis might have been tempted to support the cause of Napoleon's son and his own grandson, who had been proclaimed in Paris as Napoleon II.; and if the restoration of Louis—which Wellington believed would alone restore permanent peace to France and to Europe—was to be effected, the allies must be confronted on their arrival in Paris with the accomplished fact. He settled the affair in his usual downright manner, telling the commissioners bluntly that they must take back their legitimate king, and refusing—perhaps with more questionable wisdom—to allow the retention of the tricolour flag, which to him was a "symbol of rebellion."

Further, it was mainly owing to the influence of Wellington, in conjunction with Castlereagh, that France escaped the dismemberment for which the German powers clamoured, and which was advocated for a while by the majority of the British cabinet. Wellington realized the necessity, in the interests not only of France but of Europe, of maintaining the prestige of the restored monarchy, which such a dismemberment would have irretrievably damaged. In the same spirit he carried out the trust imposed upon him by the allies when they placed him in command of the international army by which France was to be occupied, under the terms of the second peace of Paris, for five years. By the terms of his commission he was empowered to act, in case of emergency, without waiting for orders; he was, moreover, to be kept informed by the French cabinet of the whole course of business. If he had no sympathy with revolutionary disturbers of the peace, he had even less with the fatuous extravagances of the comte d'Artois and his reactionary *entourage,* and his immense powerful influence was thrown into the scale of the moderate constitutional policy of which Richelieu and Decazes were the most conspicuous exponents. Besides the complex administrative duties connected with the army of occupation his work included the reconstruction of the military frontier of the Netherlands, and the conduct of the financial negotiations with Messrs. Baring, by which the French Government was able to pay off the indemnities due from it, and thus render it possible for the powers to reduce the occupation from five years to three.

The events of the next few months considerably modified his opinions in this matter. The new chambers proved their trustworthy quality by passing the budget, and the army of occupation was reduced by 30,000 men. Wellington now pressed for the total evacuation of France, pointing out that popular irritation had grown to such a pitch that, if the occupation were to be prolonged, he must concentrate the army between the Scheldt and the Meuse, as the forces, stretched in a thin line across France, were no longer safe in the event of a popular rising. At the congress at Aix-la-Chapelle in the autumn of 1818, which settled the question, it was owing to his common-sense criticism that the proposal of Prussia, supported by the emperor Alexander and Metternich, to establish an "army of observation" at Brussels, was nipped in the bud. The definitive financial settlement between France and the allies was left entirely to him.

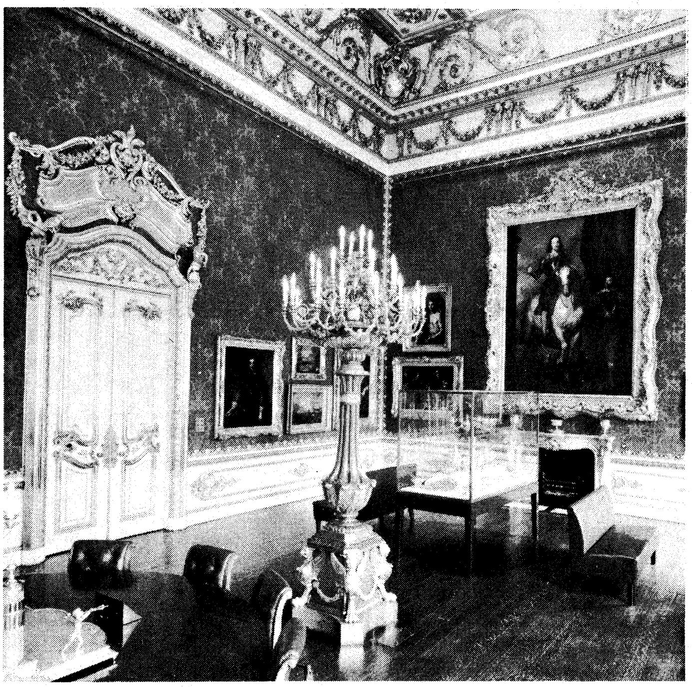
On Wellington's first entry into Paris he had been received with popular enthusiasm, but he had soon become intensely unpopular. He was held responsible not only for the occupation itself, but for every untoward incident to which it gave rise; even Blucher's attempt to blow up the Pont de Jéna, which he had prevented, was laid to his charge. His characteristically British temperament was wholly unsympathetic to the French, whose sensibility was irritated by his cold and slightly contemptuous justice. Two attempts were made to assassinate him. His work in Paris, however, was now finished, and on Oct. 30 he took leave of the international troops under his command. On Oct. 23, while still at Aix, he had received an offer from Lord Liverpool of the office of master-general of the ordnance, with a seat in the cabinet. He accepted, though with some reluctance.

He organized the military forces held in case of a Radical rising. It was his influence with George IV. that led to the readmittance of Canning to the cabinet after the affair of the royal divorce had been settled. It was only in 1822, however, that the tragic death of his friend Londonderry (Castlereagh) brought him once more into international prominence. Londonderry had been on the eve of starting for the conference at Vienna—later adjourned to Verona—and the instructions which he had drawn up for his own guidance were handed over by Canning, the new foreign secretary, to Wellington, whose official part at the congress is outlined elsewhere. (*See* VERONA, CONGRESS OF.) Unofficially, he pointed out to the French plenipotentiaries, arguing from Napoleon's experience, the extreme danger of an invasion of Spain, but at the same time explained, for the benefit of the duke of Angoulême, the best way to conduct a campaign in the Peninsula.

Wellington disliked Canning's aggressive attitude towards the autocratic powers, and viewed with some apprehension his determination to break with the European concert. He realized, however, that in the matter of Spain and the Spanish colonies the British Government had no choice, and in this question he was in complete harmony with Canning. This was also at first the case in respect to the policy to be pursued in the Eastern Question raised by the war of Greek independence. Both Canning and Wellington were anxious to preserve the integrity of Turkey, and therefore to prevent any isolated intervention of Russia; and Wellington seemed to Canning the most suitable instrument for the purpose of securing an arrangement between Great Britain and Russia on the Greek question, through which it was hoped to assure peace in the East. In Feb. 1826, accordingly, the duke was sent to St. Petersburg (Leningrad), ostensibly to congratulate the emperor Nicholas I. on his accession, but more especially—to use Wellington's own words—"to induce the emperor of Russia to put himself in our hands." In this object he signally failed. As a diplomatist the "Iron Duke"—whom Nicholas, writing to his brother Constantine, described as "old and broken (*cassé*)"—was no match for the "Iron Tsar." As for the Greeks, the emperor said bluntly that he took no interest in *ces messieurs,* whom he regarded as "rebels"; his own particular quarrel with Turkey was the concern of Russia alone. Under stress of the imminence of the peril. which Nicholas was at no pains to conceal, the duke was driven from concession to concession, until at last the tsar, having gained all he wanted, condescended to come to an arrangement with Great Britain on the Greek question. On April 4 was signed the Protocol of St. Petersburg, an instrument which—as events were to prove—fettered the free initiative not of Russia. but of Great Britain. (*See* TURKEY: *History;* GREECE: *History.*)

After the death of the duke of York on January 5, 1827, the post of commander-in-chief was conferred upon Wellington. His relations with Canning had, however, become increasingly strained, and when, in consequence of Lord Liverpool's illness. Canning in April 1827 was called to the head of the administration. the duke refused to serve under him. The effect of his withdrawal was momentous in its bearing upon Eastern affairs. Canning, freed from Wellington's restraint, carried his intervention on behalf of Greece a step further. and concluded the Treaty of London, whereby France, England and Russia bound themselves to put an end to the conflict in the East and to enforce the conditions of the St. Petersburg protocol upon the belligerents. Against this treaty Wellington protested, on the ground that it involved war. The battle of Navarino followed.

Canning died on Aug. 8. 1827. and was succeeded as premier by Lord Goderich. The duke was at once again offered the post of commander-in-chief. which he accepted on Aug. 17. On the fall of Lord Goderich's cabinet five months later Wellington became prime minister (Jan. 9. 1828). He had declared some time before that it would be an act of madness for him to take this post; but his sense of public duty led him to accept it when it was pressed upon him by the king. His cabinet included at first Huskisson, Palmerston and other followers of Canning. The repeal of the Test and Corporation Acts having been carried in the House of Commons in the session of 1828, Wellington, to the great disappointment of Tories like Lord Eldon, recommended the House of Lords not to offer further resistance, and the measure was accordingly carried through. In May Huskisson and Palmerston voted against the Government in the East Retford question; Huskisson resigned. and the other liberal members of the ministry followed suit. It was now hoped by the so-called



A HEIT A EU TE S

WATERLOO GALLERY APSLEY HOUSE WELLINGTON S LONDON RESIDENCE APSLEY WAS OPENED AS THE WELLINGTON MUSEUM IN 1952 THE CANDELABRA (ONE NOT SHOWN) WERE PRESENTED TO WELLINGTON BY NICHOLAS I OF RUSSIA THE PAINTING OF CHARLES I ON HORSEBACK IS A COPY OF THE VANDYKE AT WINDSOR CASTLE

Protestant party that Wellington, at the head of a more united cabinet. mould offer a steady resistance to Catholic emancipation. Never were men more bitterly disappointed. The Clare election and the progress of the Catholic Association convinced both Wellington and Peel that the time had come when Catholic emancipation must be granted; and, submitting when further resistance would have led to civil war, the ministry itself brought in at the beginning of the session of 1829 a bill for the relief of the Catholics in the face of opposition from the king and from Wellington's own supporters. Wellington, who had hitherto always opposed Catholic emancipation, explained and justified his change of front in simple and impressive language. He had, however, to challenge the Earl of Winchelsea to a bloodless duel. No mischief resulted from the encounter.

As soon as Catholic emancipation was carried, the demand for parliamentary reform and extension of the franchise .agitated Great Britain from end to end. The duke was ill informed as to the real spirit of the nation. He conceived the agitation for reform to be a purely fictitious one, worked up by partisans and men of disorder in their own interest. Wholly unaware of the strength of the forces which he was provoking, the duke, at the opening of the parliament which met after the death of George IV, declared against any parliamentary reform whatever. This declaration led to the immediate fall of his Government. Lord Grey, the chief of the new ministry, brought in the Reform bill, which was resisted by Wellington as long as anything was to be gained by resistance. When the creation of new peers was known to be imminent, however, Wellington was among those who counselled the abandonment of a hopeless struggle. His opposition to reform made him for a while unpopular. He was hooted by the mob on the anniversary of Waterloo, and considered it necessary to protect the windows of Apsley House with iron shutters.

For the next two years the duke was in opposition. On the removal of Lord Althorp to the House of Lords in 1834, William IV unexpectedly dismissed the Whig ministry and requested Wellington to form a cabinet. The duke. however, recommended that Peel should be at the head of the government, and served under him. during the few months that his ministry lasted, as foreign secretary. On Peel's later return to power in 1841 Wellington was again in the cabinet, but without departmental office beyond that of commander-in-chief. He supported Peel in his Corn-Law legislation, and throughout all this later period, whether in office or in opposition, gained the admiration of discerning men and excited the wonder of zealots by his habitual subordination of party spirit and party connection to whatever appeared to him the real interest of the nation. On Peel's defeat in 1846 the duke retired from active public life. Nearly 80, his organization of the military force in London against the Chartists in April 1848 and his letter to Sir John Burgoyne on the defenses of the country proved that the old man had still something of his youth. But the general character of Wellington's last years was rather that of the old age of a great man idealized. He died on Sept. 14, 1852, and was buried under the dome of St. Paul's.

BIBLIOGRAPHY.—The *Wellington Despatches,* ed. by Gurwood; *Supplementary Despatches;* and *Wellington Despatches, New Series,* ed. by the 2nd duke of Wellington. Unlike Napoleon's dispatches and correspondence, everything from Wellington's pen is absolutely trustworthy. Almost all the political memoirs of the period 1830–50 contain more or less about Wellington in his later life. Those of Greville and Croker have perhaps most of interest. A good deal of information, from the unpublished Russian archives, is given in F. F. de Martens' *Recueil des traités conclus par la Russie. See* also Sir Herbert Maxwell, *Life of Wellington,* 2 vol. (1900); J. W. Fortescue, *Wellington* (1925); literature of the Peninsular War (*q.v.*), Waterloo Campaign (*q.v.*).

WELLINGTON, a market town and urban district in the Taunton parliamentary division of Somerset, Eng., 7 mi. W.S.W. of Taunton. Pop. (1961) 7,523. Area 3.5 sq.mi. The 1st duke of Wellington is commemorated by a monument (National Trust property) on the highest point of Blackdown hills. 23 mi. S. At its foot is Wellington school, founded in 1841. The town produces woolen goods, bedding and milk products. There is also a Wellington in Shropshire; Wellington college is in Berkshire.

WELLINGTON, capital of New Zealand, on the southern shores of the natural harbour of Port Nicholson in North Island. Area 27.6 sq.mi. Pop. (1961) 123.696. The harbour, one of the finest in the world, extends over 32 sq.mi., with depths varying from 6 to 14 fathoms. It was discovered early in the 10th century by Kupe, the celebrated Polynesian navigator, who landed but found the place uninhabited. Eight centuries later in 1773 Capt. James Cook sailed through the strait which now bears his name but did not enter the harbour.

Wellington was named after the 1st duke of Wellington and the first settlement of New Zealand colonists was founded in 1840 under the auspices of the New Zealand company. The capital of New Zealand was transferred to Wellington from Auckland in 1865. Politically. commercially and geographically Wellington is the most important city in New Zealand; it is a busy passenger and freight terminal as the greater part of rail, road, sea and air traffic passes through the city for redirection to other centres. As a chief port, Wellington vies with Auckland and the city contains the head offices of many banks, shipping companies, insurance companies and mercantile houses of the dominion. Main railway lines link Wellington with Auckland, Napier and New Plymouth and there are regular air services to various cities and towns in both North Island and South Island. There is a fast overnight steamer-ferry service to Lyttleton, the port of Christchurch, in South Island.

The principal public buildings include the houses of parliament, town hall, railway station, the National Art gallery and Dominion museum and many large modern structures housing government departments. Among the city's many fine educational institutions is Victoria university, one of the four universities of the dominion, established in 1897. The business section of the city is mainly situated on land reclaimed from the harbour after 1866. The residential suburbs extend over the surrounding hills and out to the seaside bays fronting Cook strait. Necessary open space, however, was retained in the form of 1,000 ac. of town belt skirting the hill tops and slopes and which, by the foresight of the early settlers, by statute was preserved for all time for the enjoyment and recreation of citizens. In addition, there are many public parks and recreation grounds. The Wellington City corporation, which is one of the largest combined local authorities in the southern hemisphere. owns the public transport, water supply and drainage systems and controls the electrical distribution. public libraries, cemeteries, recreation areas, public baths, abattoir, zoo and municipal airport, also the milk treatment and distribution service, the first in the world to be municipally established and controlled. (B. O. PN.)

WELLS, CHARLES JEREMIAH (1798?–1879), English poet, was born in London, probably in the year 1798. He was educated at Cowden Clarke's school at Edmonton, with Tom Keats, the younger brother of the poet, and with R. H. Horne. He met John Keats, but later quarreled with him.

In 1822 he published *Stories After Nature,* and in 1823, under the pseudonym of H. L. Howard, *Joseph and His Brethren.* For the next three years Wells saw Hazlitt, as he said, "every night," but in 1827 the two men were estranged. Wells was then practising as a solicitor in London. but he went to live in the country, first in south Wales and then at Broxbourne, Hertfordshire, on account of his health. In 1840 he left England for good. He settled at Quimper in Brittany, where he lived for several years. A story called *Claribel* appeared in 1845, and one or two slight sketches later, but several tragedies and a great deal of miscellaneous verse belonging to these years are lost. \Tells stated in a letter to Horne (Nov. 1877) that he had composed eight or ten volumes of poetry during his life, but that, having in vain attempted to find a publisher for any of them, he burned the whole mass of manuscripts at his wife's death in 1874 The only work he had retained was a revised form of *Joseph and His Brethren,* which was praised in 1838 by Wade, and again with great warmth, by Horne. in his *New Spirit of the Age,* in 1844. The drama was then once more forgotten, until in 1863 it was read and vehemently praised by D. G. Rossetti. The tide turned at last; *Joseph and His Brethren* became a kind of shibboleth—a rite of initiation into the true poetic culture—but still the world at large remained indifferent. Swinburne wrote an eloquent study of it in the *Fortnightly Review* in 1875, and the drama itself was reprinted in 1876. Between 1876 and 1878 Wells added various scenes, which are in the possession of Buxton Forman, who published one of them in 1895. After leaving Quimper, Wells went to reside at Marseilles, where he held a professorial chair. He died on Feb. 17, 1879.

The famous *Joseplz and His Brethren,* concerning which criticism has recovered its self-possession. is an overgrown specimen of the pseudo-Jacobean drama in verse which was popular in ultrapoetical circles between 1820 and 1830. Its merits are those of rich versification, a rather florid and voluble eloquence and a subtle trick of reserve, akin to that displayed by Webster and Cyril Tourneur in moments of impassioned dialogue.

In 1909 a reprint was published of *Joseph and His Brethren,* with Swinburne's essay and reminiscences by T. Watts-Dunton.

WELLS, DAVID AMES (1828–1898), U.S. economist, was born in Springfield, Mass., on June 17, 1828. He graduated at Williams college in 1847 and at the Lawrence scientific school, becoming assistant professor in 1851. In 1850–65 he published with George Bliss an *Annual of Scientific Discovery.* His essay on the national debt, *Our Burden and Our Strength* (1864), secured him the appointment in 1865 as chairman of the national revenue commission, which laid the basis of scientific taxation in the United States. In 1866–70 he was special commissioner of revenue and published important annual reports; during these years he became an advocate of free trade. The creation of a federal bureau of statistics in the department of the treasury was largely due to his influence. In 1871 he was chairman of the New York state commission on local taxation. He did good work in the reorganization of the Erie and the Alabama and Chattanooga railroads and on the board of arbitration for railroads. In 1877 he was president of the American Social Science association. He died in Norwich, Conn.. on Nov. 5, 1898. He edited many scientific textbooks, and wrote *Robinson Crusoe's Money* (1876), *Our Merchant Marine* (1882), *A Primer of Tariff Reform* (1884), *Practical Economics* (1885), *Recent Economic Changes* (1889), *The Relation of the Tariff to Wages* (1888) and *The Theory and Practice of Taxation* (1900), edited by W. C. Ford.

WELLS, HENRY (1805–1878), pioneer U.S. expressman, was born in Thetford, Vt., on Dec. 12, 180;. About 1841 he became agent for Harnden's express at Albany, N.Y. Within two years he established Livingston, Wells & Pomeroy's express, Albany to Buffalo, with himself as messenger. He carried letters for six cents each, one-quarter of the government rate. His services expanded, and with various partners he soon was operating from New York to St. Louis and to Bangor, Me. In 1850 he was a leader in merging several lines into the Xmerican Express company, and was its head for 18 years. In 1852, with William Fargo (*q.v.*), he organized Wells, Fargo & Company to serve the California gold fields and the growing west. Surviving a great panic in 1855, \\'ells, Fargo grew rapidly. It furnished a mail, courier, and banking service that came to include stagecoach lines from Sacramento to Salt Lake City, to Portland, Ore., and to many developing gold areas. In 1861 Wells and associates bought the famous pony express and operated it as a Wells Fargo enterprise in its closing months. In 1866 they added Ben Holladay's prairie and Rocky mountain section to Wells Fargo's overland stagecoach mail service.

In 1868 Wells founded Wells seminary, later Wells college for women, at Aurora. N.Y. He died in Glasgow, Scot.. on Dec. 10, 1878. (N. C. W.)

WELLS, HERBERT GEORGE (1866–1946), English novelist, journalist. sociologist and popular historian, a powerful influence in the movement which worked toward the breakdown of the 19th-century outlook in economics, moral and religious belief. He was born at Bromley. Kent. on Sept 21, 1866. His father. Joseph Wells. was the proprietor of a small china shop, nho for tno seasons had played professional cricket. and his mother had been a lady's maid. Wells grew up under the continual threat of poverty, and at the age of 14, after only the sketchiest education, he was apprenticed to a draper in Windsor, a position he liked so little that he ran away. Later he made several more false starts in life, as a chemist's assistant, as a draper again and lastly as an usher at Midhurst Grammar school. There he first found opportunity to read. so that at 18 he won a scholarship to study biology at the Normal School of Science. South Kensington. London. where Thomas Henry Huxley was one of his teachers. He graduated from London university in 1888.

For several years he lived in considerable hardship, first as a student and then as a teacher of science, his financial worries being increased by ill-health and by his marriage (1891) to his cousin Isabel Mary Wells. This marriage was not successful and in 1894 Wells joined Amy Catherine Robbins, who later became his second wife. Meanwhile, he had turned to journalism and in 1895 produced his first novel. *The Time Machine,* a story of travel into the remote future. The novel was successful at once, and soon he began to produce a series of scientific romances which established him as a writer of startling originality. *The Wonderful Visit* (1895), *The Island of Doctor Moreau* (1896), *The Invisible Man* (1897), *The War of the Worlds* (1898), *The First Men in the Moon* (1901) and *The Food of the Gods* (1904) followed. together with many short stories collected under such titles as *The Stolen Bacilius* (1895), *The Plattner Story* (1897) and *Tales of Space and Ttme* (1899). In all these Wells showed an immense fecundity of ideas. a virtuosity of biological and astronomical fancy that passed far beyond the comparatively mechanical inventions of Jules Verne.

Behind this virtuosity, moreover, lay a passionate concern for man and society, and it was this concern that eventually led him to abandon fantasy for the realistic comedy of lower middle-class life represented by *Love and Mr. Lewisham* (1900), *Kipps* (1905) and *The History of Mr. Polly* (1910). In these three novels, together with *Tono-Bungay* (1909), Wells reached his highest achievement as a novelist. Here. drawing on memories of his early life, he was able to make himself the spokesman for the inarticulate and the frustrated, revealing nith rare sympathy their aspirations and disappointments, their muddled tenderness and distorted dreams of beauty. Here, too, he made his liveliest and most persuasive comment on the social predicament which was soon to become his main preoccupation. For belief in the biological theory of the evolution of the species had led him to a vision of a society which was evolving, more or less inevitably, toward utopia—a conception presented in *Anticipations* (1901), *Mankind in the Making* (1903) and *A Modern Utopia* (1905). About this time, too. he became an active socialist, joining the Fabian society in 1903, though soon he began to criticize the methods of the Fabians and was led to present his own idea of socialism in such works as *New Worlds For Old* (1908) and *First and Last Things* (1908; rev. 1917).

From then onward, the pamphleteer and the novelist mere in conflict in Wells, and only *The History of Mr. Polly,* considered by many to be his masterpiece, and the lighthearted *Bealby* (1915) can be considered primarily as fiction. The rest of his novels are mainly discussions or illustrations of various social and intellectual problems. presented, nevertheless. with enthusiasm, humour and flashes of his old skill in portraiture. *Ann Veronica* (1909), *The New Machiavelli* (1911), *Marriage* (1912), *The Wife of Sir Isaac Harman* (1914), *The Research Magnificent* (1915) and *Joan and Peter* (1918) all belong to this category. while *Mr. Britltng Sees It Through* (1916), in spite of prejudice and shortsightedness, gives a brilliant picture of the English people during World War I. About this time Wells found himself turning to a belief in the transcendental—a belief nhich he afteraard renounced. *God: the Invisible King* (1917) and a novel. *The Soul of a Bishop* (1917), are the chief productions of this phase, together nith *The Undying Fire* (1919), a modernized version of the Book of Job.

The war had shaken Wells's faith in the inevitable progress of man and now, turning to his conception of the evolution of society. he put forth the proposition that man could progress only if he adapted himself to his changing environment. To help this adaptation, he began his great work of popular education. of which the main productions were *The Outline of History* (1920; rev. 1931), *The Science of Life* (1931), written in collaboration with Julian Huxley and G. P. Wells, and *The Work, Wealth and Happiness of Mankind* (1932). At the same time, he continued to produce fiction in which, however, his imaginative gifts were almost entirely subordinated to argument. *The World of William Clissold* (1926) carried the "discussion novel" to its furthest possible development, being little more than a huge collection of the tenets and opinions of its unamiable central character. Indeed, during this period Wells's literary powers are to be seen less in his novels than in the reminiscences of *Experiment in Autobiography* (1934).

In 1933 he published a novelized version of a film script, *The Shape of Things to Come,* which was a reversal to the utopianism of his earlier work, but. on the whole, his outlook grew less optimistic. Some of his later novels contained much that was bitterly satirical: *Mu. Blettsworthy on Rampole Island* (1928), for instance, and *The Autocracy of Mr. Parham* (1930). His *Experiment in Autobiography* appeared in 1934. In the succession of short novels and fables that appeared during the 1930s there was an increasingly pessimistic awareness of the tragic dangers of the future. *The Croquet Player* (1936), *The Brothers* (1938) and *The Holy Terror* (1939) are typical in various ways of this new development of Wells's thought. He was ill and aging and. with the outbreak of World War II, he lost all confidence in man. In *Tlze Outlook For Honzo Sapiens* (1942) and *Mind at tlte End of Its Tether* (1945) he depicted a bleak vision of a world in which nature had rejected man and was destroying him. He died on Aug. 13.1946.

In spite of the pessimism of his old age, Wells is remembered chiefly as the prophet of that period of optimism and experiment that preceded World War I. No other writer caught so vividly its energy, its adventurousness, its sense of release from the conventions of Victorian thought. His influence was enormous. both on his own generation and on that which followed. Few did more to incite revolt against Christian dogma or against the accepted codes of behaviour, especially in matters of sex, in which, both in his writings and in his personal life, he was a persistent advocate of an almost completely amoral freedom. In many matters Wells was hasty, ill-tempered and contradictory, yet he was undeviating and fearless in his fight for social equity, world peace and for what he considered to be the future good of mankind.

As a creative writer his reputation rests on his scientific romances and on the comic novels of his middle period. The first achieve a near poetry which make them part of the popular mythology of their age; the latter are among the finest contributions of the 19th century to the realist tradition of the English novel. Wells's style lacked grace, his psychology lacked subtlety. but the best of his work has a vitality, a verve. an imaginative compulsion unsurpassed by any of his contemporaries.

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WELLS, HORACE (1815–1848), U.S. dental surgeon. was born at Hartford, Vt., Jan. 21, 1815. He studied dentistry in Boston, 1834. and began practice in Hartford, Conn. In 1840 he first expressed the idea that teeth might be extracted painlessly by the application of nitrous oxide gas. He tested the efficacy of the gas in this operation on his own person in 1844 and afterward frequently used it in his practice. He was long thought to have been the first to use an anesthetic in any operation. and, though he was preceded by Crawford Long (*q.v.*), he deserves the credit of an independent discovery, which through him was first brought to attention. He died in New York city, Jan. 24. 1848.

See "Life and Letters of Horace Wells, Discoverer of Anesthesia," *J.Am.Coll.Dentists,* vol. 4, no. 2, pp. 81–210 (June 1944).

WELLS (THEODUNUM, FONTICULI, TIDINGTON, WELLIAE, WELLE). a city and municipal borough in the Wells parliamentary division of Somerset, Eng., 21 mi. S. of Bristol by road. Pop. (1961) 6.691. Area 2.1 sq.mi. It lies below the Mendip hills and derived its present name from St. Andrew's wells, which during the middle ages were thought to have curative properties. There was a Roman settlement there.

During Saxon times Wells was one of the most important towns of Wessex. King Ine (688–726) built a church there, and in 909 Wells was made the seat of a bishopric by Edward the Elder. In 1088 John de Tours (or de Villula) removed the see to Bath. After struggles between the secular clergy of Wells and the regulars of Bath, it mas arranged in 1242 that the bishop should take the title of "Bath and Wells" and should be elected by representatives of the monks of Bath and of the canons of Wells. This arrangement continued until the suppression of the monasteries in 1539 when the election remained with the chapter of Wells, the bishop retaining his double title. Wells became a borough owned by the bishops before 1160, when Bishop Robert granted the first charter, and became a free borough by charter of King John in 1201. It was represented in parliament from 1295 to 1868. The theological college is well known. The diocese covers all Somerset escept Bedminster, Abbots-Leigh and Brislington.

The Cathedral.— The beautiful cathedral was executed principally by Bishop Reginald FitzJocelin (1174–91) and Bishop Jocelin of Wells (1206–42). The western part of the nave and also the lovely series of statues on the west front are attributed to Bishop Jocelin. With him was associated a famous architect, Elias de Derham (d. 1245), who was his steward in 1236. Early in the 14th century the central tower was heightened; the piers began to give way and to strengthen them the remarkable inverted arches were introduced. The beautiful octagonal chapter house on the north side and the Lady chapel at the extreme east were the nest important additions in the same century. The whole church is covered with stone groining of various dates, from the Early English of the choir to the fan vaulting of the central tower. Its plan consists of a nave (161 ft. long, 82 ft. wide) and aisles, with two short transepts, each with a western aisle and two eastern chapels. The choir and its aisles are of unusual length (103 ft.), and behind the high altar are two smaller transepts, beyond which is the very rich Decorated Lady chapel, with an eastern semioctagonal apse. On the north of the choir is the octagonal chapter house, the vaulting of which springs from a slender central shaft. The cloister, 160 hy 150 ft., extends along the southern wall of the nave. The length of the church from east to west is 383 ft.

On the south side of the cathedral stands the bishop's palace, a moated building, originally built in the form of a quadrangle by Bishop Jocelin, and surrounded by a lofty cirruit wall. The hall and chapel are beautiful structures, mostly of the 14th century. North of the cathedral are the deanery and archdeaconry (the latter now used by the theological college), the museum and the Chain gate, connecting the chapter house with the Vicars' hall and the charming 14th-century street known as Vicars' close.

The church of St. Cuthbert has a fine tower with spire at the west end. It is Early English and Perpendicular.

WELSH LANGUAGE: see CELTIC LANGUAGES.

WELSH LAWS or LEGES BRITANNIAE. The earliest and best manuscripts of these. whether in their original Welsh or Latin, do not date from before 1175–1200. Confessedly recensions and reflecting current politics. they hear notwithstanding so striking a general resemblance to one another that it is hard not to credit their common tradition, namely, that they hail from one original codification of British law and custom by King Howel (Hywel) Dda ("the Good"), who died 950. The Welsh manuscripts fall into three classes, each of which begins with its own type of preface: (1) Those which refer exclusively to the king of Aberffraw in northwest Wales and give other indications that they pertain to that kingdom: *i.e.*, Gwynedd or Venedotia. of which Aberffraw in Anglesey was the chief royal residence. The jurist Iorwerth ap Madog (*c.* 1200) would seem to be responsible for this recension. which Aneurin Owen in 1841 dubbed. not inappropriately. the "Venedotian code." (2) Those which refer exclusively to the king of Dinefwr (anglice Dynevor) in the "south." hut would seem from the preface to have prevailed in Powys. The jurists favoured are Morgeneu and his son Cyfnerth. Owen unfortunately called these the "Gwentian code" as pertaining to southeast Wales, of which the manuscripts provide no indication. (3) Those which refer to both the kings of Dinefwr and Aberffraw. stating expressly that of all the kings in Wales gold is payable only to these two.

But as they put Dinefnr before Aberffraw and refer to Rhyr ap Grufiudd (d. 1197). one of the Dinefwr kings, and contain a special section on Dyfed or Demetia in southwest Wales, they certainly pertain to the "south." Owen, however. called them insufficiently the "Dimetian code." The jurist named in the preface is Blegywryd. who is otherwise known as having intervened in a dispute in 95j, where he is described as "that most famous man" (Bk. of Llun *Dav,* 219). He is also known from some ancient Latin verses to have been a teacher of law in Howel's court and to have written a book of laws for the king. which book the king gave "ad partem dexteram"; *i.e.*, to the "south," in Welsh Deheubarth. which stands for "Dextera Pars Britanniae." the south part of Britannia or Wales (omitting Morgannwg, the country from Swansea to Chepstow).

That these three classes really represent law books in vogue in Gwynedd. Powys and Deheubarth, respectively. seems to be implied or reflected in the preface of the last-mentioned class. where we are told that "Howel ordered three law books to be made. one for the daily court to he always with him. another for the court of Dinefwr, the third for the court of Aberffraw, so that the three divisions of Wales. to wit, Gwynedd, Powys and Deheuharth should have the authority of law in their midst. at their need. always and ready." Readers for their guidance should bear in mind: (1) That the earliest manuscripts extant were written when the Norman French had long interfered in Welsh affairs and had already permanent possession of most of the petty kingdoms of south Wales; when also Geoffrey of Monmouth's History of *the Kings* of *Britain* was further confirming men's minds in the bizarre notions of the Welsh past, which had originally been set going by the book called Dc excidio *Britanniae* used by Bede. (2) That Howel Dda was not an original begetter of Welsh law; what Howel did was to "put together the laws of Britannia" (*i.e.,* Wales) with the consent and after the consideration of the wise men of his realm, assembled in one place. (3) That it is not conducive to sound knowledge to accentuate the "tribal" nature of the Welsh laws. No term for "tribe" appears. To read "tribes," therefore, into the Welsh laws is not only to force the text. but to obfuscate the emergence of Wales into the dark age from Romano-British Christian civilization.

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(A. W. W-E.)

WELSH LITERATURE. By Welsh literature is meant literature composed in the Welsh language. No account is here given of literature composed by Welshmen in English. to which the term Anglo-Welsh is more applicable. Welsh literature properly so called extends in an unbroken tradition from about the middle of the 6th century to the present day.

The Cynfeirdd or Early Poets (c. 550–c. 1100).—With the exception of two or three short pieces, all pre-Norman poetry has survived only in manuscripts written in the 12th, 13th, 14th and 15th centuries—*The* Black Book of *Carmarthen* (*c.* 1170–1230), *The* Book of Aneirin (c. 1250). The Book of *Taliesin* (*c.* 1275) and *The* Red Book of Hrrgest (*c.* 1375–1425)—and in a few others of even later date. Although their date is uncertain. it is clear that many of the poems are very much older than the manuscripts in which they have survived.

Welsh developed as a new analytic language from the older synthetic Brythonic by the middle of the 6th century. A note in the *additamenta* to the *Historia Britonum* attributed to Nennius, a disciple of Elfodd (d. 809), states that the poets Blwchfardd, Cian. Talhaern Tad Awen (the "father of the muse"). Taliesin and Neirin (later Aneirin) composed poetry in Welsh at a time roughly contemporary with Ida (547–559), son of Eobba. The first three are mere names, but *The* Book of *Taliesin* and The Book of *Aneirin* contain collections of verse which purport to be the works of Taliesin and Aneirin. All the poems in the former manuscript cannot be the work of the historical 6th-century Taliesin. but about a dozen of them appear to be authentic. In these. which may be described as heroic odes or lays. the poet praises the warlike deeds and generosity of his lord Urien of Rheged (the modern shires of Wigtown and Kirkcudbright in south Scotland) and moans the loss of Owein. son of Urien. *The* Book of Aneirin, on the other hand. contains a long poem called Y Gododdin, claimed to be the work of Aneirin. The extant text is very corrupt and contains many later interpolations, but the nucleus of it appears to have been composed (possibly in a form differing much from that in which it has survived) by Aneirin toward the close of the 6th century. It consists of series of verses, generally one for each hero, often linked together by the same initial phrase or line, and commemorates the ill-starred expedition of the war band of 300 men sent by their lord Mynyddawg Mwynfawr of Caereidyn (near Edinburgh) to recapture the old Roman stronghold of Catraeth (Catterick in Yorkshire) from the Saxons of Deira or to hold it against them. The background, inspiration and social conventions of the poems of Taliesin and Aneirin are typically heroic, the language is direct and simple, and the expression terse and vigorous. Among other technical adornments much use is made of alliteration and internal rhyme. which used in combination gradually developed by the 13th century into the intricate system of consonantal correspondences and internal rhyme called cynghanedd (*q.v.*). The later development of Welsh poetry owes much in form and matter to the continuance of the heroic mode of life. and to the pattern set by the works of Taliesin and Aneirin and those of other bards whose compositions have disappeared. It is kno n from Gildas that Maelgwn Gwynedd (d. *c.* 547), in northwest Wales, had court poets, but not a line of their compositions survived.

The connection between the Britons of Wales and those of north Britain. weakened by the battle of Chester in *c.* 61j was broken when Penda. with his British allies, was defeated in 654 or 655 by Oswiu (Oswin). king of Northumbria. Although Welsh survived as a spoken language for two or three centuries in North Britain and some interpolations in the text of Y *Gododdin*—in particular a stanza which refers to the death of Domnall Brecc in 642—show that the heroic tradition of eulogy and elegy was continued there, subsequent literary compositions in that region have disappeared. Early heroic poetry in Wales proper is first exemplified by a short poem in *The* Book *of Taliesin* in praise of Cynan Garwyn of Powys, whose son Selyf was slain in the battle of Chester. This poem strikes a note which remained constant in all Welsh eulogies and elegies down to the fall of the Welsh Bardic system: Cynan is the bravest in the field, the most generous in his home: all others are thrall to him and sing his praises.

The period between the 7th and 10th centuries is represented by a few scattered poems, most of them in the heroic tradition. Of poets there are references to Morfran, Meugan, Arofan (bard to Selyf ap Cynan mentioned above) and Afan Ferddig. whose patron Cadwallon ap Cadfan was killed in the battle of Hexham against Oswald of Bernicia in 634: The few authentic poems still extant include "The Eulogy of Cadwallon" (? by Afan Ferddig), "The Elegy of Cynddylan ap Cyndrwyn" of Powys in the first half of the 7th century and, less heroic in note and more peaceful in atmosphere. "The Eulogy of Tenby," by an unknown south Wales poet toward the end of the 9th century. Early vaticinatory poetry is represented by "The Great Prophecy of Britain." a stirring appeal c. 930 to the Welsh to unite with the Britons of the north, the Irish, the Norse of Dublin, the Cornish and the Bretons to oppose the Saxons and to refuse the unjust demands of their "great king." probably Athelstan of Wessex. Poetry outside the main bardic tradition is seen in nine *englynion* (stanzas of three or four lines) praising God; three englynion which are a monologue or part of a dialogue from a lost saga; a dialogue partly vaticinatory betneen Myrddin and Taliesin, c. 1050–1100; and "The Song of the Wind." a riddle poem which contains the germ of the later convention known as dyfaliad or comparison.

The poems associated with the name Llywarch Hen were once regarded as the work of the 6th-century leader of that name. It is clear, however, that they are the verse remains of at least two literary sagas composed toward the middle of the 9th century by an unknown but highly gifted storyteller of Powys, whose basic material was the traditions which had gathered around the historical Llywarch and Heledd, sister to Cynddylan ap Cyndrwyn. In these sagas prose was used for narrative and description, and verse for dialogue and soliloquy. The prose has been lost, and what the sagas were in their complete form can only be guessed from hints and references in the verse passages. The metrical form is the englyn embellished by alliteration, internal rhyme and incipient cynghanedd. The background is the heroic struggle of the Welsh of Powys against the Mercians, but the mode is elegiac: Llywarch bemoans the loss of his 24 sons fallen in defense of their land, and as he wanders lonely and poor from place to place he grieves at the desolation wrought by the enemy; Heledd. the other central figure. bewails the death of Cynddylan and her other brothers, and laments the passing of the glory which was once the pride of her and her family. The storyteller's mood and that of his people is relentlessly conveyed in stanzas of a haunting sadness and charm, rendered all the more effective by an extraordinary economy of words coupled with the device of incremental repetition. Both Llywarch and Heledd are portrayed as tragic, ill-starred figures (dzriaid) who envy the different fate of those born to a fortunate destiny (dedwydd), and now in their distress they call to mind the baneful pride (tmha) in word or deed which brought them to their low estate. The sheer poetry and artistic finish of these verses make regretful the loss of scores of other sagas referred to in the Triads, the "Stanzas of the Graves" and elsewhere, although they may never have received the consummate literary treatment which those of Llyuarch and Heledd received.

There are other fragments, inferior as poetry to the verses associated with Llywarch and Heledd, which were originally soliloquies or parts of dialogue in sagas. Such are the dialogues between Arthur and the porter Glewlwyd Mightygrasp. between Taliesin and Ugnach, between Gwyn ap Nudd and Gwyddneu Garanhir; the monologue of Ysgolan the Cleric; the verses praising Gereint son of Erbin (the Erec of medieval romance); and the tantalizing fragment of what appears to be an early native version of the Trystan and Esyllt (Tristan and Iseult) story. All these are found in The Black Book of Cmmarthen. Other groups of verses in the same manuscript show that there once existed in literary form a legend of Myrddin Wyllt, the wild man of the woods who went mad at the sight of a battle, a legend associated with Suibbne Geilt in Ireland, and with Lailoken in Scotland This Myrddin (later better known as Merlin) had the gift of prophecy, and so "prophecies after the event" came to be attributed to him. The historical poet Taliesin also became the central figure in a folk tale which was given literary form in the 9th or 10th century, but which has survived only in certain monologues spoken by some of the characters and preserved in The Book of *Taliesin,* and in a modernized and debased 16th-century text called *Hanes* Taliesin ("The Story of Taliesin"). As portrayed in the monologues Taliesin is the young bardic prodigy who surpasses everyone in his knowledge of the past, present and future. Hence he too, like Myrddin, came to be regarded as a prophet and many vaticinations mere attributed to him.

Nature, a source of similes in the heroic poetry and in the verse remains of the sagas, was sometimes a subject of song in its own right. Generally, the treatment of the subject is remarkable for its sensitive objectivity, its awareness of form, colour and sound and its concise expression which is often epigrammatic. In mood, matter and form (that of the englyn) it often overlaps with gnomic poetry, which consists of versified sententious sayings about man and nature. Most of the gnomic and nature poetry was probably produced in the 10th and 11th centuries by poets other than the professional bards. Toward the end of the pre-Norman period we have a few poems on religious and biblical subjects—"The Day of Judgement," "The Plagues of Egypt," "The Rod of Moses," "The Miraculous Harvest" and "The Dialogue Between the Body and the Soul"—and others which show acquaintance with nonnative legends such as those of Hercules and Alexander and that of the Irish Corroi Mac Dairi. They may be the work of inmates of the old Celtic monastic institutions.

Most of this early heritage of song—heroic, vaticinatory, nature, gnomic and religious—was developed by the medieval gogynfeirdd. Saga poetry gradually died out, for prose became the recognized medium for storytelling.

The **Gogynfeirdd or Poets of the Princes (c. 1100–c. 1350).**—With the consolidation of the principality of Gwynedd under Gruffudd ap Cynan (1054–1137) and his descendants, a new song suddenly appeared in that province. It is certain. however, that the poems of the first bards of this period are the culmination of long ages of literary activity of which there is now no record. The court poetry of the gogynfeii-dd was the direct and inevitable development of the work of the early poets (cynfeirdd) of North Britain and Wales.

The Bardic System.—The bards were divided into grades, the upper grade or pencerdd (chief of song) being a high officer of the court, whose duty it was to sing the praises of his lord and his family, and of God and the saints. He was forbidden to sing of love and nature, and his field of song was mapped out and prescribed. Under him came the bardd *teulu* (the bard of the king's war band) who did for the king's household what the pencerdd did for the king himself. He also was restricted as to subject, but he might sing of love and nature, and such songs as would please the ladies but be distasteful to the virile warriors. Last of all came many kinds of cerddorion (minstrelsj who might be permitted ribaldry and satire, and who told the *cyfarwyddyd* or oral tale which eventually developed into the Mabinogion.

Across this classification, which is somewhat analogous to a similar division in Ireland, cuts another, based on an entirely different principle—the grading of the bards according to degrees of proficiency. This classification was educational, and lay at the root of all learning in Wales. It was this latter classification which remained in Wales after the loss of its independence; its essential feature, the relation of disciple and teacher, persisting almost to modern times. In the time of Henry IV it led to the holding of an eisteddfod, or session of the bards, to confer certificates of proficiency and to prevent the lower orders from flooding the country and drifting into mere mendicancy.

One of the natural results of a bardic system of this type was an unparalleled conservatism in literature. Most of the 13th-century bards used a conventional diction which was consciously archaic in its vocabulary, grammar and idiom. It could not possibly be understood by any but those classes whose education included the study of poetry. This archaism was one of the means by which they produced that "exquisiteness," the aim of all bardism, and non-Celtic critics often find it extremely hard to appreciate an artistry the methods of which differ so widely from those of their own.

Bardism often went by families, and the first names of the new period are those of Meilyr, his son Gwalchmai and his grandson Meilyr ap Gwalchmai. who were attached to the court of Gwynedd at Aberffraw. Gwalchmai (*fl.* 1130–80) left on record his *Gorhoffedd* or "Boasting," a kind of spring song. In his Praise of *Owein* he displays one characteristic of all the gogynfeirdd, description of water, whether of river or sea. Nearly all the great poets of this period get their finest effects when they picture the waves red with the blood of their enemies. The traditional master of the archaic was Cynddelw (*fl.* 1155–1200), the court bard of the prince of Powys.

The official bards of this period all used the same material and used it in the same way. Song and its modes were prescribed for them, and to go beyond the stated limits was to be unbardic. The poetry of the bardic tradition was not measured by the depth and extension of its thought but by its exquisiteness. Its value was ornamental, and to be in a position to judge Cynddelw and his contemporaries one must think of a culture that sought not to interpret life but to adorn it. Two poet-princes, Owein Cyfeiliog of Powys (d. 1197) and Hywel ab Owein of Gwynedd (d. 1170), stand out in clear distinction from the contemporary bards. Cyfeiliog's most famous work is the *Hirlas,* "The Long Grey Drinking Horn:" in which he describes his warriors making merry over the mead after a victorious raid. Hywel ab Owein's departure from convention is even more striking than that of Cyfeiliog; for the first time in Welsh literature appears the love of country. He loved beauty. in the modern sense; land and sea and women and the Welsh speech spoken in cultured accents by his lady all awoke in him the emotion of awe and wonder. and he unifies in his own experience all these beautiful things. The *gogynfeirdd* alternated throughout this period between *marwnad* (elegy) and *moliant* (eulogy) until the time when the English conquest of Wales removed from Welsh life the occasion of both. The period ends with the most famous of all the Welsh *marwnadau,* sung by Gruffudd ab yr Pnad Coch, after the death of Llywelyn (Llewelyn) (d. 1282). the last prince of Wales.

The religious verse of the *gogynfeirdd,* comparatively small in bulk. is on the whole simpler in style than the eulogies and elegies. A set type of ode is the *marwysgafn* (deathbed song), in which the poet. sensing the approach of death, confesses his sins and prays for forgiveness. Other religious poems are in praise of God and the Trinity. to saints, on the torments of hell and on the birth of Christ. They illustrate the gradual widening of the bardic horizon but there is not much sacrifice of conservatism in diction.

The Later Gogynfeirdd.—With the princes and their pageantry, there passed away the older modes and conventions of Welsh poetry. The audience that could once accept and understand the intricate and involved *awdl* (a long stanza with a single rhyme throughout) of the old period could no longer find the means to educate themselves for the understanding of it. The old metres still remained, but the language became simpler. The poetical conventions which governed the old poetry having been thus in part relinquished. it was necessary to invent a new presentation of poetry. which contained some element that could be regarded as a substitute for them. The poets who sang in the years between the English conquest (1282) and Dafydd ap Gwilym ($. 1340–70) seem either to have returned to an earlier poetic fashion or to have been influenced by new ideas from other lands. The probability is that both suppositions are true; that is to say, the poets of the *bardd teulu* class. whose work has not been preserved, were greatly influenced in the 11th century by other trends in poetry, but this influence did not penetrate into the work of the *penceirddiaid* until the loss of Welsh independence had made them more directly dependent on what (to use an anachronism) might be called middle-class opinion.

Whereas in the early period exquisiteness was sought in archaic precision and in the suggestion of older modes. the new poets employed colour and form to an extent hitherto unknown in Welsh poetry and unparalleled in later times. Dress: jewels, armour, a lady's hair and cheeks, her form and gestures, even her silences are amply and precisely described in poetic words. The famous names in this period are those of Gruffudd ap Rlaredudd (*fl.* 1352–82), Gruffudd ap Dafydd (*fl. c.* 1300) and Casnodyn (*fl.* 1320–40) who all flourished in the first half of the 14th century.

Early and Medieval Prose (c. 900–c. 1500).—The earliest examples of Welsh prose are of a utilitarian nature: notes and glosses on Latin texts dealing with weights and measures. a record of an agreement made concerning the ownership of a piece of land and lists of dues to be paid to a church of St. Teilo's. A more substantial text is the 10th-century *Computus Fragment* of 24 lines which contains an incomplete commentary on a problem of astronomy. Their latinized vocabulary and syntax point to an ecclesiastical or monastic origin. Shortly before the middle of the 10th century Howel (Hywel) Dda (d. 950), according to the tradition recorded in the medieval law books, had the Welsh laws codified. The oldest extant version is in Latin, but the Welsh version in *The Black Book of Chirk* (*c.* 1200) derives from an earlier exemplar. It is difficult to assess how close this version may be to the original codification. However that may be, in the legal texts prose of a high order is used to describe, to define and to express precise distinctions in the organization of a complex society. Although there is no conscious effort at literary effect, there is a wealth of legal and technical terms, some of native and others of Latin origin, and a sustained clarity of expression.

The merits of the legal texts prepare one for the more conscious literary use of prose by the storytellers (*cyfarwyddiaid*) whose craft must be at least as old as that of the poets. They recited for entertainment oral tales of which the underlying material was a medley of mythology in decline, folklore and heroic. pseudo-historical and aetiological elements. Some of these tales were recorded in writing, whether by the *cyfarwyddiaid* or by others is not known. The most famous collection is that called the *Mabinogion* preserved in *The White Book of Rhydderch* (*c.* 1300–25) and *The Red Book of Hergest*. *Mabinogion,* long regarded as a plural of the authentic word *mabinogi* (youth, tale of youth) derives from a scribal error and so is a meaningless, but convenient! title for the collection of 11 tales. all anonymous. which range in date from the second half of the 11th century to the close of the 13th. These tales. it must be emphasized. are conscious literary compositions. based on older oral material. and not mechanical reproductions of the *cyfarwydd's* stock in trade. The greatest as literature are the four related stories "The Four Branches of the *Mabinogi,*" composed in the second half of the 11th century by an unknown writer from Dyfed, a fine artist in the use of description and dialogue. in the delineation of character and in investing incidents with a pathos and imagination which often transcend place and time. The author of "Culhwch and Olwen" (*c.* 1100), using basic material of the same kind as that which underlies the "Four Branches," appears to have kept closer to the oral *cyfarwyddyd*. He is less serious and on a lower artistic level. His delight in style for its own sake and his fondness for bravura and grotesque elements, together with his tendency to overcomplicate the story, prepare one for the later decadent *areithiau* (rhetorics) which are in part obvious parodies of the *Mabinogion*. "The Dream of Rhonabwy," composed in Powys late in the 13th century. forms an artistic whole. but again the style is consciously ornate and full of studied contrasts, and the action tends to become lost in the long and involved descriptions. It is significant that the colophon states that the story could not be told "without a book." Three of the *Mabinogion* tales, viz.. "Owein and Luned" (or "The Lady of the Fountain"). "Geraint and Enid" and "Peredur son of Efrawg," represent the transition from the purely native tales to those composed under Norman influence. The basic material of all three is largely native. but there is French influence in certain place and personal names. social conventions and general atmosphere. These tales correspond to the *Yvain*, *Erec* and *Perceval* of Chrétien de Troyes. and the exact relationship between the Welsh and French texts has long been a subject of debate. The weight of evidence shows that Chrétien's French versions and the Welsh tales derive independently from earlier French prose versions (now lost) which in turn were adaptations (possibly the work of Normanized Welsh or Breton *conteurs*) of pre-existing Welsh oral stories. Artistically these romances with their extreme sophistication and dreary *longueurs* show a decline from the native tales with their directness, restraint and disciplined selection of material.

Many translations from Latin and French played a part in the evolution of a prose which could express aspects of human thought and activities not often touched upon in the tales. Most of the translators are unknown by name, but they were probably monks and parish priests. Whether the medium of the original was prose or verse, the Welsh version is invariably in prose. Of the texts translated from Latin the following deserve mention: *Delw y Byt* (from the *Imago Mundi* of Honorius Augustodunensis); many lives of saints; *Gweledigaeth Bawl Abostol* (the *Visio Sancti Pauli)*; *Adrian ac Ipotis* (from the *Disputatio Hadrianz Imperatoris et Epicteti)*, *Cynghoreu Catwn* (the *Disticha Catonis)*. *Y Bibyl Ynghymraec* (the *Promptuarium Bibliae)*, three independent versions each of *Dares Phrygius,* of Geoffrey of Monmouth's *Historia Regum Britanniae,* and of the lost original Latin of "The Chronicle of the Princes of Wales"; and *Hystorya Gruffydd ap Cynan* (its Latin original disappeared). A Welsh version of the *Seven Wise Men of Rome* is a free retelling of the story rather than a close translation of any text. The translations from French, which are fewer in number, include: versions of the *Chanson de Roland;* the *Chanson d'Otinel;* the *Gestes* and the *Pelerinage* of Charlemagne; the *Queste del Saint Graal* and *Perlesvaus,* which form part i and part ii respectively of *Y Seint Greal.* Most of these translations uere produced in the 13th and 14th centuries. Their prose is to a large extent experimental and influenced in varying degrees by the language and style of their originals, but at its best, as in *Y Seint Greal* and *Seith Doethon Rufein,* it is not an unworthy development of the prose of the law tracts and native tales. Toward the end of the medieval period a few translations of religious, moralistic and allegorical texts from English appeared. some of them based on early printed books. These uere produced mainly in south Wales.

In summary, the development of medieval prose was hampered by a lack of alliance between the heirs of the Welsh literary tradition and those who cultivated the wider learning and culture of western Europe. The inspiration for the fashioning of a new prose, able to express all facets of human thought and activities, arose toward the middle of the 16th century from the joint upheavals of the Renaissance and the Protestant Reformation. As will be seen, it was the humanists, Protestant and Catholic, who laid the foundations of modern Welsh prose.

The Golden Age of the Cywydd, 1350–1450.—The conquest of Wales by Edward I did not put an end to the poetry associated with the royal courts of Gwynedd and Powys. Its effect was to transfer its patronage from the prince to the *uchelwyr* (landed aristocrats), and to diminish its prestige. Henceforth there was to be no legal recognition of the *pencerdd* and his particular department of song at the expense of the *bardd teulu.* The diminished prestige of the bards formerly associated with the native princes gave an opportunity to the lower orders nhose work had not hitherto been regarded as meriting preservation by the copyists. Indeed, in south Wales, where the Normans had been established for a whole century before the conquest of Gwynedd in 1282, the old song was gradually dying out, and the lower orders in the south were becoming more and more vocal.

While Gruffudd ap Maredudd and Casnodyn in Gwynedd were still, though in a simpler form. following old conventions of the *gwawd,* the *pencerdd's* song, the unknown bards of south Wales were developing an entirely new literature of which there is no trace in the manuscripts before the work of Dafydd ap Gmilym who, like his contemporary Chaucer in England, may be regarded in his own land as the father of modern poetry.

Dafydd ap Gwilym.—Dafydd was probably born about 1320. His family is associated with Dyfed, but he seems to have spent most of his time at his kinsmen's home in north Cardigan.

In the first of his periods he wrote according to two entirely distinct traditions. His *awdlau* to his patrons, his uncle Llywelyn and Ifor Hael, follow the strictest conventions of the later *gogynfeirdd;* he sang these as a *pencerdd.* At the same time, he produced a large body of poetry in what must be regarded as the tradition of the *bardd teulu.* These are *cywyddau* and *traethodlau.* The *cywyddau* are in couplets of seven syllables, one rhyme accented and the other unaccented; in his first period they are not regularly in *cynghanedd* as the rules of the *pencerdd's* song demanded. His other form, the *traethodl,* is also in couplets of seven syllables, but both rhymes are unaccented and there is no *cynghanedd* at all. From the fact that his *cywyddau* are the earliest known. and that his name was always associated with the *cywydd* by his contemporaries, he came to be regarded as the inventor of the *cywydd.* There is. however, ample reason to suppose that Dafydd's work was only the culmination of a long process of development among the *bezrdd teulu* in a part of Wales which. both politically and socially, had been for a century cut off from the main tradition of Welsh poetry.

Dafydd's important advance was in diction. In his *cywyddazc* he discarded the old archaisms and wrote in the ordinary language to the educated Welshmen of his own time. His successors followed his lead. and the old diction fell out of use. He thus established the standards of modern Welsh.

The substance of his poetry was also new. Up to his time, the bards were confined by regulation to a few well-defined subjects. Dafydd, however. listened to the songs which were then delighting the ordinary educated man in Europe, and he reproduced them in his *cywyddau.* The chief influences on his work were the songs of the *clerici vagantes* (wandering minstrels) and of the trouvères of France. The conventional divisions into which the poetry of the troubadours and trouvères is divided—aubade, serenade, tenson. *pastourelle* and so on—are faithfully and minutely reproduced in his work. Besides this, a large part of his poetry is derived from the uandering minstrels' popular songs in Latin, French and possibly in English. He has been hailed, without much discrimination, as the greatest of love poets. but of love poetry as such, he wrote very little. Love is a peg on which he hangs his exquisite nature poems, and it is in these that one finds his greatest achievement. In his nature poems he makes use of two conventions. that of the *llatai* or love messenger (already used by Llywarch ap Llywelyn, known as Prydydd y Moch, *fl.* 1173–1220) and that of the *dyfaliad* or descriptive poem. The first part of the poem is generally a conventional statement of his love for a lady, the second a short address to a bird or a fish or a natural feature, such as the cloud or the uave, praying it to take a message to the lady; the third and main portion is a minute description of the messenger. To Dafydd nature was purely external, and it had no mystical significance. But his treatment invested it with a new wonder.

Dafydd ap Gwilym's Contemporaries.—Dafydd's influence was twofold: not only was the *cywydd* established as the leading form, but the new subjects came to be recognized as themes fit for poetry. One of his oldest contemporaries, Gruffudd ab Adda *(d.* 1344?), wrote a *cywydd* "to a birch tree that had been made into a maypole at Llanidloes," which goes much further than Dafydd in the direction of the modern conception of nature. Iolo Goch *(c.* 1320–*c.* 1398) wrote a fine *cywydd* to the *llafurwr* (husbandman) which shows traces of contemporary English ideas as seen, for instance. in *Piers Plowman.* Llywelyn Goch Amheurug Hen (*fl.* 1360–90) wrote some of his earlier poems in the *gogynfezrdd* tradition. but his *Elegy to Lleucu Llwyd,* his best-known work, is a *cywydd* and combines nith striking success the Welsh tradition of the elegy with the imported form of the serenade. Other poets almost contemporary with Dafydd were Gruffudd Llwyd ap Dafydd (*fl.* 1380–1410), who sang two superb *cywyddau* to Omen Glendower, and Rhys Goch Eryri *(c.* 1365–*c.* 1448), who is chiefly famous for his literary quarrel on the nature of true poetry with Siôn Cent and Llywelyn ap y Moel (d. 1440), the author of a *cywydd* which gives a spirited description of a battle in which the poet fled. The most elusive figure in this period is Siôn Cent (d. *c.* 1430), to whom are attributed a number of *cywyddau brud* (semi-political songs) in the form of prophecies, and *cywyddau'r byd,* similar in every respect to the poems *du temps jadis* (of olden days), so popular in every country in Europe at the beginning of the 14th century and exemplified in the works of François Villon, William Dunbar, Michel Menot and Gómez Manrique. It is probable that these poems are by many hands. but the dominant thought of them all is so characteristic that they were attributed to the traditional name of Siôn Cent.

Dafydd ap Gwilym's Successors.—With the dawn of the 15th century the *cywydd* entered a new period. The poets purified the *cywydd* from the last traces of the old convention.

Dafydd Nanmor *(c.* 1420–*c.* 1490) in treatment of his subject and in imagination is inferior to most of Dafydd's contemporaries, but in his mastery of the cywydd form he had no equal. His poem "Llio's Hair" and his "Maiden's Elegy." among others, mark the zenith of that conception of poetic art which aimed at simplicity. Lewis Glyn Cothi (*fl.* 1447–86) and Guto'r Glyn (*fl.* 1433–93) show a further advance in the handling of the *cywydd* metre. In their work for the first time a real consciousness of nationhood among the Welsh is detected. Other poets of this period were Maredudd ap Rhys (*fl.* 1430–50), Hywel Swrdwal (*fl.* 1430–60), Tudur Penllyn (*fl.* 1470) and Dafydd Llwyd ap Llywelyn (c. 1420–*c.* 1500).

The Silver Age of the Cywydd, 1450–1650.—For a short time there arose a school of literary formalists. The chief of this school was Dafydd ab Edmwnd (*fl.* 1449–1500), who at the eisteddfod of the bards held at Carmarthen in 1451 rearranged the 24 canonical strict metres. The main characteristic of his poetry is its great ingenuity. His poetic heir was his nephew Tudur Aled (d. 1526) who made a further rearrangement of the rules of poetry, and whose poems in execution, mark the very zenith of the bard's craft as conceived in that age. His contemporary Gutyn Owain (*fl.* 1460–1500), though too much of his *moliant* consists of genealogical details, could in his dyfaliadau rival even Dafydd ap Gwilym.

In the latter part of this period, two events of supreme importance occurred—the Reformation and the accession of the Tudors. The former had little immediate influence on literature, except indirectly through its effect upon the language, since, with the decline of the old Catholic educational system, the general appreciation of literature was diminished. The Tudor policy of encouraging the spread of English at the expense of Welsh, and of inducing the Welsh aristocracy to emigrate to England, almost destroyed the old Welsh culture which was altogether bound up with the language. Yet for more than a century after Henry VII the bards plied their craft, though patronage was much diminished. Siôn Tudur (d. 1602) satirized the new aristocracy of profiteers. Edmwnd Prys (1544–1623), archdeacon of Merioneth, is best known for his "contention" with William Cynwal (d. 1587 or 1588) and for his biting satire on contemporary manners as well as for his version of the Psalms in the old ballad metre. William Llŷn (1535–80) and Siôn Phylip (c. 1543–1620) are among the great poets of the silver age of the cywydd.

The Rise of Modern Prose (c. 1550).—Traditional Welsh prose, which was becoming increasingly debased toward the end of the 15th century, was not an adequate medium of expression for the surging thoughts of the Renaissance and the Reformation. The humanists succeeded in fashioning a new prose with its accidence based on the language of the bards, its style and cadences on classical authors and its vocabulary enriched by new formations and extensive borrowings. Thus they laid the foundation of modern prose at a time when Welsh printed books began to appear.

The first Welsh book, Yn y Lhyvyr hwn, published in 1547, consisted of extracts in Welsh from the Scriptures and the Prayer Book. Probably in the same year was published William Salesbury's *Oll Synnwyr* Pen, a collection of proverbs. From this time Welsh prose literature began to take definite form, and may be studied under four headings: (1) the Reformation; (2) the Counter-Reformation; (3j the Welsh Renaissance; and (4) Puritanism.

The *Reformation.*—The most important name among this group of writers is that of William Salesbury (c. 1520–*c.* 1584). His work, begun in 1547, culminated in his translation of the New Testament published in 1567. If one considers accuracy of idiom and fidelity to the original, Salesbury's Testament must be called a great pioneer work. Unfortunately it is marred by his philological foibles and the mechanical means which he employed to make the language intelligible in every part of Wales. In the same year was published the Welsh Prayer Book, also translated for the greater part by Salesbury in collaboration with Richard Davies (c. 1501–81), bishop of St. David's. In 1j88 was published the Welsh Bible translated by William Morgan (c. 1541–1604), bishop of St. Xsaph, aided by Edmwnd Prys. This translation, revised and amended by Richard Parry (1560–1623), bishop of St. Xsaph, and John Davies (c. 1567–1644), was republished in 1620—the version which is used to this day. It would be difficult to exaggerate the importance of these three translations, the Testament and Prayer Book of 1567 and the Bible of 1588 and 1620, in the development of Welsh literature. From 1588 onward there was no break in the production of Welsh prose books. The first were translations from English and Latin aimed at grounding the Welsh nation in the principles of the Reformation. The following are the chief among them: *Deffyniad* y Ffydd (1595), a translation of Bishop John Jewel's *Apologia,* by Morys Kyffin (c. 1j55–98); Pevl *Mewn* Adfyd (1595), a translation of Miles Coverdale's A *Spiritual and* Most Precious Pearl, by Huw Lewys (1562–1634); *Homiliau* (1606), a translation of the Homilies, by Edward James (c. 1569–*c.* 1610); Llwybr *Hyfforddd* (1630), a translation of Arthur Dent's Plain *Man's* Pathway, by Robert Llwyd (1565–1655); Yr *Ymarfer* o *Dduwioldeb* (1630), a translation of Lewis Bayly's Practice of Piety, by Rowland Vychan (c. 1590–1667); *Llyfr* y *Resolution* (1632), a translation of Robert Parsons' Christian Directory, by John Davies of Mallwyd (c. 1567–1644). To these must be added the unpublished works of Ellis Gruffydd (b. c. 1500), especially his Chronicle from the creation to 1552. The latter part of it sheds much light on the life of the court and the army.

The Counter-Reformation.—During the years in which the reformed religion was being established in Wales, Welsh society and the Welsh language were at their lowest ebb. Every book during this period bewails the general ignorance. The Catholic writers of the Counter-Reformation regarded the new religion as something imported from England, and they thought that the way to preserve the old religion was to insist on the old Catholic culture. This was why Gruffydd Robert (c. 1522–*c.* 1610), canon of Milan, published his *Dosbarth* Byrr, the first printed grammar of the Welsh tongue. It consists of a series of discussions between teacher and disciple, and in beauty of style it stands among the greatest monuments of Welsh prose. Other works stimulated by the desire to preserve the old religion were: Gruffydd Robert's *Drych Cristianogawl* (158j); Theater *du Mond* (1615), a translation from the French, and two other books in 1609 and 1611 by Rhosier Smyth (1541–1625); Athravaeth *Gristnogawl* (1617) by Morys Clynnog (c. 1525–81); and Eglurhad Helaethlawn (1618), a translation from the Italian. All these and some others were published on the continent.

The Welsh Renaissance.—Just as Italy and other European countries under the Renaissance turned to the Latin and Greek classics, so Wales turned to its own classical tradition of bardism. The result mas the publication during this period of some of the most important Welsh grammars. Gruffydd Robert's Dosbarth Byrr, already mentioned, was followed in 1592 by the *Cambro*-brytannicae . . . *Institutiones* of SiBn Dafydd Rhys (1534–*c.* 1609), which was an attempt to set out before the learned world the rules of bardic poetry and principles of the Welsh language. This work was the foundation of all later grammatical studies, though Rhys was far surpassed in scientific knowledge by John Davies of Mallwyd, who published his Antiquae Linguae . . . *Rudimenta* in 1621 and his great *Dictionarium Duplex* in 1632. The Latin-Welsh portion of this dictionary was based on the work of Thomas Wiliems of Trefriw (c. 1j50–*c.* 1622), still in manuscript.

Puritanism.—So far the writers of Welsh prose had contented themselves with translation. It was left to a Puritan, Morgan Llwyd (1619–59), to make an original contribution to Welsh religious thought. He came under three influences, namely, the Quakers, the Fifth Monarchy men and Jakob Boehme, the German mystic. His chief work, Llyfr y Tri Aderyn (The Book of Three Birds) in 1653, is a disquisition in two parts, on the theory of government and on religious liberty. under the form of a disputation between the eagle (Cromwell or the secular power), the raven (the Anglicans or organized religion) and the dove (the Nonconformists or the followers of the inner light). In this and in many other works, notably *Llythur ir* Cymru (1653), he expounded a mystical gospel which had very little influence, though many editions of his books were published. The most notable prose work between Llyfr y Tri Aderyn and Ellis Wynne's Y *Bardd* Cwsc (1703) was Y Ffydd *Ddi-ffuant* (1667), enlarged in 1671 by Charles Edwards (1628–post 1691).

From the time of Morgan Llwyd until well on in the 19th century translations, mostly of theological works, poured out of the Welsh press and it is almost impossible to thread one's way among these thousands of books. Many were inspired by the Society for Promoting Christian Knonledge (S.P.C.R.). Among the clergy who produced books of this description were Edward Samuel (1674–1748), who published among other works *Holl Ddyledswydd* Dyn (1718), a translation of *The Whole Duty* of *Man* (first published in 1658 and assigned to Richard Allestree); Moses Williams (1685–1742), a most diligent searcher into Welsh manuscripts and a translator; Griffith Jones of Llanddowror (1683–1761), the father of Welsh popular education; Iaco ab Dewi (1648–1722); and Theophilus Evans (1693–1767), the author of *Drych* y *Prif* Oesoedd (1716, 1740). This book, like Llyfr y Tri *Aderyn* and Y Bardd Cwsc, is established in the annals of Welsh literature.

Ellis Wynne o Lasynys (1671–1734) is regarded as the greatest of Welsh prose nriters. His first work was a translation of Jeremy Taylor's Holy Living, under the title of *Rheol Buchedd* Sanctaidd (1710); his second, the immortal *Gweledigaetheu* y Bardd Cwsc (1703), an adaptation of Sir Roger L'Estrange's translation of the *Sueños* of the Spaniard Francisco Gomez de Quevedo y Villegas.

The Rise of Popular Poetry, 1600–1750.—When Henry **VII** ascended the throne the descendants of the old Welsh gentry began to look toward England for recognition and preferment, and their interest in their own country began to wane. It gradually came about that the poets of the older school had no audience. The only poets who still followed the old tradition were the rich gentlemen-farmers who "sang on their own food," as the Welsh phrase goes. A new school. however, was rising. The nation at large had a vast store of folk song and it was this, despised and unrecorded, which, combined with imitation of contemporary English popular poetry and the more sophisticated lyrics, formed the groundwork of the new literature.

The first landmark in this new development was the publication in 1621 of Edmwnd Prys's metrical version of the Psalms and in 1646 of the first poem of The Welshmen's Candle (Canwyll y *Cymry)* of Rhys Prichard (c. 1579–1644), vicar of Llandovery. These works were not written in the old strict metres peculiar to Wales, but in the free metres, like those of English poetry. The *Psalms* is of great importance, as these were about the first metrical hymns in use. Prichard's work, the first complete edition of which was published in 1672, consisted of moral verses in the metres of the old folk songs (Penillion Telyn). Many other poets of the early part of this period wrote in these metres, such as Rowland Fychan, Morgan Llwyd and William Phylip (d. 1669). Poetry in the free metres, however, was generally very crude, until it was given a new dignity by the greatest poet of this period, Huw Morys of Pontymeibion (1622–1709). Most of his earlier compositions are love poems, perfect marvels of felicitous ingenuity and sweetness. Toward the end of the period came Lewys Morys (1701–65), the creator of a new period, the inspirer and patron of Goronwy Owen. As were his brothers Richard and William, he was an accomplished scholar. His poetry, except for a few well-known pieces, will never be popular, because it does not conform to the modern canons of taste.

The Revival, 1750.—The middle of the 18th century was, after the 14th, the most fruitful period of Welsh literature. Up to this time, Wales had lain in a terrible stagnation, both social and literary; a people, who had until now never lacked self-expression in literature, had become inarticulate. It was clear that one of two things was essential if Welsh was to survive as a language of culture—either a recreating literary influence from the outside, or some great spiritual or intellectual revival which would stir the people once more into articulate expression. It was a coincidence that both these events should happen in Wales at the same time.

The first event was the adoption by Goronmy Owen (1723–69), inspired by Lewys Morys, of the literary standards of the English Augustan classicists; the result was the reintroduction into Welsh poetry of the *cywydd* and the awdl in all their traditional correctness of form. but with a new and larger content. Around Goronwy Owen were grouped other poets who thus established a classical school of poetry which is alive to this day. The more important among them were William Wynn of Llangynhafal (1709–60), Edward Richard (1714–77) and Evan Evans (1731–88). Much of the literary activity represented by this school was associated with the Welsh community in London, and with the establishment of the Cymmrodorion society which in turn led to the establishment of local eisteddfods in Wales under the auspices of the learned societies. These eisteddfods. by offering a chair for an *awdl* (this practice it must be noted only dates from the end of the 18th century), perpetuated the classical form *(i.e., cynghanedd* and the strict metres) which would have otherwise certainly disappeared. Thus Goronwy Owen is the fountainhead of modern classicism. His successors, the eisteddfodic bards. though greatly inferior to him in poetic power, did much to reintroduce the knowledge of the classical forms; chief among these was Dafydd Ddu Eryri (1759–1822) who, both as a writer of awdlau and as a grammarian, was the teacher of the 19th century.

His successor. Dewi Wyn o Eifion (1784–1841), was the first to deviate from the strictness of the old tradition, and much of his work is strikingly deficient in quality. Eben Fardd (1802–63) was the last of the 19th-century eisteddfodic bards who made any real contribution to literature; he is the greatest poet of the descriptive school. After him eisteddfodic poetry *(i.e.,* poetry in the classical tradition) suffered eclipse; the last 40 years of the 19th century, though an enormous mass of so-called poetry mas produced, saw what was probably the nadir of popular taste. The end of the 19th century was marked by a reaction toward Goronwy Owen and Dafydd ap Gwilym.

The Free *Metres, 1750–1890.*—The classicists of the 18th century stood aloof from the Methodist revival, but it was the intensity of the religious emotion now set free for the first time that broke the inarticulateness which had befallen Wales. The vast store of experience and expression which had been accumulating out of sight in the Penillion Telyn was at last displayed in the hymns of William Williams Pantycelyn (1717–91), almost the first poet to use the free metres for a serious purpose. He was followed by many hymn writers, the greatest being Ann Griffiths (1776–1805), who alone shows a trace of that mysticism which was lost in Wales after Morgan Llwyd. The literary importance of the hymns lies in the preparation of the Welsh language for secular poetry. All the poetry of the 19th century betrays its religious origin, the later poetry no less than the earlier. John Blackwell (Alun) (1797–1840) may be regarded as the father of the modern secular lyric. Much of his inspiration came from contemporary English songs and in originality he is inferior to Ieuan Glan Geirionydd (1795–1855), who founded the Eryri school of poetry inspired by the natural scenery of Snowdonia; the best-known member of this school is Glasynys (1828–70). These earlier lyric writers were followed by a more Bohemian group consisting of Talhaiarn (1810–70), Mynyddog (1833–77) and Ceiriog (1832–87). Ceiriog was the greatest lyrical writer of the century. Only one poet, Islwyn (1832–78), made a success of the long poem. His *Ystorm* is a series of meditations on life and art, and parts of it are in imitation of Alexander Smith and influenced by Edward Young's *Night* Thoughts.

Prose, 1750–1800.—For a long time after 1750 Welsh prose, though abundant in quantity, had a very narrow range. The end of the 18th century, however, saw much activity in political thought, which was the direct result of the French Revolution. The most important of the early political writers was John Jones Glan-y-gors (1766–1821), who was much influenced by Thomas Paine. Later, when modern liberalism began to emerge, political writing, after the establishment of the periodical press. became an important part of Welsh literature. Two great political thinkers and writers of the century were Samuel Roberts (1800–85) and Gwilym Hiraethog (1802–83).

Literary criticism up to the middle of the 19th century had been confined to the work of eisteddfod adjudicators who were still acting on the old classical theory, *ut pictura* poesis ("poetry is like painting"). The first appearance of a criticism which might be said to follow European standards was in the articles of Lewis Edwards (1809–87), the founder and editor of the *Traethodydd*, though his ideas were dominated by the Edinburgh school. Literary criticism made no progress at all until the great revival in the 20th century. It was in this period that Wales had its national novelist. Daniel Owen (1836–95), who like Dickens "wrote mythology rather than fiction." His novels must always remain an important document for the study of this extraordinary period of theocracy in Wales.

The **Second** Revival. — The most important event for the second revival in Welsh literature was the founding of the university (1872–93). The immediate result was a great widening of the horizons, accompanied by a strong reaction toward the old Welsh classical ideas. The two men who had the most influence on this new movement were Sir Owen Morgan Edwards (1858–1920) and Sir John Morris-Jones (1864–1929). Edwards made the Welsh conscious of their literary identity, and inspired the new movement on its purely literary side. Morris-Jones, by insisting that correctness was the first essential of style and sincerity the first essential of the literary art, revolutionized first the product of the eisteddfod and then literature in general. Another critic whose fearless essays stung the nation into sincerity was Emrys ap Iwan (1851–96).

The extent of the new literary revival is hardly credible to anyone whose study of Welsh ends with 1900. Almost every department of literature is represented. Poetry again became significant. Thomas Gwynn Jones (1871–1949) showed that *cynghanedd* and the old tradition can answer any demand made upon them by the modern interpretation of life; his work is, however, not confined to the strict metres. W. J. Gruffydd (1881–1954) whose medium was the free metres, represented first a rebellion against Victorian standards of morality and literature, and later a nostalgia for the society which formed the background of his youth. Robert Williams Parry (1884–1956) brought back to poetry the gift of poetic observation, expressed in a faultless technique, which had disappeared from Welsh poetry with Dafydd ap Gwilym. Of the other poets whose work has a prominent position in the literary revival, D. Gwenallt Jones and Iorwerth Peate proved outstanding.

In prose there was equal progress. This is clearly seen in the writings of Gruffydd no less than in the standards of Y *Llenor* (1922–51), the literary journal edited by him. A new literary criticism was enriched by the influence of European ideas, which can be seen most clearly in the work of Saunders Lewis. No long novel of great merit was written, though the works of Tegla Davies and T. Rowland Hughes bear many traits of genius. The younger prose writers developed the art of the short story to a high degree; the early promise of Dewi Williams was not fulfilled, but Kate Roberts' work is a striking example of the impact of contemporary Welsh life on a sensitive nature. Starting with no traditions, drama made considerable progress, though it was retarded by material reasons.

One poet, T. H. Parry-Williams, also wrote distinguished essays, which became the model for many others. Dramatists who deserve special mention are D. T. Davies, R. G. Berry, Saunders Lewis and J. Gwilym Jones.

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WELWITSCHIA, a genus of short but remarkably thick-stemmed desert plants of southwestern Africa, belonging to the family Welwitschiaceae of the order Welwitschiales. *See* GYMNOSPERMS.

WELWYN GARDEN CITY, an urban district of Hertfordshire, Eng., 20 mi. N of London by road. Pop. (1951) 18,314. Area 4.1 sq.mi. Founded in 1920 in order to provide a pleasant and well-planned town with an ultimate population of 50,000 who could find work locally and so not have to travel daily elsewhere, Welwyn had about 70 industries in operation in 1952. Under the Town Planning act (1946) Welwyn was bought from the original company by the Welwyn Garden City Development corporation.

WEMBLEY, a municipal borough (1937) of Middlesex, Eng., 7 mi. N.W. of London, which it serves as a residential suburb. Pop. (1961) 124,843. Area 9.8 sq.mi. It returns two members to parliament. Wemba Lea in Saxon times, it remained a village until the 20th century (pop. 4,519 in 1901), when it became involved in the rapid expansion of London. Many buildings erected for the British Empire exhibition (1924–25) became factories and workshops and gave impetus to a limited industrialization. Electrical and mechanical engineering and food preparation are important industries. The exhibition's open-air stadium (accommodating 100,000 spectators) remained and, with the indoor arena (skating, ice hockey, swimming), is a highly popular sports centre.

The borough includes Greenford, where Sir W. H. Perkin (1838–1907) founded the coal-tar dyeing industry, and Kingsbury, a rural retreat of Oliver Goldsmith, which has two strongly contrasting churches, each dedicated to St. Andrew: a small one containing much Saxon work and Roman materials, and a large mid-Victorian one removed stone by stone from Wells street, London, and dedicated in 1934. A farmhouse at Preston is said to have been the birthplace and home of John Lyon, who in 1572 founded Harrow school, about 2 mi. N.

WEMYSS, EARLS OF, heads of a Scottish family who had possessed the lands of Wemyss in Fifeshire since the 12th century. In 1628 Sir John Wemyss, created a baronet in 1625, was raised to the peerage as Baron Wemyss of Elcho; and in 1633 he became earl of Wemyss and Baron Elcho and Methel, in the peerage of Scotland. He took part with the Scottish parliament against Charles I and died in 1649. On the death of David, 2nd earl (1610–79), the estates and titles passed to his daughter Margaret, countess of Wemyss, whose son David, 4th earl, succeeded on her death in 1705, and became lord high admiral of Scotland and a commissioner for concluding the union of England and Scotland in 1707. His son James, 5th earl (1699–1756), married Janet, daughter of Col. Francis Charteris, who had made a large fortune by gambling. His son David, Lord Elcho (1721–87), was attainted for his part in the Jacobite rising of 1745, the estates passing to his younger brother James, while the title remained dormant after his father's death, though it was assumed by Elcho's brother Francis, who took the name of Charteris on inheriting his maternal grandfather's estate. A reversal of the attainder was granted in 1826 to his descendant Francis Charteris Wemyss Douglas (1772–1853), who had been created Baron Wemyss of Wemyss in the peerage of the United Kingdom in 1821 and had assumed the name of Charteris Wemyss Douglas on inheriting some of the Douglas estates.

WEMYSS, a civil parish of Fifeshire, Scot., including the villages of East and West Wemyss and the small burgh of Buckhaven and Methil. Pop. (1951) 28,463. It lies on the northern shore of the Firth of Forth, adjacent to the Fifeshire coal field. Methil is the county's principal port for the export of coal. Industries, apart from coal and shipping, include oilskin manufacture, brickmaking, sawmilling and the preparation of fertilizers and farm supplies.

The district derives its name from the caves (*weems;* Gaelic *uaimh,* "a cave") on the shore between East and West Wemyss. Above the shore is modern Wemyss castle, incorporating part of an earlier work in which Mary, queen of Scots, first met Darnley in 1565. There are also remains of the so-called Macduff's castle.

WEN. The popular name for a sebaceous or fatty cyst (*i.e.,* tumour) formed from a sebaceous gland and therefore occurring in the neighbourhood of hairy parts, particularly the scalp and neck. The fatty or sebaceous material collects in the mass and the normal opening of the duct of the gland is often recognizable on the surface as a minute point. A wen may be as large as a hen's egg. The treatment is surgical removal.

WENCESLAS or WENZEL (1361–1419), German king and. as Wenceslas (Vaclav) IV, king of Bohemia. was the son of the emperor Charles IV. Born at Nuremberg on Feb. 26. 1361. he was crowned king of Bohemia in 1363 In 1370 he married Joanna (d. 1386) daughter of Albert I of lower Bavaria. In 1376. still during his father's lifetime, he was elected and crowned king of the Romans. On his father's death in Nov. 1378, Wenceslas succeeded as sole ruler of Germany and Bohemia. The rest of the Luxemburg lands Charles bequeathed to his younger sons and nephews. From 1378 to 1389 Wenceslas held frequent diets in Germany. seriously endeavouring to keep the peace between town leagues and the nobles. but in spite of some success, ill-health and the endemic anarchy in Germany compelled him to leave that country to its own devices after 1389. He assisted his brother Sigismund to secure the throne of Hungary in 1387, and he himself inherited the duchy of Luxemburg from his uncle Wenceslas in 1383.

In Bohemia Wenceslas' brothers and cousins and the magnates and prelates were greedy for power and jealous of the "new men" and urban patricians to whom the king entrusted the offices of state. In 1394 his cousin Jobst, margrave of Moravia. Jan of Jenštejn, archbishop of Prague, and some of the magnates seized the king and imprisoned him in Austria. He was restored by the efforts of his brother Jan of Görlitz with help from Germany; but the lords continued the struggle for power and in 1396 Wenceslas, compelled to surrender all real power to the aristocratic royal council, made Jobst "governor" of the realm.

Wenceslas' impotence and his neglect of Germany induced the German princes to depose him on Aug. 20, 1400. The next day the three ecclesiastical electors chose Rupert III. count palatine, as king of the Romans. Henceforward Germany was completely lost to Wenceslas. When Rupert died in 1410 he was succeeded by Jobst, and he, in 1411, by Sigismund. who agreed however that Wenceslas should enjoy the title to which he had been elected in Germany until his death.

Meanwhile the struggle between crown and lords continued in Bohemia. In 1402 the lords, led by Sigismund, again made Wenceslas prisoner. He was handed over to the dukes of Austria who held him captive for almost a year. On his release in Nov. 1403 he made peace with the princes and lords. For the rest of his reign Wenceslas was content to leave the government in the hands of the royal council where royal favourites and the magnates shared power. The king grew lethargic and increasingly found solace in wine. After 1403 his only political importance was in connection with the troubles caused by the Schism and the religious reform movement led by John Huss. LVenceslas and his second queen, Sophia of Bavaria (whom he married in 1389), at first gave some support to the reformers; but when after 1411 the Bohemian "heresy" became an international scandal, he withdrew his favour. It was anger at the defenestration of the magistrates whom he had appointed to the New Town of Prague which induced the apoplexy to which Wenceslas succumbed on Aug. 16, 1419. He died childless and the title to the disturbed Bohemian inheritance was left to his brother Sigismund, king of the Romans and king of Hungary. See also GERMANY: *History;* BOHEMIA; SIGISMUND (Holy Roman emperor).

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WENCHOW (YUNGKIA), a city in the province of Chekiang, China, and one of the five ports opened by the Chefoo convention (1876) to foreign trade, situated on the Gow river: about 20 mi. from the sea. The population (1953 est.) is 200,000.

The site is said to have been chosen by Kwo P'oh (A.D. 276–324), a celebrated antiquary, and the town became known as Tow, or Great Bear, from a supposed topographical similarity of the neighbouring hills to the constellation. Later, through another legend. it became known as the Deer city, or Luh. During the Ming dynasty (1368–1644) it was named Wenchow. A four-mile wall, built in the 10th century. surrounded it. It fell to Communist forces in 1949 and was made an independent municipality.

WENGEN (4,190 ft.), a health resort and winter sports centre on the slopes of the Jungfrau in the Bernese Oberland, Switz. The place is linked with Interlaken and Lauterbrunnen by a rack railway. From the Little Scheidegg a branch leads to the Jungfraujoch (11,401 ft.) where is the highest station in Europe.

WENLOCK, a market town and municipal borough (1468) in the Ludlow parliamentary division of Shropshire, Eng., 13 mi. S.E. of Shrewsbury by road. on both sides of the Severn. Pop. (1951) 15,095. Area 35.4 sq.mi. To the southwest of Much Wenlock rises the sharp limestone ridge of Wenlock Edge and to its north the isolated hill of the Wrekin (1,385 ft.). The borough includes the townships of Much Wenlock. the civil centre; Broseley; Coalbrookdale. with ironworks; Madeley; Jackfield; Ironbridge, where the first iron bridge in England was built in 1779 at the entrance to the Ironbridge gorge carved by the Severn (the bridge is preserved as an ancient monument); Coalport. once known for its china works, transferred there from Caughley in 1814 and moved to Stoke-on-Trent in 1926; and Little Wenlock, with opencast coal mining. Barge traffic up the Severn was once very important to Broseley, Coalbrookdale and Madeley Wood, all gorge ports. The chief industries are iron founding, limestone quarrying, light engineering and the making of pajamas, at Ironbridge, rubber mats from old tires and metalwork (both in the former Coalport kilns), tiles and bricks, revived at Jackfield and Broseley.

The importance of Much Wenlock in the past depended on the great Cluniac priory of St. Milburge, refounded by Roger de Montgomery in 1017 on the site of a 7th-century foundation. Considerable remains are left of the priory which was dissolved in 1j39; the prior's house, still inhabited, incorporates Norman and 15th-century work. By the 16th century Much Wenlock was a flourishing market town, with a trade in limestone quarrying and burning, and the borough still has many old buildings including the timbered guildhall (1577) and a 12th-century church, a Tudor mansion (1535) at Benthall, the Old hall (16th–17th century) at Little Wenlock and many industrial antiquities at Ironbridge and Coalbrookdale.

WENNERBERG, GUNNAR (1817–1901), Swedish poet, musician, teacher and politician, was born on Oct. 2, the son of a Linkoping clergyman. He studied at Uppsala university from 1837 to 1845 when he was appointed lecturer in aesthetics. He later became a civil servant and politician; a capable and progressive administrator, he was minister of education 1870–7j and 1888–91. In the intervening years he was provincial governor at Vaxjo and member of parliament. In 1866 he was elected to the Swedish academy. He died on Aug. 24, 1901, at Lecko.

Wennerberg is chiefly remembered as a poet and composer, more especially of the trios *De tre* ("The Three"; 1845–47) and of the 30 duets for baritone and bass: *Gluntarne* ("The Lads"; 1849–51), written largely for the Uppsala musical society "The Juvenals." In these lyrics Wennerberg, with ingenious rhyme and singable melody, evoked the joys and troubles of student life in Sweden. Words and music were happily fused as in the work of his great predecessor C. M. Bellman (*q.v.*), and like Bellman, Wennerberg, though a late romantic, merged realism and fantasy.

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WENSLEYDALE, JAMES PARKE, BARON (1782–1868), English judge, perhaps the last of the great "block-letter lawyers." the men to whom technicalities were the breath of life, was born near Liverpool on March 22, 1782. He was educated at Macclesfield Grammar school and Trinity college, Cambridge. Called to the bar at the Inner Temple in 1813. in 1820 he was a junior counsel for the crown in the trial of Queen Caroline. In 1828 he was raised to the king's bench; in 1834 he was transferred to the court of exchequer, where for about 20 years he exercised considerable influence. The changes introduced by the Common Law Procedure acts of 1854 and 1855 proved too much for his legal conservatism and he resigned in Dec. 185j. The government, anxious to have his services as a law lord in the house of lords, proposed to confer on him a life peerage, but this was opposed by the house of lords (*see* PEERAGE), and he was eventually created a peer with the usual remainder (1856). He died at his residence, Ampthill Park. Bedfordshire, on Feb. 25, 1868, and having outlived his three sons, the title became extinct.

Of his devotion to the intricacies of pleading the stories are innumerable; best is perhaps that of his taking one of his special demurrers to read to a dying friend. "It was so exquisitely drawn," he said, "that it must cheer him to read it." In Serjeant Hayes's *Cugate's Case,* printed in Holdsworth's *History* of *English Law,* Parke figures as "Baron Sussebutter."

WENSLEYDALE, part of the upper valley of the river Ure in Yorkshire, Eng. The name Wensleydale is derived from the village of Wensley, about 25 mi. from the source of the river, and is applied to the section of the valley extending about 15 mi upstream from Kilgram bridge, between Jervaulx and Masham, where it opens into the Vale of York, to Hawes Between Masham and Jervaulx are typical morainic hills left by the glacier nhich occupied the valley during the Ice Age. The ivy-clad ruins of Jervaulx abbey, founded in 1156 by Cistercians from Byland, stand on the south side of the river. The remains, mainly transitional Norman and Early English, consist of parts of the chapter house, refectory and cloisters Where Coverdale joins the main valley stands Middleham. overlooked by the massive Norman keep of the 12th-century castle, a stronghold of Warwick the Kingmaker; subsidiary buildings around the toner date down to the 14th century Two miles up the side valley, at Coverham. are the remains of a Premonstratensian abbey, including the gatehouse and other portions of the Decorated period.

Through Leyburn. 1 mi. N. of the Ure, pass the rail and main road connections from Wensleydale to the north–south routes of the Vale of York. The finest part of the dale begins at Wensley, whose 13th-century church with some pre-Norman sculptured stones in its walls suggests its greater importance in early times. A little way upstream and standing high on its northern side are the walls and towers of the 14th-century Bolton castle.

From Leyburn to just above Hawes the valley floor is fertile and carries pastures notable for their dairy produce. though fresh milk is now of much greater importance than the cheese to which the dale long ago gave its name. The valley is bordered by steep slopes with terraces caused by the alternation of thin resistant limestones with softer shale and sandstone beds. Wide moorlands rising to heights of over 2,000 ft. separate Wensleydale from the neighbouring dales. Where the surface rock is limestone many of the moorland streams disappear underground. The Buttertubs pass shows fine examples of such solution drainage. Where the many rapid side streams and the main river cross the limestones in the valley, waterfalls and gorges are formed. At Aysgarth the Ure descends in three main cascades within 1½ mi. and with a total fall of more than 100 ft. Hardraw Force, on a tributary stream near Hawes, has a single leap of 96 ft. from a projecting ledge of limestone. From Hawes to its source the Ure flows in an open moorland valley. (T. HER.)

WENT, FRIEDRICH AUGUST FERDINAND' CHRISTIAN (1863–193j), Dutch botanist, who was responsible for the early knowledge of plant hormones, was born in Amsterdam on June 18, 1863. He contributed greatly to the development of botany in the Netherlands.

From 1891 to 1896 Went was director of a sugar cane experimental station in Java, where he laid the foundation for a physiological analysis of the sugar cane plant and exerted a continuing influence on pure and applied research in the tropics. As professor of botany at the University of Ctrecht (1896–1934), his effective teaching brought him many students. His laboratory became famous for its work on temperature effects, on plant tropisms and on plant growth hormones. particularly auxin. The early acceptance of the plant growth hormone concept in Europe was largely due to his effective lecturing. (*See* PLANTS AND PLANT SCIENCE: *Growth:*) He died at Wassenaar, near The Hague, on July 24,193j.

See G. J. Peirce in *Plant Physiology,* **pp.** 218–223 (April 1936). (F. W. WT.)

WENTWORTH, the name of an English family. various members of which are separately noticed. (*See* FITZWILLIAM, WILLIAM WENTWORTH FITZWILLIAM; ROCKINGHAM. CHARLES WATSON WENTWORTH; STRAFFORD, THOMAS WENTWORTH.) The Wentworths trace their descent to William Wentworth (who died in 1308) of Wentworth Woodhouse, Torkshire. Thomas Wentworth (1501–1551) was summoned to parliament as Baron Wentworth of Nettlestead in 1529. The last baron Wentworth in the male line was Thomas (1613–1665), son of Thomas Wentworth, 1st earl of Cleveland. His daughter Henrietta Maria became Baroness Wentworth in her own right on her grandfather's death. This lady, who was the duke of Monmouth's mistress, died unmarried in 1686. The barony of Wentworth then reverted to Cleveland's daughter Anne. who married the 2nd baron Lovelace, from whom it passed to her granddaughter Martha (d. 1745), wife of Sir Henry Johnson. and then to the great-grandson of Anne's daughter Margaret, Sir Edward Noel. who was created Viscount Wentworth of Wellesborough in 1762. The viscountcy became extinct at his son's death in 1815, when the barony fell into abeyance until 1856. It then passed to Anne Isabella. widow of the poet Lord Byron and daughter of Sir Edward's eldest daughter Judith. Her daughter Augusta Ada, whose husband had been created earl of Lovelace. predeceased her (1852), so that she was succeeded in 1860 by her grandson Byron Noel King-Noel. His brother Ralph Gordon succeeded him as 13th baron in 1862 and became 2nd earl of Lovelace in 1893. but after his death in 1906 the titles were separated, the barony passing successively to his daughter, to his sister and to his niece (1917).

WENTWORTH, WILLIAM CHARLES (1793–1872), an outstanding figure in early Xustralian history. was born Oct. 26, at Norfolk Island, the New South Wales penal settlement, the son of D'Arcy Wentworth. government surgeon of the settlement. He was educated in England, first at Greenwich. after which he went back to Australia to explore the Blue mountains. He returned to England to complete his education at Peterhouse, Cambridge. After he had been called to the bar, he began practising law in Sydney. In 1824 he published *A Statistical Account of the British Settlement in Australasia,* a plea for more powers for colonial governments and a wide franchise. Partly because of his own origin Wentworth became leader of the "emancipists" against the "exclusivists." In the same year, with Robert Wardell, he started a newspaper, the *Australian,* and conducted active opposition to the authoritarian governor Sir Ralph Darling. During the 1830s he continued active work for a constitution giving greater powers of government to New South Wales. In 183j the Xustralian Patriotic association was formed in which Wentworth was a leading figure. But he became wealthy and was no longer in favour of a wide franchise, declaring that "poverty and ignorance went hand in hand." He had much to do with designing the constitution granted to the Australian colonies in 1842. but in the first council he led the exclusivists, or "squatter" party as it had become. Wentworth was also influential in the movement which led to the constitution of 1854. After this he lived abroad for several years, then returned to Australia to become president of the upper house in 1861. In 1862 he settled in Engiand. He died on March 20. 1872, and was buried in Sydney. (J. F. C.)

WERFEL, FRANZ (1890–194j), German writer, was born in Prague on Sept. 10, 1890, and lived successively in Prague, Hamburg, Leipzig, Vienna and Breitenfeld, near Vienna. His early poems, *Der Weltfreund* (1912), *Wir Sind* (1913), *Einander* (191j) and *Der Gerichtstag* (1919), were difficult but beautiful in expression, and were animated by the idea of the community of souls in all living things. World War I and subsequent political troubles gave Werfel's work a strongly revolutionary tinge; his brotherhood seemed best attained by the destruction of obstacles erected by tradition. His novels, *Nicht der Mörder, der Ermordete ist schuldig* (1920) and *Der Abituriententag* (1928) deal with problems and revolt of adolescence, but are less fine than his verse, which ranks with the most powerful in modern German literature. His dramatic works include an adaptation of Euripides' *Troades* (1915); a very brilliant symbolic trilogy, *Der Spiegelmensch* (1920); the more conventional *Juarez und Maximilian* (1924); *Paulus unter den Juden* (1926) and *Der Tod des Kleinburgers* (1926). Werfel died on Aug. 26, 1945, at Hollywood, Calif.

See A. Luther, *Franz Werfel und seine besten Bühnenwerke* (1922).

WERGELAND, HENRIK ARNOLD (1808–1845), Norwegian poet and prose writer, was born at Christiansand on June 17, 1808. He was the eldest son of Professor Nikolai Wergeland (1780–1848), who had been a member of the constitutional assembly which proclaimed the independence of Norway in 1814 at Eidsvold. He established libraries, and tried to alleviate the widespread poverty of the Norwegian peasantry. But his numerous and varied writings were coldly received by the critics, and a monster epic, *Skabelsen, Mennesket* og *Messias* (Creation, Man and Messiah), 1830, showed no improvement in style. It was remodelled in 1845 as *Mennesket*. From 1831 to 1835 Wergeland was submitted to severe satirical attacks from J. S. le Welhaven and others, and his style improved in every respect. His popularity waned as his poetry improved, and in 1840 he found himself a really great lyric poet, but an exile from political influence. In that year he became keeper of the royal archives. He died on July 12, 1845. In 1908 a statue was erected to his memory by his compatriots at Fargo, North Dakota. His *Jan van Huysums Blomsterstykke* (1840), *Svalen* (1841), *Joden* (1842), *Jodinden* (1844) and *Den Engelske Lods* (1844), form a series of interesting narrative poems in short lyrical metres.

Wergeland's *Samlede Skrifter* (9 vols., Christiania, 1852–1857) were edited by H. Lassen, the author of *Henrik Wergeland og hans Samtid* (1866), and the editor of his *Breve* (1867). *See* also H. Schwanenflügel, *Henrik Wergeland* (Copenhagen, 1877); and J. G. Kraft, *Norsk Forfatter-Lexikon* (Christiania, 1857), for a detailed bibliography.

WERMUND, an ancestor of the Mercian royal family, a son of Wihtlaeg and father of Offa. He appears to have reigned in Angel, and his story is preserved by certain Danish historians, especially Saxo Grammaticus. According to these traditions, his reign was long and happy, though its prosperity was eventually marred by the raids of a warlike king named Athislus, who slew Frowinus, the governor of Schleswig, in battle. Frowinus's death was avenged by his two sons, Keto and Wigo, but their conduct in fighting together against a single man was thought to form a national disgrace, which was only obliterated by the subsequent single combat of Offa. It has been suggested that Athislus, though called king of the Swedes by Saxo, was really identical with the Eadgils, lord of the Myrgingas, mentioned in Widsith. As Eadgils was a contemporary of Ermanaric (Eormenric), who died about 370, his date would agree with the indication given by the genealogies which place Wermund nine generations above Penda. Frowinus and Wigo are doubtless to be identified with the Freawine and Wig who figure among the ancestors of the kings of Wessex.

WERNER, ABRAHAM GOTTLOB (1750–1817), father of German geology, was born in Upper Lusatia, Saxony, on Sept. 25, 1750. He was educated at Bunzlau, Silesia, and in 1764 joined his father at Count Solm's iron-works at Wehrau and Lorzendorf, with the idea of ultimately succeeding him as inspector. In 1769, however, he entered the mining school at Freiberg, and in 1771 went to Leipzig, where he studied law and mineralogy. In 1775 he was appointed inspector and teacher in the mining school at Freiberg. He devoted himself for 40 years to the development of the school, which rose to be one of the centres of scientific intelligence in Europe. He died at Freiberg on June 30, 1817.

One of the distinguishing features of Werner's teaching was the care with which he taught lithology and the succession of geological formation; a subject to which he applied the name geognosy. His views on a definite geological succession were inspired by the works of J. G. Lehmann and G. C. Fuchsel (1722–73). He showed that the rocks of the earth follow each other in a certain definite order. He had never travelled, and the sequence of rock-masses which he had recognized in Saxony was believed by him to be of universal application. (*See* his *Kurze Klassifikation und Beschreibung der verschiedenen Gebirgsarten*, 1787.) He taught that the rocks were precipitates of a primaeval ocean, and followed each other in successive deposits of world-wide extent. Volcanoes were regarded by him as abnormal phenomena, probably due to the combustion of subterranean beds of coal. Basalt and similar rocks, already recognized by other observers as of igneous origin, he believed to be water-formed accumulations of the same ancient ocean. Hence arose one of the great historical controversies of geology. Werner's followers preached the doctrine of the aqueous origin of rocks, and were known as Neptunists; their opponents, who recognized the important part taken in the construction of the earth's crust by subterranean heat, were styled Vulcanists.

Though much of Werner's theoretical work was erroneous, science is indebted to him for so clearly demonstrating the chronological succession of rocks.

WERNER, ALFRED (1866–1919), French-Swiss chemist, Nobel laureate in chemistry in 1913 for his work on molecular structure and noted for his co-ordination theory of valency, was born at Mulhouse, in Alsace, on Dec. 12, 1866. In 1886 he went to Zurich to study and later worked at Zurich with George Lunge and in Paris with Marcellin Berthelot, but he returned in 1893 as extraordinary professor of chemistry at Zürich. In 1895 he was made ordinary professor of chemistry, an appointment he held until his death on Nov. 15, 1919. He was awarded the Nobel prize in 1913 "in recognition of his works on the linking up of atoms within the molecule, whereby new light has been thrown upon older fields of research, and new fields have been opened up, especially within the realm of inorganic chemistry."

Werner's earliest work was with Arthur Hantzsch on the stereochemistry of the oximes (*q.v.*), but his greatest contribution to chemistry was the co-ordination theory of valency (*see* VALENCE), which he put forward in 1893. In this he introduced the important ideas of co-ordination number and subsidiary valence. Werner stated that he awoke one morning at 2, as the theory flashed into his consciousness. By 5 in the afternoon the essential features had been worked out. By means of this theory not only was a simple method of classifying complex inorganic compounds made available, but new and unsuspected cases of geometrical and optical isomerism were brought to light, including optically active substances whose activity is due to elements other than carbon. (*See* ISOMERISM.) Although Werner's views met some opposition-and had to be modified slightly, they undoubtedly gave a great stimulus to the development of certain branches of chemistry. His ideas may be said to underlie the modern development of inorganic chemistry, since they departed from the inadequate theories of structure based on the study of carbon compounds, and prepared the way for the electronic theory of valency. Werner deserves to be named with Friedrich Kekulé as an originator of structure theory. More than 200 dissertations were prepared under his direction, and his papers exceed 150 in number. He and his students prepared numerous new series of compounds and fitted them into the new system.

Werner wrote *Neuere Anschauungen auf dem Gebiet der anorganischen Chemie* (1905; 5th ed., 1923), and *Lehrbuch der Stereochemie* (1904).

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WERNIGERODE, a town in Magdeburg district, Germany, on the north slopes of the Harz mountains. Pop. (1950) 33,890.

The counts of Wernigerode, who can be traced back to the early 12th century, were successively vassals of the margraves of Brandenburg (1268) and the archbishops of Magdeburg (1381). On the extinction of the family in 1429 the county fell to the counts of Stolberg. The latter surrendered its military and fiscal independence to Prussia in 1714.

WERTHEIMER, MAX (1880–1943), German psychologist and philosopher, founder of the Gestalt theory, was born in Prague, Czech., on April 15, 1880. He studied philosophy and psychology at Prague and Berlin and received his Ph.D. *summa cum laude* from Wurzburg in 1904. He taught at Frankfurt and then at Berlin, returning to Frankfurt in 1929 to accept the chair in psychology. In 1933 he moved to the United States, joining the New School for Social Research in New York city, where he held a professorship until his death on Oct. 12, 1943.

Rertheimer's profound influence on psychology came mainly through his many devoted students. His writings ranged widely, including such fields as the psychology of perception and of thinking, crime detection, musicology and philosophical problems of logic, ethics and truth. His 1912 paper on apparent movement launched the Gestalt school, which he. with Wolfgang Kohler, Kurt Koffka (*qq.v.*) and others, made one of the major approaches of modern psychology. Gestalt theory holds that a whole is something different from the sum of its parts. and therefore analyzing parts does not provide information about the nature of the whole.. Analysis should "proceed from above to below"; in order to understand not only the whole but also its parts, each part must be viewed in its place, role and function within the whole.

See Edwin B. Newman, "Max Wertheimer (1880–1943)," *Am. J. Psychol.*, 57:428–435 (1944). (M. M. WR.)

WERTMÜLLER, ADOLF ULRICH (1751–1811), Swedish-U.S. painter, who is chiefly remembered for his figure composition, was born in Stockholm on Feb. 18, 1751. He was a cousin of the celebrated Swedish artist Alexander Roslin. Trained in Stockholm, Paris and Rome, he had a studio in Paris from 1783 to 1788 and later at Bordeaux. He was also patronized by the French and Swedish courts. He first visited the United States about 1794, remaining in Philadelphia for two years before going back to Sweden in 1796. Four years later Wertmüller returned to Philadelphia, married and settled on a farm in New Castle county, Del., where he lived until his death early in Oct. 1811. The contents of his studio were sold at auction a few months later for $4,500. In the U.S. Wertmüller painted some portraits, including one of George Washington (1795; Metropolitan Museum of Art, New York), but his more notable works are his figure paintings. His "Danae and the Shower of Gold," one of the first nudes exhibited in America, scandalized viewers during the artist's lifetime and long after his death. It is now in the National museum, Stockholm, as are also his diary and other personal papers. (D. H. W.)

WESEL, a town in the North Rhine-Westphalia Land, Ger., siiuated at the confluence of the Rhine and Lippe rivers, 46 mi. S.W. of Münster and 35 mi. N.W. of Duisburg. Pop. (1950) 18,244. Wesel arose from a Frankish court. soon surrounded by a settlement; it was made part of the duchy of Cleve in 1233, was granted municipal status in 1241 and became a flourishing commercial town. A member of the Hanseatic league from 1407, it became the most important trade centre on the lower Rhine next to Cologne. Peter Minuit (*q.v.*), the first director general of New York (New Netherlands). was born in Wesel. From 1680 to 1918 the town was a Brandenburg-Prussian fortress and garrison town. The citadel. Berlin gate and Cleve gate date from this period. In Feb. 1945, Wesel was almost completely destroyed by bombing, but was afterward rebuilt.

WESER (Lat. VISURGIS), one of the chief rivers of Germany, 273 mi. long, formed by the union of the Werra and the Fulda at Münden, flowing generally north and entering the North sea at Bremerhaven, between Jade bay and the estuary of the Elbe. The fairway up to Bremen has a minimum depth of 18 ft. and boats of 350 tons can usually go up to Münden, thanks to locks and weirs which avoid rapids. The Geeste, Wümme and Aller, Weser's right-bank tributaries, and the Hunte, its left-bank tributary, are navigable; so are the Werra and the Fulda. The Weser is connected by canals with the Rhine. Ems and Elbe rivers.

From 1924 to 1947 the urban district formed by the union of the towns of Geestemiinde and Lehe, on the right bank of the Weser estuary, was called Wesermünde. In 1939 Wesermunde had a population of 112,831. In 1947 it was absorbed by the urban district of Bremerhaven.

WESLEY (FAMILY). The Wesley family sprang from Welswe, near Wells in Somerset. Their pedigree has been traced back to Guy, whom Athelstan made a thane about 938. One branch of the family settled in Ireland. Sir Herbert Westley of Westleigh, Devon, married Elizabeth Wellesley of Dangan in Ireland. Their third son. Bartholomew, studied both medicine and theology at Oxford and, in 1619, married the daughter of Sir Henry Colley of Kildare. In 1660 he held the rectories of Catherston and Charmouth in Dorset valued at £35 10*s*. per annum. He was ejected in 1662 and gained his living as a doctor. He was buried at Lyme Regis on Feb. 15, 1670.

His son, JOHN WESTLEY, grandfather of the founder of Methodism, was born in 1636 and studied at New Inn Hall, Oxford, where he became proficient in Oriental languages and won the special regard of John Owen, then vice-chancellor. Cronwell's Triers approved him as minister of Winterborn-Whitchurch, Dorset, in 1658. The following year he married the daughter of John White, the patriarch of Dorchester. In 1661 he was committed to prison for refusing to use the Book of Common Prayer. His candour and zeal made a deep impression on Gilbert Ironside the elder, Bishop of Bristol, with whom he had an interview. He was ejected in 1662 and became a Nonconformist pastor at Poole. He died in 1678; his widow survived him for 32 years. One of his sons, Matthew, became a surgeon in London, where he died in 1737.

Another son, SAMUEL, was trained in London for the Nonconformist ministry, but changed his views, and, in Aug 1683, entered Exeter college, Oxford, as a sizar. He dropped the "t" in his name and returned to what he said was the original spelling, Wesley. In 1689 he was ordained and married Susanna, youngest daughter of Dr. Samuel Annesley, vicar of St. Giles, Cripplegate, and nephew of the 1st earl of Anglesea. Annesley gave up his living in 1662, and formed a congregation in Little St. Helen's, Bishopsgate. Samuel Wesley was appointed rector of South Ormsby in 1691, and moved to Epworth in 1697. He had 19 children, of whom eight died in infancy. His lawless parishioners could not endure his faithful preaching, and in 1705 he was confined in Lincoln castle for a small debt. Two-thirds of his parsonage was destroyed by fire in 1702 and in 1709 it was burnt to the ground. He managed to rebuild the rectory, but his resources were so heavily strained that 13 years later it was only half furnished. Samuel Wesley wrote a *Life of Christ* in verse (1693), *The History of the Old and New Testament in Verse* (1701?), a noble *Letter to a Curate,* full of strong sense and ripe experience, and *Dissertations on the Book of Job* (1735). He died at Epworth in 1735. Susanna Wesley died at the Foundry, London, in 1742 and was buried in Bunhill Fields.

Their eldest son, SAMUEL WESLEY (1690–1739), was born in London, entered Westminster school in 1704, became a Queen's scholar in 1707 and in 1711 went up to Christ Church, Oxford He returned to Westminster as head usher, took orders and enjoyed the intimate friendship of Bishop Atterbury, Harley earl of Oxford, Addison, Swift and Prior. He became headmaster of Blundell's school at Tiverton in 1732 and died there on Nov. 6, 1739. He was a finished classical scholar, a poet and a devout man, but he was never reconciled to the Methodism of his brothers. His poems, published in 1736, reached a second edition in 1743, and were reprinted with new poems and a *Life* by W. Nichols (1862).

CHARLES WESLEY (1707–1788) was the 18th child of the Rector of Epworth, and was saved from the fire of 1709 by his nurse. He entered Westminster school in 1716, became a King's Scholar and was captain of the school in 1725 He was a plucky boy, and won the life-long friendship of the future earl of Mansfield by fighting battles on his behalf. Garret Wesley of Ireland wished to adopt his young kinsman, but this offer was declined and the estates were left to Richard Colley on condition that he assumed the name Wesley. Charles Wesley was elected to Christ Church in 1726. John had become fellow of Lincoln the previous March Charles lost his first 12 months at Oxford in "diversions," but whilst John was acting as their father's curate, his brother "awoke out of his lethargy." He persuaded two or three other students to go with him to the weekly sacrament. This led a young gentleman of Christ Church to exclaim: "Here is a new set of Methodists sprung up." The name quickly spread through the university, and Oxford Methodism began its course. In 1735 Charles Wesley was ordained and went with his brother to Georgia as secretary to Colonel, afterwards General, Oglethorpe, the Governor. The work proved uncongenial, and after enduring many hardships his health failed and he left Frederica for England on July 26, 1736. He hoped to return, but in Feb. 1738 John Wesley came home, and Charles found that his state of health made it necessary to resign his secretaryship. After his evangelical conversion on Whit Sunday (May 21, 1738), he became the poet of the Revival.

He wrote about 6,500 hymns. They vary greatly in merit, but Canon Overton held him, taking quantity and quality into consideration, to be "the great hymn-writer of all ages." Their early volumes of poetry bear the names of both brothers, but it is generally assumed that the original hymns were by Charles and the translations by John Wesley. For some years Charles Wesley took a full share in the hardships and perils of the Methodist itinerancy, and was often a remarkably powerful preacher. After his marriage in 1749 his work was chiefly confined to Bristol, where he then lived, and London. He moved to London in 1771 and died in Marylebone on March 29, 1788. He was strongly opposed to his brother's ordinations, and refused to be buried at City Road, because the ground there was unconsecrated. He was buried in the graveyard of Marylebone Old Church.

Charles Wesley married Sarah Gwynne, daughter of a Welsh magistrate living at Garth, on April 8, 1749. She died in 1822 at the age of ninety-six. Five of their children died as infants and are buried in St. James's churchyard, Bristol. Their surviving daughter Sarah, who was engaged in literary work, died unmarried in 1828. Charles Wesley, Jr. (1759–1834), was organist of St. George's, Hanover Square. He published *Six Concertos for the Organ and Harp* in 1778. He also died unmarried. Samuel, the younger brother (1766–1837) (*q.v.*), was even more gifted than Charles as an organist and composer; he was also a lecturer on musical subjects. Two of his sons were Dr. Wesley, sub-dean of the Chapel Royal, and Dr. Samuel Sebastian Wesley (*q.v.*) (1810–1876), the famous organist of Gloucester cathedral.

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(J. TE.)

WESLEY, JOHN (1703–1791), English divine, was born at Epworth Rectory on June 17th (O.S.) 1703. He was the 15th child of Samuel and Susanna Wesley. (*See* WESLEY FAMILY.) His mother's training laid the foundation of his character, and under her instruction the children made remarkable progress. On Feb. 9, 1709, the rectory was burnt down, and the children had a narrow escape. On the duke of Buckingham's nomination, Wesley was for six years a pupil at Charterhouse. In June 1720 he went up to Christ Church, Oxford, with an annual allowance of £40 as a Charterhouse scholar. His health was poor and he found it hard to keep out of debt, but he made good use of his opportunities. A scheme of study which he drew up for 1722 with a time-table for each day of the week is still to be seen in his earliest diary.

The standard edition of Wesley's *Journal* (1909) has furnished much new material for this period of Wesley's life, Curnock having unravelled the difficult cipher and shorthand in which Wesley's early diaries were kept. He reached the conclusion that the religious friend who directed Wesley's attention to the writings of Thomas à Kempis and Jeremy Taylor, in 1725, was Miss Betty Kirkham, whose father was rector of Stanton in Gloucestershire. Wesley frankly disclaimed inward holiness.

He was ordained deacon on Sept. 19, 1725, and admitted to priest's orders on Sept. 22. 1728. In 1726 he had been fellow of Lincoln. His private diaries, seven of which are in the hands of Mr. Russell J. Colman of Norwich, contain monthly reviews of Wesley's reading. It covered a wide range. and he made careful notes and abstracts of it. He generally took breakfast or tea with some congenial friend and delighted to discuss the deepest subjects. At the coffee house he saw the *Spectator* and other periodicals. He loved riding and walking and was an expert swimmer.

He preached frequently in the churches near Oxford in the months succeeding his ordination, and in April 1726 he obtained leave from his college to act as his father's curate. The new material in the *Journal* describes the simple manner of his life. He read plays, attended the village fairs, shot plovers in the fenland, and enjoyed a dance with his sisters. In October he returned to Oxford, where he was appointed Greek lecturer and moderator of the classes. He gained considerable reputation in the disputation for his master's degree in February 1727. He was now free to follow his own course of studies and began to lose his love for company, unless it were with those who were drawn like himself to religion. In August he returned to Lincolnshire, where he assisted his father till Nov. 1729. During those two years he paid three visits to the university. In the summer of 1729 he was up for two months. Almost every evening found him with the little society which had gathered round Charles.

The Holy Club.—When he came into residence in November he was recognized as the father of the Holy Club. It met at first on Sunday evenings, then every evening was passed in Wesley's room or that of some other member. They read the Greek Testament and the classics; fasted on Wednesday and Friday; received the Lord's Supper every week; and brought all their life under review. In 1730 William Morgan, an Irish student, visited the gaol and reported that there was a great opening for work among the prisoners. The friends agreed to visit the Castle twice a week and to look after the sick in any parish where the clergyman was willing to accept their help. Wesley's spirit at this time is seen from his sermon on "The Circumcision of the Heart." preached before the university on January 1, 1733. In 1765 he said it "contains all that I now teach concerning salvation from all sin, and loving God with an undivided heart." Wesley rose at four, lived on £28 a year and gave away the remainder of his income. William Law's books impressed him and on his advice the young tutor began to read mystic authors, but he soon laid them aside.

Wesley had not yet found the key to the heart and conscience of his hearers. He says, "From the year 1725 to 1729, I preached much, but saw no fruit to my labour. Indeed it could not be that I should; for I neither laid the foundation of repentance nor of preaching the Gospel, taking it for granted that all to whom I preached were believers, and that many of them needed no repentance. From the year 1729 to 1734, laying a deeper foundation of repentance, I saw a little fruit. But it was only a little; and no wonder; for I did not preach faith in the blood of the covenant. From 1734 to 1738, speaking more of faith in Christ. I saw more fruit of my preaching." Looking back on these days in 1777, Wesley felt "the Methodists at Oxford were all one body, and, as it were, one soul; zealous for the religion of the Bible, of the Primitive Church, and, in consequence, of the Church of England; as they believed it to come nearer the scriptural and primitive plan than any other national church upon earth." The number of Oxford Methodists was small and probably never exceeding twenty-five. John Clayton, James Hervey, Benjamin Ingham and Thomas Broughton, were members of the Holy Club, and George Whitefield joined it on the eve of the Wesley's departure for Georgia.

Mission to Georgia.—Wesley's father died on April 25, 1735, and in the following October John and Charles took ship for Georgia, with Benjamin Ingham and Charles Delamotte. John was sent out by the Society for the Propagation of the Gospel, and hoped to labour as a missionary among the Indians, but though he had many interesting conversations with them the mission was found to be impracticable. The cabin of the "Simmonds" became a study for the four Methodists. The calm confidence of their Moravian fellow-passengers amid the Atlantic storms convinced Wesley that he did not possess the faith which casts out fear. Closer acquaintance with these German friends in Savannah deepened the impression. Wesley needed help, for he was beset by difficulties. Mrs. Hawkins and Mrs. Welch poisoned the mind of Colonel Oglethorpe against the brothers for a time. Wesley's attachment to Miss Hopkey also led to much pain and disappointment. All this is now seen more clearly in the standard edition of the *Journal*. Wesley was a stiff High Churchman, who scrupulously followed every detail of the rubrics. He insisted on baptizing children by trine immersion, and refused the Communion to a pious German because he had not been baptized by a minister who had been episcopally ordained. At the same time he was accused of "introducing into the church and service at the altar compositions of psalms and hymns not inspected or authorized by any proper judicature." The list of grievances presented by Wesley's enemies to the Grand Jury at Savannah gives abundant evidence of his unwearying labours for his flock.

The foundation of his future work as the father of Methodist hymnody was laid in Georgia. His first *Collectzon of Psalms and Hymns* (Charlestown, 1737) contains five of his incomparable translations from the German, and on his return to England he published another *Collection* in 1738, with five more translations from the German and one from the Spanish. In April 1736 Wesley formed a little society of thirty or forty of the serious members of his congregation. He calls this the second rise of Methodism, the first being at Oxford in November 1729. The company in Savannah met every Wednesday evening "in order to a free conversation, begun and ended with singing and prayer." A select company of these met at the parsonage on Sunday afternoons. In 1781 he writes, "I cannot but observe that these were the first rudiments of the Methodist societies."

In the presence of such facts we can understand the significance of the mission to Georgia. Wesley put down many severe things against himself on the return voyage, and he saw afterwards that even then he had the faith of a servant though not that of a son. In London he met Peter Bohler who had been ordained by Zinzendorf for work in Carolina. By Bohler Wesley was convinced that he lacked "that faith whereby alone we are saved." On Wednesday, May 24, 1738, he went to a society meeting in Aldersgate Street where Luther's *Preface to the Epistle to the Romans* was being read. "About a quarter before nine, while he was describing the change which God works in the heart through faith in Christ, I felt my heart strangely warmed. I felt I did trust in Christ, Christ alone, for salvation; and an assurance was given me that he had taken away *my* sins, even *mine,* and saved *me* from the law of sin and death." Mr. Lecky points out the significance of that event. "It is scarcely an exaggeration to say that the scene which took place at that humble meeting in Aldersgate Street forms an epoch in English history. The conviction which then flashed upon one of the most powerful and most active intellects in England is the true source of English Methodism" *(History of England in Eighteenth Century,* ii. 558).

Wesley spent some time during the summer of 1738 in visiting the Moravian settlement at Herrnhut and returned to London on Sept. 16, 1738, with his faith greatly strengthened. He preached in all the churches that were open to him, spoke in many religious societies, visited Newgate and the Oxford prisons. On New Year's Day, 1739, the Wesleys, Whitefield and other friends had a Love Feast at Fetter Lane. In February Whitefield went to Bristol, where his popularity was unbounded. When the churches were closed against him he spoke to the Kingswood colliers in the open air, and after six memorable weeks wrote urging Wesley to come and take up the work. Wesley was in his friend's congregation on April 1, but says, "I could scarcely reconcile myself to this strange way of preaching in the fields . . . having been all my life (till very lately) so tenacious of every point relating to decency and order, that I should have thought the saving of souls almost a sin, if it had not been done in a church." Next day Wesley followed Whitefield's example. His fears and prejudices melted away as he discerned that this was the very method needed for reaching the multitudes.

Foundation **of** the "Society."—On May 1, 1738, he wrote in his journal: "This evening our little society began, which afterwards met in Fetter Lane." Among its "fundamental rules" we find a provision for dividing the society into bands of five or ten persons who spoke freely and plainly to each other as to the "real state" of their hearts. The bands united in a conference every Wednesday evening. The society first met at James Hutton's shop, "The Bible and Sun," Wild Street, west of Temple Bar. About Sept. 25, it moved to Fetter Lane. Wesley describes this as the third beginning of Methodism. After the field preaching began converts multiplied. They found all the world against them, and Wesley advised them to strengthen one another and talk together as often as they could. When he tried to visit them at their homes he found the task beyond him, and therefore invited them to meet him on Thursday evenings. This meeting was held in the end of 1739 at the Foundry in Moorfields which Wesley had just secured as a preaching place. Grave disorders had arisen in the society at Fetter Lane, and on July 23, 1740, Wesley withdrew from it. About 25 men and 48 women also left and cast in their lot with the society at the Foundry. The centenary of Methodism was kept in 1839.

Wesley's headquarters at Bristol were in the Horse Fair, where a room was built in May 1739 for two religious societies which had been accustomed to meet in Nicholas Street and Baldwin Street. To meet the cost of this Captain Foy suggested that each member should give a penny per week. When it was urged that some were too poor to do this, he replied, "Then put eleven of the poorest with me; and if they can give anything, well: I will call on them weekly, and if they can give nothing I will give for them as well as for myself." Others followed his example and were called leaders, a name given as early as Nov. 5, 1738, to those who had charge of the bands in London. Wesley saw that here was the very means he needed to watch over his flock. The leaders thus became a body of lay pastors. Those under their care formed a class. It proved more convenient to meet together and this gave opportunity for religious conversation and prayer. As the society increased Wesley found it needed "still greater care to separate the precious from the vile." He therefore arranged to meet the classes himself every quarter and gave a ticket "under his own hand" to every one "whose seriousness and good conversation" he found no reason to doubt. The ticket furnished an easy means for guarding the meetings of the society against intrusion. "Bands" were formed for those who wished for closer communion. Love-feasts for fellowship and testimony were also introduced, according to the custom of the primitive church. Watch-nights were due to the suggestion of a Kingswood collier in 1740.

Wesley issued the rules of the united societies in February 1743. Those who wished to enter the society must have "a desire to flee from the wrath to come, to be saved from their sins" When admitted they were to give evidence of their desire for salvation "by doing no harm; by doing good of every possible sort; by attending upon all the means of grace." It was expected that all who could do so would contribute the penny a week suggested in Bristol, and give a shilling at the renewal of their quarterly ticket. Wesley had at first to take charge of the contributions, but as they grew larger he appointed stewards to receive the money, to pay debts, and to relieve the needy. The memorable arrangement in Bristol was made a few weeks before Wesley's field of labour was extended to the north of England in May 1742. He found Newcastle ripe for his message. English Christianity seemed to have no power to uplift the people. Dram-drinking was an epidemic. Freethinkers' clubs flourished.

The doctrine of election had led to a temporary separation between Whitefield and the Wesleys in 1741. Wesley believed that the grace of God could transform every life that received it. He preached the doctrine of conscious acceptance with God and daily growth in holiness. Victory over sin was the goal which he set before all his people. He made his appeal to the conscience in the clearest language, with the most cogent argument and with all the weight of personal conviction. Hearers like John Nelson felt as though every word was aimed at themselves. No preacher of the century had this mastery over his audience. His Evangelical Arminianism is shown in his four volumes of sermons and his *Notes on the New Testament.*

Itinerary **Work.**—Up till 1742 Wesley's work was chiefly confined to London and Bristol, with the adjacent towns and villages or the places which lay between them On his way to Newcastle that year Wesley visited Birstal, where John Nelson, the stonemason, had already been working. On his return he held memorable services in the churchyard at Epworth. Methodism this year spread out from Birstal into the West Riding. Societies were also formed in Somerset, Wilts, Gloucestershire, Leicester, Warwickshire, Nottinghamshire and the south of Yorkshire. In the summer Charles Wesley visited Wednesbury, Leeds and Newcastle. Next year he took Cornwall by storm. The work in London was prospering. In 1743 Wesley secured a west-end centre at West

Street, Seven Dials, which for fifty years had a wonderful history. In August 1747 Wesley paid his first visit to Ireland, where he had such success that he gave more than six years of his life to the country and crossed the Irish Channel forty-two times. Ireland has now its own conference presided over by a delegate from the British conference. Wesley's first visit to Scotland was in 1751. In all, he paid 22 visits.

Such extension of nis field would have been impossible had not Wesley been helped by a heroic band of preachers. Wesley says: "Joseph Humphreys was the first lay preacher that assisted me in England, in the year 1738." That was probably help in the Fetter Lane Society, for Wesley then had no preaching place of his own. John Cennick, the hymn-writer and schoolmaster at Kingswood, began to preach there in 1739. Thomas Maxwell, who was left to meet and pray with the members at the Foundry during the absence of the Wesleys, began to preach. Wesley hurried to London to check this irregularity, but his mother urged him to hear Maxwell for himself, and he soon saw that such assistance was of the highest value. The autobiographies of these early Methodist preachers are among the classics of the Evangelical Revival. As the work advanced Wesley held a conference at the Foundry in 1744. Besides himself and his brother, four other clergymen were present and four "lay brethren." It was agreed that "lay assistants" were allowable, but only in cases of necessity. This necessity grew more urgent every year as Methodism extended. One of the preachers in each circuit was the "assistant," who had general oversight of the work, the others were "helpers." The conference became an annual gathering of Wesley's preachers.

In the early conversations doctrine took a prominent place, but as Methodism spread the oversight of its growing organization occupied more time and more attention. In February 1784 Wesley's deed of declaration gave the conference a legal constitution. He named one hundred preachers who after his death were to meet once a year, fill up vacancies in their number, appoint a president and secretary, station the preachers, admit proper persons into the ministry, and take general oversight of the societies. In October 1768, a Methodist chapel was opened in New York. At the conference of 1769 two preachers, Richard Boardman and Joseph Pilmoor, volunteered to go out to take charge of the work. In 1771, Francis Asbury, the Wesley of America, crossed the Atlantic. Methodism grew rapidly, and it became essential to provide its people with the sacraments. In September 1784 Wesley ordained his clerical helper, Dr. Coke, superintendent (or bishop), and instructed him to ordain Asbury as his colleague. Richard Whatcoat and Thomas Vasey were ordained by Wesley, Coke and Creighton to administer the sacraments in America. Wesley had reached the conclusion in 1746 that bishops and presbyters were essentially of one order. *(See* METHODISM: *United States.)*

He told his brother in 1785: "I firmly believe that I am a scriptural ἐπισκοπος as much as any man in England or in Europe; for the uninterrupted succession I know to be a fable, which no man ever did or can prove." Other ordinations for the administration of the sacraments in Scotland, the colonies and England followed. The interests of his work stood first with Wesley. He did everything that strong words against separation could do to bind his societies to the Church of England; he also did everything that legal documents and ordinations could do to secure the permanence of that great work for which God had raised him up. In the words of Canon Overton and Rev. F. H. Relton (*Hist. of Eng. Ch.* 1714–1800): "It is purely a modern notion that the Wesleyan movement ever was, or ever was intended to be, except by Wesley, a church movement." Despite his strong sayings, it was Wesley who broke the links to the church, for, as Lord Mansfield put it, "ordination is separation."

Wesley's account of his itinerancy is given in his famous *Journal*, of which the first part appeared about 1739. Mr. Birrell has called it "the most amazing record of human exertion ever penned by man." The development of his work made a tremendous strain upon Wesley's powers. He generally travelled about 5,000 miles a year and preached fifteen sermons a week. His rule was always to look a mob in the face.

Wesley's writings did much to open the eyes of candid men to his motives and his methods. Besides the incomparable *Journal*, his *Appeals to Men of Reason and Religion* also produced an extraordinary effect in allaying prejudice and winning respect. He constantly sought to educate his own people. No man in the 18th century did so much to create a taste for good reading and to supply it with books at the lowest prices. Sir Leslie Stephen pays high praise to Wesley's writings, which went "straight to the mark without one superfluous flourish." As a social reformer Wesley was far in advance of his time. He provided work for the deserving poor, supplied them with clothes and food in seasons of special distress. The profits on his cheap books enabled him to give away as much as £1,400 a year. He established a lending stock to help struggling business men and did much to relieve debtors who had been thrown into prison. He opened dispensaries in London and Bristol and was keenly interested in medicine.

Wesley's supreme gift was his genius for organization. He was by no means ignorant of this. "I know this is the peculiar talent which God has given me." Wesley's special power lay in his quickness to avail himself of circumstances and of the suggestions made by those about him. The class-meeting, the love-feast, the watch-night, the covenant service, leaders, stewards, lay preachers, all were the fruit of this readiness to avail himself of suggestions made by men or events.

In 1751 Wesley married Mary Vazeille, a widow, but the union was unfortunate and she finally left him. John Fletcher, the vicar of Madeley, to whom Wesley had turned as a possible successor, died in 1785. He had gone to Wesley's help at West Street after his ordination at Whitehall in 1757 and had been one of his chief allies ever since. He was beloved by all the preachers, and his *Checks to Antinomianism* show that he was a courteous controversialist. Charles Wesley died three years after Fletcher. During the last three years of his life John Wesley was welcomed everywhere. His visits were public holidays.

Wesley preached his last sermon in Mr. Belson's house at Leatherhead on Wednesday, Feb. 23, 1791; wrote next day his last letter to Wilberforce, urging him to carry on his crusade against the slave trade; and died in his house at City Road on March 2, 1791, in his eighty-eighth year. He was buried on March 9, in the graveyard behind City Road chapel. (J. TE.)

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WESLEY, SAMUEL (1766–1837), English musical composer, son of Charles Wesley, was born at Bristol, Feb. 24, 1766. Though suffering for many years from an accidental injury to the brain, Wesley was one of the most brilliant organists and most accomplished extemporaneous performers of his time. He may indeed be regarded as the father of modern English organ playing, for he it was who, aided by his friends Benjamin Jacob and C. F. Horn, first introduced the works of J. S. Bach to English organists, not only by his superb playing, but by editing with Horn, in 1813. the first copy of *Das wohltemperirte Clavier* ever printed in England. Wesley died on Oct. 11, 1837, leaving a vast number of manuscripts and printed compositions.

WESLEY, SAMUEL SEBASTIAN (1810–1876), English composer and organist, natural son of Samuel Wesley, the eminent composer. was born in London on Aug. 14. 1810. He was one of the children of the Chapel Royal from 1819, held various unimportant posts as organist from the age of 15 and in 1832 was appointed to Hereford cathedral. He was successively organist at Exeter cathedral. Leeds parish church; Winchester and Gloucester cathedrals. He conducted the Three Choirs festivals of 1834 1865, 1868. 1871 and 1874. A civil list pension of £100 a year was conferred on him in 1873; he died at Gloucester, April 19, 1876, and was buried at Exeter. Wesley was the English organist of his day. As a composer he is still highly esteemed for the dignity and beauty of his anthems, the finest of which are "Blessed Be the God and Father," "The Wilderness," "Ascribe Unto the Lord" and "O Lord, Thou Art My God." His service in E. the most elaborate in design for daily use so far attempted, which was published with a rather trenchant preface in 1845, became widely known.

WESLEYAN METHODIST CHURCH. The Wesleyan Methodist Church was a direct outcome of the evangelical revival of religion in England during the 18th century (see METHODISM; WESLEY, JOHN). The people influenced by the preaching of John and Charles Wesley were its real founders, though. at first, they had no intention of establishing a new church. For some time the societies that they formed remained within the Church of England, and it was only under the compulsion of circumstances that John Wesley took the steps which led. eventually, to separation. When early Rlethodists mere excluded from their local parish churches, meetinghouses were opened and duly licensed for public worship. The services were. at first, outside the regular church hours. The actual separation from the Church of England was gradual and reluctant. It was the result of the indifference rather than the concerted opposition of contemporary Anglicans.

In 1784 two critical events occurred. A legal document, the Deed Poll or Deed of Declaration. regularized and perpetuated the constitution of the Methodist societies. A hundred preachers, carefully selected and duly named. were appointed a body in which was vested authority in matters of discipline, administration and the stationing of ministers. The Legal Hundred elected its own new members to fill up the vacancies caused by death and so remained a continuous entity. This formed the core of the annual conference. a representative body composed of ministers only, until, in 1878, laymen were admitted. The second event in the crisis of 1784 was the ordination of certain preachers to administer the sacraments in Scotland and America. This decisive step was taken by John Wesley, who claimed, as presbyter, the right to ordain. A final severance was now inevitable.

On July 26, 1791, shortly after John Wesley's death, the conference reaffirmed the privileges granted by the Deed Poll to every preacher in full connection. The questions of the sacraments and the relation of Methodists to the Church of England were hotly debated by Alexander Kilham (*q.v.*) and the conclusions were ambiguous. In 1793 it was resolved that the societies should have the privilege of the Lord's Supper where they unanimously desired it. Next year 93 of them were granted the necessary permission.

After prolonged discussions a "plan of pacification" was drawn up and accepted in 1795. This declared that the sacrament of the Lord's Supper, the sacrament of baptism, the burial of the dead and services in church hours were only to be conducted by the preachers when a majority of trustees, stewards and class leaders of the chapel concerned approved. In 1796 Alexander Kilham, refusing to cease his agitation and accusing the ministry of priestcraft, was expelled. He founded the New Connexion.

In 1797 the constitution of the Wesleyan Methodist Church took more definite shape. The nucleus or germ cell had always been the class meeting. Wherever there was a "class" there was a society. These societies or local churches were not independent or unrelated but were grouped into circuits with a senior minister as superintendent and an elected quarterly meeting as the organ of administration. Circuits, in turn. were grouped in districts. comparable to Anglican dioceses. Each district had a ministerial chairman who presided at the synods. held twice each year. The annual conference was composed of the Legal Hundred and representatives from the whole Wesleyan Methodist Church in Great Britain (Ireland had its own conference).

The theology adopted was intended not to "overthrow dogmas but to galvanise them into life." In accepting the .Apostles' Creed and the Nicene Creed the Wesleyan Methodist Church stressed the Arminian doctrine of the Atonement. assurance! conversion and holiness or perfect love. Its appeal was to personal experience of the grace of God in Jesus Christ. Gradually it developed a consciousness of the objective grace in the sacraments and a clearer meaning of the Holy Catholic Church. A modified form of morning prayer was used in many Wesleyan Methodist churches and the offices of holy communion, holy baptism and holy matrimony closely resembled those in use in the established church. The ordination of its ministers by the imposition of hands and a rigid rubric was introduced in 1836 and carefully guarded from any kind of improvisation.

In 1790 there were 294 preachers and 71,668 members in Great Britain and Ireland with 19 missionaries and 5,300 members on the mission stations. In 1848 the membership in Great Britain was 338,861, in Ireland 23,842 and on foreign stations 97.451; the total number of ministers was 1,726. During the first half of the 19th century, known as the middle period of Wesleyan Methodist history, the dominating figure was Jabez Bunting (*q.v.*).

During these years Methodism was growing into a great missionary church. Its work in the West Indies was firmly established in Wesley's lifetime. In 1786 there were 1,100 Negro members of the society in Antigua. The burden of superintending these missions and providing funds for their support rested on Thomas Coke, who took his place as the missionary bishop of Methodism. In 1813 he prevailed on the conference to sanction a mission to Ceylon. He sailed with six missionaries on Dec. 30, but died in the following May in the Indian ocean. To meet the new responsibilities a branch missionary society had been formed in Leeds in Oct. 1813, and others soon sprang up in various parts of the country. Methodist missions really date from 1786 when Coke landed at Antigua. The area of operations gradually extended. Missions were begun in Madras, at the Cape of Good Hope, in Australia and on the west coast of Africa. Two missionaries mere sent to the Friendly Islands in 1826, and in 1835 a mission among the cannibals of Fiji spread and deepened till the whole group of islands was transformed. The work in China began in 1851; the Burma mission was established in 1887. The rapid progress of the Transvaal and Swaziland missions was almost embarrassing.

The missionary jubilee in 1863–68 yielded £179,000 for the work abroad. As the growth of the missions permitted, conferences were formed in various countries. Upper Canada had its conference in 1834, France in 1852, Australia in 1855, South Africa in 1882.

In 1834 Hoxton academy was taken as a training place for ministers. Didsbury college was opened in 1842, Richmond in 1843. Headingley was added in 1868, Handsworth in 1881 and Wesley house, Cambridge, in 1925.

The centenary of Methodism was celebrated in 1839 and £221,-939 was raised as a thank offering: £71,609 was devoted to the colleges at Didsbury and Richmond; £70,000 was given to the missionary society, which spent £30,000 on the site and building of a mission house in Bishopsgate Within; £38,000 was set apart for the removal of chapel debts, etc.

In 1837 Wesleyan Methodism had 9 infant schools and 22 schools for elder children and a grant of £5,000 was made from the centenary fund for the provision of day schools. The conference of 1843 directed that greater attention should be given to this department, and a committee met in the following October which resolved that 700 schools should be established. if possible within the next seven years. In 1849 the Normal Training college for the education of day-school teachers was opened in Westminster, and in 1872 a second college was founded in Battersea for women teachers. The Leys school at Cambridge. Rydal Mount at Colwyn Bay and boarding schools for boys and girls were established.

The Forward movement began about 1878, when a thanksgiving fund was raised. Large mission halls were built in the principal towns of England, Scotland and Ireland. The Forward movement of the 1880s will always be associated with the name of Hugh Price Hughes (*q.v.*). Village Methodism shared in the quickening which the Forward movement brought to the large towns. An aggressive policy of evangelism was combined with a great extension of social ministries.

The Twentieth Century fund was initiated by Sir Robert W.

Perks in 1898. The Royal aquarium at Westminster was purchased and a central hall and church house as the headquarters of Methodism erected. Various secessions from the Wesleyan Methodist Church took place, notably that of the Primitive Methodists (*q.v.*) in 1810–12; but in 1932, the Wesleyan Methodist Church, the Primitive Methodist Church and the United Methodist Church became one under the title of the Methodist Church.

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WESSEL, JOHAN HERMAN (1742–1785), Norwegian-born writer who settled in Denmark, famous for his parody of neoclassical tragedy and his light verse. The son of a clergyman, he was born at Jonsrud near Vestby, southeast Norway, on Oct. 6, 1742. In 1761 he matriculated at the University of Copenhagen and he lived in that city until his death on Dec. 29, 1785, supporting a penurious existence by private tuition and the translation of plays for the royal theatre. He was one of the founders (1772) and the outstanding member of the *Norske Selskab,* a literary and convivial society of Norwegian students at Copenhagen, and contributed to its anthologies which began to be published in 1775. The signet of the society bore the inscription *"Vos exemplaria Graeca,"* and it was mainly directed against the extravagances with which it believed contemporary German literature was infecting that of Denmark. Wessel's only important long work *Kierlighed uden Strømper* ("Love Without Stockings," 1772), a "tragedy" in five acts written in alexandrines. by transferring the setting of a heroic tragedy to low life, mocked the rhetorical neoclassical drama then flourishing on the Danish stage. Wessel wrote two more plays, of little account, and a number of graceful epigrams, impromptus, songs and (often indecent) verse tales in the manner of La Fontaine.

Wessel's collected works, *Samtlige Skrivter,* were published in two volumes (1787); his verse, *Digte,* was published with a foreword by P. V. Rubow (1936).

See W. P. Sommerfelt (ed.), *J. H. Wessel og Norge* (1942); A. H. Winsnes, *Det norske Selskab* (1924). (B. W. D.)

WESSEX, one of the kingdoms of Anglo-Saxon Britain. According to the Saxon Chronicle, it was founded by two princes, Cerdic and his son Cynric, who landed in 494 or 495 and were followed by other settlers in 501 and 514. After several successful battles against the Welsh they became kings in 519 around the southern part of Hampshire. In 530 Cerdic and Cynric are said to have conquered the Isle of Wight, which they gave to two of their relatives, Stuf and Wihtgar. Cerdic died in 534. Cynric defeated the Britons at (Old) Salisbury in 552 and again in conjunction with his son Ceawlin at Beranburh, probably Barbury hill near Swindon, in 556. At his death in 560 he was succeeded by Ceawlin, who is mentioned by Bede as the second of the English kings to hold an imperium in Britain. With him a period of more or less reliable tradition is entered upon. How far the earlier part of the story deserves credence is still much debated. It is worthy of note that the dynasty claimed to be of the same origin as the royal house of Bernicia.

Whatever may be the truth about the origin of the kingdom, its dimensions were largely increased under Ceawlin. In his reign the Chronicle mentions two great victories over the Welsh, one at a place called Bedcanford in 571, by which Aylesbury and the upper part of the Thames valley fell into the hands of the West Saxons, and another at Dyrham in Gloucestershire in 577, which led to the capture of Cirencester, Bath and Gloucester. Ceawlin is also said to have defeated Aethelberht of Kent at a place called Wibbandun in 568. In 592 he was expelled and died in the following year. His obscure successors Ceol and Ceolwulf were followed in 611 by Cynegils. whose son Cwichelm provoked a Northumbrian invasion by the attempted murder of Edwin in 626. These kings are also said to have come into collision with the Mercian king Penda, and it is possible that the province of the Hwicce (*q.v.*) was lost in their time. After the accession of Oswald, who married Cynegils's daughter, to the throne of Northumbria, both Cynegils and Cwichelm were baptized. Cynegils was succeeded in 642 by his son Cenwalh, who married and subsequently divorced Penda's sister and was on that account expelled by that king. After his return he gained a victory over the Welsh near Pen-Selwood, by which most, if not all, of Somerset came into his hands. In 661 he was again attacked by the Mercians under Wulfhere. At his death, probably in 673, the throne is said to have been held for a year by his widow Sexburh, who was succeeded by Aescwine, 674–676, and Centwine, 676–685. According to Bede, however, the kingdom was in a state of disunion from the death of Cenwalh to the accession of Ceadwalla in 685, who greatly increased its prestige and conquered the Isle of Wight, the inhabitants of which he treated with great barbarity. After a brief reign Ceadwalla went to Rome, where he was baptized, and died shortly afterward, leaving the kingdom to Ine. Before the end of the 7th century a considerable part of Devon as well as the whole of Somerset and Dorset had come into the hands of the West Saxons. Ine founded a new bishopric at Sherborne for these western provinces, held synods for the better government of the church and issued an elaborate code of laws. He is the real founder of the organized West Saxon kingdom of later times. On his resignation in 726 he was succeeded by an obscure nobleman named Aethelheard, and he, in 740, by a certain Cuthred, who reigned until 750. Each of these kings was overshadowed by Aethelbald, king of Mercia, though Cuthred revolted, apparently successfully, from Aethelbald's domination in 752. At his death in 756 Sigebert succeeded, but on account of his misgovernment was deserted by most of the leading nobles, and with the exception of Hampshire the whole kingdom came into the hands of Cynewulf. Sigebert, after putting to death the last of the princes who remained faithful to him, was driven into exile and subsequently murdered; but his brother Cyneheard afterward avenged him on Cynewulf. Cynewulf was succeeded in 786 by Berhtric, who married Eadburg, daughter of the Mercian king Offa. Berhtric was succeeded in 802 by Ecgbert, who overthrew the Mercian king Beornwuli in 825. This led to the annexation by Wessex of Sussex, Surrey, Kent and Essex and the temporary recognition of West Saxon supremacy by Mercia.

Aethelwulf (*q.v.*), son of Ecgbert, succeeded to Wessex at his father's death in 839, while the eastern provinces went to his son Aethelstan. A similar division took place on Aethelwulf's death in 858 between his two sons Aethelbald and Aethelberht, but on the death of the former in 860 Aethelberht united the whole in his own hands, his younger brothers Aethelred and Alfred renouncing their claims. Aethelberht was succeeded in 865 by Aethelred, and the latter by Alfred in 871. This was the period of the great Danish invasion which culminated in the submission of Guthrum in 878. Shortly afterward the kingdom of the Mercians came to an end and in 886 Alfred's authority was accepted by all Englishmen who were not under the power of the Danes. From this time onward the history of Wessex is the history of England.

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WEST, BENJAMIN (1738–1820), U.S. artist, was history painter to George III, 1772–1801, and a charter member (1768) and president of the Royal Academy (1792–1820). Born on Oct. 10, 1738, near Springfield, Pa., he showed precocious artistic talent and was sent to Philadelphia in 1756 to study painting. In 1759 he sought further commissions in New York and through the assistance of friends sailed for Italy. In 1763 West left Italy for London. He became intimate with Sir Joshua Reynolds and gained widespread popularity. His "Agrippina With the Ashes of Germanicus" was admired by George III. "The Death of Wolfe" (*c.* 1771), one of his best-known works, did not introduce but popularized modern costume in history painting. Though loyal to America he retained the king's friendship and patronage until 1801. In 1802 he visited Paris and exhibited his final sketch for "Death on a Pale Horse," which anticipated developments in French romantic painting. Though he never returned to the United States among his pupils are found all the leading American artists to the foundation of the National Academy (1826). West died in London, March 11, 1820. (WM. O.)

WEST, THE, is a term which in the United States has been applied both to a geographic location and to a social-economic condition. Because settlement began on the eastern rim of the continent and in most cases expanded in a westerly direction, the west was both a place farther out toward the setting sun and a place where men were beginning over again the creation of a new society. Strictly speaking, each eastern physical-social region had its own west where its patterns of life were exposed to a new environment. All wests, therefore. differed to a degree according to the origins of their people. but all partook of the quality of newness and all revealed some similarity in outlook and attitude.

The outer edge of any western advance was known as the frontier. The U.S. census bureau defined it as a place where the population was not more than two persons to the square mile. Its first inhabitants, except in a few unusual cases. were trappers. traders and lone settlers. Always on the move. they left behind them, as they pushed on into the wilderness, a gradually maturing society which the people to its east called the west. In early stages at least, each west was supposed to exhibit certain characteristics --individualism, boastfulness. materialism. hurry, crudeness and a tendency to see things not as they then were but as they might some day become. In time, of course. each west reached some degree of social maturity. political independence and economic complexity, and became eastern in all but geographic location.

Historians, dealing with the growth of the United States, have recognized and given names to at least seven distinct wests that appeared as the population spread from the Atlantic to the Pacific. The first of these, the old west. grew up in the back country of the original colonies. In the years between 1676 and 1763, it constituted a region which contrasted sharply with the older settlements and which was often in conflict with them. It stretched roughly from New England to Georgia and varied in character as the colonies differed from each other. But, as Frederick Jackson Turner says, it formed "a democratic, self-sufficing, primitive agricultural society in which individualism was more pronounced than the community life of the lowlands." It was short on schools and churches, and only gradually acquired a surplus of cattle and grain to exchange for what its people called store goods. Against unjust taxes or the failure to give protection from Indian raids, its people more than once rose in open rebellion against some mother colony.

The thrust of population through the Allegheny mountains after 1763, created a new west in Kentucky and Tennessee. Theodore Roosevelt told its story under the suggestive title *The Winning of the West,* 4 vol. (1889–96). There were settlements whose welfare depended on the use of the Mississippi river and whose citizens did not hesitate to enter into intrigues with the Spanish or French who controlled its waters. They provided much of the drive for expansion in the War of 1812, and caused easterners to tremble at the thought of their growing power in congress.

This, however, was only the beginning. With peace in 1815, what was known as the great migration began and two new wests quickly made their appearance. Between the Ohio river and the Great Lakes and reaching westward to the Mississippi and beyond, the old northwest filled up with peoples irom the south. the east and Europe. On corn and hogs, and then with wheat, they prospered, blended the county system of local government with the township system and, by 1860, had developed such thriving commercial industrial centres as Cleveland, O., Cincinnati. O., Chicago, Ill., and St. Louis, Mo. Expanded a bit to the south and west, the region in later days mas often spoken of as the midwest. (See MIDDLE WEST, THE.)

Meanwhile in the region between Tennessee and the Gulf of Mexico another new west had been developing. Its people came primarily from the old south and that region furnished the patterns on which its social-economic life evolved. With cotton as its major crop, and with the plantation and negro slavery as the basis for large-scale production, this west was soon known as the cotton kingdom. Yet in temper and in attitude toward the public lands, banking and internal improvements. the region was thoroughly western, and in speculation and lawlessness it quite surpassed the old northn-est. Southerners along the Atlantic coast always spoke of it as the west. (See SOUTH. THE.)

In the vast trans-Mississippi territory, the first region to be settled was that lying between the river and the 100th meridian. At this line where the prairies fade out and mood and water grow scarce, commence the Great Plains. extending to the Rocky mountains and their inland basins. followed by the Pacific slopes. Although these units varied greatly in physical features and resources, only two wests distinct enough to acquire names of their own developed within their boundaries. These were the southwest and the Pacific northwest.

At the southern end of the Great Plains. stretching from Texas northward toward Kansas and westward across New Mexico and Arizona, lay a region where the heat and dryness were more extreme and whose Indian tribes had developed a culture quite distinct from that of the tribes to the north. Its early settlement had taken place under Spanish and Mexican auspices and much of the region had come into the possession of the United States after the Mexican War in 1848.

U.S. settlers who came largely from the states directly to the east brought their ways and institutions with them, but Mexican influences remained as a permanent force in the region. The cattle business which became a spectacular feature of its life mas Spanish in most details. Architecture bore the same stamp. Yet the region became the U.S. southwest with a degree of self-consciousness that continued to express itself in titles given to numerous organizations and publications.

The Pacific northwest, because of its great distance from older U.S. settlements and its mixed British and U.S. beginnings, early acquired recognition and a name as a distinct west. The Lewis and Clark expedition in 1803–06, the struggle over the Oregon boundary from 1803 to 1846. and the wide interest in the China trade turned national interest in its direction as a new west.

California never quite became a distinctive American west. It had already progressed beyond early frontier stages before it became a part of the nation. It was always just California. The discovery of gold in 1848 did not greatly alter the situation. It made California a part of the mining frontier and of a great trans-Mississippi west which became the last frontier and the west of song and story.

The discovery of gold and the building of the transcontinental railroads sharply altered the character of the westward movement in the United States. The slow, steady advance suddenly became a series of mad rushes. Where in agricultural areas it had taken a generation to produce a surplus of any great value, localities in this west did so from the first year. Under such conditions, every so-called western characteristic was exaggerated and magnified. Mining camps appeared in a vast area from California to Oregon, from Montana and Idaho to Colorado and the Dakotas. Cattle ranches crowded the buffalo from the plains and the cowboy took his place alongside the miner as a new frontier type. Bad men flourished their six-shooters and brave sheriffs tamed them. The Indian, after a few efforts at resistance, gave way and accepted reservation life until the Dawes act (1887) made possible individual ownership and the Burke act (1896) opened the way to citizenship. Farms grew up about the mines. Supply and shipping towns soon appeared so that by 1890 the census bureau reported that a continuous frontier line could no longer be drawn.

Political organization followed economic developments. Territorial governments were quickly established and by 1890 all but four of these had become states. All had reached statehood by 1912. The constitutions which these states adopted were notable for their democratic provisions. Such advanced ideas as the initiative and referendum and recall were introduced. Women were accorded a larger political place. Even as a territory. Wyoming granted women the vote, and both Wyoming and Utah did so as states. Montana elected the first woman to the U.S. congress, and Texas elected the first woman governor. These states took the lead in passing eight-hour day legislation, in limiting the hours of labour for women and children. in providing for the arbitration of labour disputes and in increasing employer liability. Arizona included the recall of judges in its constitution, removed the provision under pressure, but reinstated it as soon as Arizona became a state.

Thus the term, the west. had by the mid-20th century lost much of its earlier meaning, both as applied to a definite geographic location and as a place where certain attitudes and values existed.

Men still liked to believe that western traits lingered in many parts of the nation, but the forces which once gave them dominance had largely disappeared. Such expressions as the midwest, the far west, the southwest, etc., were still in use, and conveyed to residents and outsiders the idea of a peculiar set of qualities. but they referred more to what once was than to what then existed.

(AY. CN.)

WEST AFRICA is that part of Africa lying between the Sahara and the Gulf of Guinea, west of a line extending along the Cameroons mountains to the desert north of Lake Chad. It comprises about 14° of latitude and 32° of longitude. The political units that roughly coincide with this region total 2,400,000 sq.mi. and in 1960 were estimated to have about 67,200,000 inhabitants.

PHYSIOGRAPHY

From south to north, West Africa can be divided into a number of latitude belts, each of which possesses remarkably uniform characteristics of climate, vegetation and animal life. The natural characteristics of each of these belts are determined principally by the amount and duration of the rainfall received.

Guinea. — From the coast to about 8° N. is the belt of country known as Guinea, where rainfall occurs throughout the year, though mostly during the months from March to November. The amount of rainfall received is in the range from 60 to 170 in. a year, except in an area between about 1" W. and 3° E., where it is between 30 and 60 in. Both diurnally and annually, there is a notably small variation in shade temperatures and in relative humidity. The former are normally in the range 70"–go° F.. and the latter between 80% and 90%. The high and frequent rainfall results in the greater part of this belt being covered with dense tropical forest, whose evergreen trees may reach more than zoo ft. in height. The forest is inhabited by few large mammals but by many birds and reptiles and by myriads of insects and microorganisms, including most of those which infect man and beast with so-called tropical diseases.

The Sudan. — Between about 8° and 16° N. lies the country of the Sudan, where an annual rainfall of between 20 and 60 in. is concentrated almost entirely during the months from June to October. Mean temperatures and relative humidity vary between 65° and 95° F. and 30% and 90% respectively, according to the season and the time of day. The vegetation is of the savanna type, nith coarse grasses and scattered small trees. In the dry season all but the largest rivers run dry, the trees shed their leaves and the dry grass is often subject to bush fires. Wildlife includes elephant, lion. buffalo, antelope and many smaller mammals. In the dry season the country is relatively free of insect-borne diseases.

The **Sahel.**—Between the Sudan and the Sahara desert is the Sahel. where rain falls only between July and October and amounts only to between about 5 and 20 in. a year. Daytime temperatures are high, mean daily maxima lying between 95° and 100° F., but the nights are relatively cool, with temperatures around 65° F. Relative humidity is low except in the rains, and ranges from 25% to 70%. In the dry season. a parching wind from the Sahara, the harmattan (which in December and January penetrates as far south as the coast), creates a constant haze of fine dust. Permanent water is rare and wildlife thin. Grass grows only in small clumps and the typical vegetation is a thorn scrub of bushes and small trees.

Uplands. — There are only three districts where the height of land much exceeds 2,000 ft. and thus serves to modify the characteristic pattern of climatic and vegetation zones. These are the uplands of the Futa Jallon plateau and Nimba mountains in Guinea and the Jos plateau in northern central Nigeria, both of which contain considerable areas of land between 2,000 and 6,000 ft. high. and the Cameroons mountains in the extreme southeast, where the highest peak, Mt. Cameroon. is 13,350 ft. high. Rain falling on the Futa Jallon-Nimba uplands feeds the sources of the Niger and Senegal. the two principal rivers in the drainage pattern of West Africa, while streams rising in the Cameroons and the Jos plateau go to feed the Niger and its principal tributary. the Benue. The Niger can be navigated for most of the 2,500 mi. of its course below Kurussa, about 100 mi. from its source; the Senegal is seasonably navigable below Kayes, about 550 mi. from its mouth.

Coast. — The seacoast is 2,500 mi. long. uncommonly uniform and notoriously difficult of access. A heavy surf beats on most of the coast and has built up a permanent sand bar through nhich only the largest streams can scour a permanent channel, and then rarely more than 10 ft. deep. By exception, the Gambia river has a deep estuary. However, its lower course, and the several outlets of the Niger delta and of other lesser streams, are lined with mangrove swamps, barriers hardly less obstructive than the sand bar. In places the low coast is interrupted by promontories, in the lee of which the surf is reduced. Sporadic examples, generally associated with volcanic action, occur at Cape Verde. the Iles de Los (Conakry). Sierra Leone (Freetown) and Mt. Cameroon. The coast of Ghana (formerly the Gold Coast) east of Cape Three Points presents a score of low headlands, often within sight of each other.

Soils and Minerals. — The soils of Guinea and the Sudan are generally lateritic, contain little plant food and are unproductive except in deltas and areas of high rainfall. The acre yield of crops is thought to be decreasing, especially in the drier grasslands. Some observers believe the Sahara is encroaching on West Africa, but the data are too few to be conclusive. The deterioration may be produced or hastened by improper use of land.

For centuries the natives of West Africa have panned placer gold in the forest region of Ghana and also along the headwaters of the Senegal and Niger. and placer tin on the Nigerian plateau. Europeans have intensified these operations, and have added workings of manganese and bauxite in the Ghana forest region, bauxite in Guinea, iron ore in Sierra Leone and Liberia, columbite on the Nigerian plateau, coal at Enugu in southeastern Nigeria and diamonds in Sierra Leone, Guinea and Ghana. All these minerals except the coal figure in the world market.

SETTLEMENT AND HISTORY

The people of West Africa are for the most part true Negroes, that is Negroes without a significant element of other racial strains. The major unit of social organization is typically the descent group, which among the less advanced peoples does duty as the political unit also. But in general the descent groups have become merged into tribes governed by chiefs and elders, usually elected from among the senior male members of certain prominent families. For about 2.000 years, the West African Negroes, particularly those in the Sudan, have been subjected to economic, social and sometimes political influence from white peoples advancing along the trans-Saharan trade routes from North Africa — Hamitic Berbers and Semitic Arabs and Jews. One of the principal results of this influence has been the emergence of territorial states in West Africa, first in the Sudanic grasslands and then in the Guinea forest. (See AFRICA: *Ethnography [Anthropology.]*)

The Sudan. — Movement across the grasslands is uninterrupted during the dry season, except at a few large rivers. Because both Sahel and Sudan lie open to the desert and stretch without a break across the continent south of the Sahara, a succession of wanderers from the north and east filtered in from very early times. Horses and oxen were the first beasts of burden to be used, but movement appears to have been greatly extended and perhaps also accelerated about A.D. 300, nhen camels appeared in the steppe and desert west of Egypt and camel caravans began to cross the Sahara.

The basis of the trans-Saharan trade was the exchange of salt from rock-salt deposits in the Sahara and manufactures from northern Africa, the Levant and southern Europe for gold, slaves and kola nuts from Guinea. In addition, the nomadic Berbers and Arabs of the desert have for centuries used the Sahel as a grazing ground for their cattle. A specifically Sudanese group of cattle nomads are the Fulani, a people of mixed Negro and white ancestry whose original home was in Tekrur in the extreme west, but who are now widely spread throughout the Sudan to as far east as Lake Chad. Although most of the Fulani have settled down and identified themselves with the life of the various Negro peoples of the Sudan, there are still about 300,000 pastoral nomads—the cow Fulani—who continue to pasture their herds without mixing with the sedentary Negro agriculturalists.

Knowledge of Sudanese conditions before the 19th century comes through Arab chroniclers, who reported on the "land of the blacks" (Bilad-es-Sudan) as a result of their own or others' visits. From a confusion of names emerges a picture of tribal groups consolidated into powerful and extensive states by military rule, the larger and most enduring of which seem to have been associated with the termini of the desert trade routes. West of the great northern bend of the Niger, the white influences reached the Sudan along the trade routes from Morocco; east of the Niger bend, the white influence has come principally from the direction of Egypt.

The earliest of the Sudanese states about which we are tolerably well informed is that of Ghana, created about A.D. 300 by Jewish or Berber settlers in the area to the west of Timbuktu, but which reached its peak under the rule of a Kegro dynasty. The attacks of the Almoravides in the 11th century seriously affected the power of Ghana, and its place as the principal state of the western Sudan was taken by the Mandingo empire of Mali. nhose centre was on the upper Niger. Mali absorbed the territories of Ghana in the 13th century and reached its peak in the early 14th century, when its power extended from Tekrur in the west to the Hausa states in the east, and from the desert in the north to the edge of the forest in the south. In the latter half of the 15th century, Mali was overthrown by the expansion of the Sonrhaï (Songhai) empire of Gao, a state ahich had emerged from Berber settlements on the lower Niger about the 7th century.

All these states of the Niger bend profited not only from the desert caravans but also from easy access to the gold-mining areas of the headwaters of the Niger and Senegal. A military expedition was sent across the desert from Morocco in 1590 to try and secure control of these gold-producing areas. This aim was not achieved, but the Sonrhai empire was destroyed and its chief commercial towns. Gao, Timbuktu and Jenne, occupied. At first these towns owed allegiance to the sultan of Morocco, but after about 1670 political power over most of the western Sudan passed into the hands of the Bambara (Mandingo) states of Segu and Kaarta. Between 1854 and 1863, the Sudan west of Timbuktu was conquered by Moslem Tucolors from Futa Jallon.

Between the Niger and Lake Chad, the states of Hausaland and Bornu were created by Berber invaders of about the 10th century. Bornu became a powerful though not very extensive state. but the Hausa states were always small and divided among themselves. Their strength lay in the industry and commercial ability of their people. The Hausa are noted for the manufacture of cotton cloth, ornamented morocco leatherware and tooled brass- and silverware. They became the leading traders of the Sudan from Lake Chad to Timbuktu, an area in which their language became the lingua franca of commerce. Islam reached the Hausa states from the west about the 14th century and, though never wholly accepted as a religion, greatly influenced their systems of law and administration. Between 1804 and 1810, a group of settled Moslem Fulani in Hausaland organized a crusade against religious dereliction. They made themselves masters of the Hausa states, but failed to conquer Bornu.

In the basin of the upper Volta, south of the Niger bend, the Mossi-Dagomba group of states succeeded in remaining independent of the great Sudanese empires. Although these states were in all probability organized about the 14th century by part-Hamitic refugees from the Berber conquest of Hausaland, their culture is essentially Kegroid, and their political permanence has been ascribed to the success of their rulers in utilizing the animist ancestor worship of their peoples as a tool for the consolidation of nation-states.

Between about 1880 and about 1906, the British and French overthrew the rulers of the Sudanese states and annexed their territories. The French from the first ruled these territories directly, but in northern Nigeria the British, lacking adequate administrators, restored the Fulani rulers, although each was provided with a British resident and a small advisory staff to prevent abuses in his government. This system of indirect rule was afterward widely adopted elsewhere in British tropical Africa.

The strong influence of Levantine civilization is evident throughout the Sudan and Sahel. From about the 11th century onward, Islam was widely disseminated from such Moslem commercial and scholastic centres as Walata, Timbuktu, Jenne and Sokoto. Government and law are commonly based on the precepts of the Koran. Many of the people are Moslems, and most wear the flowing robes and fezzes characteristic of the near east. Although farm villages are generally composed of clusters of circular thatched huts made of sun-baked mud, there are some hamlets and many walled cities built in the Levantine manner, where blind walls of courtyards and rectangular flat-roofed houses, sometimes built of burnt brick, form zigzag alleys that serve as streets. However the Futa Jallon uplands and the Bauchi plateau have remained refuges of animism, and the well-organized Mossi and Dagomba have also kept comparatively aloof from Islam.

Guinea. — Under native conditions, movement through the thick forest was all but impossible except on the streams and lagoons. The formidable surf discourages travel by sea, and seagoing canoes are rare except among the Kru, who live north of Cape Palmas on a coast dotted with offshore islands and reefs, and among the fishermen of the promontory reach of Ghana. Despite a population unusually dense for rain-forest country, most of the tribes have of necessity been small and scattered. Few of the peoples are Moslems; the great majority are animists. practising ancestor worship and, until recently, ritual human sacrifice. There are many professing Christians, particularly in the coast towns where individuals and families are separated from their tribal authority and customs and where Christian missions have been continuously at work since the early 19th century.

The military strength of the great states of the Sudan was based on their possession of cavalry, who could not operate in the forest. Nevertheless powerful states emerged in the forest with political customs and organization remarkably similar to those of the Sudan. The earliest of these states, Oyo and Benin, existed before Europeans began to trade on the coast in the 15th century, but their expansion and that of Ashanti and Dahomey was greatly influenced by the desire to capture slaves for sale to Europeans and by the possession of the firearms received in exchange from European traders. The Yoruba state of Oyo, in the southwest of modern Nigeria. existed before the 11th century, but it reached its peak of extent and prosperity in the 18th century, after which the slave trade engendered chronic warfare and the eventual disintegration of the state. Benin, to the southeast, was founded by Yoruba emigrants in the 14th century, reached its peak about the 16th century and thereafter declined for the same reasons as Oyo. Ashanti and Dahomey were organized as inland states at the beginning of the 17th century and reached their apogee in the early years of the 19th century. Their interest in the slave trade led them to conquer north of the forest in search of slaves, and southward to Ghana and the Slave Coast so as to establish direct contact with the European traders.

The Portuguese established trading posts on the Guinea coast in the 15th century and were followed and practically displaced by the Dutch, French, English and Danes in the 17th century. The trading posts built before about 1750 were usuelly fortified and garrisoned to protect them from attacks by rival European trading nations. They served as depots for a trade in gold, ivory. pepper, gum and slaves, but from about 1640 to about 1815 the dominating European interest in West Africa was the trade in slaves to the sugar and other plantations of tropical America. The tribal wars engendered by the slave trade and the jealousy of the African merchants on the coast from whom the Europeans bought their slaves combined with the natural obstacle of the forest to prevent the Europeans extending their power or influence for any great distance inland.

ECONOMICS

During the 19th century both the political and the economic complexion of West Africa changed. The European slave trade was outlaned; the elephants were all but exterminated; the output of the native gold workings declined. The only flourishing trade was in the palm products of the coast east of Ghana. By 1870 Great Britain and France were alone among the European powers in retaining an interest in West Africa. Since 1854 France had begun to penetrate up the Senegal and to develop the export of peanuts from its hinterland. Britain was interested in the suppression of the slave trade and in its replacement by legitimate trade, particularly in Nigeria and Ghana. In 1885 Germany precipitated a political revolution by proclaiming its colonies of Togoland and the Cameroons, forcing France and Britain to convert spheres of influence into definite colonies. While the French advanced from the Senegal eastward across the Sudan and linked up their conquests there with their trading posts in French Guinea and on the Ivory Coast and the Slave Coast of Dahomey, the British struck inland up the Niger and from the coast of Ghana into Ashanti and beyond.

The European penetration and pacification of the interior permitted the use of European capital in developing railways, deepwater ports and inland trade centres. The expanded colonies and the lengthened routes cut across the east-west grain of the country, facilitating internal trade between contrasting areas of production and bringing the interior into direct touch with the overseas world. Principal items of export are palm oil and peanuts, hides and skins, cocoa, cotton, rubber, gold, iron and manganese ores, bauxite and tin. Imports include a wide range of low-priced articles for African consumption, especially textiles and hardware, motor vehicles and machinery. Most goods move through half a dozen harbours constructed after 1910, which are increasingly replacing the primitive landing places previously used.

Tillage and grazing came under African control except for a few plantations in former French and German colonies and in Liberia. Agricultural exports are usually subject to inspection and grading by government authorities. Large-scale mining is organized by Europeans. Trade is shared by European, Asian and African merchants. Big business is largely handled by a few corporations with head offices in Europe and branches in all or several of the colonies. Small shops may be operated by individual Africans, though Levantines from Lebanon and Syria play an important part in the retail trade of the towns. Most shops, large and small, are general stores, each carrying nearly every kind of import and some local products. Perishables and most products of native craftsmen are sold by Africans, principally women, at markets, or by itinerant Hausa traders who traverse the country offering leatherwork, carved ivory and ebony, brassware and cottons and woolens from native looms. The climate prohibits permanent European settlement, and all heavy work is done by Africans.

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WEST ALLIS, a city of Wisconsin, U.S., a suburb of Milwaukee (*q.v.*), which surrounds it on three sides. Settlement began with the establishing of a station named North Greenfield by the Chicago and North Western railroad in 1880; the village plat was recorded in 1887.

In 1902 the Allis-Chalmers Manufacturing company (a consolidation of the 40-year-old Edward P. Allis company and three others), manufacturers of heavy machinery, purchased a 100-ac. site near the village and established their plant there. The settlement was renamed West Allis and in 1906 became a city. Thereafter a number of other manufacturing establishments located there. In 1891 grounds in the township were purchased for the Wisconsin State fair, subsequently held there annually.

Pop. (1960) 68,157. For comparative population figures see table in WISCONSIN: Population. (AL. E. SM.)

WEST BENGAL, a state of the republic of India, representing one-third of the former British Indian province of Bengal, partitioned between India and Pakistan in 1947. Area 33,885 sq.mi.; pop. (1951) 26,302,386. State capital, Calcutta (*q.v.*). West Bengal is bounded by the Himalayas on the north, Bihar on the west, Orissa on the southwest, the Bay of Bengal on the south and Assam and East Pakistan (East Bengal) on the east.

The northern districts of Darjeeling, Jalpaiguri and Cooch Behar have no territorial contiguity with the rest of the state. (Cooch Behar, *q.v.*, formerly a princely state, was absorbed into West Bengal on Jan. 1, 1950.) The whole area, apart from some hills in the north, is a deltaic plain watered by the Ganges and its tributaries. Normal annual rainfall is 78.06 in., mostly in the north and southeast. Rice is the most important crop, but some jute is grown and there are large tea plantations in the north. Forests, forming 14% of the total area, are found in the north and in the Sundarbans on the coast of the Bay of Bengal. At Raniganj in the west lies one of the richest coal deposits of India; iron, copper, tungsten and mica are also found. Jute, cotton, tea, oil and sugar are the principal industries, centred mostly in and around Calcutta. The only other important city is Kharagpur (pop., [1951] 129,636). There is a large railway workshop at Chittaranjan.

The state has a ministry and a bicameral legislature: the upper house has 51 members and the lower house or legislative assembly has 238 members. The first stage of the Mayurakshi river irrigation project—a diversion barrage at Tilpara, near Suri—was completed in 1951; the Damodar river valley project (initiated in 1945–46), though in Bihar, will benefit West Bengal, whose government is bearing 57% of the cost. In 1951 a ten-year plan was inaugurated to provide free and compulsory primary education, and in two years one-fifth of the state was covered. The whole state is malarial and intensive antimalarial operations have had to be undertaken. Attempts were being made in the 1950s to introduce legislation abolishing the permanent zamindari revenue settlement of 1793 (see BENGAL). (S. GL.)

WEST BROMWICH, a municipal, county and parliamentary borough in Staffordshire, Eng., 6 mi. N.W. of Birmingham. Pop. (1951) 87,981. Area 11.2 sq.mi. Although of ancient origin, the appearance of the town is modern and industrial. Coal is mined in and around the borough and the industries are mainly metallurgical—heavy and light engineering, springs, weighing machines and many other kinds of hardware. There are also chemical, oil and paint works. Canals connect with the Severn, Mersey, Thames and Humber. The church of All Saints, formerly St. Clement, was rebuilt in 1872. A technical college was built in 1952–53. The picturesque Oak house (16th century) has been modernized as a museum. The borough was incorporated in 1882 and became a county borough in 1888.

WESTBURY, RICHARD BETHELL, 1ST BARON (1800–1873), lord chancellor of Great Britain, whose most important public service was the reform of the then-existing mode of legal education, was born at Bradford, Wiltshire, on June 30, 1800. He was educated at Wadham college, Oxford, and in 1823 was called to the bar at the Middle Temple. He was appointed vice-chancellor of the duchy of Lancaster in 1851. In that year he obtained a seat in the house of commons, where he continued to sit until he was raised to the peerage. Politically a Liberal, he became solicitor general in 1852 and attorney general in 1856 and again in 1859. In 1861, on the death of Lord Campbell, he was created lord chancellor, with the title of Baron Westbury of Westbury. He acted with some laxity, and after parliamentary inquiries he resigned in 1865.

What chiefly distinguished Lord Westbury was the possession of a blistering tongue. He waged a remorseless war on the clergy in general and bishops in particular. He died in London on July 20, 1873, within a day of the death of Bishop Wilberforce, his special antagonist in debate among the clergymen of England.

See T. A. Nash, *Life of Lord Westbury*, 2 vol. (1888).

WESTBURY, an urban district in the Westbury parliamentary division of Wiltshire, Eng., 25 mi. N.W. of Salisbury by road. Pop. (1951) 5,260. Area 5.8 sq.mi. All Saints' church is Norman and later, with a magnificent nave and a chained black-letter copy of Erasmus' Paraphrase of the New Testament.

Westberie figures in Domesday Book as a manor held by the king. The earliest mention of the town as a borough occurs in 1442–43 but in 1886 the borough ceased to exist. Edington priory, now a private house, was owned by the abbess of Romsey in 960, by Augustinian monks in 1352 and by Queen Catherine Parr after the death of Henry VIII. The "White Horse" cut on the side of Bratton down is mentioned in a 1772 edition of William Camden's Britannia and was reshaped in 1873. Principal industries are the manufacture of west of England cloth and of gloves; also there are a tannery and a railway workshop. Westbury is a railway junction.

WEST CHESTER, a borough of southeastern Pennsylvania, U.S., some 18 mi. S.W. of Philadelphia; the seat of Chester county.

In 1762 the Turk's Head inn was established there but the growth of a town awaited the location of the seat of Chester county near the tavern after 1784. Thereafter West Chester history was enlivened for a time by threats of miniature war with Chester over the permanent location of the county seat. Eventually West Chester triumphed and the town came to be graced with the present court house, a Greek Revival structure by Thomas U. Walter. The life of the borough revolves around the adjacent farms, minor industry and the West Chester State Teachers college, established in 1871. West Chester was incorporated as a borough in 1799. Pop. (1950) 15,168. (R. F. WE.)

WESTCOTT, BROOKE FOSS (1825–1901), English theologian and bishop of Durham, was born on Jan. 12, 1825, near Birmingham. Westcott was educated at King Edward VI school, Birmingham, and at Trinity college, Cambridge. He took his degree in Jan. 1848, obtaining double first honours. Westcott remained for four years in residence at Trinity. In 1849 he obtained his fellowship and took holy orders.

In 1852 he became an assistant master at Harrow, where he taught for nearly 20 years. The writings which he produced at this period were: *History of the New Testament Canon* (1855), which, frequently revised and expanded, became the standard English work upon the subject; *Characteristics of the Gospel Miracles* (1859); *Introduction to the Study of the Gospels* (1860), expanded from his Norrisian essay; *The Bible in the Church* (1864); *The Gospel of the Resurrection* (1866); and a *History of the English Bible* (1869).

In 1868 Westcott was appointed examining chaplain by Bishop Connor Magee of Peterborough and in the following year he accepted a canonry at Peterborough, which necessitated his leaving Harrow. But the regius professorship of divinity at Cambridge fell vacant and Westcott was elected to the chair on Nov. 1, 1870. His *Commentaries* on St. John's Gospel (1881), on the Epistle to the Hebrews (1889) and the Epistles of St. John (1883) resulted from his public lectures. One of his most valuable works, *The Gospel of Life* (1892), a study of Christian doctrine, incorporated the materials upon which he was engaged in a series of more private and esoteric lectures delivered on weekday evenings. In 1881 there appeared the famous Westcott and Hort text of the New Testament. *(See* HORT, FENTON JOHN ANTHONY.)

In 1883 Westcott was elected to a professorial fellowship at King's. Shortly afterward he was appointed by the crown to a canonry at Westminster and became examining chaplain to Archbishop Benson. He held his canonry at Westminster in conjunction with the regius professorship. His sermons were generally portions of a series. To this period belong the volumes *Christus Consummator* (1886) and *Social Aspects of Christianity* (1887).

In March 1890 he succeeded his friend J. B. Lightfoot as bishop of Durham. He took an interest in the mining population of Durham and in the great shipping and artisan industries of Sunderland and Gateshead. His last book was *Lessons From Work* (1901). He preached a farewell sermon to the miners in Durham cathedral at their annual festival on July 20, and died on July 27.

See the **Lije** by his son B. F. Westcott (1903), and also that by J. Clayton (1906).

WESTCOTT, EDWARD NOYES (1846–1898), U.S. banker and novelist, author of *David Harum,* which brought him literary fame after his death. Born in Syracuse, N.Y., on Sept. 27, 1846, he attended schools in Syracuse until he was 16, when he became a junior clerk in the Mechanics' Bank of Syracuse. For 30 years his life was devoted to business except for some amateur singing and composing and some writing of pamphlets issued by the Reform club, New York city, of which he was a member. In the summer of 1895 Westcott began *David Harum: a Story of American Life* at Lake Meacham in the Adirondacks, where he had gone to recover from tuberculosis. He continued it in Italy, at a friend's villa near Naples, in the winter of 1895–96, and finished it in late 1896 after returning to the United States. The story of a crusty small-town banker with a hidden heart of gold and an obvious talent for horse trading and homely humour was rejected by six publishers before it was finally accepted late in 1897.

Westcott died on March 31, 1898, six months before publication of the book, which became at once a best seller. Over 1,000,000 copies were sold in the next four decades. A dramatization in 1900 provided William H. Crane (1845–1928) with one of his most successful roles; Crane later appeared in a motion-picture version, and Will Rogers appeared in another motion-picture version in 1934.

In 1901 appeared a short story, "The Teller . . . With the Letters of Edward N. Westcott," in which there was an account of Westcott's life.

WEST COVINA, a suburban residential city of California, U.S., located at the eastern end of the San Gabriel valley, 20 mi. E. of the centre of Los Angeles. Cultivation of the land for citrus fruit and walnuts began in the early 20th century. West Covina was incorporated as a city in 1923, the population then being about 500, and for some time remained primarily an agricultural community. After World War II it experienced rapid growth as part of the urbanization and industrialization of the eastern part of Los Angeles county. Almost entirely made up of moderate-sized single-family dwellings, West Covina had comparatively little commercial and virtually no industrial development in the early 1960s. Its working population mainly commutes by automobile to Los Angeles, Pomona and other neighbouring manufacturing and commercial areas. Its population in 1940 was 1,072 and in 1950 it was 4,499; a special census of 1958 showed an increase to over 47,000. (J. H. K.)

WESTERGAARD, HARALD MALCOLM (1888–1950), U.S. civil engineer and educator, was born in Copenhagen, Den., on Oct. 9, 1888, and received the B.S. degree from the Royal Technical college there in 1911. After further study at the University of Gottingen (1913) and the Technische Hochschule in Munich (1914), he was a fellow of the American-Scandinavian foundation at the University of Illinois (1914–15), receiving the Ph.D. degree in 1916.

He became a U.S. citizen in 1920.

Westergaard taught theoretical and applied mechanics at the University of Illinois from 1916 to 1936, becoming a professor in 1927. In 1936 he was appointed Gordon McKay professor of civil engineering at Harvard university; he also served as dean of the Harvard graduate school of engineering (1937–46).

He became widely known as a specialist in structural mechanics. He served the U.S. bureau of public roads on stresses in pavements, was senior mathematician (1929–30) and consulting engineer (1930–32) for the bureau of reclamation on the Hoover (then Boulder) Dam and was consultant to the bureau of yards and docks (1935–37) and the Panama canal (1946–47). Westergaard rose to captain in the Civil Engineer Corps, U.S. naval reserve (1936–46).

Westergaard died in Cambridge, Mass., on June 22, 1950. (S. C. HR.)

WESTERMARCK, EDWARD ALEXANDER (1862–1939), Finnish sociologist, philosopher and anthropologist, noted chiefly for his studies of the development of marriage and the family, was born at Helsingfors on Nov. 20, 1862. In his philosophical studies he was greatly influenced by the English empiricists. especially Adam Smith and Herbert Spencer, and later opened up for his students in Finland the world of English thought. He was concurrently professor of sociology at the University of London and professor of moral philosophy at the University of Helsingfors. In the course of three decades he also spent about nine years in Morocco, usually devoting the summer months to ethnological research.

Westermarck's major interests were the history of marriage and the comparative, sociological study of the moral ideas and institutions of mankind as well as the culture of the Moors. In his *The History of Human Marriage* (1891; 5th ed., 3 vol., 1921) he maintained that the family lies at the basis of human society and, like Sir Henry Maine earlier, denied the widely held view of J. J. Bachofen, Lewis H. Morgan and Engels that early man had lived in a state of promiscuity. In *The Origin and Development of the Moral Ideas* (2 vol., 1906–08; 2nd ed., 1912–17) he proposed a theory of ethical relativity, according to which moral judgments are ultimately based on emotions of approval and disapproval *(see* ETHICS, HISTORY OF: *Ethical Relativity).* While he appealed to the concept of an ideal society he provided no analysis of the concept of an ideal. for which it is difficult to find a place in his system. In religion, his position was that of an agnostic. He died on Sept. 3, 1939, in Lapinlahti, Fin.

Other works by Westermarck include *Ethical Relativity* (1932); *Christianity and Morals* (1939); *Ritual and Belief in Morocco,* 2 vol. (1926); *Marriage Ceremonies in Morocco* (1914); *A Short History of Marriage* (1926); *Wit and Wisdom in Morocco* (1930); *The Future of Marriage in Western Civilization* (1936); *Early Beliefs and Their Social Influence* (1932); *Memories of My Life* (Eng. trans. by Anna Barwell, 1929). (D. By.)

WESTERN AUSTRALIA, the largest Australian state, covers 975,920 sq.mi. (37.3% lying north of the Tropic of Capricorn) and has a maximum southwest to northeast length of 1,480 mi. Its isolation from the more thickly populated eastern coastal belt of the continent has been diminished by increasingly improved rail, road, sea, air and radio communications with other states in the Australian commonwealth and compensated for by the fact that Fremantle, the port of its capital city. Perth, is the first Australian landfall for most ships from the United Kingdom and Europe. Perth airport is the place of entry for the trans-Indian ocean service from Johannesburg to Sydney and for a weekly service to and from London via Djakarta and Singapore.

Significant changes in the domestic economy of the state around the middle of the 20th century also served to confirm the trend of the preceding 50 years toward increasingly close political integration of the once highly self-conscious western community with the rest of the Australian commonwealth.

PHYSIOGRAPHY

Nearly the whole state lies on the west Australian shield of Archean rocks, chiefly granite and gneiss, overlain in the north by Proterozsic sandstones and other sedimentary rocks, and here and there by younger sediments. The continental shelf is very narrow in the south, very broad, sloping, and deeper than usual in the north (Arafura sea). Evidence of subsidence is given by numerous coral and limestone reefs in the north and west and by granite islands in the south.

The Kimberley block (70,000 sq.mi.) is the northernmost region, bounded by King sound and the King Leopold range (Mt. Broome, 3,040 ft.). It is a plateau of sandstones and some basalts, cut by deep valleys and with a rugged coast line cut by drowned valleys. Tides are extreme (Hanover bay, 38 ft.).

The Canning basin (150,000 sq.mi.) shows Permian sediments covered by Jurassic sediments near the coast, which is low-lying and uniform (Eighty-Mile beach). There is artesian water. Most of the interior is covered with sand dunes.

The Nullagine platform (200,000 sq.mi.) is a plateau (1,000 ft.–1,400 ft.) with residual hills of sandstone, often flat-topped, giving way to dunes in the northeast. Archean granite and greenstone rise in the north to form the Pilbara block, worn down to 1,200 ft., with flat-topped hills. The Hamersley plateau has been uplifted and dissected, residual mountains rising to over 3,000 ft. (Mt. Bruce, 4,024 ft., highest in Western Australia). Metal ores are common. Rocky headlands and coral islets line the shore.

The Carnarvon basin (50,000 sq.mi.) has Permian and other sediments, and artesian water. It rises gradually to 1,000 ft. from the hills near Exmouth gulf and the lowlands around Shark bay.

The Yilgarn block (300,000 sq.mi.) is the main plateau of Archean granites, gneisses, etc., with greenstone intrusions. In the west and south it is covered in patches with a lateritic cap or its residuals (gravel, sand) which form very poor soils. To the southwest are small Permian glacial basins (Collie, Wilga) with coal deposits. To the south is the quartzitic Stirling range (Bluff knoll, 3,640 ft.). The southwestern edge of the plateau is deeply dissected and forms the Darling hills (Mt. Cooke, 1,910 ft.) which rise above the great Darling fault (500 mi. north to south).

The Swan coastal belt covers about 16,000 sq mi. (400 mi. north to south, 30–100 mi. west to east) west of the Darling-fault scarp. The main part is a sunkland covered with Quaternary sands and with calcareous dunes near the shore; it forms an artesian basin. To the west are calcareous reefs and islands (Rottnest, Garden; Abrolhos farther north) which are hazards for navigation. The removal of a bar has opened up Fremantle at the mouth of the Swan and dredging has opened Cockburn sound to oil tankers bound for the Kwinana refinery.

Part of the Eucla basin, which is artesian and underlies the enormous limestone waste of the Nullarbor plain, is in Western Australia; it slopes to the south from about 1,000 ft., ending in cliffs 200–400 ft. high.

Climate. — Weather is affected by any of four types of air masses: equatorial (hot and humid). tropical maritime (warm and humid), tropical continental (hot and dry in summer, cool and dry in winter) and polar maritime (cool and humid), referred to as *Eq*, *Tm*, *Tc* and *Pm* respectively. Migratory anticyclones cross the state regularly from west to east, affecting latitudes 20°–35° S. in summer and 12°–27° S. in winter, at a speed of about 300 mi. a day. Since anticyclonic circulation is anticlockwise in the southern hemisphere, an anticyclone approaches Western Australia from the Indian ocean with a stream of cool humid southwesterly air, usually *Pm* in winter, modified in summer. As the anticyclone proceeds inland, the air becomes drier and the southwesterly is gradually replaced by a northeasterly, with all the characteristics of *Tc* air. Then a new anticyclone arrives and the same sequence is repeated.

In summer (Dec.–Feb.) the anticyclones travel along their southernmost path and bring an alternation of cool southwesterlies (70°–75° F.) and hot dry northeasterlies (80°–100° F.) to the southern parts of the state. Occasional maxima reach 105° F. or 110° F. Humidity is very low and there is no rain except from rare local thunderstorms. The heat over the northwest gives rise to a low pressure which allows Eq air to flow in forming an intertropical front and bringing torrential rains to the north and sultry days to large areas. Temperatures there vary from 75°–80° F. at night to 95°–105° F. in the afternoon. Marble Bar has recorded as many as 160 consecutive days above 100° F. in one year and Wyndham has the highest annual average in Australia (84.4" F.). Summer rains vary from 1–3 in. in the south to 20–30 in. in the north, with large dry areas in the interior.

In February and March disastrous hurricanes ("willy-willies") sometimes hit the coast between Broome and Onslow and proceed toward the southeast, bringing torrential rains, perhaps 2–3 in. in one hour. There are occasional hurricanes in the northwest during autumn (March–May), the last rains in the north with the gradual retreat of *Eq* air and the advance of dry *Tc* air, and the gradual northward migration of the anticyclones. The pressure troughs between anticyclones deepen and cold fronts appear. Humidity varies and the far southwest gets its first frontal rains (6–9 in. for the season). In winter (June–August) the anticyclones are in complete control of northern weather, with cool dry air blowing offshore. There are heavy frontal rains in the south, ranging from 15–20 in. on the coast to 8–10 in. in the interior. Temperatures are 30°–60° F. at night, 60°–75° F. in the afternoon in the south, some 20° warmer in the north. Spring (Sept.–Nov.) brings the last frontal rains to the south (4–8 in.) and the highest temperatures to the parched north, before the first "monsoonal" rains fall, sometime in November.

The rainfall is very reliable in the far south and the far north, but is very variable in the intermediate areas (Onslow 60%) where it is also very scarce, 58% of the state getting under 10 in. a year on the average. Reliable rains of 30 in. a year or more fall over only 5.4% of the state, mostly in the southwest, where the climate is very pleasant.

Rivers and Water Supply. — The Kimberley rivers flow only after the summer rains, but have large permanent pools. The Ord (300 mi.) has a large estuary. The Fitzroy (325 mi.) crosses the King Leopold range. The northwestern rivers flow occasionally, but may be dry for several years.

They include the DeGrey-Oakover (370 mi.), the Fortescue (340 mi.), the Ashburton (220 mi.), the Gascoyne (475 mi.) and the Murchison (440 mi.). A very large inland area has no drainage or sporadic drainage (salt lakes).

The rivers which rise on the Yilgarn block and flow west through the Swan coastal plain are short, like the Swan-Avon (240 mi., dry in summer), the Murray (50 mi., 213,000 ac.-ft. yearly) and the Collie (60 mi.). Farther south the flow is nearly perennial with strong winter-spring maximum. The Blackwood (190 mi.) conveys 445,000 ac.-ft. a year from 6,800 sq.mi. of basin, the Frankland (80 mi.) 135,000 ac.-ft. a year from 1,510 sq.mi.; but these rivers are more or less brackish. The rivers which flow to the south are short and intermittent and run mostly in winter.

Most of the water used in Western Australia comes from reservoirs built in the hills on the western edge of the Yilgarn block. Mundaring (15,100,000,000 gal.) supplies water to agricultural and mining areas east of Perth, as far as Kalgoorlie (348 mi.) and Norseman and is linked with the Canning (20,550,000,000 gal.) which supplies most of Perth's needs. Reservoirs farther south supply irrigation districts on the coastal plain. Many country areas still rely on wells tapping the water table and on rain water, but an increasing number receive water from the Wellington (Collie) reservoir (8,700,000,000 gal., to be increased to 40,800,000,000 gal.).

Flora and Fauna.—Botanically Western Australia may be divided into three provinces each with its own distinctive vegetation. The southwestern province comprises the area inside a line from Shark bay to Israelite bay. Climatically it is characterized by summer drought and winter rain. Nearly 80% of the species are endemic and include the kangaroo-paws (Anigozanthos and Macropidia), the Christmas tree (Nuytsia) and many members of the families Proteaceae and Leguminosae. The richest flora and the most striking flowers occur on the leached sand plains. The northern province experiences summer monsoonal rainfall and the vegetation consists of savanna (grassland), savanna woodland, and harsh Triodia steppe. The Eremean or desert province includes a vast inland area of capricious rainfall, the main types of vegetation being mulga bush (Acacia), eucalyptus woodland and Triodia steppe. In favourable seasons the desert blossoms with annuals.

The isolation of Western Australia is largely responsible for its peculiar flora and fauna. In the evolution of the flora, elements derived from Antarctic and Indo-Melanesian sources are important. (See C. A. Gardner, "The Vegetation of Western Australia, with Special Reference to the Climate and Soils," Proc. Roy. *Soc.* W.A., 1942.)

Fauna in the western state lacks the diversity found in the animals of eastern Australia and is deficient in the large number of endemics characteristic of the plants. Zoogeographically the fauna falls into three regions agreeing in area with the botanical provinces. The southwestern province has a fauna characteristic of the Bassian subregion. Cave deposits indicate that in pleistocene times a much more varied fauna occurred and animals such as the koala (Phascolarctos cinereus), wombat (Phascolomis sp.), Tasmanian devil (Sarcophilus harrisii) and Tasmanian wolf (Thylacinus cynocephalus), now found only in southeastern Australia, were common. Unique forms are the burrowing frog (Myoba trachus gouldii) found associated with termites, and *Metacrinia nichollsi,* often found in the nests of the ant Myrmecia *regularis.* The numbat (*Myrmecobius* fasciatus) formerly had a wider range but is now restricted to the wandoo (Eucalyptus redunca var. elate) forests. The northern province has a fauna related to that of the Torresian subregion of Queensland and northern Australia. In the desert areas between the southwest and northern provinces occurs a fauna characteristic of the Eyrean subregion. The ant-eating mountain devil (Moloch horridus) of the Agamidae is a common and well-known representative of this fauna.

Forests.—Western Australia is a land of vegetation, but not of forests. Species of the genus Eucalyptus are the dominating trees throughout the land. The timber forests in the true sense are confined to a comparatively small area in the extreme southwest of the state in the regions of higher winter rainfalls. Jarrah forest (*Eucalyptus* marginata) occurs on lateritic soil while karri forest (*Eucalyptus* diversicolor) occurs on karri loams in the 40 in. rainfall belt. Important tree growth. however. has occurred on the wheat belt of 34,000,000 ac. About 10,000,000 ac. which carried forest and mallee have been cleared for wheat growing. Farther inland there are 18,000,000 ac. of dry country eucalypt woodlands, with a rainfall of down to 10 in. annually. Of this area about 6,000,000 ac. have been cut over for firewood and timber for gold mining, yielding about 24,000,000 tons of firewood over a period of 60 yr. The mulga belt to the north, covering about 50,000,000 ac., has yielded and is still yielding important supplies of fuel, mining timber, fencing and general pastoral requirements. It has been estimated that 4,000,000 tons of wood have been cut there. In the extreme north of the state river rain-forest is met with along the main streams. This consists of eucalypts with species of other genera. There is a sparse stocking of eucalypts over a large part of the area. In some parts this may amount to three tons of firewood per acre. Native pine (*Callitris* intratropica) is met with rarely and mainly north of the King Leopold range. Mangroves are found near the coast.

A line drawn from York to Walpole marks off what is perhaps the most valuable timber area in Australia. There the distribution of types is markedly dependent upon rainfall and soils. Behind the immediate coastal fringe in the south lie, in the areas of 30–60 in. rainfall, about 250,000 ac. of karri forest composed of handsome giants 200–250 ft. high yielding tough wood valuable for constructional purposes, etc. From near Busselton to north of Fremantle the 5-mi.-wide strip of coastal limestones supports tuart (average height 80 ft.) growing in more open formation. But the greater part of the area (40–25 in. rainfall) north of the karri forests is occupied mainly by jarrah interspersed with marri (about 8,000,000 ac., of which about 6,000,000 ac. are commercially useful). The jarrah prefers lateritic soils and the trees. which in good areas average 100 ft. in height, yield first-class hardwood resistant to weathering and insects, which is in demand for all types of constructional purposes and for interior works.

State forest in the main forest zone of the southwest totalled 3,400,000 ac. in 1953 with 4,000,000 ac. as the ultimate objective.

The sawmilling industry, based chiefly on jarrah and karri, is important to the state and 17,000,000 cu.ft. of sawn timber a year are produced, of which about 24% is exported.

Vigorous measures were taken after the passing of the Forests act in 1918 to control and regenerate the indigenous forests as they were cut over, and to establish pine plantations. Nearly 2,000,000 ac. of indigenous forest over which the sawmilling industry had operated were under intensive management and protection in 1953. Thirty-four fire lookout towers, 13,000 mi. of road and 339 houses in the forest for resident employees indicated the extent of this development in 1953. Plantations of pine then totalled 17,000 ac. and there were 18,000 ac. of mallet plantations, grown chiefly for tanbark. The production of tannin extracts from the wood of the wandoo tree is an important industry using over 65,000 tons of timber a year. Sandalwood, a small tree which grows in the low rainfall inland areas, is exported and also yields oil by distillation of the wood. (See also AUSTRALIA: Forestry.)

HISTORY

The date of the first discovery of the western shores of Australia is uncertain. It has been suggested that both the western and northern coasts of the state may be identified with the "Java le Grande" of maps said to date from around 1550. It is possible that Portuguese navigators sighted the northwest coast on the way to the Spice Islands, as early as 1527. The first landing of which definite record exists is that of the Dutch captain, Dirk Hartog, in Oct. 1616. To commemorate his discovery, Hartog left a pewter dinner plate, with an inscription scratched into it, on the island now bearing his name. Subsequent Dutch navigators, including Abel Janszoon Tasman (*q.v.*), charted the coast as far east as Nuyts Land, between 1618 and 1644. Later comers included William Dampier (*q.v.;* 1688 and 1699), William de Vlamingh (1696–97), George Vancouver (*q.v.;* 1791) and Bruni d'Entrecasteaux (*q.v.,* 1792).

The earliest settlement was made from Sydney, in Dec. 1826, when, due to suspicions that the French might found a base on the west coast of Australia, Maj. Edmund Lockyer was dispatched to take formal possession of King George's sound, with a party of convicts and soldiers. This establishment returned to Sydney in

1831. Meanwhile, in March 1827, Capt. James Stirling had made a survey of the Swan river and Thomas Peel, encouraged by Stirling's report. formed a syndicate, offering to send out and settle 10.000 emigrants to the Swan river.

Because of these prospects of settlement. the British government dispatched Capt. C. H. Fremantle to take possession of the unoccupied part of Australia west of 129° E. In June 1829 Stirling arrived. as lieutenant governor. and shortly after founded the towns of Perth and Fremantle: on the Swan river. Several parties of migrants began to arrive. including those brought out by Peel. They were ill-prepared for pioneering; the coastal land was poor and labour was unobtainable to work the large and scattered land grants. Many left for the eastern colonies, but the discovery of better land beyond the Darling ranges led to the extension and consolidation of settlement by 1835.

Despite Peel's failure, a second syndicate, the Western Australian company, was formed in 1839, to acquire the Lautour estate. 100 mi. S. of Perth. and there to establish a settlement on Wakefieldian lines. Between 1841 and 1843. several parties were sent out to this new settlement. Australind, but loss of confidence among those financing the scheme contributed to its failure. The explorations of George Grey (1838) and the Gregory brothers (1845–46 and 1848) led to the settlement of the Champion bay district, north of Perth. centred around the town of Geraldton. Lead and copper mines were established in this district, although grazing and farming were the principal pursuits.

The continued labour shortage in the colony led to a local demand that convicts should be sent out from the United Kingdom for employment on public works. An order-in-council authorizing the formation of a penal settlement was issued in 1849. The supply of convicts and ticket-of-leave men overcame the labour shortage. which would have become more acute as the result of the gold discoveries in the eastern colonies. The cheap convict labour and the imperial grant-in-aid gave an impetus to expansion before transportation ceased in 1868. The northwest pastoral country was opened in 1863 after further explorations by the Gregory brothers.

After the abolition of transportation. a partly elective legislative council was appointed in 1870, during the administration of Gov. F. A. Weld. Between 1870 and 1890, valuable work in opening up more land for pastoral and agricultural settlement was performed by the officers of the survey department, under Malcolm Fraser and John Forrest. The brothers John and Alexander Forrest crossed the continent between Esperance and Adelaide in 1870 and between Geraldton and the overland telegraph line in 1874. Other transcontinental crossings were made by P. E. Warburton in 1873 and E. Giles in 1875. Such explorations enlarged the area of pastoral settlement but demonstrated the desert nature of much of the interior.

Alexander Forrest opened up the Kimberley district in 1880 and there, in 1884, the government geologist reported indications of auriferous country. A gold rush followed at Hall's Creek (1885–87), but this field was largely abandoned with the proclamation of gold fields in the Pilbara district in the north. in 1888. and in the Yilgarn, 200 mi. to the east of Perth. Within five years, richer finds followed in the Murchison (1891), at Coolgardie (1892) and at Kalgoorlie (1893).

Progress in other directions had included the construction of a railway, begun on the land-grant principle. from Perth to Albany (completed in 1889), and the commencement of another to Geraldton. The improving prospects of the colony induced a demand for complete self-government, A bill enabling Queen Victoria to grant a constitution to Western Australia received the royal assent on Aug. 1 j. 1890. This provided for a governor, a nominee legislative council and an elective legislative assembly. The legislative council mas to become elective when the population reached 60,000 —a change effected in 1893.

Sir (later Lord) John Forrest (*q.v.*), premier from 1890 until his entry into federal politics on the establishment of the Australian commonwealth in 1901, led a parliament at first dominated by primary producing interests. The advent of thousands of gold miners accelerated the progress of the country and led to the provision of such public works as the Fremantle harbour and the Perth-Kalgoorlie railway. Forrest also sponsored the provision of a pipeline through nhich water mas pumped over 300 mi. from Mundaring (near Perth) to the arid Coolgardie gold fields During Forrest's later years of office. however an opposition party arose among the gold-fields men — many of them "t'othersiders" from Victoria and New South Wales—who strongly supported the federation movement.

The agricultural interests hesitated to join the new Australian commonnealth nithout receiving a pledge for the retention of their onn customs dues for five years but after Sir John Forrest had made an unsuccessful attempt early in 1900 to secure this concession from the other colonies. a referendum in July of that year showed a majority of over 25.000 in favour of federation. The Constitution act ultimately provided that Western Australia should have the right to enact its own tariff as against the sister states for the desired five years, decreasing annually at the rate of one-fifth of the amount of the original duty until the whole disappeared.

With the rise of the Labour party in Western Australia, the other two groups in the state parliament sank their differences and coalesced in 1905. With the decline of alluvial mining. a policy of agricultural settlement was pursued and. between 1906 and 1914, the wheat lands were extended within the 10-in. rainfall area. From this region there arose a new Country party. which usually aligned itself against Labour. The latter's strongholds lay in gold fields. inner metropolitan and northern pastoral electorates.

The federal government's policy of protecting secondary industries tended to react unfavourably on Western Australia. a primary producing state, so that. during the depression at the end of the 1920s, a movement arose for secession from the federation. though it included many who were more eager to air grievances than ready to secede. A referendum held in 1933 favoured secession, by 138.653 votes to 70,706, but in 1935 a joint committee of the British houses of parliament declared itself incompetent to consider the state's petition to give effect to this move. With the revival of prosperity and the coming of World War II. during which Western Australia faced a threat of invasion by Japan, the secession movement became moribund. Good wheat and wool prices ensured postwar prosperity and a movement toward industrialization mas highlighted by the decision of the Anglo-Iranian Oil company, in 1952, to begin construction of a refinery at Kwinana, south of Fremantle. as part of an investment of £A40.000,000. Investigations in the Exmouth gulf area. in the northwest, in 1952–53, also aroused hopes of the discovery of oil. In late 1953 oil was discovered at Learmonth and. in some quarters. this was hailed as the most important development in Western Australia since the discovery of the Coolgardie gold field in the 1890s.

Western Australians thus entered the second half of the 20th century with an awareness of impending economic and social changes. The material changes. it was felt. might prove comparable with those following the gold discoveries toward the close of the preceding century, which had revolutionized the economy of the isolated, agricultural western colony and had jolted it into foundation membership of the Australian commonwealth, against the wishes of many of its settled population. Cultural influences were also producing results in the western state whose estimated expenditure in 1953–54 was £A4,902,486 on government primary, secondary and technical education in addition to the expenditure of church (notably Roman Catholic) and other private schools. This was a substantial increase on the amount spent in previous years when Western Australia's expenditure in this field was greater per head of population than that of any other Australian state. In 1953 the University of Western Australia — the first. and. until the establishment of the University of Ceylon, the only "free" university in the British commonwealth — spread its annual expenditure of £A467,1jj over 7 faculties. embracing 16 chairs and 1,741 students. Between 1901 and 1953, non-Labour and Labour ministries each enjoyed 26 years in office. In 1953, the premier (A. R. G. Hawke) headed a Labour ministry; the leader of the opposition was Sir Ross McLarty, who had been premier from 1947 to 1953 in a Liberal-Country party coalition government with the Country party leader (A. F. Watts) as deputy premier.

POPULATION AND ADMINISTRATION

Much of the interior of the state, apart from relatively impermanent mining centres, is sparsely populated by human beings, whatever its pastoral capacities may be. Most of the increase is taking place on and near the coasts. chiefly in the temperate southwest corner. In this zone of settlement, ports naturally play a prominent part. Perth (*q.v.*) with its port Fremantle (*q.v.*; combined population 120,145 in 1954) holds a key position. Commercially if not physically it lies midway between north and south, and a consistent policy of centralization has fostered its importance. The settlements of the southwest are (1955) mainly small agricultural and railway centres, with the beginnings also of some industries processing primary products.

Constitution. — The legislative council of the state parliament consists of 30 members, representing ten provinces and elected on a restricted franchise for six years. The legislative assembly has 50 members elected for three years. Ten senators and eight representatives 'represent the state in the federal parliament at Canberra.

Education. — Two systems of primary and secondary education exist side by side. The state schools are under centralized administration; the private or independent schools, serving between one-quarter and one-fifth of the children, are controlled for the most part by church organizations among which the Roman Catholic teaching orders predominate. Education is compulsory for children between the ages of 6 and 14 years who live within three miles of an established school or within two miles of a school bus route. In rural areas, more than 500 buses cater daily at government expense for 14,000 children attending schools at central points serving a radius of 20 mi. This system, together with correspondence classes for more isolated children, is conducted from Perth and supplemented by itinerant teachers in the extremely remote northwest areas. There are two teachers' colleges, six technical schools and an agricultural college.

The contribution of the private or independent schools is numerically greater at the secondary than at the primary level. All the private schools are dependent on fees and endowments, while both primary and secondary education is free at government schools. There is an increasingly close association between government and nongovernment schools and the secondary school syllabuses are co-ordinated by the requirements of the university's public examinations board.

At the University of Western Australia (founded 1911) there are no tuition fees for bona fide Australian residents in the faculties of arts, law, education, science, engineering and agriculture and relatively low tuition fees are payable in dental science and medicine.

Social Services. — In social services generally, the payment of age. invalid and widows' pensions is regarded as a federal government responsibility. Canberra is also responsible for such income services as unemployment. sickness and certain special payments as well as maternity, child endowment, tuberculosis, repatriation and rehabilitation allowances.

The state's social services additional to the above-mentioned supplementary income services include those of municipalities and state government departments such as public health, police. mental health, child welfare and native welfare as well as education. and those of voluntary associations such as the spastic welfare association, the institute for the blind, the maimed and limbless association and the marriage guidance council. Western Australia played a leading part in executing the federal-state tuberculosis agreement of 1948 and was also a pioneer among the Australian states in making compulsory chest X-ray examinations, which began in Aug. 1952.

The Western Australian Workers' Compensation act, 1912–1954, provides for compulsory insurance by employers to compensate for losses by industrial accident, including industrial diseases. For the year 1954–55 the sum of £41,647,458 was spent on insurance premiums and £A1,248,920 paid out in claims.

ECONOMICS

Agriculture, Pastoral Activities and Land Settlement.

After the foundation of the colony, in 1829, gold, wool and wheat were Western Australia's most important products. In the first 60 years wool was the chief exportable commodity. The colony made very slow progress. the population being 5.886 in 1850 and only 46,290 in 1890. The first ventures into the pastoral lands in the northwest of the state were made in the 1860s and wheat production barely kept pace with the needs of the small community. When the gold rushes of the 1890s led to a rapid population growth — the total reached 179,708 in 1900 and 276.832 in 1910 — agriculture was stimulated by the existence of a profitable home market for nearly everything that could be produced.

The decline of the gold industry between 1900 and 1910 coincided with the opening of the "wheat belt" and the state's emergence as a wheat exporter. This development marked the real beginning of agricultural expansion. The population grew to 331,323 in 1920 and 431,610 in 1930. By 1930 the wheat belt had extended eastward. in some cases into country with less than 11 in. annual rainfall. A record crop of 53,000,000 bu. was harvested in that year. In the next decade low prices and dry seasons forced some retreat from the northeastern section of the wheat-growing country. Fortunately wheat-growing and wool production were complementary activities over most of Western Australia's farming country. When wheat prices became less attractive farmers concentrated more of their attention on carrying sheep and by 1950 nearly every wheat farm had its flock of sheep.

The boom in prices after World War II, particularly in wool, transformed the outlook for thousands of farmers in Western Australia. In 1939 the total value of agricultural and pastoral production had been estimated at £A20,000,000. At that time wool, wheat and other agricultural products accounted for more than 40% of the state's income from exports and were about equal in importance to gold. As a contrast, averages of values for the five-year period 1950–51 to 1954–55 were wool £A40,200,000, wheat £A24,900,000, livestock slaughterings £A10,900,000, milk £A5,300,000, fruit £A3,900,000, vegetables £A3,400,000, poultry £A2,600,000. The total value of agricultural and pastoral production was then more than twice as great as that of manufacturing and nearly five times that from mining, forestry and fisheries combined. Rural industry retained its dominant position in the economic life of the state despite the manufacturing and urban industrial progress referred to below, which helped to raise the state's population to 573,671 in 1950 and 639,771 in 1954.

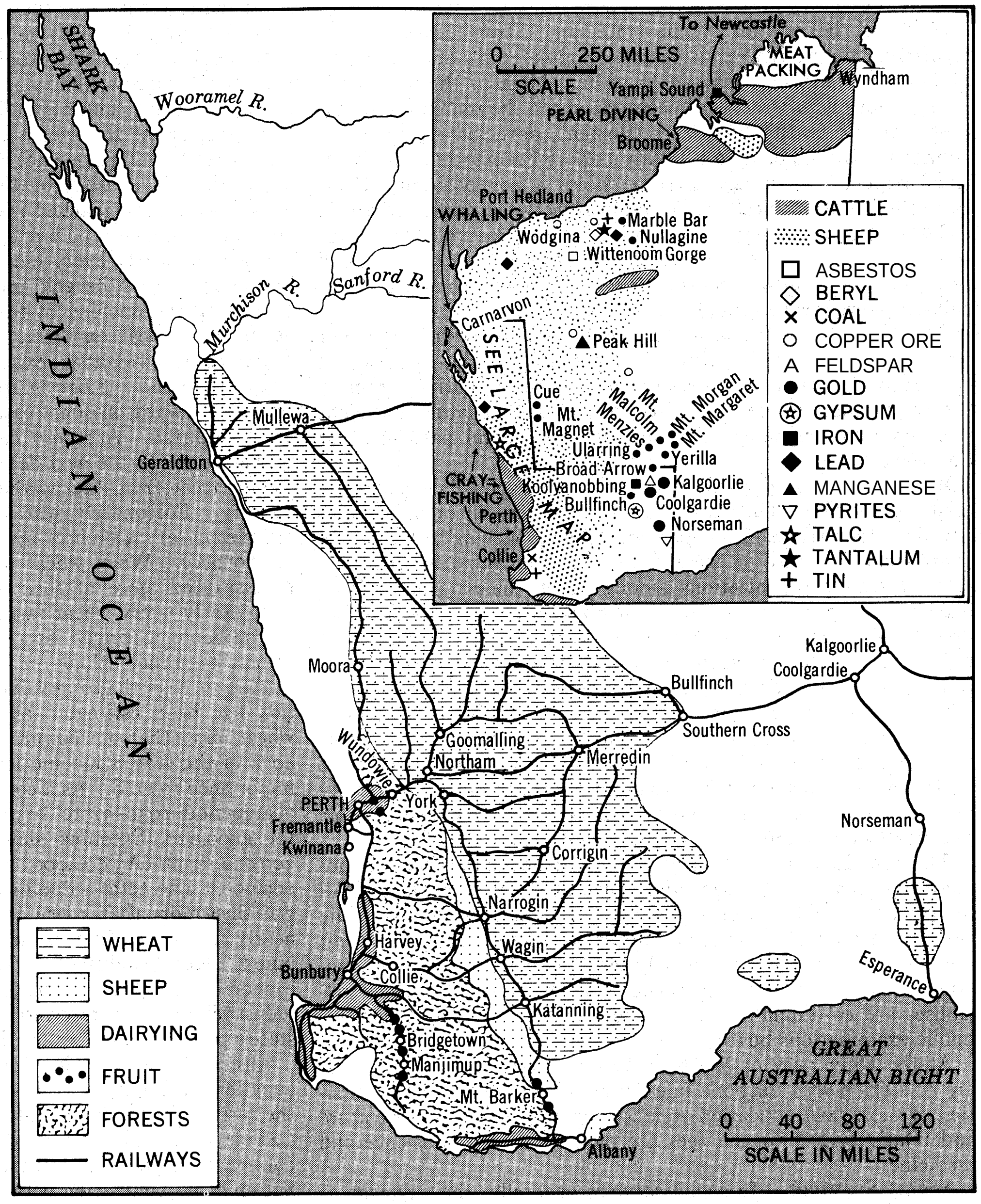
Although there is this strong rural bias in its economy, the occupational grouping of the state's population is similar to that of the rest of Australia and of countries like the United States and Canada where less than 25% of the population is engaged in agricultural pursuits. It resembles these countries, too, in the distribution of its population between town and country. Rather more than half its inhabitants are urban and live in the metropolitan area of Perth. the capital city.

Agriculture is specialized and commercial in character and not of the subsistence or peasant type. The farmer expects to produce sufficient supplies for sale to enable him to enjoy a standard of living comparable with that of the town worker. Farm labour is scarce and expensive and full advantage is taken of mechanization, particularly in cereal growing.

Climate and topography are the chief determinants of the extent to which land can be used for agricultural and grazing purposes and also of the forms of agriculture which can develop. Rainfall has always been the dominant factor governing agricultural and pastoral expansion. On the basis of rainfall distribution the state falls into three well-defined zones, namely (1) the Kimberley division in the extreme ncrth; (2) an area in the southwestern corner where the rainfall ranges from 50 in. on parts of the coastline and the 11 in. isohyet forms the northern and eastern boundaries; and (3) the large area lying between these two. where the annual rainfall is sparse (10 in. and less) and uncertain in its incidence.

The northern region, which lies within the tropics, has a short wet season (December–March) during the hot summer. Average yearly recordings range from 1j in. to over 50 in. in the northern part of the Kimberley division. The rain is often torrential and frequently erratic in its distribution through the season. About half the state's cattle are to be found in this region and sheep raising has penetrated into its southern part. The commonwealth and state governments have co-operated in investigating the potentialities of the valley of the Ord river, one of the region's two large river systems, for an irrigation project. The Rimberley research station, 50 mi. from Wyndham, was established in 1936. Sugar cane and rice have emerged as potential cominercial crops. A dam site on the Ord river has been selected which commands nearly 100,000 ac. of alluvial flats. Private operators have carried out interesting investigations into the air freighting of beef carcasses from a cattle station to coastal meat works and rice growing in the food plain of the Fitzroy river. Pearling and some small-scale mining constitute the only other economic activities of note in this northern region.

The aridity of the vast expanse of country lying between the two well-defined winter and summer rainfall regions of the southnest and the far north imposes severe. limitations on its value for agriculture or grazing purposes. About 200,000,000 ac are occupied as pastoral leasehold and merino wool is produced under conditions of extensive grazing, but, over much of the area, the rainfall is insufficient even for pastoral activities. Nearly half the state. including the central portion and some of the northnest coastal region. has an annual rainfall of less than 10 in. The only agricultural settlement in this region is at Carnarvon, on the coast, where bananas and vegetables are grown under irrigation with water pumped from beneath the sands in the bed of a usually dry river.



WESTERN AUSTRALIA: LAND USE. THE LARGER MAP SHOWS THE SOUTHWESTERN PART. WHERE POPULATION IS CONCENTRATED. PRINCIPAL MINERAL DEPOSITS FOR THE ENTIRE STATE ARE SHOWN ON THE INSET MAP

In the absence of any substantial supplies of water for irrigation, the pastoral country is utilized to nearly its maximum capacity.

Only in the southwestern part of the state, where there is a Mediterranean type of climate, has it been possible for agriculture to develop; it extends. in an irregular pattern, over nearly 100,000 sq.mi. The inland boundary is approximately the 11 in, isohyet. The rainfall, which is concentrated mostly in the April–October period, reaches jo in. along the extreme southwest coast but dwindles rapidly as distance from the coast line increases.

Most of the country in this region has little value for grazing before it is cleared of timber or scrub and fertilized with phosphates. consequently a suitable measure of progress in land development is afforded by statistics of the area of cleared arable land. In 1890 it was only a50,000 ac. compared with 20,500,000 ac. in 1955. A feature of this development was the assumption of the initial risk by governments. It was the government which built railways before the agricultural possibilities of the land were thoroughly examined; it then provided roads, water supplies, schools and even the credit for the potential farmer without capital. After World Wars I and II it concerned itself with settling returned servicemen on the land.

Agriculture was long handicapped by the widespread phosphorous deficiency of Western Australian soils. When the geographical expansion of the wheat belt occurred, between 1905 and 1930, it was associated with the use of superphosphate, the development of new drought-resisting wheats and the adoption of suitable methods and implements for farming in low rainfall areas. After 1920 considerable attention was given to settlement of the wetter, more heavily timbered country nearer the southwest coast. An ambitious government scheme for group settlement of migrants from the United Kingdom encountered technical difficulties, to which the economic depression of the 1930s added a severe setback. However, the practical experience gained in this period was subsequently put to good use. During this phase of land settlement the extraordinary value of subterranean clover as a pioneer pasture plant, when top dressed every year with superphosphate, was first realized.

A third wave of interest in land settlement was assisted by the favourable outlook for agricultural commodities which had developed by 1950. There were then several million acres of country which could be brought into production, and land development, which was mostly being carried out by farmers already established, was progressing at the rate of 500,000 ac. a year. The bulk of this land is the light textured "sand plain" country which is very deficient in plant food.

Subterranean clover (T. *subterraneum*) and heavy dressings of superphosphate, often in association with small applications of trace elements. chiefly copper and zinc, transform this formerly useless land into productive farms. The use of the bulldozer for land clearing and dam sinking constituted another notable technical advance in land development methods in the years following World War II.

Wool production is the most widespread of the state's rural industries. The state's sheep population by the mid-1950s exceeded 12,000,000, mostly merinos; the 1953–54 clip of 126,500,000 lb. was a record. Nearly three-quarters of the sheep are located in the agricultural districts in the southwest where cereal cropping and sheep raising combine well together. Subterranean clover and a variety of introduced grasses and herbage plants constitute the bulk of the grazing available in the farming country. The average yield of wool per head of sheep shorn (including lambs) for the five years 1950–51 to 1954–55 was 8.7 lb. In 1950–51, a year of record prices. wool output was valued at £A59,000,000.

In the northwest. where the rainfall is scanty and uncertain. an "extensive" form of husbandry is practised. The grazing consists of natural grasses, herbage and top feed; *i.e.*, native bushes and low trees. especially acacias. Little or no conservation of fodder or supplementary feeding is possible. thus making the sheep very susceptible to the drought periods which occur with varying frequency throughout the pastoral areas. The pastoral properties are held under leasehold conditions and range in size between 100,000 and 1,000,000 ac. The carrying capacity varies with the district and seasonal conditions; one sheep to 20–30 ac. is regarded as an average for the area.

Wheat is grown on approximately 3,000,000 ac. and on nearly 9,000 holdings each year. Annual production is between 30,000,000 and 50,000,000 bu. Western Australia wheats are white wheats of slightly below "filler" strength. valued mainly for high flour yield and the colour and bloom they impart to flour blends.

Most of the wheat crop is planted with the aid of tractors and the appropriate large machines. Horse teams have almost disappeared from wheat farms. A large modern tractor can comfortably handle from 500 to 1,000 ac. of cereal crop. Planting commences in late April and is usually completed early in June. Superphosphate is always applied in dressings of from 70 to 150 lb. to the acre when the grain is sown. Much of the wheat, particularly in the lower rainfall areas, is sown on bare fallow, but this practice has declined in the higher rainfall districts of the wheat belt. The wheat crop matures in late Oct.–Nov., soon after the warm, dry summer weather begins, and harvesting is carried out in November and December. Locally bred varieties constitute the bulk of the state's crop.

The average yield per acre for the period 1950–54 was 13.2 bu. Although judged by European standards the grain yields of Western Australian farms are low, a favourable combination of circumstances permits high output per man and the large wheat and sheep property is usually a highly mechanized and very efficient concern. Wheat is handled in bulk and a start has been made with the bulk handling of oats and barley. A somewhat unorthodox system has been very successful. The grain is stored at railway sidings in corrugated iron sheds or bins and not in the concrete silos generally used elsewhere. It may be taken to ports in ordinary rail trucks fitted with canvas extensions to the sides and lined with hessian.

About 60% of Western Australian production is exported overseas as grain and another 15% as flour.

Meat *production* ranks third to wool and wheat in value. The only area where it is a single specialized enterprise on a large scale is in the northern part of the state where cattle raising is almost the sole occupation. The cattle carried on large "stations" are utilized solely for beef. Nearly all are shorthorns. There is a pronounced seasonal fluctuation in the quantity and quality of the grazing which constitutes a handicap to the production of high-quality beef. The cattle are treated at meatworks at Wyndham and Broome and shipped abroad in the form of frozen beef Some live cattle are shipped south for slaughter and consumption in the Perth metropolitan area Improvement of the cattle industry on any substantial scale will involve considerable public and private investment for better inland transport facilities, nater supplies and fencing. In the agricultural areas meat production is mainly a sideline to wool production cereal growing and dairying. In the past, appreciable quantities mere exported of frozen lamb and mutton, live sheep (to Singapore) and pork but with a rapidly expanding population a greater percentage of the output is absorbed by the local market.

Dairying has usually been the pioneer occupation in the more heavily timbered country of the extreme southwest. where the annual rainfall ranges from 30 to 50 in. It is associated chiefly with the grazing of annual pasture species, notably subterranean clover. but there is an area near the southern coast where a longer growing season and a light, though useful. summer rainfall makes possible the utilization of certain perennial grasses. Irrigation and drainage schemes on the coastal plain to the south of Perth have considerably increased the productivity of the area. Nearly 20,000 ac., mostly of pasture for dairy cows, are irrigated each year, but lack of suitable water supplies prevents any great expansion of this activity.

By the early 19jos there were about 130,000 dairy cows in Western Xustralia. the chief breeds being milking shorthorns. Jerseys and Guernseys. Less than two-thirds of the state's milk production is used for butter making. About a quarter is consumed as fresh milk and 5% as processed milk.

Miscellaneous Products.—Orchards and vineyards occupy about 30.000 ac. Apples and dried vine fruits form the bulk of the exports. Potatoes, onions. tomatoes and a large variety of other vegetables are grown commercially. Green vegetables of some sort are available throughout the year. Potatoes. tomatoes and green vegetables are exported, the chief markets being the eastern states of Australia and Singapore. The poultry industry produces a surplus of eggs which is exported to the United Kingdom.

Oats are grown extensively for hay. as a grazing crop and for grain. Most of the grain is used as stock feed in the farms where it is produced, though in the postwar period there was some development of an export trade. Barley. of suitable quality. both six-row and two-row, is grown. the latter being used by local malsters. Tobacco and flax are also grown on a small scale.

Mining and Industries.—Of diminished importance since World War II, mining revived somewhat after 1950, output reaching a record value of £A16,920,445 in 1952. Gold, the most important mineral, accounted for £A11,847,917 (729,975 fine oz.. or 73.1% of the commonwealth total); the Coolgardie and Murchison fields being the most valuable. The only coal field being worked in 1953 was at Collie, where 830.461 tons were produced in the preceding year. The coal is consumed within the state. largely by railways. The state is almost entirely self-supporting. only a small quantity of bunkering coal being imported from the eastern states. Iron ore production at Yampi sound was developed after World War II, together with lead and silver-lead mining, asbestos. manganese, tin. wolfram and scheelite. Most of these deposits are in the northwest, Wittenoom and Marble Bar being the centres of activity. Borings for oil in the north. at Learmonth, and in the Kimberleys, attracted increasing attention. (See AUSTRALIA, COMMONWEALTH OF: The Economy: Mining; KALGOORLIE.)

Manufactures are confined mainly to the metropolitan area. particularly Fremantle, Midland Junction. Innaloo and Welshpool, industries favoured there being also those suited to a primary producing country (*e* g., sanmilling, bacon curing, processing dairy produce, ore crushing and concentrating the manufacture of superphosphates and railway engineering).

The limited size of the home market and the strength of established industries in the eastern states retarded manufactures in Western Australia. Following the adverse effect of the depression of 1929–3j on agriculture, a department of industrial development was set up by the state to advance secondary industry. The value of industrial output increased from £A31,740,740 in 1945 to

£A106,377,022 in 1952.

After the 1952 decision to construct a deep-water port at Cockburn sound. south of Fremantle, the site of the Anglo-Iranian Oil company's projected refinery at Kninana was the scene of considerable industrial planning including steel and cement works. (See History, above.)

Trade increased in volume and variety throughout the first half of the century The trade of Fremantle, which took the lion's share, provided an index of this development:

Port of Fremantle	1903–04	1950–51
Shipping tonnage (net!	626,692	5,435,737
Cargo tonnage	560,000	3,097,374
Revenue collected (£A)	79,361	1,574,066
Wheat shipped (bags)	3,132	10,303
" (bulk; tons)	000	500,142
Flour shipped (tons)	000	154,147
Oil fuel bunkered (tons)	000	336,801

A considerable portion of the state's trade is with the other Australian states (1952–53 value of such imports: £A68,606,336; exports: £A24,829,409; 1952–53 value of total imports: £A98,480,531: exports: £A113,132,804).

Communications.—Railways were first developed in the coastal areas behind Geraldton (1879) and Perth (1881). In the following decade. private companies began the construction of lines to join Perth with Albany to the south and Geraldton to the north. After 1894 came the construction of lines to the goldmining centres of the interior—Perth to Kalgoorlie. 380 mi., with extension to Laverton, 591 mi.; Perth to Meekatharra, 600 mi.; and in the northwest an isolated line, Port Hedland to Marble Bar. 114 mi. (closed in 1951).

These lines also proved useful in opening up the pastoral interior. The railway system of the southwest, centralized in Perth, included timber, mineral and agricultural lines. Between 1910 and 1930, an outstanding feature was the construction of developmental wheat-belt spur lines to draw grain and wool into the main trunk systems as in the South Australian Mallee and the Victorian Wimmera. Apart from the Midland railway between Perth and Geraldton. and certain mineral and timber lines, all railways are state-owned. Of narrow gauge (3 ft. 6 in.) the Western Australian railways differ from the commonwealth government's transcontinental line (4 ft. 8½ in.) joining Kalgoorlie with Port Pirie in South Australia. The state railways ran at an increasing deficit after 1945, principally because of increased maintenance costs and the growing competition of privately owned road transport.

Motor transport for road haulage came gradually into use after 192j even in remote pastoral areas where it displaced camel teams and bullock drays, but it was not until after World War II that it presented serious competition to the railways. These responded by developing their own passenger and freighter road services in the southwest.

In the northern pastoral areas the aeroplane provided a pioneering service. As early as 1921, an airline (W.X. Airways) connected Derby with the south. In later years, Airlines (W.A.), MacRobertson-Miller Aviation, and Connellan Airways built up a network of flight schedules connecting outback stations with the larger centres. Of particular importance was the "flying doctor" scheme. begun in 1935, to assure the isolated stations of the northwest of regular medical attention. Air Beef Pty., Ltd.. pioneered the use of air freighters in the Kimberley beef industry in 1949.

In 1953 air services connected I'erth with Adelaide (South Australia) and other state capitals, with Johannesburg (South Africa) and with London (via Djakarta and Singapore, Darwin or Johannesburg). Internal lines provided regular services for all centres of importance.

Shipping services include (1) the main overseas lines which make Fremantle their first port of call and help to make Fremantle the largest oil-bunkering port in Australia; (2) services to other states; (3) Western Australian coastal services. mainly northward, extending also to Java and Singapore. where a trade in fat sheep and fruits has been developed.

From Western Australia submarine cables connect with Africa and Europe.

See J. S. Battye, *History* of *Western Australia (1924)*. (F. A.)

WESTERN EUROPEAN UNION: see PAN-EUROPEAN MOVEMENT.

WESTERN RESERVE UNIVERSITY, a coeducational institution of higher learning. chartered on Feb. 7, 1826. at Hudson. O..and moved to Cleveland in 1882. See CLEVELAND.

WESTFIELD, a city of southwestern Massachusetts, C.S., in Hampden county. is on the Westfield river about 7 mi. W. of Springfield. It is part of the Springfield-Holyoke standard metropolitan statistical area. A central square, a high percentage of privately owned homes on tree-lined residential streets and a predominantly Yankee population give the city a distinctive New England flavour.

Established in 1660 as a trading post within the boundaries of Springfield, it was set off as a town in 1669. Farming gave way to commerce and light industry in the early 19th century. The manufacture of whips and lashes was a leading industry until the advent of the automobile. In 1920. after a steady, slow population growth, Westfield was chartered as a city to meet the needs of the growing community.

The city has a number of small industries. the most important of which produce paper, machinery and bicycles. It is the site of the Westfield State Teachers college. founded by Horace Mann in 1844. For comparative population figures see table in MASSACHUSETTS: *Population.* (GE. G.)

WESTFIELD, a city of Union county. northeastern New Jersey. U.S.. 22 mi. S.W. of New York city. It is almost exclusively residential. industry being restricted to light manufacturing and service enterprises. Most residents commute to nearby metropolitan areas for work. Consequently, it has the character of a suburban town with its network of quiet parks and streets: there are more than 100 different club organizations ranging from national affiliations to local art groups.

Westfield was settled in the 18th century by residents of nearby Elizabeth seeking room in the prairie lands of "West Fields." During the American Revolution it was a strategic outpost for Washington's army, guarding the passes of the nearby Watchung mountains. It was incorporated in 1903. For comparative population figures *see* table in NEW JERSEY: *Population.* (W. L. CA.)

WEST FLANDERS (Flemish WEST-VLAANDEREN; French FLANDRE OCCIDENTALE), the most westerly of the nine provinces of Belgium, is bordered by the North sea, the French and Dutch frontiers. East Flanders and Hainaut. It consists of eight administrative *arrondissements*, 31 judicial cantons and 253 communes. Area 1.249 sq.mi. Pop. (1955 est.) 1,032,169.

Maritime Flanders has a straight. unembayed coast line. 42 mi. long. A broad sandy beach is backed by a rampart of sand dunes, in places a mile wide, many of which exceed 100 ft. in height. Planted marram grass and conifers help to stabilize the sand. This line of dunes is broken only at the mouth of the Yser, at Ostend (Oostende), near Zeebrugge and at the mud-covered inlet marking the former Zwin estuary. Behind the dunes lies a flat plain, the Flemish polders, seamed with drainage channels and extending for 6–10 mi. inland to about 15 ft. above sea level. The surface is interrupted by water-filled depressions and by low sandy hillocks. the remnants of old dunes or patches of Pleistocene marine sands. Soils are variable; yellow sand, black silt and blue or gray clays can be seen within a few yards.

The part of interior Flanders lying within the province includes three elements: the Recent alluvium on the valley floor of the Leie (Lys), the Flanders Clay (Eocene) overlying much of the area, and higher relict patches of Pliocene sands northwest of the Leie valley. The last form a low ridge extending westward from near Passchendaele and reaching 531 ft. in Mt. Kemmel. These hillocks had great tactical importance in World War I.

West Flanders is the most important farming province in Belgium. It has more farmland. cereals, industrial crops, beef cattle and pigs than any other province. Sheep formed the basis of the medieval Flemish textile industry, but few are now kept. Along the edge of the dunes the sandy soils grow potatoes and carrots. and half the polderlands are under permanent or temporary grass. with oats and green crops for fodder. Farther inland. wheat, malting barley, sugar beet, potatoes and tobacco are grown, together with fodder crops for the dairy herds.

Industrial development is found in the coastal towns. at Bruges (Brugge) and in the Leie valley. At Ostend there are fish curing, canning plants, fertilizer factories and a shipyard building trawlers and dredgers. Nieuwpoort (Nieuport) has a chemical works and Zeebrugge a coke-oven plant, glassworks and chemical works. The old part of Bruges still has craft industries (lace, embroidery, glass painting, wood carving), and northwest of the town there is heavy industry (engineering works, barge-building yards, flour mills, timberyards). In the Leie valley is part of the Flanders textile industry, mainly cotton and linen at Courtrai (Kortrijk), Menin (Menen), Roeselare (Roulers) and Ronse (Renaix).

Along the coast line there is an almost continuous line of resorts, the chief being Ostend (also the ferry port for England) and Blankenberge, while Nieuwpoort and Zeebrugge have small commercial harbours. The polders are thinly populated, with isolated farms on sandy hillocks or ridges and only a few small market towns: such as Veurne (Furnes). The largest town is Bruges (*q.v.*), the provincial capital. Interior Flanders is densely populated. The rural dwellers are dispersed widely over the countryside, with individual houses situated within small holdings, but there are many urban centres. the largest being Courtrai, Roeselare and Menin. This area suffered grievously in World War I and many of the towns, such as Tpres. were virtually rebuilt. Most people in the province speak Flemish.

A main line railway runs inland from Ostend to Brussels, joining one from Zeebrugge at Bruges; a line runs from Ostend to Courtrai and another from Veurne to Ghent (Gent). There are numerous tramways, notably linking the coastal resorts. Roads follow embankments among the polders and there are two major trunk roads, Ostend-Brussels and Knokke-Antwerp. The famous Route Royale runs along almost the entire coast from Het Zoute to De Panne. Numerous small canals lie parallel with the coast; the Ghent-Ostend canal runs from the coast via Bruges, and a ship canal links Bruges with Zeebrugge. (For the history of the province see FLANDERS, COUNTY OF.) (F. J. M.)

WEST HAM, a county and parliamentary borough of Essex, Eng., forming an eastward suburb of London. Pop. (1961) 157,-186. Area 7.3 sq.mi. It lies in the angle made by the confluence of the Lea river with the Thames and extends north to Leyton and Wanstead and east to East Ham. The borough. which suffered severely during World War II. includes Stratford. Forest Gate. Plaistow and Canning Town. It is almost entirely a product of 19th-century industrial expansion. 40% of the area being occupied by a variety of factories, railways and docks including the Royal Victoria dock and parts of the Royal Albert and King George V docks. All Saints church has a good Perpendicular tower. The only considerable open spaces are West Ham park (66.19 ac.) and Canning Town recreation ground (20.16 ac.).

After the Conquest the manor of Hamme (approximating to the present East and West Ham) was divided into nine smaller manors. Between the 12th and 14th centuries five of these passed to the abbey of Stratford Langthorne founded in West Ham by William de Montfichet c. 113j. At the dissolution the manor of Westham was retained by the crown and in 1629 became part of the jointure of Henrietta Maria and then of Catherine of Portugal. and was therefore called the Queen's manor. West Ham was incorporated in 1886 and made a county borough in 1888. It returns two members to parliament.

WEST HARTFORD, a residential town in central Connecticut, U.S., is in Hartiord county. A prosperous farming community and Congregational church stronghold during its early history. it became a fashionable residential suburb of Hartford. First laid out in 1672 as West division of Hartford. it was incorporated in 1854, and in 1921 was the first Connecticut town to adopt a manager-council form of government. Rapid growth in population from 8.854 in 1920 to 62.332 in 1960 was accompanied by the application of rigid zoning. which helped to preserve the town's attractive general appearance.

Business zones at intersections of arterial roads provide suburban shopping and service centres for residents of West Hartford and surrounding towns. The per capita income of residents is among the highest in the country. Industry is restricted to a relatively small zone in the southeast corner of town. The American School for the Deaf, founded by Thomas Hopkins Gallaudet in 1817. and St. Joseph's college (1925) are located there. West Hartford was the birthplace of Noah Webster, the American lexicographer. (R. L. GA.)

WEST HARTLEPOOL, a seaport and county borough in the Hartlepools parliamentary division of County Durham. Eng., 18 mi. S.E. of Durham by road. Pop. (1961) 77.073. Area 6.5 sq.mi. In the early 19th century there was only the small village of Stranton near Hartlepool on the site. but intensified coal mining in County Durham led to the building of the railway from Billingham in 1841. West Hartlepool arose from the decision of one man, Ralph Ward Jackson. who, after bringing coal by rail to the old Hartlepool harbour, decided in 1844 to construct his own dock ior coaling about a mile away on wasteland in Stranton parish. Within 20 years this port had become one of the largest on the northeast coast.

By 1882 West Hartlepool and Hartlepool had been joined by docks and building extensions, so that the whole community was often called The Hartlepools. But the towns remained distinct from the point of view of municipal administration. West Hartlepool was incorporated in 1887 and created a county borough in 1902. The port. with two tidal harbours and five docks comprising about 103 ac. of water and 4 mi. of quays, exports mainly coal and basic slag and imports chiefly timber. especially pit props. and iron ore. There are a number of graving docks and extensive areas for storing timber. The principal industries are shipbuilding. iron and steel manufacture. heavy and light engineering and brewing. A trading estate for light industries was opened between the Hartlepools after World War II. The town has a college of art and a technical college.

At the southern end of the borough is the seaside holiday town of Seaton Carew with long sandy beaches. There is a civic airport at Greatham. about 4 mi. S.S.W. of West Hartlepool.

WEST INDIES, sometimes called the Antilles, form an archipelago more than 1.000 mi. in length which lies between North and South America. From the Yucatán and Florida peninsulas in the west. it stretches in the shape of an arc to Venezuela in the south. Except for the Bahamas. which lie farther north. all the islands are between the Tropic of Cancer and latitude 10° N. They enclose the Gulf of Mexico and the Caribbean sea, which they separate from the Atlantic ocean on the east. The land area of the islands is over 91,000 sq.mi., that of the British islands about 12,100 sq.mi.

The West Indies, apart from the Bahamas, are commonly divided into two groups. The Greater Antilles comprise the large islands of Cuba. Jamaica. Hispaniola (Haiti and the Dominican Republic! and Puerto Rico. The Lesser Antilles include the small islands which form the Windward and Leeward groups, Barbados, and Trinidad and Tobago. The largest island is Cuba which, although narrow, covers 44.218 sq.mi., but many of the islands cover only a few square miles. The political allegiance of the different territories is given in the section *Population,* below.

In Jan. 1958 all the British islands (with the exception of the British Virgin Islands and the Bahamas) joined to form the West Indies Federation. The dissolution of the federation was announced in Feb. 1962. (*See* WEST INDIES [FEDERATION], THE.)

Besides its commonwealth of Puerto Rico. the territory of the Virgin Islands, the inhabitants of which are C.S. citizens while the territory is under the jurisdiction of the U.S. department of the interior, and Navassa Island, off the southwest tip of Haiti. the United State.; leases air and naval bases in the British West Indies.

The West Indies are islands of great contrast. The contrasts in population and language reflect their varied history. while they also differ in physical characteristics and economic development. Several steamship services link the West Indies with Europe and America. but interisland communication is chiefly by air.

This article is divided into the following main sections and divisions:

I. Physical Geography

1. Geological History and Geology
2. Physiography
3. Climate
4. Vegetation
5. Animal Life

II. Natural Resources
1. Water Supply
2. Soils
3. Mineral Wealth
4. Land Use

III. Anthropology and Archaeology
IV. History
V. Population

I. PHYSICAL GEOGRAPHY

1. Geological History and Geology.—The West Indian islands are the summits of a partially submerged mountain chain, which is continued westward through Honduras. and in the south through Venezuela. The chain divides into branches which may be traced from Hispaniola through Jamaica, the Sierra Maestra of east Cuba and the Cayman Islands, and the Sierra de los Organos.

A simple distinction may be made between the Greater Antilles and the outer chain of the Lesser Antilles (Antigua, Barbados, east Guadeloupe, Virgins), which are composed largely of sedimentary rocks, and the inner chain of the Lesser Antilles. which is chiefly volcanic. Trinidad is structurally associated more closely with the South American continent. In Cuba and Hispaniola there are schists which are probably older than the Cretaceous period, but the oldest rocks which have been certainly identified in the West Indies, apart from some Jurassic in the northern range of Trinidad, belong to the Cretaceous. Throughout the Greater Antilles, the geological succession begins as a rule with volcanic tuffs and conglomerates of hornblende-andesite. in the midst of which are intercalated occasional beds of limestone with Rudista and other Cretaceous fossils. These are overlaid by sediments of terrigenous origin, and the whole series was folded before the deposition of the next succeeding strata. The nature of these Cretaceous deposits clearly indicates the neighbourhood of an extensive area of land; but during the succeeding Eocene epoch and the early part of the Oligocene, a profound subsidence led to the deposition of the Globigerina chalks and white Radiolarian earths of Jamaica, Cuba and Hispaniola. The Greater Antilles must, at this time, have been almost completely submerged, and the similar deposits of Barbados and Trinidad point to a similar submergence beyond the Windward Islands. In the middle of the Oligocene epoch a mighty upheaval, accompanied.by mountain folding and the intrusion of plutonic rocks, raised the Greater Antilles above their present level and united the islands with one another. and perhaps with Florida. A subsequent depression and a series of minor oscillations finally resulted in the production of the present topography.

Except in Trinidad and Barbados, no deep-sea deposits have yet been found in the Lesser Antilles, and there is no evidence that the area ever sank to abyssal depths. In some of the islands there are old volcanic tuffs which may possibly be the equivalent of the Cretaceous beds of Jamaica, but volcanic activity continued throughout the Tertiary period and persists today in several islands. Both Martinique and St. Vincent have experienced serious eruptions in the 20th century, the worst being that of Mt. Pelée (Martinique) in 1902, when the capital of the island was destroyed. and that of Soufrière (St. Vincent) in the same year. Earthquakes also occur throughout the archipelago. Usually the shocks are slight, but there have been severe shocks in Jamaica and the Windward and Leeward islands.

2. Physiography.—J. A. Froude, writing in 1887, quotes Père Labat as saying of Grenada, one of the Windward Islands; that "In itself it was all that man could desire. To live there was to live in Paradise." The proximity of warm seas, green mountains and fertile valleys give the West Indies this quality which many travelers have noticed.

Generally the islands are of high relief. The highest point is in Hispaniola, where the Pico Trujillo rises to 10,417 ft. In Jamaica, Blue Mountain peak reaches 7,402 ft. and heights of more than 4,000 ft. are reached in Puerto Rico and several of the Windward and Leeward islands. Most islands are dominated by a central range of mountains; long spurs stretch toward the coast and deep valleys lie between them. Rivers are necessarily short and swift-flowing, and plains are chiefly confined to the coasts, although in the larger islands of Hispaniola and Jamaica level valleys lie between the mountain ranges. Passes over the mountains are rare and difficult.

Cuba is the only island with extensive areas of lowland. The high mountains of the Sierra Maestra are restricted to the eastern end and nowhere form a barrier. Barbados and Antigua, composed largely of coral, are also low-lying, while islands such as the Bahamas and Anguilla barely rise above sea level.

Lagoons and mangrove swamps are common features of the island coast lines, which are intricate and fringed by coral reefs. There are many deep natural harbours. such as those of Havana (Cuba) or St. Georges (Grenada), but the approaches are often dangerous.

3. Climate.—In the West Indies, as in most tropical countries. there is little seasonal variation in temperature. Even in the cool months of January and February it rarely falls below 75° F., and the average annual temperature is 80° F. The islands lie in the path of the northeast trade winds which, as they blow from the sea. modify the intensity of the tropical heat, and most of the islands have a pleasant climate. Trinidad, the most southerly of the islands, is slightly hotter, but even there the nights are cool and refreshing.

More significant than the seasonal changes of temperature are those of rainfall, and a wet and dry season are usually distinguished. More rain falls while the sun is north of the equator, until shortly after the autumnal equinox, and the wet season lasts from June to October or November. The average annual rainfall is about 65 in., but there are considerable variations according to position and altitude. Much of Cuba. for example, which is only just within the tropics and is low-lying, receives an average of 55 in., whereas parts of Jamaica, being high, receive 75 in. Altitude also accounts for such different totals as those of Antigua (46 in.) and Dominica (120 in.). In nearly all the islands there is a great difference between the leeward slopes, which are relatively dry, and the windward slopes. which are wet. In eastern Jamaica, for instance, the windward slope receives over 100 in. of rain, whereas the leeward slope receives only 40 in. These local differences can be very important, and show themselves in contrasted vegetation and agriculture.

Hurricanes are the menace of the West Indian climate. These violent wind and rain storms blow in from the Atlantic, generally north of Barbados, and strike one or more of the Lesser Antilles. They then turn northward across the larger islands toward North America. The season for hurricanes, and storms of near-hurricane intensity, is well defined. They are expected between July and October and are a partial cause of the heavier rainfall of these months. Occasionally they strike out of season, The hurricanes are traced and forecast as far as possible, but they often cause great devastation. In Aug. 1951, a hurricane killed many people and did a great deal of damage in Jamaica, and another in Sept. 1955 hit Grenada, Carriacou and Barbados.

4. Vegetation.—The flora of the West Indies is rich and varied. Almost every tropical plant will grow and many temperate plants have been introduced. Much of the mountain land preserves a tropical forest cover! although in places, especially in limestone districts, there is a poor scrub of thorn trees and cacti. Nearly all the lowland has been cleared for cultivation. Economically useful trees include the mahogany, cedar, guaiacum or lignum vitae, greenheart and mora. There are many plants of great brilliance and beauty, such as the flamboyant, frangipani, bougainvillea. hibiscus and poinsettia; there is also a wealth of palm and fruit trees.

5. Animal Life.—The animal life is similar to that of the neighbouring South American continent. Birds, brightly coloured and numerous! include trogons. sugarbirds, chatterers and many parrots and hummingbirds, as well as migrants from Korth America. Mammals, as in most island groups, are rare, but there are agouti, manicou, deer, monkeys and bats. The mongoose, introduced to get rid of snakes and rats, is now abundant, and there

are numerous lizards, iguana, tortoises. scorpions, toads, spiders and centipedes, as well as a few poisonous snakes, such as the fer-de-lance, bushmaster and coral. There is a variety of insects, but much has been done to rid the islands of mosquitoes, so that yellow fever is now almost unknown, although malaria persists in some country districts. The seas abound with fish, the most famous being the flying fish, caught off Barbados, and around the shores are many delicious crustaceans.

Many domestic animals have been introduced and cattle are reared successfully in Cuba and Jamaica, while some sheep are bred for meat. Donkeys are the chief form of transport in the poorer islands. There are also many goats and dogs.

II. NATURAL RESOURCES

1. Water Supply.—The West Indies are on the whole adequately supplied with water, but the marked dry season, which causes rivers to dry up for part of the year, the lack of rainfall on the sheltered leeward slopes and the porosity of much of the land, make drought a very real problem in some areas. Irrigation is used in parts of Jamaica, Cuba and Hispaniola, while in dry islands such as the Virgins and Antigua, deep wells are dug and catchments and cisterns built to conserve water.

2. Soils.—The soils of the islands vary considerably over even small areas. They are sometimes fertile and may give high yields. Limestone, overlain with loam or alluvium, and clay cover large areas in the Greater Antilles, whereas the Lesser Antilles usually have a volcanic soil which is rich and heavy. In Barbados and Puerto Rico, where the land has been worked for a long time, manure must be added to produce good crops. The richest soils are probably the deep red clays of Cuba.

3. Mineral Wealth.—Except in Trinidad, the mineral deposits of the West Indies are neither large nor of great value. There are various deposits in the mountains of Cuba, Hispaniola and Jamaica, and iron, nickel, manganese, chrome and copper are all mined on a small scale. Extensive deposits of bauxite, associated with the Tertiary white limestone, are worked in Jamaica. The petroleum of Trinidad is of far greater importance, and the annual production by 1960 exceeded 40.000.000 bbl. Asphalt is worked in Trinidad's famous Pitch lake. Small quantities of oil have been found in Barbados and Cuba and prospecting has been conducted in Hispaniola and other islands.

4. Land Use.—Much of the land is still forest-clad and in places the cleared hill-slopes are replanted with pine trees, but all the land which is level and fertile enough is cultivated and agriculture is by far the most important occupation of the people. The moist sunny climate and the abundant labour supply ideally suit the West Indies to the production of sugar cane which is still, as it has been since the early days of colonization, the principal crop. However, the islands have suffered from this one-crop economy and although some islands. such as Barbados and St. Kitts, still grow cane almost to the exclusion of anything else, most islands have an important subsidiary crop. Cuba grows tobacco; Jamaica, bananas; St. Vincent, arrowroot; Grenada, spices; Trinidad, cacao; Dominica, limes; Antigua, cotton; Puerto Rico and the Dominican Republic, coffee; and Haiti, sisal. Apart from these and other cash crops, peasant farmers also grow food for their own needs, and of the fruits and vegetables, yams, sweet potatoes, eddoes. mangoes, pineapples, pawpaw, breadfruit and soursop are typical. Some land is always devoted to pasture, as each island produces its own meat. In Cuba, nhere cattle rearing is on a large scale, the animals graze on extensive areas of paraná grass in the eastern half of the island

Most of the manufacturing industries are concerned with the products of the land The processing of sugar cane, which must take place immediately after the cane is cut, is the chief industry By-products of sugar are many and rum is distilled in all the islands. Molasses, molascuit, a cattle feed and alcohol are also produced. Other industries based on agricultural produce include fruit canning, cotton ginning and the manufacture of cigars, cigar boxes and sacking.

The chief extractive industry is the oil drilling of Trinidad. Oil fields underlie the southwestern portion of the island and drilling has been extended to the Gulf of Paria. The ancillary industries are oil refining and the production of gasoline, kerosene and fuel oil. Although bauxite mining began on a large scale in Jamaica only in 1952, by the 1960s bauxite and alumina ranked first in the list of exports. The ores of the Sierra Maestra in Cuba are also mined, although the production has fluctuated with world markets and political upheavals. Limestone quarries and cement works are found in most islands.

Large settlements are usually found on the leeward coasts which, although less pleasant climatically. provide shelter for ports such as Kingston (Jamaica), Port-of-Spain (Trinidad) and Bridgetown (Barbados); Havana (Cuba) and San Juan (Puerto Rico) occupy sheltered sites on the windward coasts. Railways are important only in the large islands although there are small lines to carry cane to the factories. Only Cuba has a network of railways. In most islands there is an effective road system and all but the smallest possess an airport. Tourism and the rapidly increasing facilities for air travel have encouraged public and private enterprise to develop the amenities of the islands. (RD. T.)

III. ANTHROPOLOGY AND ARCHAEOLOGY

According to present estimates, the West Indies were not settled until the first millennium B.C., when primitive Indians. living only by hunting and fishing, arrived from Florida or Venezuela. These Indians are known as Ciboney and the time of their arrival is designated Period I.

During Period II, *i.e.*, shortly after the time of Christ, a new and more advanced group of Indians called Arawak (q.v.), invaded the Antilles from Venezuela, introducing agriculture as well as pottery. The Aramak penetrated as far north as Puerto Rico, while the Ciboney continued to occupy the rest of the islands.

The Arawak seized the remaining islands during Period III, which lasted from about A.D. 350 to 1150 according to the radiocarbon method of dating. They pushed the Ciboney back into the peripheral areas occupied by these Indians in the time of Columbus: the southwestern tip of Haiti, the western end of Cuba and the various islets offshore.

Period IV (A.D. 1150–1500) was marked by the arrival of a third group of Indians, the Carib (q.v.), who appear to have originated in either the Guianas or Venezuela. They seized the small islands of the Lesser Antilles from the Arawak, splitting the latter into tuo groups, one in Trinidad to the south and the other in the Greater Antilles and the Bahamas to the north and west.

Ciboney archaeological remains consist of the refuse of habitation, occurring principally in caves and on islands. The deposits are small and relatively shallow, indicating that the people lived in bands and moved frequently. doubtless as supplies of fish and game became exhausted. Burial was directly in the refuse or in caves, with no grave objects except an occasional series of stone balls.

Archaeologists classify the remains into a series of cultures on the basis of the artifacts they contain. These cannot yet be dated by period, but they indicate a surprising amount of geographical variation from island to island. For example, the Ortoire culture of Trinidad is characterized by tiny, irregular stone chips of unknown function; the Couri culture of Haiti, by large flint blades; and the Cuban cultures, by gouges of shell.

The Ciboney who survived until historic time were so few and so isolated that they never came into effective contact with Europeans. As a result, we know practically nothing about Ciboney ethnology. except that they spoke a language different from that of the Aramak and had a simpler culture.

Arawak archaeological sites contain larger and deeper shell middens. indicating more permanent habitation in villages, and are situated in land more suitable for agriculture. Pottery is abundant, and the changes in its shape and decoration serve as a basis for formulating and dating a large number of cultures.. The earliest cultures, of Period II, are marked by little but pottery Those of Period III also have a few simple amulets and other ceremonial objects carved out of stone, bone and shell. These become more numerous and more elaborate in the sites of Period IV, nith the appearance of such unique and artistic objects as large stone collars and three-pointed, sculptured figures of stone. The latter are associated with ball courts or dance plazas lined with stone slabs. In addition, carved wooden idols and stools are found in caves used as shrines.

These ceremonial developments reached their climax among the Taino and Ciguayo Arawak of the heart of the Antilles, were less in evidence among the sub-Taino of central Cuba and the Lucayo of the Bahamas and were virtually absent among the isolated Igneri of Trinidad. When Columbus established the first Spanish settlement among the Taino, he commissioned a friar, Ramón Pané, to study the Taino religion. Pané's report, which has been termed the first ethnological research in the new world, agrees very well with the archaeological finds. From his and other contemporary accounts. we know that the Arawak were peaceful and had a relatively elaborate social organization headed by hereditary chieftains nho derived their power from personal deities called zemis. Their language belongs to the Arawakan family of tropical South America

Archaeologists are only beginning to identify the remains of the Carib in the Lesser Antilles. The sites of these Indians have relatively crude pottery, characterized by long solid legs not found on Arawak ceramics, and lack the ceremonial structures and cawings of the Arawak.

Much more is known of the ethnology of the Carib, not only from observations made by Columbus and his successors but also from accounts by 17th-century French missionaries and by modern anthropologists who have studied the surviving Indians. These indicate that the Carib had a less elaborate social organization. without hereditary chiefs or classes. Carib life centred about warfare rather than religion; and our term cannibalism is derived from their custom of eating the flesh of captives in order to obtain the latters' personal power.

The Carib have also given their name to the Cariban linguistic stock of South America, although they themselves spoke Arawakan. The explanation for this anomaly is to be found in their tradition that when they conquered the Lesser Antilles they killed the Arawak men but married the women. Apparently, it was the women's language that prevailed.

While Columbus explored all parts of the Antilles, his successors colonized only those parts inhabited by the Ciboney and Arawak, avoiding the Carib islands because they lacked gold and because the Carib were too difficult to subjugate. As the Spaniards conquered each island, they rounded up its Indians and put them to work in mines or on plantations.

Many were worked to death, some starved because the Spaniards failed to provide food; others died from diseases introduced from Europe; and still others lost their lives in unsuccessful efforts to throw off the Spanish yoke. By the time the system of forced labour ended in 1550, the Ciboney had become extinct and appreciable numbers of Arawak survived only on the islands of Cuba and Trinidad. These survivors gradually became assimilated in the European population. A few villages retained their Indian identity well into the 19th century but all are now indistinguishable from the rest of the population.

The Carib fared somewhat better. Their territory was not conquered until the mid-17th century. While most of them perished as pawns in the struggle between the French, English, Dutch and Danes for control of the area, some retained their independence on the smaller islands.

Many runaway Negro slaves took refuge among them They gradually changed in racial composition from Indian to Negro but retained their Indian language and culture because runaway slaves had to "go native" in order to avoid recapture. In 1795 the British moved one group, which had become troublesome, to the coast of Central America, where they multiplied, prospered and are now knonn as the Black Carib. Subsequently. the British rounded up the remnants surviving in the Lesser Antilles and installed them in a reservation on the island of Dominica, which they still inhabit. These island Carib have not retained as much of their aboriginal language and culture.

The Spaniards introduced the first Negro slaves in the middle of the 16th century to replace the dnindling supply of Indian labour. They did not bring in many, for their mines had become exhausted and they specialized in cattle ranches, which did not require much labour. The main influx of Negro slaves took place in the 18th century with the development of sugar plantations by the French, first in the Lesser Antilles and then in Haiti. After the French Revolution the slaves in the latter country revolted, drove out the French plantation owners and set up an independent Negro republic. The owners took refuge in the neighbouring British and Spanish countries, established new plantations there and imported additional slaves from Africa.

The freed slaves of Haiti abandoned the plantations and became subsistence farmers. The same thing happened in the British colonies when slavery was abolished in the middle of the 19th century. To take the place of the slaves the British imported Chinese and East Indians. The latter became particularly common in Trinidad, where they, too, set themselves up as subsistence farmers after their terms on the plantations had expired. They increased in numbers at a greater rate than the Negroes, and by the middle of the 20th century comprised half the population of the island.

Elsewhere, especially in the former Spanish colonies, the Negroes tended to remain on the plantations as paid labourers. There was a greater tendency to intermarry nith whites than in English-speaking countries, and the colour line was weak.

Throughout the Antilles the Negroes and Asians in towns and cities assumed more and more prominence in economic and political affairs, so that in effect they came to dominate the area except in countries with large white populations, such as Cuba and Puerto Rico.

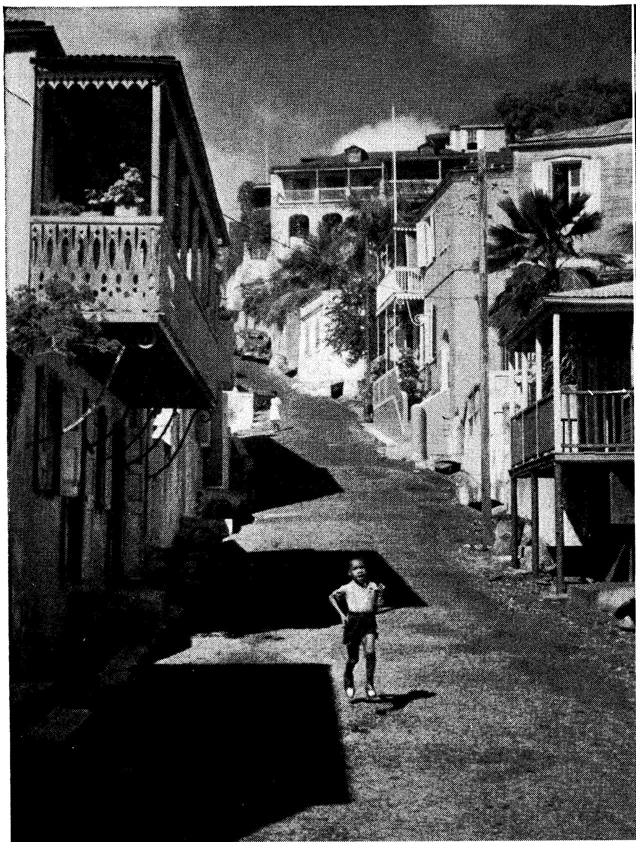
While European languages and customs have been widely adopted, this process has gone further in some places than in others. Everywhere, one finds persistence of many African and Asian traits such as the creole language and voodoo religion of Haiti, and rice cultivation and Islam in Trinidad. The mixture of Amerindian, African, Asian and European peoples and cultures is exceedingly rich and varied, and can scarcely be matched in other parts of the world.

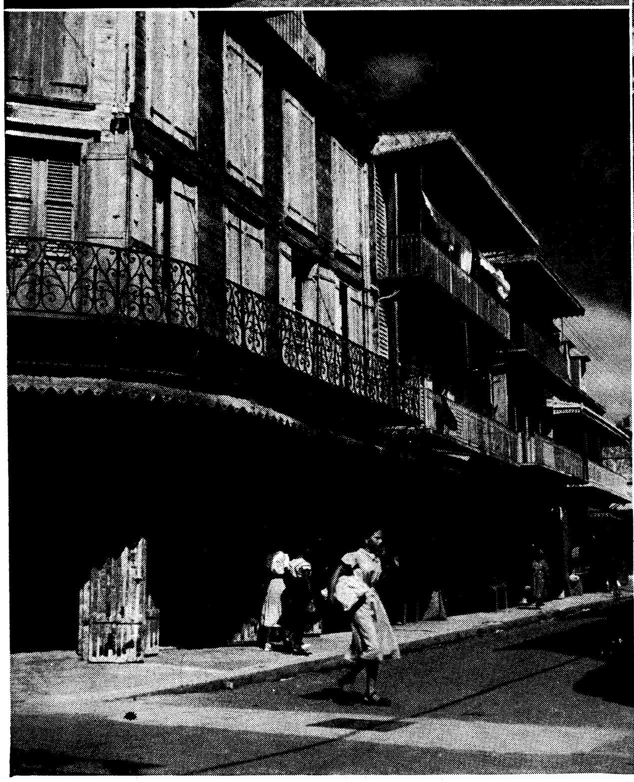
See also MIDDLE AMERICA. (I. RE.)

IV. HISTORY

The West Indian islands were revealed to Europeans by the first voyage uhich Christopher Columbus made, in 1492, in search of an Atlantic route to the far east. Columbus touched at various islands in the Bahamas and at points on the north coasts of Cuba and Hispaniola. On his second voyage in 1493 he founded the town of Isabela in Hispaniola, the first permanent European settlement. Santo Domingo (renamed Ciudad Trujillo, 1936–61), for many years the capital of the Spanish Indies, was founded on the southern shore in 1496. The settlement of Puerto Rico was begun in 1508, of Jamaica in 1509 and of Cuba in 1511. The presence of alluvial gold in Hispaniola and Cuba attracted considerable numbers of Spanish settlers. The primitive Arawak natives died off rapidly as the result of European diseases, against which they had no immunity; of starvation, through the destruction of their crops by Spanish domestic animals; and of the severities associated with the forced labour system introduced by the Spaniards. By the end of the 16th century the natives of the greater islands were extinct. From about 1510 the Spaniards began to replace them by purchasing, through Portuguese dealers, small numbers of West African slaves.

Throughout the first three decades of the 16th century the islands were bases from which expeditions sailed to Central Xmerica and Mexico. These territories had the advantage of abundant native labour. and in the 1520s drew many settlers from the islands, especially as the island gold became exhausted. The islands came to be valued chiefly as ports of call. Their inhabitants lived by selling bacon. dried beef and cassava bread for victualing passing ships, and by exporting hides, tallow and sugar to Europe. At the same time, the islands acquired a new strategic importance. The increasing volume of shipping, carrying tropical products and Mexican or Peruvian silver, attracted the attention of pirates, privateers and smugglers. In the second half of the 16th century

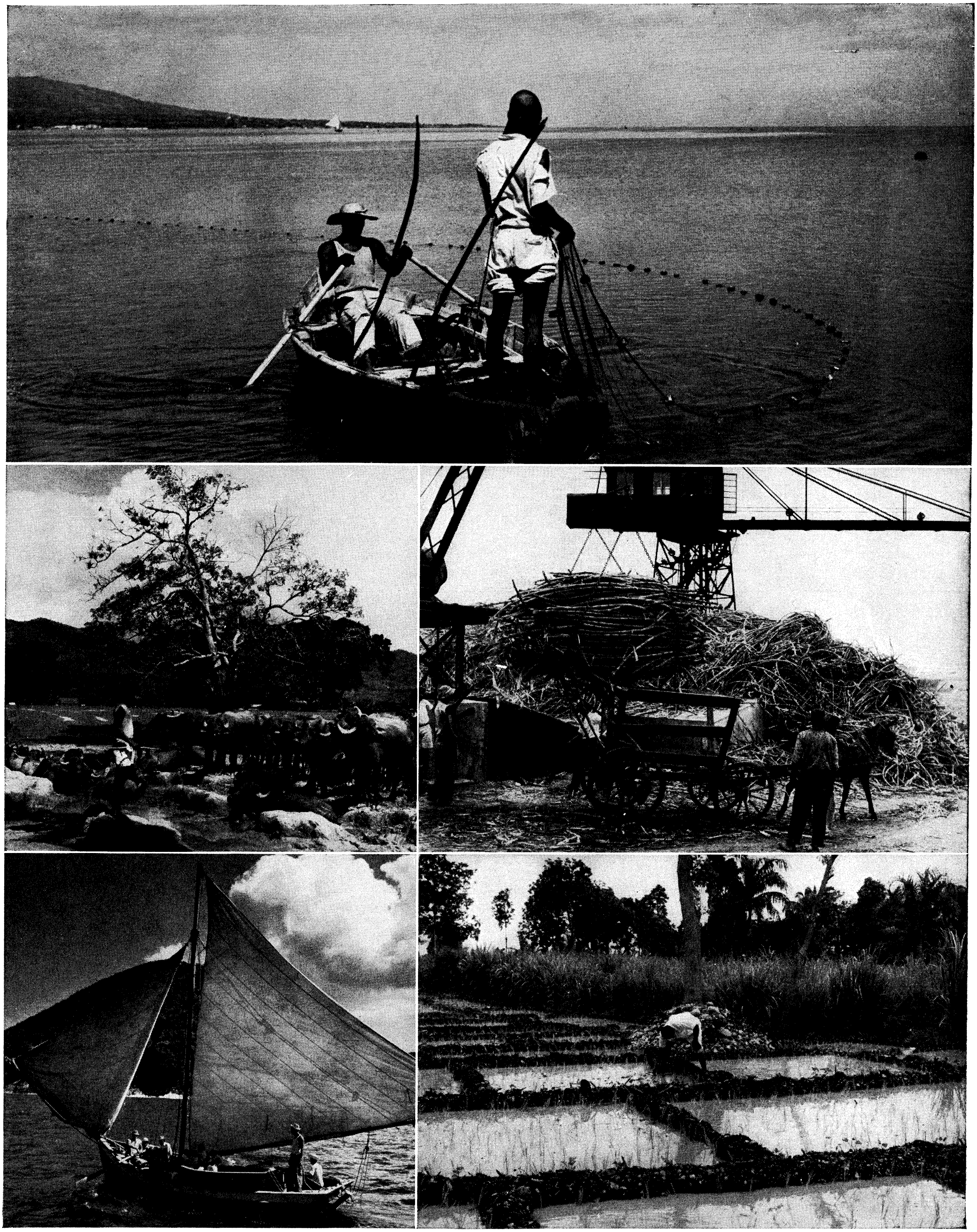




PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, CENTRE RIGHT, BOTTOM RIGHT) HERBERT LANKS FROM BLACK STAR, (BOTTOM LEFT) MAX HUNN

STREET SCENES IN CITIES OF THE WEST INDIES

Top left: A hilly residential section of St. Thomas, Virgin Islands
Top right: Market place in Nassau, Bahamas
Centre right: Business and shopping section of Willemstad, capital of the Netherlands Antilles
Bottom left: Pointe-8-Pitre, Guadeloupe. The louvred shutter and balcony are characteristic of the West Indies
Bottom right: Market, Kingston, Jamaica



PHOTOGRAPHS, (TOP) HERBERT LANKS FROM BLACK STAR, (CENTRE LEFT) FRITZ HERLE FROM MONKMEYER, (CENTRE RIGHT, BOTTOM RIGHT) EWING GALLOWAY, (BOTTOM LEFT) FRITZ HENLE FROM PUBLIX

ECONOMIC ACTIVITIES IN THE WEST INDIES

Top: Fishermen of Haiti casting their nets
Centre left: Farmer *of* Trinidad and his water buffaloes
Centre right: Unloading a sugar cane cart at crushing mill, Barbados
Bottom left: Sloop off the coast oi St. John, Virgin Islands
Bottom right: Rice field worker, Haiti

the Spanish government was obliged, even in peacetime, to organize shipping through the Caribbean in convoys and to construct ponerful fortifications at the strategic harbours — Cartagena. San Juan de Puerto Rico and, above all. Havana. The leading military engineer of his day, Juan Bautista Antonelli. nas employed on these works.

Spanish dispositions could not prevent all raiding in so large an area. Sir John Han kins' slaving voyages of the 1560s set a new fashion in smuggling. Sir Francis Drake captured a large quantity of silver on the isthmus in 1572, and during his bigger expedition of 1585 took, but could not hold, both Santo Domingo and Cartagena. Another fleet of similar size, however, under the joint command of Drake and Hawkins. in 1595, mas defeated. Despite sporadic raiding despite an extensive, though still risky, smuggling trade, Spain's rivals achieved nothing permanent until the end of the 12 years' truce between Spain and the Netherlands in 1621. In that year the Dutch West India company received its formal charter, incorporating it for conquest and plunder as well as for trade. The heavy attacks which this company delivered against Spanish shipping — even though much of the company's energy was diverted to Brazil — enabled other groups of foreigners to settle in unoccupied islands in the eastern Caribbean nithout fear of Spanish interference. English settlers occupied part of St. Kitts in 1623, Barbados in 1624, St. Croix in 1625, Nevis in 1623, Antigua and Montserrat in 1632. An attempt to settle St. Lucia was defeated by the fierce Carib inhabitants in 1641. The French Compagnie des Isles d'Amérique was formed in 1635. and the settlement of Martinique and Guadeloupe began in the same year. The Dutch themselves, though little interested in settlement. seized betneen 1630 and 1640 Curaçao, Saba, St. Martin and St. Eustatius, all valuable as trading and smuggling depots; all were confirmed to the Dutch in the treaty of Münster in 1648

Before the middle of the 17th century no serious attempt had been made to capture territory in actual Spanish occupation; but in 16jj a large naval and military force sent from England by Oliver Cromwell. after being driven off from Santo Domingo. attacked and eventually conquered Jamaica. Adm. Robert Blake's victory over the Spanish fleet at Santa Cruz in 1657 made the dispatch of a relief expedition impossible; and Jamaica was formally ceded at the treaty of Madrid in 1670. Meanwhile effective control over the western part of Hispaniola passed out of the hands of the Spanish governors into those of buccaneers — cattle hunters turned pirates. many of them of French origin — who received ever increasing support from the French government. This territory, under the name of Saint-Domingue, was eventually ceded to France at the treaty of Rijswijk in 1697. The second half of the 17th century was a period of continuous disorder in the Caribbean, in which bands of buccaneers, either in the nominal employ of French or English governments, or on their own account, plundered Spanish harbours and preyed on the shipping of all nations. It was only after the treaty of Rijswijk that effective steps were taken by all governments to put an end to buccaneering.

The early settlers in the eastern Caribbean relied on tobacco as their main cash crop and employed European labour, recruited either by indenture or by penal sentences. Both proved inadequate; after the middle of the 17th century most island planters turned to sugar as the most profitable crop and to West African slaves as the only form of labour available in sufficient quantity. The techniques of sugar manufacture were introduced from Brazil by Dutch traders, who — having acquired most of the old Portuguese barracoons (enclosures for slaves) in West Africa — also supplied the slaves. In the non-Spanish islands, sugar soon became the main export crop. The peculiarities of sugar production required comparatively large estates. The class of European small holders began to dwindle and disappear, and Negro slaves greatly exceeded in numbers the small groups of planters, overseers, merchants and professional men who remained.

The gronth of trade in sugar, rum and slaves. and the mounting value of the sugar duties, made the possession of West Indian territory a chief aim of European colonial powers Every major European war in the 18th century was reflected in heavy fighting in the Caribbean and every peace treaty included transfers of West Indian islands. The settlements of Utrecht (1713), Aix-la-Chapelle (1738) and Paris (1763) all favoured Great Britain at the expense of France and Spain; and Great Britain also secured most of the slave trade. In the American Revolution major losses of British territory were averted only by Sir George Rodney's last minute victory off the Saintes Islands (Guadeloupe) in 1782. The final settlement of 1815 confirmed to Great Britain: St. Lucia. Grenada, Dominica, St. Vincent. Trinidad. Tobago (all acquired from France) and British Guiana (from the Dutch). France retained Martinique and Guadeloupe; but Saint-Domingue had become in 1804 the independent state of Haiti. Spain retained Cuba, Puerto Rico and Santo Domingo, but lost them in the 19th century. Santo Domingo became the Dominican Republic in 1844; and as a result of the Spanish-American War in 1898, Cuba became independent and Puerto Rico was annexed by the C.S.

West Indian prosperity did not long outlast the 18th century. A steady increase in sugar production in other parts of the world

Name	Area (sq. mi.)	Population (1960 census)	Capital city with pop. 11960 census)
Independent Republics			
Cuba	41,218	6,933,253*	Havana (785,455†)
Dominican Republic	18,i03	3,013,525	Santo Domingo 1367,053)
Haiti	10,714	3,505,000‡	Port-au-Prince (112,296‡)
British West Indies			
(Colonies of the United Kingdom, enjoying various degrees of internal self-government.)			
Bahamas	4,403.5	103,955‡	Nassau (53,622‡)
Barbados	166	232,085	Bridgetown (11,304)
Cayman Islands	100	7,616	Georgetown (2,558§)
Jamaica (with Morant and Pedro cays)	4,413	1,613,880	Kingston (123.495)
Leeward Islands			
Antigua (with Barbuda and Redonda)	170	54,354	St. Johns (21,637)
St. Kitts (Christopher)-Nevis-Anguilla	153	56,658	Basseterre (15,742)
Montserrat	32	12,157	Plymouth (1,921)
Virgin Islands	59	7,338	Road Town (891)
Trinidad and Tobago	1,980	827,957	Port-of-Spain (91,596)
Turks and Caicos Islands	169	5,716	Grand Turk (2,3469)
Windward Islands			
Dominica	305	59,916	Roseau (13,500‖)
Grenada (with Carriacou and southern Grenadines)	133	88,677	St. George's ([illegible]‖)
St. Lucia	238	86,108	Castries (25,000‖)
St. Vincent (with northern Grenadines)	150	79,948	Kingstown (4,296)
French West Indies			
(The two major islands rank as overseas *départements* of metropolitan France.)			
Guadeloupe (Basse-Terre and Grande-Terre; with Marie-Galante, Les Saintes, Petite Terre, La Désirade, St.-Barthélemy, north part of St. Martin)	687	274,7747	Basse-Terre 111,8379); (Chief commercial centre, Pointe-à-Pitre, 26,1609)
Martinique	431	277,0007	Fort-de-France (62,0007)
Netherlands Antilles'			
(An internally self-governing group within the kingdom of the Netherlands, sharing in policy on kingdom affairs, mainly defense and foreign relations, as an integral part of the realm.)	371	188,199	Willemstad (49,2486)
Leeward Islands			
Curacao	(173)	(124,500)	
Aruba	(69)	(53,199)	
Bonaire	(95)	(5,800)	
Windward Islands			
St. Martin (south part)	(17)		
St. Eustatius	(12)	(4,700)	
Saba	(5)		
Associated mith'the United States			
Puerto Rico (Self-governing state, enjoying the title of commonwealth, freely associated with the American Union)	3,435	2,349,544	San Juan (451,658)
Virgin Islands of the United States (Organized, unincorporated territory)	133	32,099	Charlotte Amalie (12,880)
St. Thomas	(33)	(16,201)	
St. John	(20)	(925)	
St. Croix	(80)	(14,973)	
Navassa Island (possession)	2		—
Insular parts of Venezuela			
Nueva Esparta (state; Marparita Island and Coche and Cubaqua islands)	444	87,545□	La Asunción (5,541")
Federal dependencies (islands directly under the national government)	4 6	851")	—

*1961 estimate. †1953 census. ‡1959 estimate. §District population. ‖1957 estimate. 71960 estimate. 91954 census. 61955 estimate. "1961 census.

led to a decline in price. Recurrent war dislocated trade and raised freight and insurance charges. Further blows to the prosperity of planters and sugar factors were the abolition of the British slave trade in 1807; the emancipation of slaves in the British colonies between 1833 and 1838, in the French in 1848; and the abolition of preferential sugar duties by the British government in 1846. For most West Indian territories, the 19th century was a period of impoverishment and neglect. The principal exceptions were Trinidad and British Guiana, where indentured immigrants from India supplied cheap labour, and Cuba, which retained slavery until 1886 and exported vast quantities of sugar to an expanding market in the United States. Only in the 20th century has there been any marked evidence of a change for the better. Oil has brought considerable wealth to Trinidad and great prosperity to Curaçao since the beginning of the 20th century; bananas and bauxite have taken their place beside sugar as the major exports from Jamaica; and the tourist trade has become an important source of revenue.

On the political side, the middle years of the 20th century were marked by a steady trend toward self-government in all the colonial possessions in the West Indies, culminating in the British islands in proposals for independence and plans for federation. In Cuba. Haiti and the Dominican Republic, on the other hand, varying degrees of local dictatorship have been the price of technical independence. Throughout the area, economic dependence upon the United States has steadily increased. *(See* also WEST INDIES [FEDERATION], THE.) (J. H. PY.)

V. POPULATION

Of a total area of over 91.000 sq.mi. the Greater Antilles take up nearly 82,000. Official area and population figures are given in the table; also the political status of territories.

The total population of the West Indies was about 20,000.000 in 1960. In 1957 about 61% were of African and mixed descent and 39% were white — overwhelmingly the Spanish groups of Cuba (73%), Puerto Rico (80%) and the Dominican Republic (20%); Curaçao is about 14% white.

Jamaica and the remaining islands have, with few exceptions, an African and mixed population with a sprinkling of whites; *e.g.,* British territories have a total population of about 3,500,000 people with 1.5% white. Trinidad has the majority of the region's 1,250,000 island East Indians, who form one-third of its population and increase exceptionally fast. The rate of increase of many island populations, *e.g.,* Jamaica and especially Puerto Rico, is notable.

The official language of Cuba and the Dominican Republic is Spanish; of Puerto Rico. Spanish and English jointly; and of Haiti. French. Elsewhere it is that of the associated power Haiti recognizes creole as a language and patois is spoken in French and former French islands. A dialect of mixed origin called Papiamento is spoken in Curaçao.

Education is compulsory in Cuba, Puerto Rico, Martinique, Trinidad and various other islands but cost is a source of acute difficulty in poor communities. There are nine public universities: four in Cuba, two in Puerto Rico and one each in the Dominican Republic, Haiti and Jamaica.

Normally the white and middle-class population adhere to a traditional European culture, ahich may, indeed, penetrate all classes. Large groups of the poorer and more remote African people are, however, incompletely assimilated. especially as regards the basing of family structure upon legal marriage. Possession cults are strong in some parts. East Indians are mainly non-Christian and have retained in some measure their own religions, languages and customs. Puerto Rico and Jamaica show interesting social experiments such as aided self-help and community development.

Until communication by air became possible the islands were much isolated, and differences of situation. size and history, combined with lack of any common indigenous culture, have affected all aspects of social life. Spanish-speaking communities have bonds nith Central and South America, regions little known to others The influence of the U.S. is generally felt, and English-speaking islands have special ties of blood and trade with both the United States and Canada. Artistic and scholarly contacts as well as tourism link the West Indies increasingly with one another and with a wider world, but they still retain an inner diversity.

(D. I.)

See also references under "West Indies" in the Index volume.

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WEST INDIES (FEDERATION), THE, islands in the Caribbean sea consisting of 10 territories that voluntarily joined to form a union of free and equal partners. The West Indies federation. a nation within the Commonwealth of Nations, came into existence on Jan. 3. 1958. and its dissolution was announced on Feb. 6. 1962. During the five years of its existence it was subject to certain limitations of authority in matters concerning defense, external relations and finance. The first aim of the government was to fashion the 10 territories into one politically and economically viable union able to act as a sovereign state. Problems common to any new nation are complicated by the unique geographical situation of the federation — it is more than 1,000 mi. from Jamaica to Trinidad — and its intricate historical and cultural background. The site chosen for the capital in Trinidad, Chaguaramas, is leased to the United States, and a Joint commission reported in May 1958 that, for financial and strategic reasons, it could not be made available to the government of The West Indies. Another site, required to be twin-town to a large existing town, remained to be found. (R. To.)

For physical geography, natural resources, anthropology, ***see*** WEST INDIES. This article is divided into the following sections and divisions:

I. HISTORY

The governments which came together to form the federation were Jamaica. Barbados, Trinidad. the Leeward Islands and the Windward Islands; but of these, Jamaica had (and has) dependencies, consisting of the numerous islands of the Cayman, Turks and Caicos groups; the Leeward Islands group was itself a federdtion of presidencies comprising a large number of inhabited islands, including the British Virgin Islands; the Windward Islands was a collection of four fair-sized islands (with various satellites) which had a common governor but othernise had little common machinery of government; and Trinidad had associated with it in government the smaller island of Tobago. When the federation was formed, some of these groupings were disregarded or dissolved The presidencies of the Leeward Islands colony, for instance, and the colonies of the Windward Islands, all entered the federation as separate units. The units of the federation, therefore. were Barbados, Jamaica, Antigua, St. Kitts-Nevis-Anguilla (properly called St. Christopher-Nevis-Anguilla). Montserrat, Trinidad with Tobago, Grenada. Dominica, St. Lucia, and St. Vincent. British Guiana and British Honduras could accede to the federation at any time if they so desired.

Of the islands which made up the federation, Jamaica, uith an area about that of Wales and a population of 1,250,000, was by far the largest; Trinidad with 500.000 people was considerably smaller, and all the others were smaller still, far too small to be workable self-governing units in 20th-century conditions. The island governments were driven to federation by the conviction that only in that way could they achieve dominion status. independence within the British Commonwealth; a status to which the island peoples, or at least their political leaders, all professed to aspire. Only in that way. also, could they exert their maximum bargaining power in international discussions affecting their vital economic interests; in such matters. for example, as the fixing of sugar quotas. The federation came into being in the face of very strong island loyalties and jealousies; jealousies which throughout two and a half centuries had defeated almost all previous attempts at administrative grouping. These jealousies reflect a considerable diversity in social and economic origins and in political development among islands which are superficially much alike.

The first British settlements were made from 1624 onward in the Caribbee Islands, a loosely defined group which included Barbados and the present Leeward Islands. All these settlements developed along similar economic lines, first producing food crops and tobacco for export on small farms with indented European labour. but later turning to sugar produced on relatively large plantations with African slave labour, the European small holders being displaced.

By the late 17th century the Caribbee Islands had become both productive and prosperous and were regarded as valuable possessions. Barbados was the largest and most populous. It retained a bigger proportion of its early white small holders than did the other islands. and its white population was almost entirely English, unlike the Leeward Islands, where many Irish had settled. and where the French held part of St. Kitts. The Caribbee Islands had a common governor in their early days; but friction between St. Kitts and Barbados, and difficult communications. led to a demand for separation. In 1671 Barbados became a separate government. with its own governor, council and assembly. The appointment of a separate governor of the Leeward Islands did not. however, create a united government there. Each island early in its history had developed its own assembly. empowered to vote taxes and make laws not repugnant to the laws of England. A general assembly was created in 1674. but was always unpopular and ineffectual. It met for the last time in 1798. Throughout the 18th century the Leeward Islands were, in effect, four separate colonies under a common governor residing in Antigua.

Jamaica, unlike the Caribbee Islands, was a conquered colony, taken from the Spaniards between 1655 and 1660. and initially governed by the military commander. It came under civil government in 1661, and secured representative institutions similar to those of Barbados and the Leeward Islands. Many dispossessed small holders from those islands moved to Jamaica. which was a base for buccaneering and for illicit trade with Spanish America. as well as a plantation colony. After the treaty of Utrecht (1713) the island was the chief Caribbean depot of the South Sea company, in the company's slave-dealing activities under the Spanish Asiento (*q.v.*). In the 18th century Jamaica became by far the richest of the British Caribbean colonies, and one of the most valuable tropical "plantations" in the world. Being far to leeward of the Caribbee Islands it had feu direct dealings with them, and not until federal government was considered was there any suggestion of associating its government with that of any other colony.

The treaty of Utrecht. which confirmed all these possessions to Great Britain and added the former French holdings in St. Kitts, set the territorial pattern of the West Indies for more than half a century. Throughout the 18th century the sugar islands were prized objects of war; the purpose of capture, however, was to destroy, rather than to retain, the enemy's possessions. For this reason, conquests were usually restored at each peace treaty. The first major change came in 1763, when as a result of naval operations during the Seven Tears' War, Great Britain temporarily achieved a mastery so complete that. had the government so wished, almost the whole of the West Indies could have been united under one flag. In fact, however, the only territorial cessions in the West Indies eventually agreed at the peace of Paris were those of Grenada, Dominica. St. Vincent and Tobago to Great Britain. This group, then known as the Southern Caribbee Islands, was first organized as a single colony under a governor-in-chief, with lieutenant-governors in the individual islands. The islands had then very few European inhabitants and were still largely occupied by Caribs; but under British government! settlers entered from the Leeward Islands and Barbados and the familiar sugar-plantatisn pattern spread rapidly. The islands developed their own assemblies, as the Leeward Islands had done a century before, and their own insular feelings. Dominica was constituted a separate government in 1771, St. Vincent in 1776. During the American Revolution many of the islands were captured and devastated by the French, but with the exception of Tobago all mere restored at the treaty of Versailles. By the same treaty, the logwood cutters of British Honduras first received a precarious recognition.

During the long period of war between 1793 and 1815 there was much fighting in the West Indies, in the course of which Great Britain seized Trinidad, Tobago and St. Lucia and the three Dutch mainland colonies. Demerara, Essequibo and Berbice. All were retained at the peace in 1815, and the three mainland territories were united in 1831 to form British Guiana.

The 19th century in most of the British islands was a period of economic depression. The steady fall in the price of sugar, due partly to its successful cultivation in other parts of the world, emphasized the costly inefficiency of slave labour (the British slave-labour trade was abolished in 1807). The plantation system was beginning to break down even before the great social revolution of the 1830s, when the slaves were all emancipated and became either labourers or peasant small holders. The equalization of sugar duties in 1846 made fresh difficulties for the West Indian producers. The only exceptions to the general distress were Trinidad and British Guiana. which were largely undeveloped in 181j, and which later in the century imported great numbers of indented labourers. chiefly from India. Increasing poverty led to the decay of the old assemblies. After a dangerous outbreak of rioting in 1865 the Jamaica assembly was abolished and crown colony government instituted there. Most of the other islands followed, Barbados being the only conspicuous exception. Nevertheless, the islands resisted as strongly as ever all attempts to amalgamate their governments.

The Windward Islands were placed in 1833 under the governor of Barbados, as governor-general. but the legislatures remained separate and an attempt to federate them in 1876 was abandoned after rioting in Barbados. In 188; the Windward Islands were again given their own governor. Tobago was separated from the group in 1888 and its government amalgamated with Trinidad. British Honduras. declared a British colony subordinate to Jamaica in 1862, was separated under its own governor in 1884. Only the Leeward Islands agreed, with some reluctance, to federate and to revive their old general legislature; the federal colony of the Leeward Islands was established by act of parliament in 1871.

In the 20th century there has been a revival of the sugar industry in the West Indies, and a development of other export crops, notably bananas. Mineral products—oil and asphalt in Trinidad, bauxite in Jamaica—and the tourist trade increased the islands' prosperity. The authoritarian structure of crown colony government was progressively relaxed, especially after World War II, and Jamaica and Trinidad at least became for all practical purposes internally self-governing. This very progress, however, revealed the limitations of self-government at "unit" level. and led to a demand for federation from the more far-sighted political leaders in the smaller units; a demand which was warmly encouraged by the government of the United Kingdom. both directly by political suggestion and indirectly through the working of the Development and Welfare organization with its headquarters in Barbados.

The first conference on British West India federation was held at Montego Bay in 1947. By a majority vote it accepted the principle of political federation and set up a Standing Closer Association committee to study the possibilities of federation and to draft a federal constitution. The committee produced a report which was notable both for wisdom and for ingenuity. In 1953 the S.C.A.C. report was submitted to a second conference in London and accepted! with modifications, for embodiment in the conference's recommendations. It then went back to the individual governments for acceptance. Jamaica, by a unanimous vote of both houses. accepted the recommendations. British Guiana and British Honduras both announced beforehand that they would not do so, but the other islands followed Jamaica. A period of administrative preparation followed during which a Regional Economic committee, a Regional Labour board and an Air Transport Advisory council were set up. Reports were prepared on a number of important topics. including federal finance, the federal public service and the possibility of a customs union. A third conference on federation met in London in 1956. At this conference the final decision was made to federate the island territories and to leave the way open for the inclusion of British Guiana and British Honduras at a later date. The following year, after long and stubborn argument, it was agreed that the federal capital—to be built with the help of £1,000,000 to be contributed by the government of the United Kingdom—should be in Trinidad.

In 1957 Lord Hailes was appointed the first governor general of the federation. The first federal elections were held in 1958, and Sir Grantley Adams, chief minister of Barbados, became the first federal prime minister.

The difficulties in the way of West Indian federation, apart from insular prejudice, have included the personal jealousies of political leaders; the fear of the larger and stronger territories that they were being asked to support the smaller and weaker ones; and the fear of the politically rnore developed communities that their progress in local self-government might be delayed by association with less "advanced" groups. These fears were. to a great extent, removed by the discussion at the 1953 London conference.

More serious was the resolute refusal of the mainland territories to join in a political federation. It arose from a complicated blend of economic. political, racial, religious and sentimental motives. In both territories the idea of "continental destiny" and similar slogans have considerable emotional force. and in both there is widespread fear of a flood of immigration from the over-populated islands. Their refusal to participate robbed the project of some of its attraction. Dissolution of the federation was announced Feb. 6, 1962. Jamaican independence was announced for Aug. 6, 1962; a proposal was advanced for a federation of the "little eight" islands headed by Barbados; Trinidad offered to accept other territories in its unitary system. (J. H. Py.)

II. POPULATION

The population of the territories comprising the federation was high in relation to the natural resources of the area. and in 1958 the rate of increase was such that the population of nearly 3,000,000 in 1955 would he doubled by 1985. The rate of natural increase (excess of live births over deaths per 1,000) in 1955 over 1954 was 20.5 in Barbados; 26.3 in Jamaica (excluding Cayman Is. and Turks and Caicos Is.); 26.4 in Antigua (including Barbuda); 17.8 in Montserrat; 33.9 in St. Kitts-Nevis-Anguilla; 31.6 in Trinidad and Tobago; 26.9 in Dominica; 31.1 in Grenada with Carriacou; 28.8 in St. Lucia; 33.0 in St. Vincent (including the Grenadine Is.); the average of all being 27.6. In 195j all territories showed birth rates exceeding 30 per 1,000 while the over-all death rate was 12.1. Jamaica recorded for the first time a death rate of under 10, and only St. Vincent stood out as a territory showing little marked decline in its death rate; in 1954 it mas 15.2, and in 19jj it was 14.j—nearly 50% higher than the regional average.

The result of this constant increase is that attempts to provide adequate social services and labour opportunities are apt to come to nothing because the yearly increase in population takes up the margin of improvement and leaves the position unchanged. The population is very young and there are many more women than men, particularly in urban areas. The smaller territories, which have never found adequate employment for their adult populations, claimed that federation gave the right of unrestricted movement within federal territory while the larger islands saw in this claim a threat to their own labour markets. However, it was decided that one of the objects of federation was the greatest possible freedom of movement within the area. and agreement was reached on measures to be taken for facilitating and controlling interisland migration. Emigration, which was common practice during the first 30 years of the 20th century, was later restricted almost entirely to the United Kingdom. The U.S. immigration policy is highly restrictive, and neither Central nor South America wants a large influx of Negro labour. The American and Dutch Caribbean islands gave work to emigrants from British islands in the past, but now have sufficient labour for their own needs. In the United Kingdom there were 80,000 West Indian emigrants in 1958; enough to create a number of welfare problems there, but not enough to make any real difference in the labour markets of the federation.

Birth control would be a solution to the problem of overpopulation, but the social and religious difficulties are great. What is called common-law marriage is the rule in The West Indies, and the rate of illegitimacy is above 65%. The family is a loose structure and family feeling as a restrictive influence unknown. The population problem creates more problems in education and labour employment, and it is difficult to see how production, which is dependent on assistance in some form from outside, can be stepped up to overtake the natural increase in population. At the end of the 1950s the federal and territorial governments were concerned to overcome these difficulties, and if new industries and businesses were to see opportunities for development they would undoubtedly receive every assistance.

For area and population figures of the members of The West Indies federation, see Table in WEST INDIES.

The total area of the federated territories is just over 8,000 sq.mi. In those islands which are mountainous population is concentrated in the valleys and coastal areas, and this must be remembered when considering the figures for the density of population. Even in Antigua, where there are no mountains (Boggy peak, 1,333 ft., is the highest feature), there is a considerable highland region in the southeast which is sparsely inhabited.

The population of the islands is not homogeneous although the majority is of African Negro origin. Of the total shown ,above more than 78% are of Negro origin and about 18% mixed; East Indians form 1.8%; Chinese. 1.0%; Europeans. 0.4%; and Syrians, 0.1%. Jamaica and Trinidad account for nearly four-fifths of the population of the federation; and Trinidad has the largest number of East Indians, 36% of its total.

A conference on demographic problems was held in Trinidad in 1957 under the auspices of the Caribbean commission, and their recommendations included the promotion of vocational guidance and training as a means of economic development; the study of conditions under which emigration can be organized; and the undertaking of fertility surveys as part of the 1960 world census program.

III. ADMINISTRATION AND SOCIAL CONDITIONS

1. Constitution.—The constitution of The West Indies as agreed in 1956 was approved by the parliament of the United Kingdom in July 1957. The legislature was inaugurated in Port of Spain on April 22, 1958. The constitution provides for a governor general appointed by the crown and assisted by a council of state; a senate of 19 members, nominated by the governor general and serving five years; and a house of representatives of 45 members elected by adult suffrage. In the senate each territory has two representatives, except Montserrat which has one. In the house of representatives. Jamaica has 17 members; Trinidad, 10; Barbados, 5; Antigua. St. Kitts, Dominica, Grenada, St. Lucia and St. Vincent, two members each; and Montserrat, one member. Montserrat also has an "alternate member" who may deputize for the member if he is incapacitated.

The first elections were held in March 1958, with the result'that the Socialists. known as the Federal Labour party. won 25 seats; the anti-Socialists. called the Democratic Labour party, 19 seats; and the Barbados Independent party, one seat. The premier of

Barbados: Sir Grantley Adams, was elected prime minister by secret ballot. Politicians cannot sit in both federal and territorial legislatures. and this accounts for the absence from the federal parliament of the chief ministers of Jamaica and Trinidad.

The executive authority is exercised by the governor general. A council of state, which consists of the prime minister (who is nominated by the house) and 10 ministers, is the chief instrument of policy. Ministers, not less than three of whom are senators, are appointed by the governor general on the prime minister's advice. The governor general is required to act on his council's advice except in certain specified contingencies and he must obtain the secretary of state's approval if he acts against that advice. Provision is also reserved to the United Kingdom government to legislate in respect of defense, external relations and the financial stability of the federation.

The powers of the federation are specifically defined. Certain subjects, including defense, external relations, federal services, migration and borrowing outside the region, are "exclusive" subjects of federal legislation. Emergency powers, criminal law and administration, aviation and trade unions are among the "concurrent" subjects; that is, subjects both of federal and unit legislation. with the understanding that in case of conflict the federal will shall prevail. All subjects not specified—for example, agriculture, housing and the maintenance of public order—are left to the unit legislatures.

Money bills are introduced in the house of representatives only and may be presented for the governor general's assent even if not passed by the senate, which on other bills has delaying powers for one year. The queen in council may amend any of the provisions of the constitution. particularly for the purpose of including other territories in the federation. General elections are held every five years, and the governor general has the power to prorogue or dissolve parliament.

2. Taxation.— Until 1963, the government would obtain revenue chiefly from a mandatory levy on territorial governments, which must not exceed £1,900,000 per annum. It is also entitled to profits from the currency issue and. after five years, will levy its own income tax. The federal government is responsible for the control of territorial governments which receive grants-in-aid. Taxation varies in different territories as do customs and excise.

3. Living Conditions.— The islands are overpopulated in relation to their resources and in the 1950s unemployment and underemployment were severe. Standards of living are low because territorial economies cannot support anything better. and the climate is undemanding. Wages are low, although workers in many industries have received yearly increases since 1946 and tend to regard this as a normal feature of employment.

Housing conditions are poor. The shacks in which the majority live are small and built of timber. with no washing or cooking facilities, and no water or electricity laid on. Overcrowding is the worst defect and if the family is large (the average number of children is five) several members sleep outside. The staple food of the people is fungi or rice and salt fish, fruit and vegetables. Food is cooked on coalpots and eaten outside.

4. Welfare Services.— Public welfare is recognized as an essential part of the administration, and committees representing all social services are working on long-term policies. The Development and Welfare organization, established in 1940, assisted all territories, and its functions and responsibilities have been assumed by the federal government. The organization plans services to agriculture, education, fisheries, forestry. housing. industrial development, health, surveys and water supplies; and during the years 1946–56, £23,140,200 was expended in grants and loans. Voluntary organizations were encouraged to work on modern lines and made great progress. The idea of self-help. based on home, family and village. has been widely adopted and commands the support of administrations, churches and voluntary organizations. The federal government is maintaining the tradition of welfare, and the inclusion of the minister for social affairs in the council of state guarantees the integration of welfare with other services.

5. Justice.— The establishment of the federal supreme court was the first duty of the newly elected federal parliament. The court has original jurisdiction in all federal territories and can hear appeals from courts of colonies not included in the federation. All judges are appointed by the governor general, and the bench consists of a chief justice and three justices. Courts may be established anywhere in the federation. Police forces are organized on a territorial basis. but there is effective co-operation throughout the federation.

6. Education.— Primary education for all children of school age is the declared policy of the government. The system of secondary education, on which the fortunes of the University College of The West Indies depend, is being consolidated; but the problems of education at all levels are (1) the difficulty of providing adequate staff and accommodation; (2) a continuous rise in the costs of education; (3) the need for reform in methods of teacher-training; and (4) the need for a revision of curriculums and for the development of technical education. The university college teaches for honours degrees in English, history, French, Latin and mathematics, and has a well-equipped medical faculty. The extramural department has resident tutors in each territory and peripatetic staff-tutors.

7. Defense.— Defense of The West Indies is essential to the defense of the Americas, and thus closely linked to the over-all defense strategy of the United States. The Caribbean is one of the great seaways and in wartime the federation is peculiarly dependent on its effective defense. The U.S. has established a chain of bases from Newfoundland in the north to Trinidad in the south and it was decided in May 1958 that the existing base at Chaguaramas. which had been considered as a site for the administrative capital of the federation, fulfilled all strategic and military requirements and that an alternate site would cost between £47,000,000 and £88,000,000 and take from $5\frac{1}{2}$ to 10 years to build. The United States has small military bases in other territories, and since the abolition of the Royal Navy's America-West Indies station the defense of the area has been entirely in American hands.

A British army headquarters is situated in Jamaica for liaison purposes. The Jamaica regiment, under its command, was to be incorporated in a re-formed West Indies regiment. The role of these troops is local defense and internal security.

IV. THE ECONOMY

1. Production.— The economy of the islands has in the past been based on a few agricultural products, but the present aim is to diversify production so that each island will be economically independent when grant-aid is withdrawn. Cultivation of the land is the chief occupation in the federation; over 50% of the cultivable land. and over 80% in some islands, is farmed in large plantations on which cash crops are grown, although the number of small holdings is increasing. Much land is also devoted to food crops for home consumption, some of which are traded between the islands. Tree planting is encouraged, not only to promote timber and fruit yields, but also to improve water supply. The largest stands of valuable timber are in Trinidad. Most islands have a small fishing industry, and a variety of fish is caught. In Barbados, famous for flying fish, the fishing fleet is equipped with power units.

In 1957, Trinidad's oil fields were drilled by 12 companies; marine drilling has also achieved favourable results and production

TABLE I.—*Exports, 1955*

Territory	Value of exports	Main exports with percentage of total
Trinidad and Tobago . .	£59,500,000	Oil and oil products, 76%; sugar and rum, 11½%; cocoa, 4%; asphalt. citrus. coffee, copra
Jamaica . . .	£33,627,724	Sugar and rum, 36½%; bauxite and alumina, *2634%;* bananas, 15%; cigars, pimento, coffee, citrus
Barbados	£8,141,085	Sugar, molasses and rum, **93%**
Windward Islands . .	£4,220,000	
Dominica . . .		Lime products, bananas
Grenada		Nutmegs, mace, cocoa
St. Lucia		Sugar, coconut oil, copra, cocoa
St. Vincent		Arrowroot, cotton, copra, bananas
Leeward Islands . . .	£2,640,000	
Antigua		Sugar, cotton
St. Kitts-Nevis-Anguilla .		Sugar, cotton
Montserrat		Cotton, vegetables

Table 11.—Bauxite and Alumina Exports, 1955 and 1957

continues to increase. Asphalt from the pitch lake is mined. The production of bauxite in Jamaica has shown a striking increase since it was first developed on a large scale in 1952. Oil refining and the extraction of alumina are associated industries. However, sugar refining and its by-products are still the chief industries of the area. The territories of the federation produced 815,841 long tons of sugar during 1957. Other industries associated with agriculture are the canning of fruit juices, cotton ginning and the production of copra and coconut oil, while many small manufactures for local consumption include ice! cigarettes, mineral waters and beer.

2. Trade and Finance.—The prosperity of the federation depends on an integrated trade policy and regional co-operation, and in its early days a commission on trades and tariffs sat to examine the fiscal and technical problems involved in the establishment of a customs union. The domestic trade is varied and includes sugar, rum, fruit, vegetables, copra, charcoal, salt and sloops.

The chief importers into the federation are Great Britain, the United States, Canada and Central and South America: the distribution of exports is similar except that the positions of the United States and Canada are exchanged. Imports include flour and meal, rice, salt fish. meat, canned foodstuffs, cotton piece goods, motor vehicles and transport equipment, machinery, fuel oils, lubricants. lumber and fertilizers. Needs vary between islands, and Trinidad—the largest single importer—obtains crude oil from Venezuela which ranks second among its suppliers after Great Britain. The Canada-West Indies trade is traditionally based on the exchange of food and forestry products for sugar, molasses and rum; but the federation lies in the sterling area and trade with North America is less than it used to be. The price for export sugar under the negotiated price quota of the commonwealth sugar agreement was £43 16*s.* 8*d.* a ton for 1958. Potentialities for the entertainment of tourists are great. In all islands, except Trinidad, there is a steady upward trend in the tourist trade. which is one of the largest revenue-producing activities.

The monetary unit in all territories, except Jamaica. is the B.W.I. dollar, and in Jamaica it is the £J. = $4.80 = £1 sterling. Jamaica currency is legal tender in other territories and vice versa. The coinage. introduced in 1955, is that issued by the British Caribbean Currency board with decimal values. A large sum of money is being allowed by the British government to enable the federal government to make grants to territorial governments whose resources are insufficient to enable them to defray their administrative expenses during the first ten years of the federation.

3. Transport and Communications.—&lainhighways in all territories are constantly being improved, but the huge increase in traffic—especially in Trinidad—necessitates a new approach to the problem. Railway systems exist only in Jamaica and Trinidad, but the sugar islands have railways for carrying cane from field to factory. There is an interisland shipping service, two small ships providing a 10-day service from British Guiana to Jamaica calling at islands in between; both carry general and refrigerated cargo and 60 passengers. There are services from Canada and the United States; from the United Kingdom, France. Italy and Sweden. Italian lines have obtained a monopoly of the emigrant trade. Air travel has made the islands accessible, and they are well served by international air lines and there is also an inter-island service. The Leeward Islands Air transport and the St. Vincent Government Air service serve their respective localities. The post office maintains surface and air mail services, and all territories are linked by telecommunications with Europe and America.

(R. To.)

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WESTINGHOUSE, GEORGE (1846–1914), U.S. inventor and manufacturer, was born at Central Bridge. N.Y., on Oct. 6, 1846. He entered the Union army in the Civil War in 1863, but in 1864 was appointed third assistant engineer in the navy. In 186j he invented a device for replacing derailed cars and also a reversible steel railway frog. In 1869 he patented his air brake and organized the Westinghouse Air Brake company. In 1872 he invented the automatic air brake. This brake was quickly adopted by railways in America and gradually in Europe. He also developed a system of railway signals, operated by compressed air with the assistance of electrical contrivances. In 1893 this system was installed at the Chicago exposition. He built dynamos for the power plants at Niagara falls, for the rapid transit systems of New York city, and for the London Metropolitan railway. He died in New York on March 12. 1914.

WESTLAKE, JOHN (1828–1913), international lawyer and social reiormer, was born at Lostwithiel, Cornwall, on Feb. 4, 1828. and educated privately and at Trinity college. Cambridge. Taking silk in 1874. he became Liberal member of parliament (1885–86) and Whewell professor of international law at Cambridge (1888–1908). Though trained as an equity and conveyancing lawyer, his main interest lay in public and private international law. He virtually laid the foundations of the conflict of laws as a systematic branch of the laws of England, publishing in 1858 his Treatise on Private International Law, which exercised a profound influence on the judicial bench. Westlake was one of the founders of the Institut de Droit International in 1873 and a most active worker in the advancement of international law. His International *Law* (part i. Peace, 1904; part ii. *War,* 1907) and his Collected *Papers* (1914) are representative of his work in this field.

He was active in the movement for the restoration of the constitution of Finland (1899–1900), in the work of the Balkan committee (1905–13) and on behalf of many oppressed peoples. He was one of the founders of the Working Men's college in 1854, and a strong supporter of women's suffrage and many other social movements. He died in London on April 14, 1913.

See *Memories of John Westlake* (1914). (McN.)

WEST LOTHIAN, a county of Scotland, bounded north by the Firth of Forth, east by Midlothian. south and southwest by Lanarkshire and west by Stirlingshire. The area is 120 sq.mi. with a population (1961) of 92.764. The surface rises gradually from the firth to a hilly district in the south. with summits up to 1,000 ft. Traces of the prehistoric inhabitants still exist. Stone cists have been discovered at Carlowrie, Dalmeny, Newliston and elsewhere; the stone burial mound at Cairnpapple hill, excavated in 1946–48, was found to be a "henge" used from Neolithic times (c. 2000 B.C.) and through the Bronze and Iron Ages. At Kipps is a cromlech) that was once surrounded by stones. The eastern end of the wall of Antoninus passed through the shire; and Roman camps can be distinguished. At Carriden evidence has been found of a Roman fort. possibly the Credigone recorded in the 7th-century *Ravenna Cosmography,* and at Bo'ness was a temporary camp. The historical associations mainly cluster round Linlithgow (*q.v.*) and the county was formerly known as Linlithgowshire.

There is arable farming on the coastal lands between the Almond and Avon, fattening cattle, grain and potatoes being the main features. Southward is the grazing area, where dairy farming and stock raising are predominant. The greater part of the county is poor marginal land. There are numerous large shale-oil works and big ironworks; coal is mined, and steel is made at Armadale. Fire clay is extensively worked; limestone, freestone and whinstone are all quarried. Paper is made at Linlithgow and Bathgate, and distilling carried on at Linlithgow. Bathgate and Bo'ness. Bo'ness (Borrowstounness in full) is the principal port. From South Queensferry the Forth railway bridge crosses the firth to North Queensferry in Fife and a ferry perpetuates that used by Queen Margaret. wife of Malcolm Canmore. The Union canal (31 mi. long), connecting Edinburgh with the Forth and Clyde canal, crosses the county. In 1951 Gaelic and English were spoken by 145 persons. The small burghs are Linlithgow (pop. [1961] 4,327), Queensferry (2,929), both royal burghs, Bathgate (12,-686). Bo'ness (10,194), Armadale (6,193) and Whitburn (5,902). There are six county districts. The shire returns one member to parliament and is part of the sheriffdom of the Lothians, Selkirk and Peebles, with a resident sheriff substitute at Linlithgow.

WESTMACOTT, SIR RICHARD (1775–1856), an accomplished and popular English academic sculptor. was born in London on July 1j, 1775. He worked for a time under his father and in 1793 went to Rome to study under A. Canova. He returned to London in 1797, and in the next year set up on his own. soon becoming one of the most popular sculptors, carving statues, busts, chimney pieces and monuments. His principal statues include Lord Duncan in St. Paul's cathedral. Joseph Addison in Westminster abbey. Lord Nelson at Birmingham, Charles James Fox in Bloomsbury square, London, George III at Liverpool and in Windsor Great park, the duke of York in Carlton House terrace, London, and "Achilles" in Hyde park. London. Westmacott also carved reliefs on the Marble arch, London, in 1828 and the bas-relief in the pediment of the British museum in 1847. He was elected royal academician in 1811 He was knighted in 1837 and died Sept 1, 1856, in London. Westmacott, if he never reached the highest point of grandeur or beauty, was a dignified and impressive artist.

See Rupert Gunnis, *Dictionary of* Sculptors *1660–1851 (1953).*

(R. Gs.)

WESTMEATH, a county of Ireland in the province of Leinster. Pop. (1961) 52,774; area 680.6 sq.mi. Westmeath is a county of carboniferous limestone and bogs.

The only heights are Knocklayde (797 ft), Hill of Ben (713 ft.) and Knockayon (710 ft). A considerable system of eskers, notably north of Tullamore, diversifies the surface of the limestone plain. In the north, on the borders of Cavan, is Lough Sheelin, 5 mi long and between 2 and 3 mi wide, and adjoining it is the smaller Lough Kinale. In the centre is Lough Derravaragh, 6 mi long by 2 mi broad at its widest part. To the north are Loughs Lene, Glore. Bamn and others; and to the south, Loughs Iron and Owel. Farther south is Lough Ennell or Belvedere, and in the southwest Lough Ree. a great expansion of the river Shannon, forming part of the boundary with Roscommon. The loughs are noted for their trout.

Westmeath was severed from Meath (*q.v.*) in 1543. The insurrection of 1641 was concerted at Multyfarnham abbey, and both in the wars of this period and those of 1688 the majority of the estates in the county were confiscated. There are a considerable number of raths or encampments: one at Rathconrath is of great extent; another at Ballymore was fortified during the Cromwellian wars and those of 1688 and was afterward the headquarters of Gen. Godart van Ginkel, when preparing to besiege Athlone: there is a third near Lough Lene. The soil is generally a deep rich loam well adapted both for tillage and pasturage. The occupations are almost wholly agricultural. The principal crops are oats, potatoes and wheat. Friezes, flannels and coarse linens are produced. The constituency of Longford-Westmeath returns five members to *dnil eireann.* Westmeath includes the towns of Athlone (*q.v.*) and Mullingar (*q.v.*), which is the county town.

WEST MIFFLIN, a borough of Allegheny county, Pa., U S., partially bounded by the Monongahela river, lies 8 mi. S.E of Pittsburgh (*q.v*). It is in the centre of a rich industrial area, producing steel. tin cans. electrical equipment, automobile bodies, oxygen, coal, slag and highway construction materials, and contains Kennywood park, one of the leading recreational centres of the Pittsburgh area. The township of West Mifflin was created in 1788 and incorporated as a borough in 1944. For comparative population figures *see* table in PENNSYLVANIA: *Population.*

(M. R Wo)

WESTMINSTER, MARQUESSES AND DUKES OF. The title of marquess of Westminster was bestowed in 1831 upon Robert Grosvenor, 2nd Earl Grosvenor (1767–1845), whose grandson, Hugh Lupus Grosvenor (1825–99), was created duke of Westminster in 1874. The family of Grosvenor is of great antiquity in Cheshire The ancestors of the dukes of Westminster, the Grosvenors of Eaton, near Chester, were cadets of the knightly house of Le Grosvenur. Their baronetcy dates from 1622.

SIR THOMAS GROSVENOR, the 3rd baronet (1656–1700), in 1676 married Mary (d. 1730), heiress of Alexander Davies (d. 1665), a scrivener, who brought to the Grosvenor family certain lands non covered by some of the most fashionable quarters of the West End. His grandson, SIR RICHARD GROSVENOR (1731–1802), was created Baron Grosvenor in 1761 and Viscount Belgrave and Earl Grosvenor in 1784. The 1st earl, a great breeder of race horses, was succeeded by his only surviving son ROBERT, 2nd earl (1767–1845), who rebuilt Eaton hall and developed his London property. In the house of commons from 1788 to 1802. he mas a follower of Pitt, who made him a lord of the admiralty and a commissioner of the board of control, but after 1806 he left the Tories for the Whigs. He was created a marquess in 1831. HUGH LUPUS (1825–99), grandson of the preceding, was created a duke in 1874, and was a member of parliament for Chester (1847–69) and master of the horse under Gladstone (1880–85), but he left the Liberal party over home rule for Ireland He was succeeded by his grandson Hugh Richard Arthur, 2nd duke (1879–1953).

WESTMINSTER, a part of London, Eng.; strictly a city in the administrative county of London. bounded east by the City, south by the Thames river, west by the boroughs of Chelsea and Kensington and north by Paddington. St Marylebone and Holborn. Westminster was formed into a borough by the London Government act of 1899, and by a royal charter of Oct 29, 1900. it was created a city The cities of London and Westminster comprise one parliamentary constituency and return one member. Pop. (1961) 85,223. Area 3.9 sq.mi. Within its bounds are Hyde park, St. James's and Green parks; Victoria and Charing Cross stations; Piccadilly. Regent street. Park lane. the Strand and Aldwych; Charing Cross and Westminster hospitals; the Royal Albert hall, the Tate gallery, King's college. Covent Garden market and opera house, Drury Lane and many other theatres round Piccadilly circus and Leicester square; the districts of Mayfair, Soho, Belgravia and Pimlico. The City of Westminster, as thus depicted, extends from the western end of Fleet street to Kensington gardens. and from Oxford street to the Thames, which it borders over a distance of 3 mi between Victoria (Chelsea) bridge and a point below Waterloo bridge. It contains a large number of national and imperial public buildings from the Law courts in the east to the Imperial institute in the west, includicg Buckingham and St James's palaces and the National gallery. The name of Westminster is generally associated with a more confined area, namely, the quarter that includes the abbey, the houses of parliament, the government and other buildings in Whitehall, and the Roman Catholic cathedral.

Westminster Abbey.—The abbey, properly the Collegiate Church of St Peter in Westminster, is the most widely celebrated church in the commonwealth The Thames was bordered in early times by a great expanse of fenland from Chelsea and Battersea, while near the point where the abbey stands was a low island perhaps three-quarters of a mile in circumference. known as Thorney or Bramble Isle. There have been stories of a temple of Apollo and of a church founded under "King Lucius"; there is more probability in the statement of Stou that King Sebert founded a church of St. Peter on Thorney Isle, and legend relates the coming of St. Peter himself to hallow his new church.

A charter of Offa, king of Mercia (785), deals with the conveyance of certain land to the monastery of St. Peter, and King Edgar restored the church, defining by a dubious charter dated 951 the boundary of Westminster. extending (in modern terms) from the Marble arch south to the Thames and east to the City boundary, the former Fleet river. Westminster was a Benedictine foundation. In 1050 Edward the Confessor took up the erection of a new church: cruciform, with a central and two western towers. It was consecrated in 1065 before the Confessor died, but building was continued afterward. In 1245 Henry III set about the rebuilding of the church east of the nave.

The present abbey is a cruciform structure consisting of nave with aisles, transepts with aisles (but in the south transept the place of the western aisle is occupied by the eastern cloister walk) and choir of polygonal apsidal form, with six chapels (four polygonal) opening north and south of it, and an eastern Lady chapel, known as Henry VII's chapel. There are two western towers, but in the centre a low square tower hardly rises above the pitch of the roof. The main entrance in common use is through the great west door. The chapter house, cloisters and other conventual buildings and remains lie to the south. The total length of the church (exterior) is 531 ft. and of the transepts 203 ft. in all. The breadth of the nave without the aisles is 38 ft. 7 in. and its height close to 102 ft. These dimensions are very slightly lessened in the choir. The exterior is finely proportioned, but the building has been much altered. Sir Christopher Wren is usually said to have designed the western towers, completed by Nicholas Hawksmoor (1745), and Sir Gilbert Scott and J. L. Pearson rebuilt the north front.

Within, the abbey is a superb example of the Pointed style. The body of the church is remarkably uniform because, although the building of the new nave was continued with intermissions from the 14th century until Tudor times, the Early English design in the eastern part was carried on. The choir, with its radiating chapels, plainly follows French models. Exquisite ornament is seen in the triforium arcade. and beneath the rose windows in the transepts are figures. specially finely carved though much mutilated, known as the censing angels.

Henry VII's chapel replaces an earlier Lady chapel, and is the most remarkable building of its period. It comprises a nave with aisles and an apsidal eastward end formed of five small radiating chapels. A splendid series of carved oak stalls lines each side of the nave. and above them hang the banners of the Knights of the Bath. The fan-traceried roof. with its carved stone pendants. is exquisite. The choir stalls in the body of the church are modern. The reredos is by Scott. with mosaic by Antonio Salviati (1865).

Abbey Ceremonies and Monuments.— From William the Conqueror onward every sovereign has been crowned at Westminster excepting Edward V and Edward VIII. The coronation chair, which stands in the Confessor's chapel. dates from the time of Ednard I and contains beneath its seat the stone of Scone, on which the Scottish kings were crowned. The stone is of Scottish origin, but tradition identifies it with Jacob's pillow at Bethel. (It was stolen by Scottish nationalists on Christmas morning 1950 but was restored to Westminster abbey in April the next year after being left in Arbroath abbey.) In the Confessor's chapel also are kept the sword and shield of Edward III and the second coronation chair that was made for Mary, wife of William III. Subsequent to the Conquest many kings and queens were buried in this chapel. from Henry III to George II. A part of the south transept is famed under the name of the Poets' Corner. The north transept contains many monuments to statesmen, and the abbey is crowded with tombs and memorials of famous British subjects, the custom of burial there being traditionally linked with the presence of the shrine of Edward the Confessor. The burial of the "Unknown Warrior," in the centre of the nave near the west door, after World War I is a notable commemoration of the sacrifice made by the people in that war. A number of undistinguished persons also have their tombs in the abbey.

Conventual and Other Buildings.— The monastery was dissolved in 1539, and Westminster was then erected into a bishopric, but only one prelate, Thomas Thirlby, held the office of bishop. In 1553 Mary I again appointed an abbot. but Elizabeth I reinstated the dean, with 12 prebendaries. Of the conventual buildings, the cloisters are of the 13th and 14th centuries. On the south side of the southern walk remains of a wall of the refectory are seen from without. From the eastern walk a porch gives entry to the chapter house and the Chapel of the Pyx. The first is of the time of Henry III, a fine octagonal building, its vaulted roof supported by a slender clustered column of marble. It was largely restored by Scott. There are mural paintings of the 14th and 15th centuries. The Chapel or Chamber of the Pyx is part of the undercroft of the original dormitory, and is early Norman work of the Confessor's time. It was used as a treasury for the regalia in early times, and there were kept the standard coins of the realm used in the trial of the pyx now carried out at the mint. The undercroft is now the Abbey museum; above it is the chapter library. To the southeast lies the picturesque Little Cloister, with its court and fountain. Near it are slight ruins of the monastic infirmary chapel of St. Catherine. West of the main cloisters is the former abbot's lodging which is now occupied by the Deanery. Jerusalem chamber and College hall. built round a small court and dating mainly from the 14th century. Its most famous portion is the Jerusalem chamber. believed to be named from the former tapestries on its walls, representing the holy city. The College hall, adjoining it, is the dining hall of Westminster school.

During World War II the abbey was seriously damaged at the crossing. but the surrounding buildings suffered more. The Deanery. the Little Cloister. with its residences, the great schoolroom, with its hammer-beam roof. and Dr. Busby's library were completely gutted. The dormitory of Westminster school was also burned out. but its interior was of slight architectural value. It was later rebuilt internally.

Westminster School.— St. Peter's college, commonly called Westminster school, is one of the ancient foundations of England. A school was maintained by the monks from very early times. Henry VIII took interest in it, but the school owes its present standing to Queen Elizabeth I. The school buildings lie east of the conventual buildings. They were remodelled after World War II. Ashburnham house, containing one of the schoolhouses, the library and many classrooms, is named from the family for whom it was built, traditionally, but not certainly. by Inigo Jones. The finest part remaining is the grand staircase. In the college dormitory a Latin play used to be annually presented. but this ancient custom was interrupted during World War II and not resumed afterward. The boys have the privilege of acclaiming the sovereign at the coronation in the abbey. There is a long-standing custom of struggling for the possession of a tossed pancake on Shrove Tuesday. The winner of this Pancake Greaze is rewarded by the dean.

St. Margaret's.— On the north side of the abbey, close beside it, is the parish church of St. Margaret. It was founded in or soon after the time of the Confessor, but the present building is Perpendicular, of greater beauty within than without. St. Margaret's is officially the church of the house of commons.

Westminster Palace: Houses of Parliament.— A royal palace existed at Westminster under Canute. but the building spoken of by Fitzstephen as an "incomparable structure furnished with a breastwork and a bastion" is supposed to have been founded by Edward the Confessor and enlarged by William I. The hall, called Westminster hall. was built by William Rufus and altered by Richard II. In 1512 the palace suffered greatly from fire, and thereafter ceased to be used as a royal residence. St. Stephen's chapel, originally built by King Stephen, was used from 1547 for the meetings of the house of commons, which had been held previously in the chapter house of the abbey; the lords used another apartment of the palace. A fire in 1834 destroyed the whole palace except the historic hall and St. Stephen's chapel. The present buildings were erected on the site in 1840–67, but of these the commons chamber was burned out in the air raids of World War II. The southwestern Victoria tower is 336 ft. high. The Clock tower, 329 ft. high, contains the clock famous for its 13-ton bell, Big Ben, upon which the hours are struck. The bell is named after Sir Benjamin Hall, first commissioner of works at the time it was hung. Of the modern rooms, the house of lords is an ornate chamber, 97 ft. in length; that of the commons, reopened in 1950, is 70 ft. long.

Westminster Hall.— The original hall was finished in 1097. It is recorded that in the year 1099 King William Rufus held his first court in the hall. Little remains of Rufus' hall beyond its walls which have been encased with modern linings. The open timber roofs, described as a "miracle of Gothic carpentry, easily the most remarkable timber structure of its age in any country," was erected by King Richard II (completed 1399), when Richard appointed John Gedeney to supervise the work of repair to the hall. with power to engage any necessary masons, carpenters and labourers. Hugh Herland. a master carpenter in the service of the king, was appointed controller to Gedeney and Herland probably deserves credit for the creation of the magnificent roof.

The span is 67 ft. 6 in. without any intermediate supports, and its construction presented a problem the solving of which had not previously been attempted. The roof was designed with an upper triangulated framed structure consisting of the main collar beam, principal rafters and queen posts. with a crown post centrally supporting the heavy ridge piece. This upper triangular framed structure was supported on two cantilever structures embodying the lower principal rafter, the hammer post, the hammer beam. the wall post and the curved strut between wall post and hammer beam, the whole roof being tied together by a great curved brace or arch springing from the corbel at the foot of the wall post passing the hammer beam, the hammer post with its crown at the centre of the main collar beam.

Evidence is available of repairs being carried out to the structure and the roof on many occasions. but the most drastic restoration work was undertaken in relatively recent years and was not completed until 1922. This restoration became an urgent necessity because of the ravages of the deathwatch beetle (*Xestobium rufovillosum*), whose operations during many years had caused the roof to become entirely unsafe. The ends of many of the principal rafters, the purlins and some of the main collar beams were found to be hollowed out to a thin shell by the attacks of the beetle. In the restoration various expedients were tried to destroy the beetle and its eggs, the most satisfactory result being obtained by spraying the affected timbers after they had been thoroughly cleaned with a solution of orthoparadichlorobenzene. A system of steel reinforcement was adopted for supporting the roof structure, and this was so placed as to be invisible. The roof was damaged. fortunately slightly, during an air raid in World War II.

Westminster hall was the seat of the chief law court of England for centuries and it witnessed the trials of. among others. William Wallace. Richard II. Sir Thomas More. Edmund Campion, Charles I, Titus Oates, Warren Hastings and Queen Caroline. It is thus one of the chief centres of English history.

Whitehall **and** Trafalgar **Square.**—Northward from Parliament square a broad, slightly curving thoroughfare leads to Trafalgar square. This is Whitehall. which replaced the narrow King street. There, between the Thames and St. James's park, formerly stood York house, a residence of the archbishops of York from 1298. Wolsey beautified the mansion and kept high state there, but on his fall Henry VIII acquired and reconstructed it, employed Holbein in its decoration and made it his principal residence. Inigo Jones designed a new palace for James I, but only the banqueting hall was completed (1622) and this survived several fires, one of which (1698) nearly destroyed the whole of the rest of the palace. The hall. converted into a royal chapel by George I and now housing the museum of the Royal United Service institution, is a fine specimen of Palladian architecture, and its ceiling is adorned with allegorical paintings by Rubens.

The principal government offices are situated in Whitehall. Downing street, on the western side and separating the foreign office from the treasury. contains the official residences of the prime minister and first lord of the treasury (No. 10) and the chancellor of the exchequer (No. 11). The official connection of these houses with their occupiers dates from the time of Sir Robert Walpole, the first prime minister, who occupied No. 10 from 1735 to 1742. George II, who owned it. had offered it to Walpole as a gift in 1731. He refused it, but it was soon after arranged that the two houses should accompany the offices with which they are now associated. The Horse Guards was begun by W. Kent and finished in the 1750s after his death. It is on the site of a tiltyard and guardhouse dating from 1631. The portion of the admiralty facing Whitehall dates from 1726, the larger part in St. James's park dates from about 1900. Admiralty arch. between Trafalgar square and the Mall. was built in 1910. On the right of Whitehall, besides the banqueting hall. are the war office and other government office departments. The Cenotaph, erected in memory of those who fell in World War I, stands in Whitehall.

Trafalgar square is an open space sloping sharply up to the north. On the south side, facing the entry of Whitehall. is the Nelson column (1843). 185 ft., a copy in granite from the temple of Mars Ultor in Rome, crowned with a statue of Nelson. Behind the terrace on the north rises the National gallery (1838), with its splendid collection of paintings, and adjoining it is the National Portrait gallery. St. Martin-in-the-Fields (1721–26), with its Corinthian portico, stands at the northeastern corner.

Westminster **Cathedral.**—A short distance from Victoria street. toward its western end. stands Westminster cathedral (Roman Catholic), a remarkable modern building (1895–1905) in early Christian Byzantine style with a stately domed campanile.

WESTMINSTER, STATUTES OF. During the reign of Edward I two statutes were passed bearing this title. The first, in 1275, was, in the words of Stubbs (*Const. Hist.*, ch. xiv), "almost a code by itself; it contains fifty-one clauses, and covers the whole ground of legislation. Its language now recalls that of Canute or Alfred, now anticipates that of our own day; on the one hand common right is to be done to all, as well poor as rich. without respect of persons; on the other, elections are to be free, and no man is by force, malice or menace, to disturb them. The spirit of the Great Charter is not less discernible: excessive amercements, abuses of wardship, irregular demands for feudal aids are forbidden in the same words or by amending enactments."

The second Statute of Westminster was passed in the parliament of 1285. Like the first statute it is a code in itself, and contains the famous clause De *donis conditionalibus*, "one of the fundamental institutes of the mediaeval land law of England." Stubbs says of it: "The law of dower, of advowson, of appeal for felonies. is largely amended; the institution of justices of assize is remodelled. and the abuses of manorial jurisdiction repressed; the statute De *religiosis*, the statutes of Merton and Gloucester, are amended and re-enacted."

The Statute of Westminster, 1931, laid down that "Dominions are autonomous Communities within the British Empire. equal in status, in no way subordinate to one another in their domestic or external affairs though united by a common allegiance to the Crown. and freely associated as members of the British Commonwealth of Nations."

The statute *Quia Emptores* of 1290 is sometimes called the Statute of Westminster III. (See ENGLISH HISTORY: *Edward* I.)

WESTMORLAND, EARLS OF. RALPH NEVILLE. 4th Baron Neville of Raby and 1st earl of Westmorland (1364–1425), eldest son of John, 3rd Baron Neville, and his wife Maud Percy (*see* NEVILLE. family'). was knighted by Thomas of Woodstock, afterward duke of Gloucester. during the French expedition of 1380. and succeeded to his father's barony in 1388.

He was repeatedly engaged in negotiations with the Scots, and his help to the court party against the lords appellant was rewarded in 1397 by the earldom of Westmorland. He had married as his second wife Joan Beaufort, half-sister of Henry of Lancaster, afterward Henry IV, whom he joined on his landing in Yorkshire in 1399. He already held the castles of Brancepeth. Raby, Middleham and Sheriff Hutton when he received from Henry IV the honour and lordship of Richmond for life. The only rivals of the Nevilles in the north were the Percies. whose power was broken at Shrewsbury in 1403; and the wardenship of the west marches was now assigned to Westmorland, whose influence was also paramount in the east. which was under the nominal wardenship of the young Prince John, afterward duke of Bedford. In May 1405 the Percies were in revolt. with Thomas Mowbray, earl marshal. and Archbishop Scrope. Westmorland met them on Shipton moor. near York, on May 29 and suggested a parley between the leaders. By pretending accord with the archbishop. the earl induced him to allow his followers to disperse. Scrope and Mowbray were then seized and handed over to Henry at Pontefract on June 3. The improbabilities of this narrative have led some writers to think, in face of contemporary authorities, that Scrope and Mowbray must have surrendered voluntarily. If Westmorland betrayed them he at least had no share in their execution. Thenceforward he was busily engaged in negotiating with the Scots and keeping the peace on the borders. He did not play the part assigned to him by Shakespeare in *Henry V*, for during Henry's absence he remained in charge of the north: and was a member of Bedford's council. Of his daughters by his second wife, Catherine married in 1412 John Mowbray, 2nd duke of Norfolk, brother and heir of the earl marshal; Anne married Humphrey, 1st duke of Buckingham; Eleanor married first Richard le Despenser, then Henry Percy, 2nd earl of Northumberland; Cicely married Richard! duke of York, and was the mother of Edward IV and Richard III. The earl died on Oct. 21, 1425, and a fine alabaster tomb was erected to his memory in Staindrop church close by Raby castle.

CHARLES, 6th earl (1543–1601), eldest son of Henry, 5th earl, by his first wife Jane, daughter of Thomas Manners, 1st earl of Rutland, was brought up a Roman Catholic and was further attached to the Catholic party by his marriage with Jane, daughter of Henry Howard, earl of Surrey. He was a member of the council of the north in 1569, when he joined Thomas Percy, 7th earl of Northumberland, and his uncle Christopher Neville. in the Catholic rising of the north, which aimed at the liberation of Mary, queen of Scots. On the collapse of the ill-organized insurrection Westmorland fled with his brother earl over the borders and eventually to the Spanish Netherlands, where he died on Nov. 16. 1601. He left no sons, and his honours were forfeited by his formal attainder in 1571. Raby castle remained in the hands of the crown until 1645.

The title was revived in 1624 in favour of SIR FRANCIS FANE (c. 1574–1628), whose mother, Mary Neville, was a descendant of a younger son of the 1st earl. He was created baron of Eurghersh and earl of Westmorland in 1624 and became Lord le Despenser on his mother's death in 1626. His son MILDMAY FANE, 2nd or 8th earl of Westmorland *(c.* 1602–66), at first sided with the king's party, but was afterward reconciled with the parliament. JOHN FANE, 7th or 13th earl of Westmorland (1682?–1762), served with distinction in various campaigns under Marlborough and was made in 1742 lieutenant general of the British armies.

JOHN FAKE, 11th or 17th earl (1784–1859), eldest son of John, 10th earl, was known as Lord Burghersh until he succeeded to the earldom in 1841. He entered the army in 1803, and in 1805 he took part in the Hanoverian campaign as aide-de-camp to Gen. George Don. He was assistant adjutant general in Sicily and Egypt (1806–07), served in the Peninsular War (1808–13), was British military commissioner to the allied armies under Schwarzenberg and marched with the allies to Paris in 1814. He was subsequently promoted major general (1825), lieutenant general (1838) and general (1854), although the latter half of his life was given to the diplomatic service. He was British resident at Florence (1814–30) and ambassador at Berlin (1841–51), after which he was transferred to Vienna. He retired in 18jj and died at Apthorpe house, Northamptonshire, on Oct. 16, 1859. He composed several operas; took a keen interest in the cause of music in England and in 1822 made proposals which led to the foundation in 1823 of the Royal Academy of Music. His wife Priscilla Anne (1793–1879), daughter of William Wellesley-Pole, 3rd earl of Mornington, was a distinguished artist.

His published works include *Memoirs of the Early Campaigns of the Duke of Wellington in Portugal and Spain* (1820) and *Memoir of the Operations of the Allied Armies Under Prince Schwarzenberg and Marshal Blücher* (1822). *See* also *Correspondence of Priscilla, Countess of Westmorland, 1812–1870* (1909).

FRANCIS WILLIAM HENRY, 12th or 18th earl (1825–91), third son of the preceding. served through the Punjab campaign of 1846 and at Gujarat on Feb. 21, 1849. He went to the Crimea as aide-de-camp to Lord Raglan. His great-grandson, DAVID ANTHONY THOMAS; became 15th or 21st earl in 1948.

WESTMORLAND, one of the northwestern counties of England extending from the Pennines on the east to the centre of the Lake district on the west, and from the Eden valley in the north to Arnside, on Morecambe bay, in the south. It is bounded on the north and west by Cumberland (with which it has many affinities), on the west and south by Lancashire, on the southeast by Yorkshire and on the northeast by Durham. The area of the county—including water—is 788.9 sq.mi., of which about one-quarter forms part of the Lake District National park.

Its general character is rural, and there is a large proportion of mountain, fell and moor (hence the name of the county, "the western moorland") but there is also good agricultural land in the Eden valley from Kirkby Stephen to Temple Sowerby and in the Kent valley from Kendal to Milnthorpe. The climate is mild and damp, and the rainfall is heavy in the mountains (about 80 in. per year). Snow frequently lies on the fells in winter and patches sometimes persist until June.

The county town is the tiny borough of Appleby and the most important place is Kendal: the only other borough.

Physical Features.— The outstanding physical features of the county are the mountains and lakes which, with those in Cumberland and Lancashire, together form the Lake district (*q.v.*). Geologically, all this is the "Cumbrian" group of mountains and consists partly of hard volcanic rocks (the Borrowdale series) and partly of an inferior sort (the Silurian), with intrusions of granite, notably near Shap. Three of the highest peaks in Westmorland are on the county boundary and shared with Cumberland: Helvellyn (3,118 ft.), Bow Fell (2,960 ft.) and Crinkle Crags (2,816 ft.). but the following are wholly within the county: Fairfield (2,863 it.), Red Screes (2,541 ft.) and High Street (2.633 ft.). The Cumbrian group is linked to the Pennines by an upland area often between 500 it. and 1,000 ft., largely limestone, which extends eastward across the middle of the county.

The principal lakes are: Windermere (10 mi. long. the largest in England), Ullswater (partly in Cumberland). Hawes Water, Grasmere. Rydal Water, Elterwater and Brothers Water. In 1936 Hawes Water was enlarged to about twice its natural size when it became a reservoir for Manchester. The principal rivers are the Eden, the Lune and the Kent. The Tees rises almost on the boundary between Cumberland and Westmorland (near Cross Fell) and for 8 mi. forms the boundary between Westmorland and County Durham.

History and Antiquities.— Westmorland has no certain remains of the Stone Age but abounds in antiquities of the Bronze Age such as cairns and burial mounds, stone circles and hut settlements—particularly at Crosby Ravensworth—which may still have been occupied in the Early Iron Age. Roman antiquities inside the county consist of a main road from Stainmore to Brougham (Brocavum) with intermediate forts at Brough (Verteraej. Crackenthorpe and Kirkby Thore (Braboniacumj; another main road from Kirkby Lonsdale to Brougham with a fort at Low Borrow Bridge; and a branch road from this, bearing westward to forts at Kendal (Alone) and Ambleside (Galavaj. The latter has been excavated and can be seen (National trust). Between Ambleside and Brougham "the most adventurous Roman road in Britain" went along the ridge of fells aptly named High street—over 1,000 ft. above sea level for more than 10 mi.

In the dark ages the Anglians probably settled in the lower Kent valley and the Eden valley, but did not penetrate into the fells. Very few antiquities of this period have been found and the same is true of the Danes who arrived from Uorkshire in the 9th century and of the Norsemen who came in the 10th century from the Isle of Man. The earliest historical record of Westmorland is in the Anglo-Saxon Chronicle for 996, but at that date the county was not yet in existence and the name refers to what is now the northern part of it, the barony of Appleby (later divided into East and West wards) which until 1092 was part of the earldom of Carlisle and was sometimes claimed by Scotland. It was separated from the earldom in 1131 and, together with the barony of Kendal (later divided into Kendal and Lonsdale wards) took its present administrative form. (Westmorland is not mentioned in Domesday Book but part of the barony of Kendal is included under Yorkshire.) Thus Appleby became the county town, being then a larger and more important place than Kendal. In the Wars of the Roses Westmorland favoured the Lancastrians and in the Civil War the chief local families were royalists. In 174j the Jacobites marched through the county, and a skirmish at Clifton on their return journey was "the last battle fought on English soil."

North Westmorland has been in the diocese of Carlisle since the see was founded in 1133; south Westmorland was in the vast diocese of York until 1543, was then transferred to Chester and was attached to Carlisle only in 1856.

There are fine parish churches at Kendal (with double aisles), Kirkby Lonsdale (Norman), Kirkby Stephen and Appleby. Those at Morland and Crosby Garrett have pre-Conquest features incorporated in them. There was an abbey at Shap. of which the tower still stands. A number of churches have remains of pre-Norman crosses and tombstones, and Windermere has remarkable mediaeval glass.

There are castles at Appleby (12th-century keep; house still occupied), Kendal (ruins). Brough and Brougham. Mediaeval peel towers were built for refuge during Scots raids, and good examples exist in the north. Yanwath and Askham; and in the south, Sizergh and Levens; they are usually combined with later halls. Levens is also remarkable for its topiary garden, and Sizergh (belonging to the National trust since 1950) was the home of the Strickland family from 1239. There are many farmhouses and cottages bearing 17th-century dates, and there is a whole village at Lowther built by the Lowther family about 1700.

The Devil's bridge over the Lune at Kirkby Lonsdale, about 1500, is one of the finest bridges in the north of England.

Agriculture, Industries and **Communications.**—Westmorland has always been a pastoral county, the fells providing enormous areas of grazing for sheep. The two native breeds, the Herdwick and the Rough Fell, have been largely supplanted by the Swaledale and Black-faced. The cattle used to be almost entirely Shorthorn, but dairy breeds (mostly Ayrshire or Friesian) are now found everywhere, and milk is taken daily to a depot at Appleby and a factory at Milnthorpe. The county is noted for its attested herds. There is very little arable land and the climate is more suitable for growing root crops than corn. A breed of fell ponies is native to this county and Cumberland.

Kendal produces shoes, blankets, carpets, laundry machinery, turbines, and tobacco and snuff. and there are paper mills at Burneside. The lead mine at Glenridding is the largest and oldest in the country and in different parts of Westmorland quarries yield slate, granite, limestone and marble. There is a diatomite factory in Kentmere.

Two main railway lines from London to Carlisle pass through the county, one down the Eden valley and the other over Shap Fell, and two trunk roads follow approximately similar routes.

Westmorland has no real coast—barely two miles on Morecambe bay, from which the sea disappears at low tide—but formerly small ships came up the Kent estuary to Milnthorpe. The Kendal and Lancaster canal was opened in 1819 but has been abandoned at the Kendal end.

Population and Administration.—The population in 1801 was 40,805; in 1851, 58,287; in 1901, 64,409; and in 1951, 67.392 (which is less than 100 per square mile). The only large town is Kendal (18.541) which is more than ten times the size of Appleby (1,70j). There are two urban districts. Windermere (6.315) and Lakes (6,096). but the latter is the least "urban" district imaginable, as its area is just short of 50,000 ac. (mostly mountain) and the biggest place in it is Ambleside. The rest of the county is covered by the rural districts of North Westmorland (population 16,959) and South Westmorland (17,776).

The county council functions from Kendal. Assizes are held at the Shire hall. Appleby (Westmorland is in the Northern circuit) and courts of quarter sessions are held at the town hall, Kendal. There are seven petty sessional divisions and nine courts. For many centuries the county returned two members to parliament, and Appleby two until 1832, but the whole county including the two boroughs is now a single constituency and returns only one member.

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WEST NEW YORK, a town of Hudson county, in northeastern New Jersey, U.S., is located on the Hudson river adjacent to Weehawken, about 5 mi. N. of Jersey City and due west of Manhattan Island. It is connected with New York city by the Lincoln and Holland auto tunnels and railroads. The area was originally settled by the Dutch in the 17th century and was alternately a part of Guttenberg and North Bergen until 1898, when it was detached from North Bergen as a separate town. It is a part of New York harbour and has over a mile of docks and grain elevators serving ocean-going ships. Local manufactures include a wide variety of textiles, novelties, commercial containers, leather goods, embroideries, silk processing, toys, clothing and rubber products. For comparative population figures *see* table in New Jersey. *Population.* (D. N. A.; M. P. M.)

WESTON-SUPER-MARE, a seaside town and municipal borough (1937) in the Weston-super-Mare parliamentary division of Somerset, Eng., on the Bristol channel, 21 mi. S.W. of Bristol by road. Pop. (1951) 40,396. Area 7.7 sq mi. It lies on a sandy bay between Brean down (south) and Worlebury hill, on which is an Iron Age B hill fort. Weston is a residential and holiday town.

WEST ORANGE, a town of New Jersey, U.S., a suburban industrial and residential community near Newark. was a portion of Orange until 1862 and was incorporated in 1900. The Edison Laboratory National monument there, established in 1956, is composed of the buildings where Thomas A. Edison for 44 years, beginning in 1887, conducted research which brought him 520 patents. It was there that he perfected, among many other things, silent and sound motion pictures; improved methods of recording and reproducing sound; and conducted experiments to extract rubber from plants grown in the United States.

Llewellyn park, established by Llewellyn S. Haskell, is considered the forerunner of the modern garden type of suburban development. The famous inventor resided there at Glenmont. designated as the Edison Home National Historic site in 1955. The Carteret school for boys and the internationally known Kessler Institute for Rehabilitation, a private hospital specializing in physical rehabilitation, are l'ocated in West Orange. For comparative population figures *see* table in New Jersey: *Population.* (E. R. D.)

WEST PALM BEACH: *see* Palm Beach and West Palm Beach.

WESTPHALIA (Ger. Westfalen), formerly a province of Prussia, Ger. The area of the province is 7,806 sq.mi., its length both from north to south and from east to west is about 130 mi. Since 1945 it has been part of the *Land* of North Rhine-Westphalia

Nearly half of Westphalia is an extension of the great north German plain, which is broken by outcrops of the underlying Cretaceous beds, and is not very fertile, except in the Hellweg, a zone between the Haarstrang and the Lippe. There are extensive fens in the north and west, and north of Paderborn is a sandy waste called the Senne. The plain is drained in the north by the Ems and in the south by the Lippe, which rise close together in the Teutoburger Wald. Between their basins are the Vechte and other small rivers flowing into the Zuider Zee. The triangular southern portion of Westphalia, most of which is included in Sauerland ("southland"), is a rugged region of slate hills and wooded valleys drained chiefly by the Ruhr with its affluents, the Lenne. Mohne, etc., and in the south by the Sieg and Eder. The hills rise in the southeast to the Rotlager or Rothaargebirge, culminating in the Winterberg plateau with the Kahler Asten (2.759 ft.), the highest summit in the province. The Rotlagergebirge, Eggegebirge and Teutoburger Wald form the watershed between the Weser and the Rhine and Ems. The Weser divides the U'iehengebirge from the Wesergebirge by the narrow pass called Porta Westfalica.

The climate is temperate except in the south, which is cold in winter and has a heavy rainfall. The crops include grain of all kinds, peas and beans, buckwheat, potatoes, fruit and hemp. The cultivation of flax is very extensive, especially in the northeast.

Swine, which are reared in great numbers in the plains, yield the famous Westphalian hams; horse breeding and the rearing of cattle and goats are also important.

The mineral wealth is very great, especially in coal and iron. The production of coal is greater than that of any other province of Prussia. The great Ruhr coal field extends from the Rhineland into the province as far as Unna, the centre being Dortmund, and there is a smaller coal field in the north at Ibbenbüren. The production of iron ore, chiefly south of the Ruhr, is exceeded in Prussia only by that of the Rhine province. After coal and iron the most valuable minerals are zinc, lead, pyrites and copper. Antimony, quicksilver, stone, marble, slate and potter's clay are also worked, and there are brine springs in the Hellweg and mineral springs at Lippspringe, Öynhausen, etc.

The manufacturing industry of the province, which chiefly depends upon its mineral wealth, is very extensive. Iron and steel goods are produced in the so-called "Enneper Strasse," the valley of the Ennepe, a small tributary of the Ruhr with the town of Hagen, and in the neighbouring towns of Bochum, Dortmund, Iserlohn and Altena, and also in the Siegen district. The brass and bronze industries are carried on at Iserlohn and Altena, those of tin and Britannia metal at Liidenscheid; needles are made at Iserlohn and wire at Altena. The very important linen industry of Bielefeld, Herford, Minden and Warendorf has flourished in this region since the 14th century. Jute is manufactured at Bielefeld and cotton goods in the west. Paper is extensively made on the lower Lenne, and leather around Siegen. Other manufactures are glass, chemicals, sugar, sausages and cigars. An active trade is promoted by several trunk lines of railway which cross the province and by the navigation of the Weser (on which Minden has a port), Ems, Ruhr and Lippe. Beverungen is the chief market for corn and Paderborn for wool.

The population in 1939 was 5,205,705, or about 666 per sq.mi. It is very unevenly distributed, and in the industrial districts has been increasing very rapidly; it includes a considerable element of Polish workpeople. As at the peace of Westphalia, the bishoprics of Munster and Paderborn and the former duchy of Westphalia are Roman Catholic, while the secularized bishopric of Minden and the former counties of Ravensberg and Mark (former possessions of Brandenburg) and Siegen (Nassau) are predominantly Protestant.

The province is divided into the three governmental departments *(Regierungsbezirke)* of Minden, Münster and Arnsberg. Miinster is the seat of government and of the provincial university.

The inhabitants are mainly of the Saxon stock and speak Low German dialects, except in the Upper Frankish district around Siegen where the Hessian dialect is spoken.

History. — Westphalia, "the western plain" (in early records *Westfalani*), was originally the name of the western province of the early duchy of Saxony, including the western portion of the modern province and extending north to the borders of Friesland. When Duke Henry the Lion of Saxony fell under the ban of the empire in 1180, and his duchy was divided, the archbishop of Cologne, Philip of Heinsberg, received from the emperor Frederick I the Sauerland and some other districts which became the duchy of Westphalia. The duchy received a constitution of its own, and was governed for the archbishop, afterwards elector, by a marshal (*Landmarschall,* after 1480 *Landdrost),* who was also stadtholder, and presided over the Westphalian chancellery. This system lasted till 1803. By the settlement of 1803 the Church lands were secularized, and Prussia received the bishopric of Paderborn and the eastern part of Münster, while the electoral duchy of Westphalia was given to Hesse-Darmstadt.

After the peace of Tilsit, the kingdom of Westphalia was created by Napoleon I on Aug. 18, 1807, and given to his brother Jerome (see BONAPARTE). It included the present governmental department of Minden, but by far the larger part of the kingdom lay outside and chiefly to the east of the modern province, and comprised the Hanoverian department of Hildesheim and in part that of Arensberg, Brunswick, the northern part of the province of Saxony as far as the Elbe, Halle, and most of Hesse-Cassel. The area was 14.627 sq mi., and the population nearly 2.000.000. Cassel was the capital. A constitution on the French imperial pattern granted by the king remained practically inoperative, an arbitrary bureaucratic régime was instituted, the finances were from the beginning in a hopeless condition, and the country was drained of men and money for Napoleon's wars. In Jan. 1810 most of Hanover was added, but at the end of the same year half the latter, together with the city of Minden, was annexed to the French empire. At the congress of Vienna (1815) Hesse-Darmstadt surrendered her share of Westphalia to Prussia. The province suffered heavy bombing attacks in World War II.

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WESTPHALIA, PEACE OF, the name given to the settlement embodied in two treaties concluded on Oct. 24, 1648, by the Holy Roman Empire with France at Munster and with Sweden and the Protestant estates of the empire at Osnabriick, by which the Thirty Years' War (*q.v.*) was brought to an end.

As early as 1636 negotiations had been opened at Cologne at the instance of Pope Urban VIII, supported by the seigniory of Venice, but failed oning to the disinclination of Richelieu to stop the progress of the French arms, and to the refusal of Sweden to treat with the papal legate. In 1637 the agents of the emperor began to negotiate at Hamburg with Sweden, though the mediation of Christian IV, king of Denmark, was rejected by Sweden, and the discussions dragged on for years without result. In the meantime the new emperor Ferdinand III proposed at the diet of Regensburg in 1640 to extend the peace of Prague to the whole empire, on the basis of an amnesty, from which, however, those Protestant estates[1] who were still leagued with foreign pouers were to be excluded. His aim m-as by settling the internal affairs of the empire to exclude the German princes from participation in negotiations with foreign powers; these efforts failed.

The Comte d'Avaux, French envoy at Hamburg, proposed in 1641 that negotiations should be transferred to Munster and Osnabruck. A preliminary treaty embodying this proposal was concluded betneen the representatives of the emperor, France, and Sweden at Hamburg on Dec. 25, 1641. The two assemblies were to be regarded as a single congress, and neither should conclude peace without the other. The date fixed for the meeting was March 25, 1642, but many months elapsed before all the representatives arrived, and the settlement of many questions of precedence and etiquette caused further delays. England, Poland, Muscovy, and Turkey were the only European powers unrepresented.

The chief representative of the emperor was Count Maximilian von Trautmansdorff, to whose sagacity the conclusion of peace was largely due. The French envoys were nominally under Henry of Orleans, duke of Longueville, but the marquis de Sablé and the comte d'Avaux mere the real agents of France. Sweden was represented by John Oxenstierna, son of the chancellor, and by John Adler Salvius, who had previously acted for Sweden at Hamburg. The papal nuncio was Fabio Chigi, afternards Pope Alexander VII. Brandenburg, represented by Count Johann von Sayn-Wittgenstein, played the foremost part among the Protestant states of the empire. On June 1, 164;. France and Sweden brought forward propositions of peace, which were discussed by the estates of the empire from Oct. 1645 to April 1646. The settlement of religious matters w-as effected between Feb. 1646 and March 1648. The war continued during the deliberations. The treaty was signed at Munster by the members of both conventions on Oct. 24. 1648, and ratifications were exchanged on Feb. 8, 1649. The papal protest of Jan. 3, 1651, was disregarded.

[1]*i.e. Reichsstände,* princes, nobles, and cities holding immediately of the emperor.

Sweden received western Pomerania with the isles of Rügen, Usedom and Wollin, the mouths of the Oder, Wismar, and the lands of the archbishopric of Bremen and the bishopric of Verden, together with an indemnity of 5,000,000 thalers. The privileges of the Free Towns were preserved. Sweden thus obtained control of the Baltic and a footing on the North Sea, and became an estate of the empire with three deliberative voices in the diet.

The elector of Brandenburg received the greater part of eastern Pomerania and Cammin, and, as he had a claim on the whole duchy since the death of the last duke in 1635, he was indemnified by the bishoprics of Halberstadt, Minden and the reversion of the archbishopric of Magdeburg, which came to him on the death of the administrator, Prince Augustus of Saxony, in 1680. The elector of Saxony mas allowed to retain Lusatia. As compensation for Wismar, Mecklenburg-Schwerin obtained the bishoprics of Schwerin and Ratzeburg and some lands of the Knights of St. John. Brunswick-Liineburg restored Hildesheim to the elector of Cologne, and gave Minden to Brandenburg, but obtained the alternate succession to the bishopric of Osnabruck and the church lands of Walkenried and Groningen. Hesse-Cassel received the prince-abbacy of Hersfeld and the county of Schaumburg. The elector of Bavaria was confirmed in his possession of the Upper Palatinate, and in his position as an elector which he had obtained in 1623. Charles Louis, the son and heir of Frederick V., the count palatine of the Rhine, who had been placed under the ban of the Empire, received back the Lower Palatinate, and a new electorate, the eighth, was created for him.

France obtained the recognition of the sovereignty (which she had enjoyed *de facto* since 1552) over the bishoprics and cities of Metz, Toul, and Verdun, Pinerolo in Piedmont, the town of Breisach, the landgraviate of Upper and Lower Alsace, the Sundgau, the advocacy *(Landvogtei)* of the ten imperial cities in Alsace, and the right to garrison Philippsburg. During the Thirty Years' War France had professed to be fighting against the house of Austria, and not against the empire. It was stipulated that the immediate fiefs of the Empire in Alsace should remain in enjoyment of their liberties, but it was added as a condition that the sovereignty of France in the territories ceded to her should not be impaired. The intention of France was to acquire the full rights of Austria in Alsace, but as Austria had never owned the landgraviate af Lower Alsace, and the *Landvogtei* of the ten free cities did not in itself imply possession, the door was left open for disputes. Louis XIV afterwards availed himself of this ambiguous clause in support of his aggressive policy on the Rhine. The independence of Switzerland was at last formally recognized, as was that of the United Netherlands in a separate treaty.

Apart from these territorial changes, a universal and unconditional amnesty to all those who had been deprived of their possessions was declared, and it was decreed that all secular lands should be restored to those who had held them in 1618. Some exceptions were made in the case of the hereditary dominions of the emperor.

Even more important than the territorial redistribution was the ecclesiastical settlement. By the confirmation of the treaty of Passau of 1552 and the religious peace of Augsburg of 1555, and the extension of their provisions to the Reformed (Calvinist) Church, toleration was secured for the three great religious communities of the empire. Within these limits the governments were bound to allow at least private worship, liberty of conscience, and the right of emigration, but these measures of toleration were not extended to the hereditary lands of the house of Habsburg. The Protestant minority in the imperial diet was not to be coerced by the majority, but religious questions were to be decided by amicable agreement. Protestant administrators of church lands obtained seats in the diet. Religious parity was established in the imperial chamber *(Reichskammergericht)*, and in the imperial deputations and commissions.

The difficult question of the ownership of spiritual lands was decided by a compromise. The edict of restitution of 1629 was annulled. By the important provision that a prince should forfeit his lands if he changed his religion an obstacle was placed in the way of a further spread of the Reformation. The declaration that all protests or vetoes by whomsoever pronounced should be null and void dealt a blow at the intervention of the Roman curia in German affairs.

The constitutional changes made by the treaty had far-reaching effects. The territorial sovereignty of the states of the empire was recognized. They were empowered to contract treaties with one another and with foreign powers, provided that the emperor and the empire suffered no prejudice. By this and other changes the princes of the empire became absolute sovereigns in their own dominions. The emperor and the diet were left with a mere shadow of their former power. The emperor could not pronounce the ban of the empire without the consent of the diet. The diet, in which the 61 imperial cities gained the right of voting on all imperial business, and thus'were put on an equality with the princes, retained its legislative and fiscal powers in name, but practically lost them by the requirement of unanimity among the three colleges.

Not only was the central authority replaced almost entirely by the sovereignty of about 300 princes, but the power of the empire was materially weakened in other ways. It lost about 40,000 sq.mi. of territory, and obtained a frontier against France which was incapable of defence. Sweden and France as guarantors of the peace acquired the right of interference in the affairs of the empire, and the former gained a voice in its councils. For many years Germany thus became the principal theatre of European diplomacy and war and the natural development of national unity was delayed. But if the treaty of Westphalia pronounced the dissolution of the old order in the empire, it facilitated the growth of new powers in its component parts, especially Austria, Bavaria, and Brandenburg. The treaty was recognized as a fundamental law of the German constitution, and formed the basis of all subsequent treaties until the dissolution of the empire.

See the text in Dumont, *Corps universel diplomatique*, vi. 429 ff. (The Hague, 1726–31); J. G. von Meiern, *Acta pacis Westphalicae publica* (Hanover and Gottingen, 1734–36), *Instrumenta pacis Caesareo-Suectcae et Caesareo-Gallicae* (Gottingen, 1738); "A.A." (Bishop Adam Adami), *Arcana pacis Westphalicae* (Frankfort, 1698), ed. J. G. von Meiern (Leipzig, 1737); K. T. Heigel, "Das Westfalische Friedenswerk von 1643–48" in *Zeitschrift* fur *Geschichte und Politik* (1888); F. Philippi and others, *Der Westfalische Frieden, ein Gedenkbuch* (Miinster, 1898); *Journal du Congris de Munster par F. Ogier, aumônier du conzte d'Avaux*, ed. A. Boppe (1893); *Cambridge Modern History*, iv. p. 395 ff. and bibliography, p. 866 ff.; J. Bryce, *The Holy Roman Empire*, (1926) ch. xix.; Andrea Rapisardi-Mirabelli, *Le Congris de Westphalie, ses negociations et ses résultats au point de vue de l'histoire du* droit des gens (1929). **(A. B. G.)**

WEST POINT (UNITED STATES MILITARY ACADEMY): see MILITARY, NAVAL AND AIR ACADEMIES.

WEST UNIVERSITY PLACE, a residential city of southeastern Texas, U.S., in Harris county, lies within the Houston standard metropolitan statistical area and is completely surrounded by Houston. Founded in 1917, in what was then a rural area, and incorporated in 1925, the city took its name from its nearness to Rice university, in Houston. West University Place was conceived in 1910 by Ben W. Hooper, governor of Tennessee (1911–15), uho bought a tract of land southwest of Houston and planned to develop a community of country houses. The development was begun seven years later by A. D. Foreman. Managerial, professional and technical workers predominate in the city's population; virtually all the city's 2 sq.mi. of land was occupied by the 1960s. West University Place adopted the council-manager form of government in 1955. For comparative population figures *see* table in TEXAS: *Population.* (G. M. F.)

WEST VIRGINIA, popularly called the "Panhandle state" or the "Mountain state," one of the Ohio valley states of the United States, admitted to the union on June 20, 1863, as the 35th state. Roughly oval in shape except for two extensions or panhandles, West Virginia is bordered on the north by Pennsylvania and Maryland, on the east and southeast by Virginia, on the southwest by Kentucky and on the west by Ohio. Its area is 24,181 sq.mi., of which 102 sq.mi. are water surface; in size it ranks 41st among the states. The state bird is the cardinal, the animal the black bear, the flower the big rhododendron, the tree the sugar maple and the song (unofficial) "West Virginia Hills." The flag has a field of white surrounded by a blue border; in the centre of the field is placed the coat of arms and symbols of the state, and the state motto, *Montani Semper Liberi* ("Mountaineers Are Always Freemen"). The capital is at Charleston.

PHYSICAL GEOGRAPHY

Physical Features. — West Virginia (lying between the extremes of about latitude 37° 12' and 40° 38' N. and longitude 77° 40' and 82° 40' W.) is the most mountainous state east of the Rockies, having an average elevation of 1.500 ft. It may be divided into two distinct physiographic areas: (1) the Allegheny plateau on the west, comprising about two-thirds of the area of the state, and forming a part of the great Appalachian plateau province that extends from New York to Alabama; and (2) the newer Appalachian or Great valley region on the east, being a part of the large province of the same name which extends from Canada to central Alabama.

Allegheny *Plateau.*—The Allegheny plateau consists of nearly horizontal beds of limestone, sandstone and shales, including important seams of coal; it inclines slightly toward the northwest and is intricately dissected by streams into a maze of narrow canyons and steep-sided hills. Along the Ohio river, which forms the western boundary of West Virginia, these hills rise to an elevation of 800 to 1,000 ft. above sea level, while toward the southeast the elevation increases until 3,500 and 4,000 ft. are reached along the eastern margin of the plateau, known as the Allegheny front. The entire plateau area is drained by the Ohio and its tributaries. Starting at the north, the first of these tributaries is the Monongahela, which crosses into Pennsylvania before it joins the Ohio. Its headaater valleys in the east-central part of the state are among the most beautiful and fertile in West Virginia. A system of dams renders the Monongahela navigable as far as Fairmont. Farther south, entering the Ohio at Parkersburg, is the Little Kanawha river, which drains seven or eight central northwestern counties. More than 44 mi. below Parkersburg, at Point Pleasant, the Kanawha river (called New river farther upstream), the principal tributary in West Virginia, enters the Ohio. This river drains more than one-third of the state, and its headwaters reach far back through the long mountain valleys to its source in North Carolina. On its banks the capital of the state, Charleston, is situated, and along its main valley and branch valleys several of the principal railway lines are built. The river itself is navigable to Kanawha falls, about 39 mi, above Charleston, and is used regularly by barge lines. Principal tributaries of the Kanawha-New river are the Elk, Gauley and Greenbrier, entering from. the north; and the Coal and Bluestone, entering from the south.

In the southwest the Guyandot, Big Sandy (forming part of the boundary between West Virginia and Kentucky) and Tug Fork rivers complete the plateau drainage system.

Appalachian Region. — In the Appalachian region, the same beds that lie horizontally in the plateau provinces were long ago thrown into folds and subsequently planed off by erosion, leaving alternate belts of hard and soft rock exposed. Uplift permitted renewed erosion to wear away the soft belts, leaving mountain ridges of hard rock separated by parallel valleys. The mountain ridges vary in height to more than 4,000 ft., the highest point in the state being Spruce Knob (4.860 ft.) in Pendleton county. The parallel valleys are drained by streams flowing northeast and southwest. those in the northeast being tributary to the Potomac, which forms part of the northeastern boundary, and those farther south tributary to the Kanawha. The valleys between the ridges, although not always easy of access, provide broad areas of nearly level agricultural land. The rivers flowing northeast and southwest, after running between parallel ridges for long distances, often turn suddenly through transverse passes formed by erosive cutting of gaps through ridges. One of the best known is Harpers Ferry, where the Potomac has cut through the Blue Ridge mountains; at 247 ft. elevation, this is the lowest point in the state.

All of West Virginia enjoys complete drainage.

Climate. — The climate of West Virginia is determined largely by land elevations and rainfall. The mean annual precipitation varies from about 70 in. at Pickens, Randolph county, to about 25 in. at Upper Tract, Pendleton county. The mean, however, is about 45 in., generally rather evenly distributed, though some seasons, notably that of 1930, are extremely dry, whereas others, notably that of 1950, are extremely wet. These factors combine to give trans-Allegheny West Virginia a decidedly continental climate subject to great and frequent changes in temperature. The range is from −15° to 100° F., but readings as low as −35° and as high as 112° have been recorded. The mean is between 52° and 53°. Because of Atlantic ocean influences, the changes east of the Allegheny front are not so frequent or so extreme.

(C. H. A.; K. K. McC.)

Soil. — The soils of West Virginia were formed under dominantly mixed hardwood forests, with a continental type of climate in which the annual rainfall averages nearly 40 in. The underlying rocks are mainly sandstone and shale, but important areas of limestone occur in some sections. The soils formed under these conditions are mostly in the groups known as gray-brown podzolic and red-yellow podzolic. Due to the downward movement of clays and minerals, most soils are strongly acid in the surface, even though the underlying rock is limestone. Over most of the state, slopes are steep to very steep; consequently, there is much mixing of the soil.

In the Limestone valley, in the eastern part of the state, the soils are mostly deep, well drained and productive. Hagerstown, Fredrick and Duffield are important soil series in this area. These soils also occur in the Greenbrier Limestone valley. In the Ridge and Valley province, the soils are mainly shallow and are formed on strongly folded shales. There the Ashby, Litz and Calvin are important soil series.

On the high Allegheny plateau most of the rocks are sandstone and shales of the coal measures, and the soils are mainly in the Dekalb, Gilpin and Wharton series. In the western part of the state, soils formed on interbedded sandstones and red and gray shales are dominant, and the important soils belong to the Upshur, Muskingum and Westmoreland series.

Where cropland and steep pastures have been mismanaged, erosion has been serious, removing from one-half to nearly all the original topsoil in many places. (B. J. P.)

Vegetation. — Before the white man settled in the region that became West Virginia, it was covered by a practically unbroken forest of hardwood trees, except in the elevated areas where pines were predominant. The area was a part of the Appalachian hardwood forest, early recognized by botanists as richer than any similar area in either Europe or Asia in the variety of its plants and in their economic value. The Appalachian forest then contained, in addition to representatives of all important genera of European forest trees, the following trees unknown to Europe: tulip, locust, gum, hickory, magnolia, persimmon, ash, oak, maple, walnut, beech, chestnut, cherry, buckeye, sycamore, elm, birch, mulberry and willow. The growths just named later made West Virginia one of the chief hardwood-producing states in the United States.

Because of excessive cutting, forest fires, blights and insects, and the long absence of a conservation policy, only small areas of the primeval forest remain. The chestnut trees have disappeared almost entirely. Fortunately, perhaps, the trend to industry led to abandonment of farm lands and subsequent reforestation. Reforestation was aided also by the establishment of a number of national and state forests (see Parks *and* Recreation, below). The timber stands are still predominantly hardwoods, of which oak comprises about 54%.

In addition to trees there are about 1,900 other seed plants or higher forms of vegetable life. The forests are filled with beautiful shrubs, including azaleas (wild honeysuckle), rhododendrons (big laurel), kalmias (laurel) and American wistarias. West Virginia university, Morgantown, catalogued 125 plants that originated in Canada and were brought by glaciers or birds to West Virginia, nhere they thrived; among these are sumac, yew, club moss, hemlock, violet, honeysuckle, raspberry, mountain maple, oxalis and holly. Among rare plants is the box huckleberry.

Animal Life. — White settlers in western Virginia found deer, bears, wolves, pumas (panthers), beaver and elk in large numbers. Except for protected deer the large native animals are almost extinct, but the smaller animals found by the first settlers, such as foxes, skunks, opossums, raccoons and rabbits, remain. This is notably true in those areas left for self-reforestation. Beaver are being rehabilitated and trapped under conservation regulations. About *268* species of birds have been noted, about one-fourth of all the different kinds found in the United States and Canada. Wastes from mines and sawmills have been destructive of fish in many West Virginia streams. Through stocking, restocking and protection, however, enough game fish have been preserved to make good fishing, and there are many varieties of nongame fish. There are also frogs, toads, mud puppies, turtles and snakes. Only two species of native snakes, rattlers and copperheads, are poisonous.

Parks, Monuments and Recreation.—More than *1,100,000* ac. of West Virginia are publicly owned and devoted to conservation or recreation. There are *20* state parks, embracing approximately *41,000* ac.; *11* public hunting areas, embracing *92,000* ac.; and *9* state forests, embracing *80,000* ac. There are *880,000* ac. of national forest lands included in the George Washington and Monongahela National forests, by far the larger part being in the latter.

The forest service has established a'park at Harpers Ferry and is restoring it as of *1865.* At White Sulphur Springs is located the famous Greenbrier hotel.

HISTORY

The first inhabitants of West Virginia were mound builders, whose mounds still may be seen along the Ohio and Kanawha rivers. The largest of these, and the largest in the country, located at Moundsville in the Ohio valley, is *69* ft. high and *927* ft. in circumference. Years before the white man arrived an Indian intertribal war occurred in southern West Virginia, and, by *1700,* Indian towns, villages and camps along New river had been destroyed and the river itself had become a sort of dividing line between the Iroquois (*q.v.*) of the north and the Cherokee (*q.v.*) of the south. White settlers quickly evicted the Indians from the region, but the Shawnee (*q.v.*) from Ohio frequently raided the settlements. Shawnee, Delaware and other Indians occupied the upper Ohio valley as late as *1725.*

A contest between the French and English over control of the Ohio valley began in the early part of the 18th century. French explorers had been to parts of western Virginia as early as *1625.* An English explorer, Abraham Wood, of Petersburg, Va., explored the region in *1671,* and New river was called Wood's river for many years. The activity of Gov. Alexander Spotswood (*q.v.*) of Virginia, was largely responsible for the movement of settlers into the western part of the colony. Spotswood visited the region in *1716* and brought back glowing reports of it. The first settlers of the region may have been Welsh, Scotch-Irish and German pioneers, who as early as *1719* came by way of Pennsylvania or Maryland, crossing the Potomac near Shepherdstown. The first known permanent settler in the state, however, was Morgan ap Morgan, who in *1731* made his home on Mill creek in Berkeley county, in the eastern panhandle. Perhaps the first recorded settlement west of the Alleghenies was made by Jacob Marlin and Stephen Sewell, who settled at Marlinton, in Pocahontas county, in *1749.*

Formation of the Ohio company (*q.v.*) in *1749,* and the subsequent French and Indian War, determined English dominance in the territory now embraced by West Virginia. In *1774,* during Lord Dunmore's war, Gen. Andrew Lewis defeated the allied Indian nations under Chief Cornstalk in a battle at Point Pleasant. Shawnee raids in Mercer and Greenbrier counties and in the bordering counties of Virginia were nonetheless frequent during the American Revolution, and the settlers suffered repeated attacks from British-led Indian armies. By *1800* the settlements were sufficiently strong to fight off raiding parties.

After the American Revolution the older settled parts of the region filled up rapidly. The first federal census of *1790* enumerated *55,873* persons living in what is now West Virginia, and by *1800* the population had increased to *78,592.* Completion of the National, or Cumberland, road, closely paralleling the northern boundary of the state, in *1818* brought in many new settlers.

Statehood.—Many factors played their parts in the ultimate separation of West Virginia from Virginia during the American Civil War. Among these were the differences in background, religion and interests between the settlers north of the Kanawha river and those in east Virginia. Another was the difficulty of transportation to Richmond, the seat of government, from western Virginia; after the opening of the Mississippi and the introduction of steamboats on the Ohio it was easier to get to New Orleans, La. Western Virginians resented their unfair legislative representation; there were few slaves in the area, and since slaves were considered part of the population, and representation was apportioned on the basis of population, the westerners were underrepresented in the legislature.

Several economic factors also existed. Commercial competition between Baltimore and Richmond for control of western Virginia played a part. Building of the Baltimore and Ohio railway, financed by the city of Baltimore, through the region was fought by eastern Virginia interests. In addition, the state of Virginia contracted an enormous debt for improvements in schools, roads, canals and railways, but practically none of the money was spent in the future West Virginia, where schools and roads were desperately needed. A further irritant was the matter of taxation, in which western Virginia suffered as a nonslaveholding region, slaves being taxed at a lower rate than other property.

Talk of separation began as early as the 1820s and continued to gain momentum. Shortly before the American Civil War began, eastern Virginia, realizing that the western part would almost certainly break away if the state seceded from the union, began to grant some concessions to the west, but John Brown's seizure of the arsenal at Harpers Ferry (*q.v.*) in *1859* further widened the breach between the two parts of Virginia. When on April *17, 1861*, Virginia voted to secede, *29* of the *46* legislative members from what is now West Virginia voted against the ordinance (9 voted for it, *7* were absent and *1* was excused).

On April *22, 1,200* citizens met at Clarksburg and called for a general convention to meet at Wheeling in May. The convention, at which *26* counties were represented, voted overwhelmingly against secession. At a second convention held in Wheeling on June *11* the Virginia ordinance of secession was nullified and provision was made for a popular vote on formation of a new state. An election was held Oct. *24, 1861,* resulting in a vote of *18.408* to *781* in favour of separation. At a third convention held at Wheeling (Nov. *1861* to Feb. *1862)* a constitution was drafted. It was ratified by a vote of *18,862* to *514* in April, and on April *20, 1863,* President Lincoln caused a proclamation to be issued under which West Virginia became the 35th state on June *20, 1863.*

Later History.—The state made rapid and peaceful progress for the next several generations, particularly in school and railway construction.

The years *1870, 1872* and *1876* were marked by Democratic election victories, following the enfranchisement of former Confederate soldiers. Confederate veterans had been barred from voting by the Test act of *1865,* which required the voter to swear that he had never borne arms against the United States or aided armed hostile forces, and under it more than *15,000* adult males were disfranchised. When the Democrats elected their first governor in *1870,* the Test act was repealed, and in *1872* a constitutional convention was called. The new constitution, adopted in that year, thoroughly remodeled the state government. In *1896* the state returned to the Republican party, which thereafter controlled the government until *1933,* except during the administration of John Jacob Cornwell, elected governor as a Democrat in *1916;* even during the latter period, however, the legislature remained Republican.

The administration of Gov. Henry D. Hatfield (1913–17) saw the building of the state department of health, adoption of the first workmen's compensation law in the United States, creation of the department of labour and the public service commission and the reorganization of the state department of mines. The administration of Governor Cornwell *(1917–21)* was marked by the creation of the state police, or department of public safety, and the payment of West Virginia's share of the Virginia debt, necessary because bankers declined to purchase $50,000,000 in road bonds until the Virginia debt was satisfied (see VIRGINIA). A new and modern state capitol was built after the burning of the old capitol in Feb, 1921.

The years 1912-21 saw much labour trouble, with a certain amount of violence, calling for the use of the national guard twice and the United States army four times in mining territory. Casualties were few, however, despite two marches by armed miners. The question of the right to organize unions was ended with the passage of the National Recovery act and the Wagner National Labor Relations act.

After 1933 West Virginia remained under Democratic control except for the election of 1956, when Republican Gov. Cecil Underwood was elected (though with a Democratic legislature), the Democrats regaining control of the statehouse in 1960. The principal changes occurring in government under the Democrats were creation of the department of public assistance and of the county unit system of schools, with state aid; and incorporation of the functions of the county systems of roads into the State Road commission. Numbers of new minor departments of state government were created. In national elections the state also voted Democratic after 1932, with the exception of 1956 when the voters supported Republican Dwight D. Eisenhower. In 1960 West Virginia was back on the Democratic side, supporting John F. Kennedy for president and with both senatorial seats and five out of six house seats occupied by Democrats. An increasingly important factor economically as well as politically was prolonged unemployment in the state and the depressed nature of the coal industry after World War II.

GOVERNMENT

At the time of its adoption, in 1872, the West Virginia constitution was described by its critics as reactionary. Revision by a constitutional convention requires the approval of a majority of the members elected to each branch of the state legislature and of a majority of the participating voters in an election held not less than three months after the passage of the legislative authorization. As in the case of constitutional amendments submitted to the voters by a two-thirds majority of the members elected to each house of the legislature, a new constitution would have to be approved by a majority of the participating voters to be effective. All residents of the state who are 21 years old and native or naturalized citizens are entitled to vote, provided they conform to the requirements of a registration law passed in 1902 and amended from time to time thereafter.

Executive. — The executive department of the state government consists of the governor, auditor, treasurer, attorney general, secretary of state, superintendent of free schools and commissioner of agriculture, who jointly constitute the board of public works charged with making the biennial budget and assessing public-service utilities. They are elected by the people at the time of the regular presidential election. The governor is ineligible for re-election to a second consecutive term. With the approval of the senate he appoints all state officers whose selection is not otherwise vested, and practically all of his appointees, except the controlling boards of the institutions of higher learning, are subject to summary removal.

Legislative. — The legislature consists of a senate of 32 members and a house of delegates of 100 members. Two senators are chosen from each of 16 districts for four-year terms; one-half of them retire biennially. The delegates are apportioned among the counties on a population basis, but each county is entitled to one delegate. The legislature meets in odd-numbered years, and its acts are subject to executive veto, which may be overridden by a majority of the total membership of each house. From the mid-1930s most legislatures referred special problems to interim committees instructed to study and report.

Judiciary. — The judicial power of the state is vested in a supreme court of appeals, in circuit courts, in inferior tribunals (domestic, common pleas, criminal, intermediate and juvenile) and in justices of the peace. The highest court, consisting of five judges elected for 12-year terms, holds two regular terms annually. The 28 circuit judges are elected for terms of eight years. Justices of the peace are elected by magisterial districts of the counties.

Local Government. — West Virginia towns and cities choose their own forms of government from a number of models approved by the state legislature. The city-manager form is commonest. County government is of the county-township form.

Finance. — By the second half of the 20th century the state's chief sources of revenue were sales taxes, federal aid, property taxes (on rates of which there is a constitutional limit), goods and services, other taxes, and sale of bonds; there was no state income tax, either corporate or individual. Major items of state expenditure were education, highways, public assistance and unemployment compensation. The state budget had a cash balance. The last road bond issue had been voted $50,000,000 in 1948, but bonds were reissued as other bonds were retired. The state voted $90,000,000 in 1950 for bonuses to the soldiers of World War I and World War II. In Nov. 1956 a bonus for veterans of the Korean war also was voted, being paid out of the unexpended balance of the appropriation of 1950.

POPULATION

The population of West Virginia in 1870 was 442,014; in 1890 it was 762,794; in 1910, 1,221,119; in 1940, 1,901,974; in 1950, 2,005,552; and in 1960, 1,860,421. This last figure represents a decrease of 7.2% from the population in 1950. The population per square mile in 1960 was 76.9, as compared with 83.3 in 1950, with 79.0 in 1940, and with 49.6 for the United States in 1960.

*West Virginia: Places of 5,000 or More Population (1960 Census)**

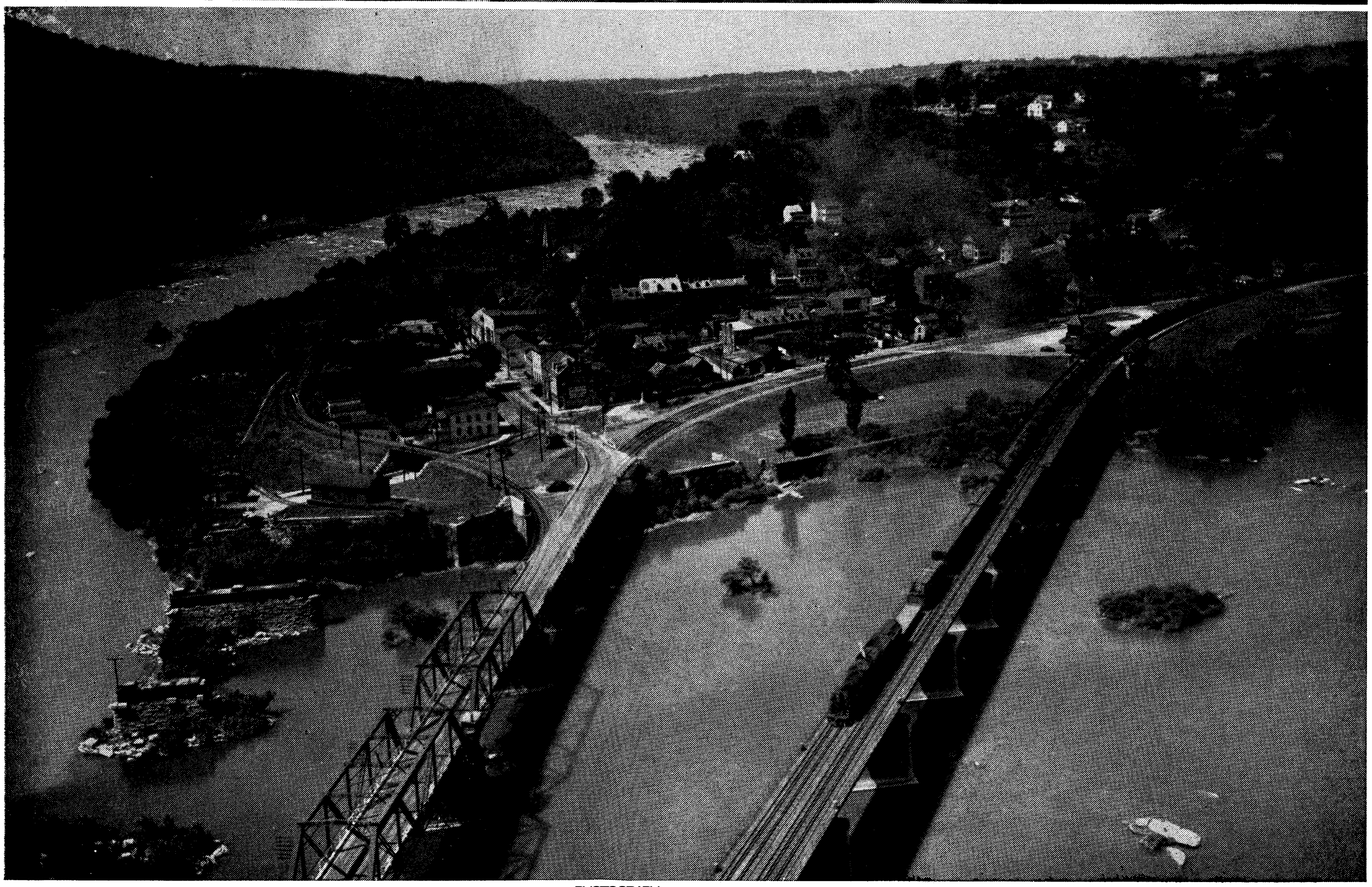
Place	Population				
	1960	1950	1940	1920	1900
Total state	1,860,421	2,005,552	1,901,974	1,463,701	958,800
Beckley	18,642	19,397	12,852	4,149	342
Bluefield	19,256	21,506	20,641	15,282	4,644
Buckhannon	6,386	6,016	4,450	3,785	1,589
Charleston	85,796	73,501	67,914	39,608	11,099
Clarksburg	28,112	32,014	30,579	27,869	4,050
Dunbar	11,006	8,032	5,266	—	—
Elkins	8,307	9,121	8,133	6,788	2,016
Fairmont	27,477	29,346	23,105	17,851	5,655
Grafton	5,791	7,365	7,431	8,517	5,650
Hinton	5,197	5,780	5,815	3,912	3,763
Huntington	83,627	86,353	78,836	50,177	11,923
Keyser	6,192	6,347	6,177	6,003	2,536
Martinsburg	15,179	15,621	15,063	12,515	7,564
Morgantown		25,525	16,655	12,127	1,895
Moundsville		14,772	14,168	10,669	5,362
New Martinsville	5,607	4,084	3,491	2,341	1,089
Nitro	6,894	3,314	2,983	—	—
Parkersburg	44,797	29,684	30,103	20,050	11,703
Point Pleasant	5,785	4,596	3,538	3,059	1,934
Princeton	8,393	8,279	7,426	6,224	—
St. Albans	15,103	9,870	3,558	2,825	816
South Charleston	19,180	16,686	10,377	3,650	—
Vienna	9,381	[illegible]	2,338	—	—
Weirton	28,201	24,005		—	—
Welch	5,313	6,603	6,264	3,232	442
Wellsburg	5,514	5,787	6,255	4,918	2,588
Weston	8,754	8,945	8,268	5,701	2,560
Wheeling	53,400	58,891	61,099	56,208	38,878
Williamson	6,746	8,624	8,366	6,819	

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during reported census, or data not available.

Of the 1960 population 476,674, or 25.6%, lived in incorporated places of 2,500 or more, as compared with 32.1% in 1950. The state has four standard metropolitan statistical areas, which are Charleston, Huntington-Ashland, Steubenville-Weirton and Wheeling (three of which include portions of surrounding states). These areas had a total population of 865,803; this included the West Virginia portion, 575,137, or 30.9% of the total population of the state in 1960.

The number of occupied dwelling units (or households) in 1960 was approximately 576,000, as compared with 527,000 in 1950 and 445,000 in 1940. The average population per household had declined from 4.3 in 1940 to 3.8 in 1950 and to 3.2 in 1960.

The population of the state was distributed by colour and nativity in 1950 as follows: 92.5% native white; 1.7% foreign-born white; and 5.8% nonwhite, practically all Negro. There were 100.0 males per 100 females in the native white population, and 101.1 in the Negro population; 6.8% of the population was 65

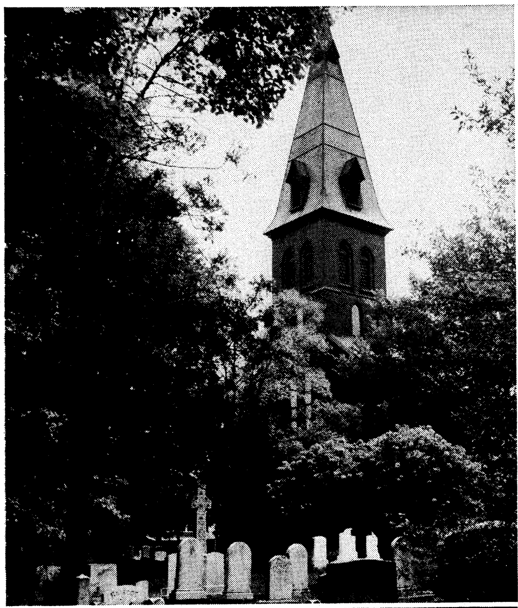


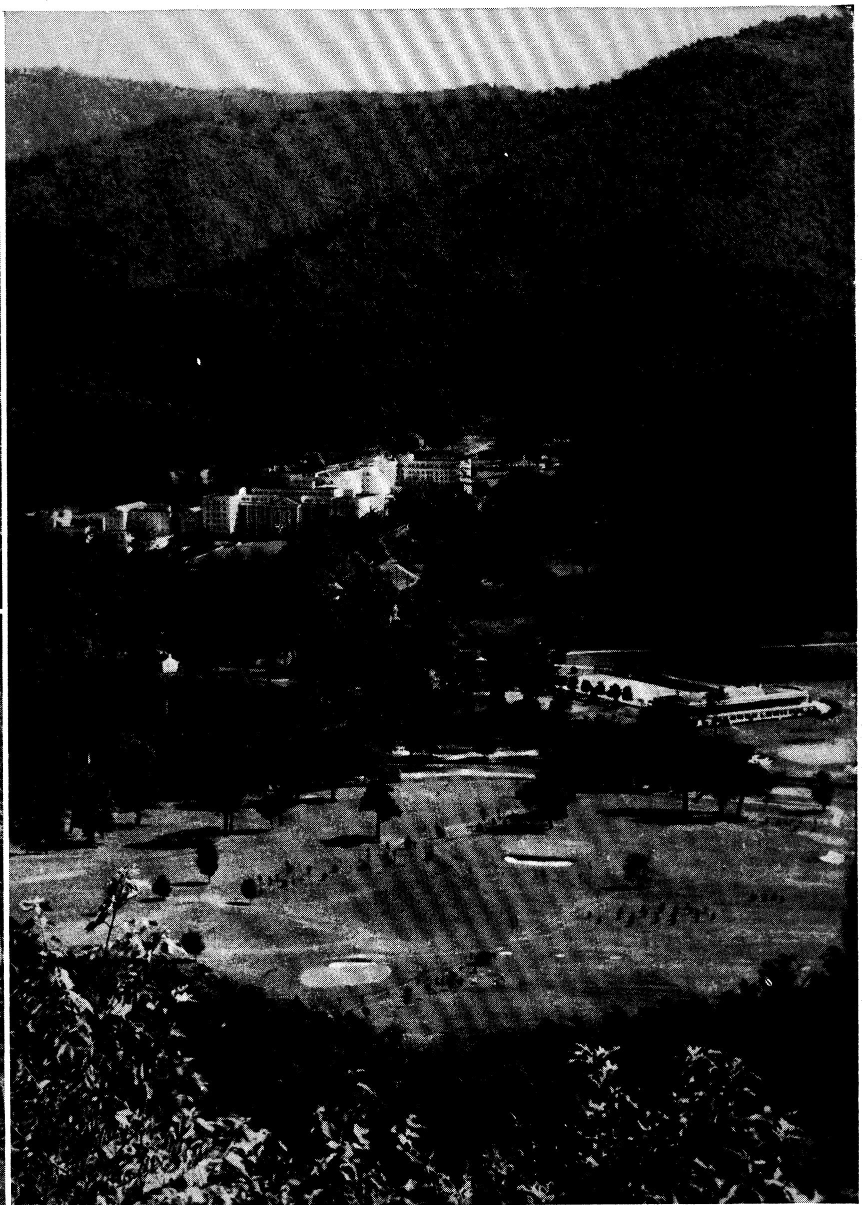
BY COURTESY OF (BOTTOM) THE BALTIMORE AND OHIO RAILROAD COMPANY; PHOTOGRAPH, (TOP) HERBERT LANKS—FROM PIX

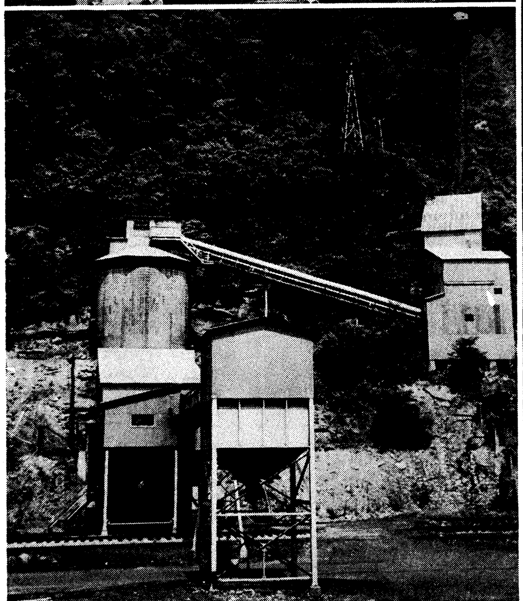
THE STATE CAPITOL AND HARPERS FERRY

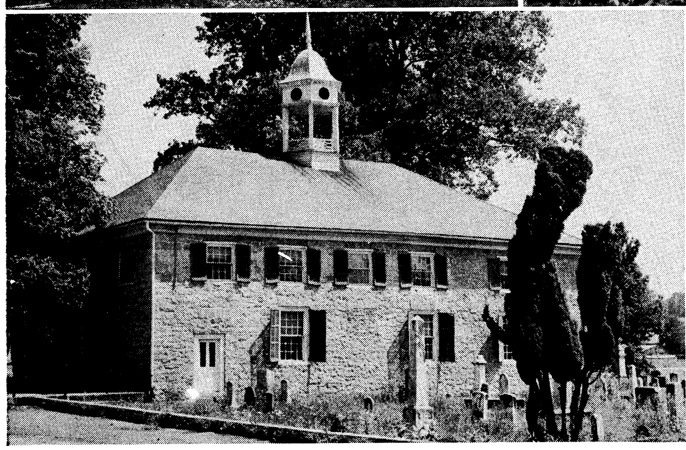
Top: The state capitol at Charleston, designed by Cass Gilbert in Italian Renaissance style, was completed in 1932. Embossed with gold leaf, a dome 300 ft. high crowns the central unit which measures 120 by 558 ft.

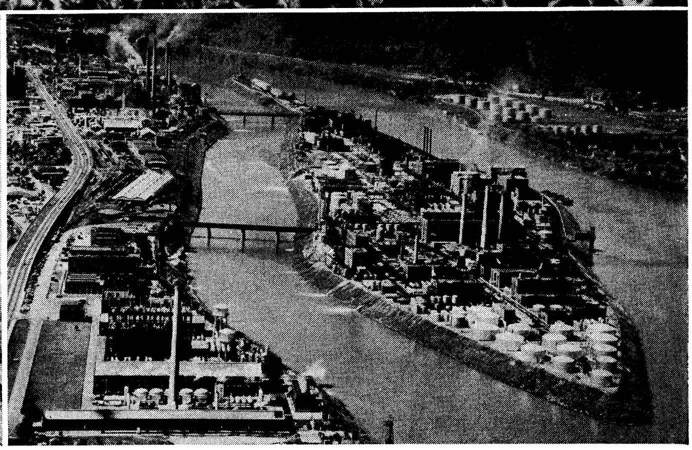
Bottom: Harpers Ferry, scene of John Brown's historic raid on the federal arsenal in 1859. The position of the town at the lower end of the Shenandoah valley made it a place of strategic importance during the Civil War











BY COURTESY OF (TOP LEFT, BOTTOM LEFT) WEST VIRGINIA INDUSTRIAL AND PUBLICITY COMMISSION, (TOP RIGHT) CHESAPEAKE AND OHIO RAILWAY COMPANY, (BOTTOM RIGHT) CARBIDE AND CARBON CHFMICALS COMPANY; PHOTOGRAPH, (CENTRE LEFT) PHILIP GENDREAU

SCENES IN WEST VIRGINIA

Top left: Zion Episcopal church (1852), Charles Town. In the old church. yard are the graves of many members of the Washington family, and of Revolutionary and Confederate soldiers

Top right: Greenbrier hotel, White Sulphur Springs, a famous resort

Centre left: Coal mines near the West Virginia turnpike. West Virginia ranks first among coal-producing states in the U.S.

Bottom left: Old Stone church, Lewisburg (1796), was the first Presbyterian Church west of the Allegheny mountains

Bottom right: Chemical manufacturing plant at South Charleston. Chemicals and chemical products are the state's leading industries years old or over; and 47.0% of the population 14 years old and over was in the labour force.

Of the total number of employed males, 12.0% was engaged in agriculture, 26.8% in mining, 6.3% in construction, 19.6% in manufacturing and 19.7% in transportation and trade.

West Virginians are 97.5% native-born, and persons of English descent predominate. There are strong German elements in the eastern and northern panhandles, however, and a considerable Scotch-Irish element in southern West Virginia. Northern West Virginia was populated largely by persons from New York, Pennsylvania and Maryland, and southern West Virginia almost wholly by former Virginians, except for Negroes brought in from North Carolina.

Methodists and Baptists predominate in the state, but there is a considerable Roman Catholic population in the northern panhandle, particularly in the city of Wheeling, and a large Presbyterian group in the Kanawha valley.

EDUCATION

Public Schools. — Enactment of a county unit law in 1933 changed the school system from one of magisterial districts to one in which the county unit system prevailed, with consolidation of school districts where improved roads permit and a uniform system of salaries for teachers in grade and high schools; a free textbook system also was adopted. By the second half of the century the state's elementary schools enrolled about 300,000 pupils annually, high schools had about 170,000 students, and teachers numbered 10,500 in the elementary schools and 7,000 in the secondary schools. The total net revenue for public school education was nearly $200,000,000 yearly, of which more than half was state aid.

Racial integration is complete in the schools of West Virginia, and there is no contention. An unusual situation is found in the former Negro colleges, to which many white students have been attracted. Storer college, in Harpers Ferry, a former Negro college, has ceased operation. In some sections Negroes have retained their own secondary schools through agreement.

Higher Education. — There are 11 state-supported institutions of higher learning, chief among which is West Virginia university, at Morgantown. A coeducational land-grant institution, the university was established in 1867 as the Agricultural College of West Virginia. It is governed by a nine-member board of governors, appointed by the governor for nine-year staggered terms. The university's colleges and schools include arts and sciences, agriculture, commerce, dentistry, education, engineering, journalism, law, medicine (a new medical school was opened in 1960), mines, music, pharmacy and physical education. Enrollment approaches 7,000 annually, and the faculty numbers nearly 500. Potomac State College of West Virginia university, at Keyser, is a junior college preparatory to the university.

The other state-controlled institutions of higher education are Bluefield State college (chartered 1895), Bluefield; Concord college (1875), Athens; Fairmont State college (1867), Fairmont; Glenville State college (1872), Glenville; Marshall college (1837), Huntington; Shepherd college (1872), Shepherdstown; West Liberty State college (1837), West Liberty; West Virginia Institute of Technology (1895), Montgomery; West Virginia State college (1891), Institute. These are under the control of a state board of education of nine members.

Private and denominational colleges are Alderson-Broaddus college (Baptist; 1871), Philippi; Bethany college (Disciples of Christ; 1840), Bethany; Davis and Elkins college (Presbyterian; 1904), Elkins; Salem college (Baptist; 1888), Salem; West Virginia Wesleyan college (Methodist; 1890), Buckhannon; Morris Harvey college (nonsectarian; 1888), Charleston; Wheeling college (Roman Catholic; 1954), Wheeling. There are two private junior colleges, Greenbrier college (for women), at Lewisburg, and Beckley college, at Beckley.

HEALTH, WELFARE AND CORRECTIONS

Under the office of public institutions the state maintains a children's home at Elkins for orphaned and neglected boys and girls, and eight hospitals and sanitariums, as well as three correctional institutions (a forestry camp for boys at Davis; an industrial school for boys at Grafton; and an industrial home for girls at Salem) and three penal institutions (a state prison for women at Pence Springs; a penitentiary at Moundsville; and a medium security prison located on a farm near Huttonsville).

Under the department of mental health there are five hospitals for the mentally ill and a training school for mentally defective children at St. Marys.

THE ECONOMY

Agriculture. — West Virginia agriculture is primarily part-time or subsistence in nature, but there were nearly 22,000 commercial farms in the state out of the 68,583 recorded in the 1954 census of agriculture. Early agricultural development was confined to the many small valleys and areas bordering the rivers and the eastern panhandle. Later agricultural development was more or less incidental to the development of the lumber and mineral industries, which brought into cultivation much hill land. Twentieth-century changes in the mineral industries caused some decreases in population in rural areas coupled with a decline in cultivated crops and a shift to livestock farming enterprises. Many agencies assisted in changing interests to horticulture, livestock and livestock products, among them being the Grange (*q.v.*); the West Virginia university college of agriculture working through county and extension agents; the West Virginia Agricultural Experiment station; the state department of agriculture, established in 1911; boys' and girls' clubs, functioning since 1907; 4-H clubs, with headquarters at Jackson's Mill since 1921; the Future Farmers of America; and a number of other societies and associations.

Under the stimulus of these agencies and the demands of a growing population the total state gross farm income reached an all-time high in 1951 of $192,700,000. Four-fifths of the cash total was for livestock and livestock products sold.

After 1953 gross farm income held near the $150,000,000 level because of declining production and lower average prices received. The number of farms declined gradually to about 64,000 in the late 1950s from the peak of 105,000 recorded in 1935. Though the net farm income for the state in 1958 ($904 per farm) was the lowest in the nation, this does not reflect the fact that more than one-half the farm families received more income from other sources than from farming.

The principal agricultural crops are corn, wheat, oats, tobacco, apples (commercial), peaches and potatoes.

Industry. — The value of manufacturing output in West Virginia by the early 1960s was around $2,500,000,000 annually, and about 130,000 West Virginia workers found employment in manufacturing. The durable goods manufacturing industry, with an output valued at around $1,500,000,000, was led by the metals industry (primary metals, machinery and fabricated metals). The glass, clay and stone products industries were only slightly less important; more than 4% of all U.S. workers in such industries were employed in West Virginia.

The nondurable segment of the state's industry produced goods worth more than $1,000,000,000 annually, the chemical manufacturing industry, employing an average of 27,000 workers, leading this division. Food, textile, apparel, printing-publishing and petroleum-coal products industries were also important to the state's economy.

Minerals. — Bituminous coal is the most abundant and the most valuable mineral in West Virginia. The state's 136 coal seams, 62 of which are mineable, contain about 63,000,000,000 tons. There are also thinner (three feet and less) and lower-grade beds containing about 40,000,000,000 tons. The coal area is 17,280 sq.mi., but the total mineable area is equivalent to about 37,550 sq.mi., or about 1½ times the entire area of the state. Of the 55 counties 44 are underlaid by mineable coal. In 1936 West Virginia became first among the soft-coal-producing states. More than 50,000 miners are employed, and total all-time production (to 1960) was about 6,375,000,000 tons.

From 1909 to 1924 West Virginia was first among the states in the production of natural gas, with a peak of 308,617,101,000 cu.ft.

in 1917. In 1924 the state dropped to third place, being passed by both Oklahoma and California, and after the discoveries of gas in the southwest its position was still further lowered. During the decade ending in 1950 the average annual production of the state's 15,800 gas wells was more than 200,000,000,000 cu.ft., but the amount of natural gas imported in 1959 by pipelines from the southwest for redistribution to the east by West Virginia networks was almost as great as the volume produced within the state. After the peak year of 1900, when a total of 16,195,675 bbl. was extracted, West Virginia's production of high-quality crude oil declined rapidly. By the early 1960s it was around 2,000,000 bbl. annually.

Among other widely distributed minerals are rock salt, underlying about 2,400 sq.mi. along the Ohio river and forming the basis of chemical industries that produce pigments, plastics, pharmaceuticals, chlorine, caustic soda and insecticides; the salt brines of the Kanawha valley, which, after World War I, made possible the beginning of the great chemical industry; practically pure glass sand, the use of which for scientific purposes placed West Virginia high among the states in volume output; stone, river sand and gravel, used extensively in construction; and clays, used in the northern panhandle for the fabrication of pottery and china. Other minerals of more or less commercial value include grahamite, once mined extensively in Ritchie county; nitre, in Greenbrier, Monroe and Pocahontas counties; psilomelane and pyrolusite, in Monroe county; sphalerite, in Jefferson county; and limonite, hematite and siderite, found in a number of counties. Minerals of limited occurrence include barite, bromine, celestite, fluorspar, galena and gypsum.

Transportation and Communication. — The major factor in transportation at mid-20th century was the discontinuance of many passenger trains, the increase in air flight, and the replacement of streetcars by buses. Passenger, cargo and air mail service were provided to all the major cities. Martinsburg was the headquarters of the national guard jet transport. Road mileage totaled more than 31,000. In addition, the 88-mi. West Virginia turnpike, constructed by private capital between Charleston and Princeton, one of the most modern mountain roads in the world, had a ½ mi. highway tunnel, all parts of which were under television supervision by an outside watchman. More than 375 mi. of navigable water ays on the Ohio, the Monongahela, the Kanawha and the Big Sandy link the state with Pittsburgh and with the Mississippi and the Gulf of Mexico.

In the early 1960s there were more than 500,000 telephones in the state, more than 50 radio stations, 9 television stations and about 30 daily newspapers.

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WET, CHRISTIAAN RUDOLF DE (1854–1922), South African soldier, who was commander in chief of the Orange Free State forces in the South African War (*q.v.*) and a leader of the 1914 rebellion, was born in the Smithfield district, Orange Free State, on Oct. 7, 1854. De Wet fought with the Transvaal Boers in their war for independence (1880–81) and then served his political apprenticeship as a member of the Transvaal volksraad (parliament). He later returned to the Free State and became a member of its volksraad. In the first months of the South African War he was with the Free State forces in Natal. He was transferred to the western Free State front in Dec. 1899 and, soon after Piet Cronje's surrender at Paardeberg (Feb. 1900) and the British occupation of Bloemfontein and Pretoria, became commander in chief. He resorted to guerrilla warfare, making numerous hit-and-run raids on British troops, their supplies and lines of communication, and narrowly evaded capture on many occasions. In May 1902 he was still prepared to continue the struggle, in spite of the growing success of British countermeasures, but eventually he yielded and was a signatory of the treaty of Vereeniging (May 31, 1902).

De Wet was minister of agriculture in the Orange River colony under responsible government from 1907 to 1910 and represented that colony in the national convention (1908–09) which drafted the constitution of the Union of South Africa. Although he did not sit in the Union parliament, he threw his great influence on the side of J. B. M. Hertzog when the latter left Louis Botha's cabinet and party and founded the Nationalist party (1913). After the outbreak of World War I he opposed Botha's decision to conquer German South-West Africa and, in conjunction with C. F. Beyers, organized a rebellion. Captured in Dec. 1914, he was found guilty of treason and sentenced to six years' imprisonment but was released in Dec. 1915. He died on Feb. 3, 1922, in the Dewetsdorp district, Orange Free State.

De Wet was an ardent Calvinist. He believed that it was the destiny of Afrikaners to rule South Africa as an independent state, and that African and coloured people were inferior beings. Consequently, he is regarded by Afrikaner nationalists as one of their great heroes. (L. M. T.)

WETTIN, the name of a family from which many European dynasties have sprung. Dietrich, of the tribe of the Buzici, left two sons, Dedo (count of Hassegau, 997; d. 1009) and Frederick (d. 1017), who received lands taken from the Wends, including the county or Gau of Wettin on the right bank of the Saale. Dedo's son Dietrich married Matilda, daughter of Ekkard I, margrave of Meissen. Their son Dedo II obtained the Saxon Eastmark and lower Lusatia in 1046, but in 1069 quarreled with the emperor Henry IV and was compelled to surrender his possessions. He died in 1075, and his lands were granted to his son Henry I, who in 1089 was invested with the mark of Meissen. In 1103 Henry was succeeded by his cousin Thimo (d. 1104), who built a castle at Wettin and was called by this name. Henry II, son of Henry I, followed, but died childless in 1123; his cousin, Conrad I, son of Thimo, claimed Meissen, of which he secured possession in 1130, and in 1136 the emperor Lothair II added lower Lusatia to his possessions. Conrad abdicated in 1156 and his lands were divided between his five sons; Meissen (*q.v.*) fell to Otto and the county of Wettin to the fourth son Henry, whose family died out in 1217. Wettin then passed to the descendants of Conrad's youngest son Frederick. and in 1288 the countv. town and castle of Wettin were sold to the archbishop of Magdeburg, eventually becoming incorporated in the kingdom of Prussia.

Conrad I and his successors had added largely to their possessions, until under Henry III the Illustrious, margrave of Meissen (1221–88), who acquired Thuringia (*q.v.*), the lands of the Wettins stretched from the Oder to the Werra and from the Erzgebirge to the Harz mountains. Frederick the Warlike (1381–1428) became electoral duke of Saxe-Wittenberg in 1423.

From his son Frederick are descended the Ernestine and Albertine branches of the family. To the former belong the dukes of Saxe-Weimar-Eisenach (grand dukes of Saxony), of Saxe-Meiningen, of Saxe-Altenburg and of Saxe-Coburg-Gotha (whence the kings of Belgium from 1831, of Portugal from 1837 to 1910, of Great Britain from 1901 and of Bulgaria from 1908 to 1946); to the latter, the electors (who were also kings of Poland from 1697 to 1763) and the kings of Saxony (*q.v.*).

WEXFORD, a county of Ireland in the province of Leinster, bounded north by Wicklow, east and south by St. George's channel and west by Waterford, Kilkenny and Carlow. The land area is 581,061 ac. or 908 sq.mi. Pop. (1961) 83,259. The number of sandbanks makes navigation dangerous near the shore. The only safe harbour on the east coast is Wexford harbour, which, because of a bar, is not accessible to large vessels at ebb tide. The artificial harbour of Rosslare, outside Wexford harbour to the south, was therefore opened in 1906. On the south coast the great inlet of Waterford harbour separates the county from Waterford and

Kilkenny, and among several inlets Bannow bay is the largest. South from Crossfarnoge point are the Saltee Islands, and Coningmore and Coningbeg, beyond the latter of which is the Saltee lightship. Southeast from Greenore point is the Tuskar rock.

An elevated ridge on the northuestern boundary forms the termination of the granite range in Wicklow, and in Croghan Kinshela, on the borders of Wicklow, rises to a height of 1,993 ft. On the western border another range, situated chiefly in Carlow, extends from the valley of the Slaney at Newtownbarry to the confluence of the Barrow with the Nore at New Ross, and reaches 2,409 ft. in Blackstairs mountain and 2,610 ft, in Mt. Leinster on the border of Countv Carlow. In the southern district a hilly region, reaching in Forth mountain a height of i64 ft., forms with Wexford harbour the northern boundaries of the baronies of Forth and Bargy. a peninsula of flat and fertile land. The Slaney river enters the county in the northwest and flows southeastward to Wexford harbour. Its chief tributary. the Bann, flows southwestward from the borders of Wicklow. The Barrow forms the western boundary of the county from the Blackstairs mountains till its confluence with the Suir at Waterford harbour.

The northern portion of Wexford nas included in Hy Kinselagh, the peculiar territory of the MacMurroughs, overlords of Leinster, who had their chief residence at Ferns. Dermot MacMurrough, having been deposed from the kingdom of Leinster, asked help of Henry II, king of England, secured the aid of the 2nd earl of Pembroke ("Strongbow") and obtained assistance from Robert Fitz Stephen and Maurice Fitz Gerald of Wales. In 1169 Fitz Stephen landed at Bagenbon on the south side of Fethard and captured the town of Wexford. After this Dermot granted the territory of Rexford to Fitz Stephen and Fitz Gerald. MacMurrough having died in 1171, Strongbow became lord of Leinster At first Henry II retained Wexford, but in 1174 he committed it to Strongbow.

Wexford was one of the 12 counties into which the conquered territory in Ireland is generally stated to have been divided by King John, and formed part of the possessions of William Marshal, earl of Pembroke. It ultimately passed to John Talbot. earl of Shrewsbury, who in 1446 was made earl of Waterford and baron of Dungarvan. The district was actively concerned in the rebellion of 1641; and during the Cromwellian campaign the town of Wexford was carried by storm in 1649. Wexford was the chief seat of the rebellion of 1798. in which local priests played a prominent part.

Evidences of the Danish occupation are seen in the numerous raths, or encampments, especially at Dunbrody. Enniscorthy and New Ross. Among the monastic ruins special mention may be made of Dunbrody abbey, of great extent, founded about 1178 for Cistercian monks by Hervey de Montmorency, marshal of Henry II; Tintern abbey. founded in 1200 by William Marshal and peopled by monks from Tintern abbey in Monmouthshire; the abbey of St. Sepulchre. Wexford, founded shortly after the invasion by the Roches, lords of Fermoy: Ferns abbey, founded by Dermot MacMurrough (with other remains including the modernized cathedral of a former see, and ruins of a church); and the abbey of New Ross. founded by St. Alban in the 6th century. Old castles include Ferns dismantled by parliamentary forces in 1641 and occupying the site of the old palace of the MacMurroughs; Enniscorthy. founded by Raymond le Gros: Carrick castle, near Wexford, the first built by the English; and the fort of Duncannon.

The soil of the county of Wexford consists mostly of a cold stiff clay resting on clay slate. Preglacial sands and gravels are used for liming fields, under the name of "manure gravels," on account of the fossil shells which they contain. The interior and western districts are much inferior to those round the coasts. In the southeastern peninsula of Forth and Bargy the soil is a rich alluvial mould mixed with coralline sandstone and limestone. The peninsula of Hookhead, as a result of the limestone formation, is specially fruitful. In the western districts of the county there are large tracts of turf and peat moss. The principal crops are oats. barley, turnips. wheat and potatoes. The numbers of cattle, sheep, pigs and poultry are well maintained. Except in the town of Wexford the manufactures are of small importance. The toun of Wexford is the headquarters of sea and salmon fishing districts, and there are a few fishing villages on the inlets of the south coast.

A railway branch line enters the county from the northeast and serves Wexford by way of Enniscorthy. with a branch westward to New Ross from Macmine Junction. Palace East, on this branch line, is also served by the Kildare line. Wexford has railway connections with Rosslare. and a line across the south of the county connects it also with Waterford (County Waterford). There is water communication for barges by the Slaney to Enniscorthy; by the Barrow for larger vessels to New Ross and by this river and the Grand canal for barges to Dublin. The administrative county of Wexford returns five members to *dail eireann.*

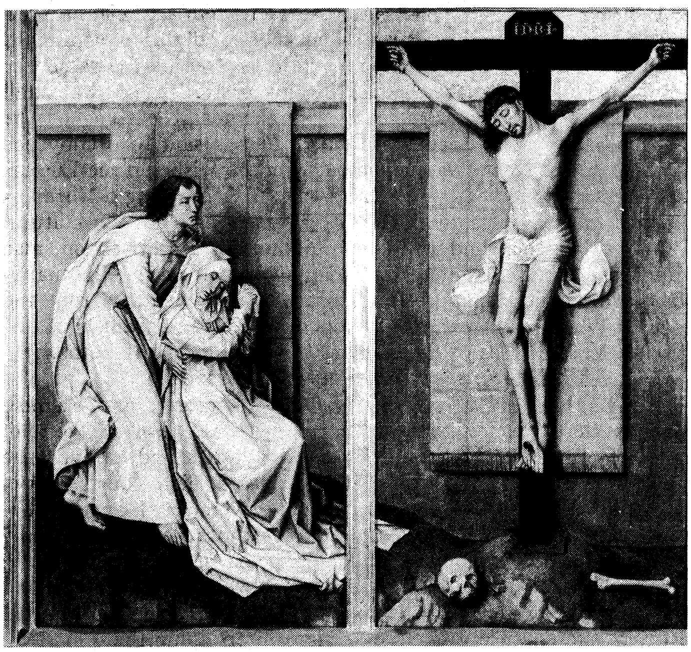
WEXFORD, a seaport and the county town of County Wexford, Ire., 83 mi. S. of Dublin by road. Pop. (1956) 10,838. Wexford was an early colony of the English. having been taken by Robert Fitz Stephen in 1169. In 1318 the town received a charter from Aymer de Valence, which was extended by Henry IV in 1411 and confirmed by Elizabeth I in 1jj8. It was besieged and sacked by Oliver Cromwell in 1649, and in 1690 it was garrisoned for William III. In 1798 it was made the headquarters of the rebels, who, however, surrendered it on June 21.

Wexford harbour, formed by the estuary of the Slaney, is about 5 mi. from north to south and about 4 mi. from east to west. There are quays extending nearly 900 yd. A bar at its mouth prevents the entrance of vessels drawing more than 12 ft. An artificial harbour was therefore opened at Rosslare in 1906, and this is connected with Wexford by a railway ($8\frac{3}{4}$ mi.) and is served by the passenger steamers from Fishguard. Some remains exist of the old walls and flanking towers. The Protestant church, near the ruins of the ancient abbey of St. Sepulchre or Selskar, is said to occupy the spot where the treaty was signed between the Irish and the English invaders in 1169. At Carrick, 2 mi. W., the Anglo-Normans erected their first castle. The principal exports are agricultural produce, livestock and whisky. Shipbuilding is carried on, also tanning, malting, brewing, iron founding, distilling and the manufacture of artificial manure, flour, agricultural implements, rope and twine. Wexford is the headquarters of salmon and sea fishery districts. It is the seat of the Roman Catholic diocese of Ferns.

WEYBRIDGE: *see* WALTON AND WEYBRIDGE.

WEYDEN, ROGIER VAN DER *(c.* 1400–1464), Flemish painter, the most influential artist of his time, born at Tournai, was painter to the town of Brussels (1435–64) and enjoyed the patronage of the Burgundian and various Italian courts (Este, Medici). His early career remains controversial. He was probably the Maistre Rogier de le Pasture who received an honorarium of wine at Tournai in 1426; he is also most generally identified with the Rogelet de le Pasture who was apprenticed to the Tournai painter Robert Campin (*q.v.*) in 1427 and the Maistre Rogier de le Pasture who entered the painters' guild there in 1432, although this namesake is regarded by some as a separate personality. Linked with this problem is that of the attribution of a group of pictures showing a more primitive and virile version of Rogier's style. These, either assigned to the youthful Rogier or to his putative master Campin, include "Entombment" (in private collection), and "Annunciation" (Metropolitan museum, New York), triptychs, altar wings and fragment (Frankfurt), "Nativity" (Dijon), "Marriage of the Virgin" and altar wings dated 1438 (Madrid), "Virgin and Child" (London), "Madonna on a Crescent" (Aix-en-Provence), a diptych with the "Trinity" and the "Madonna at the Chimney" (Leningrad) and a few portraits (Berlin, London).

No painting is authenticated as Rogier's by contemporary documents, but those attributed in early texts provide a reasonably secure basis for the reconstruction of his mature work. The monumental "Deposition" commissioned by the Louvain Archers' guild for their chapel in Notre-Dame-hors-les-Murs, then sent to the Escorial, Madrid, for Philip II of Spain by Mary of Hungary and now in the Prado, Madrid, clasely related to the group just mentioned, is probably of the 1430s, as are probably the "Annunciation" (Louvre, Paris) and "St. Luke Painting the Portrait of the Virgin" (Boston; replicas in Munich, Leningrad, Vienna). The large polyptych of the "Last Judgment" commissioned by the chancellor N. Rolin for his hospital in Beaune and the "Calvary" triptych at Vienna date from the following decade. Of numerous smaller religious pieces, the triptychs of "The Virgin" (Granada, New York, Berlin) and of "John the Baptist" (Berlin) are probably fairly early; of a little later date are the "Seven Sacraments" (Antwerp) painted for the bishop of Tournai, Jean Chevrot, and the large "Christ on the Cross" and "The Virgin and St. John," on two panels (Philadelphia); the "Entombment" (Florence) and "Virgin and Saints" (Frankfurt) show Italian compositional ideas, perhaps assimilated during the reported visit to Rome in the Holy year 1450; the Braque triptych (Paris) is dated 1450–52 by internal evidence; the triptych of the "Nativity" (Berlin) painted for Peter Bladelin, *receveur général* of Philip the Good and founder of Middelburg (Zealand), and of the "Adoration of the Magi," called "Columba Altar" (Munich) from St. Columba in Cologne, are probably late. Rogier's secular works include a lost bathing scene described by B. Facius, and the four large panels exemplifying Justice (Trajan and Herkinbald), which were in the Brussels town hall and were buried in the bombing of 1695. Reflections of them remain in tapestries in Bern. There are some sensitive portraits, most of them being part of a diptych: "Charles the Bold" (Berlin), "Francesco d'Este" (New Tork), "Jean de Gros" (Chicago), "Laurent Froimont" and the "Knight With a Spire" (Brussels), etc.



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"THE VIRGIN AND ST. JOHN." AND "CHRIST ON THE CROSS." BY VAN DER WEYDEN

Rogier's style, whether or not derived from Campin's, owes its crystalline vision and colour to Van Eyck, but the profound religious emotion, expressed through Gothic linear rhythms, is his own. In this personal vein of Netherlandish realism, he not only produced unique masterpieces, but also explored a new world of religious art and profoundly affected the whole course of European painting in the second half of the 15th century.

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WEYERHAEUSER, FREDERICK (1834–1914), pioneer U.S. lumberman, was born in Neidersaulheim, Ger., on Nov. 21, 1834. He migrated to the United States in 1852 where he soon entered the lumber business in Illinois. In 1899 he led a group of lumbermen to the state of Washington where they purchased 900,000 ac. of Douglas fir from the Northern Pacific railroad. They formed the Weyerhaeuser Timber company in 1900. Weyerhaeuser served as president of this and other lumber companies until his death on April 4. 1914. The Weyerhaeuser firm became the largest lumber company in the United States, in 1957 owning 3,200,000 ac. of timberland. The Weyerhaeuser family is given credit for changing United States lumbering "from a looter's privilege to a responsible business." (J. R. LT.)

WEYGAND, MAXIME (1867–), French army officer, was born at Brussels. Jan. 21, 1867. Having entered the military college of St. Cyr in 1886, he proceeded to the cavalry school at Saumur. He was commissioned second lieutenant in 1888 and in 1914 was made lieutenant colonel in the 5th hussars. In the meantime he graduated from the Centre des Hautes Btudes Militaires. At the beginning of World War I he served as chief of staff of an army under Cen. F. Foch. In Aug. 1916 he was made a general of brigade and the following year was appointed French representative on the Inter-Allied general staff. In April 1918 he resumed his work as chief of the general staff under Marshal Foch, which post he held during the remainder of the war. On July 28, 1920, he arrived in Warsaw as military adviser. After World War I Weygand became a member of the Conseil Supérieur de la Guerre; in 1923–24 he served as French high commissioner in Syria; in Nov. 1924 he took charge of the Centre des Hautes Études hfilitaires; and in 1931–35 was inspector general of the army. He was elected to the French Academy on June 11, 1931.

Recalled to service on the eve of World War II, he left for Beirut on Aug. 29, 1939, as high commissioner for Syria and the Lebanon and commander in chief. On May 20, 1940, he succeeded Gen. Maurice Gamelin as commander in chief in France, and on June 12 advised the French government to capitulate. On July 16, 1940, he was appointed minister of national defense in the Pétain government, but on Oct. 4 was sent to Algiers as the government's delegate and commander in chief for French North Africa. On Nov. 18, 1941, on German orders, he was recalled to France. On Nov. 12, 1942, he was arrested and interned in Germany. Liberated by the Americans on May 2, 1945, in the Tirol, he returned to France and was arrested there a week later. On May 6, 1948, all charges against him were dropped.

Weygand's writings include: *Le Maréchal Foch* (1929), *Turenne* (1930), *Histoire de l'armée française* (1938), *Recalled to Service* (1952).

WEYL, HERMANN (1885–1955), one of the greatest mathematicians of the first half of the 20th century, was born at Elmshorn near Hamburg, Ger., on Nov. 9, 1885. He was professor at the Technische Hochschule, Ziirich (1913), at Gottingen university (1930) and at the Institute for Advanced Study in Princeton, N.J. (1933–51). He died in Zurich on Dec. 8, 1955.

By his original contributions to pure mathematics, mathematical physics and philosophy, Weyl can be compared with his teacher David Hilbert and with Henri Poincaré (*qq.v.*). His interest in philosophical problems influenced his view of science and mathematics; he had a profound belief that the harmony of nature is expressible in mathematically beautiful laws, and the outstanding characteristic of his work nas his ability to unite previously unrelated subjects. In *Die Idee der Riemannschen Fläche* (1913) he created a new branch of mathematics by uniting function theory and geometry, thereby opening up the modern synoptic view of analysis, geometry and topology. He turned his attention to relativity in *Raum-Zeit-Materie* (1918). He produced the first unified field theory in which the Maxwell electromagnetic field, as well as the gravitational field, appeared as a geometrical property of space-time. By freeing T. Levi-Civita's concept of parallel displacement from dependence on a Riemannian metric, he provided the starting point for the researches of O. Veblen and others in projective differential geometry. Weyl created a general theory of matrix representation of continuous groups and discovered that many of the regularities of quantum phenomena could best be understood by means of group theory (*Gruppentheorie und Quantenmechanik,* 1928). Weyl also wrote on the philosophy of mathematics; he inclined to the views of the intuitionist L. E. J.

Brouwer. His *Philosophy of Mathematics and Natural Science* (1949) has been influential. (G. J. Ww)

WEYLER Y NICOLAU, VALERIANO, MARQUESS OF TENERIFE (1838–1930), Spanish soldier of Prussian descent, born at Palma de Mallorca. At 16 he entered the military college of infantry at Toledo, passed into the staff college as lieutenant and came out head of his class. Two years aftenvard he became captain and was sent to Cuba. He distinguished himself in the expedition to Santo Domingo, winning the cross with laurels of San Fernando. From 1868 to 1872 he served brilliantly against the Cuban rebels. He returned to Spain in 1873 as brigadier general, fought the Carlists in the eastern provinces in 1875–76 and was promoted general of division. Then he was elected senator and created marquess of Tenerife. He was captain general in the Canary Isles (1878–83) and afteru-ard in the Balearic Islands and in the Philippines (1888), where he dealt sternly with the native rebels of the Carolines, of Mindanao and other provinces. On his return to Spain in 1892 he commanded the 6th army corps in the Basque provinces and Navarre where he quelled agitations, and then became captain general at Barcelona until Jan. 1896, making himself the terror of anarchists and socialists. On the failure of Arsenio Martinez de Campos to pacify Cuba, Weyler was sent out again by the Conservative Antonio Cánovas del Castillo and pursued a policy of inexorable repression which raised a storm of indignation and led to a demand from the U.S. for his recall. This was granted by the Liberal Práxedes Sagasta. Back in Spain his reputation as a strong and ambitious soldier gave him prominence in times of constitutional disturbance; his appointment in 1900 as captain general of Madrid resulted in more than one ministerial crisis.

Thrice minister of war (1901, 1905 and 1906), he was again captain general at Barcelona (Oct. 1909) and, without bloodshed, quelled the disturbance connected with the execution of Francisco Ferrer. Weyler died Oct. 20, 1930.

WEYMOUTH, a town (township) of Norfolk county, Mass., U.S.. 12 mi. S.E. of Boston, is bordered on the north by Hingham bay and the Weymouth Fore and Back rivers.

The first English colonists arrived in 1622. The plantation (Wessaguscus or Wessagusset), second oldest settlement in the state. became the dispersal point for the earliest adventurers around Massachusetts bay. Incorporated as a town in 1635 and named for Weymouth, Eng., the government came to extend over several villages, which are still identified. The community has become primarily a residential suburb of Quincy and Boston. It is governed by a representative town meeting.

In its first 200 years, Weymouth developed fishing and agriculture. Water pollution ended the herring fishery. Early manufacturing began with iron, discovered in 1771. Modern manufacturing centres on shoes. the oldest plant dating from 1853; fertilizer, lacquers and electric power are other products.

In the township are the Fogg library (1898. in South Weymouth) founded by a bequest of John S. Fogg; and the Tufts library (1879, in Weymouth village) endowed by Quincy Tufts and his sister Susan Tufts. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (CA. M. C.)

WEYMOUTH AND MELCOMBE REGIS, a seaport and municipal borough in the South Dorset parliamentary division of Dorset. Eng., 8 mi. S. of Dorchester. Pop. (1961) 40,962. Area 11.0 sq.mi. The amalgamated towns lie on the western shore of the wide sweep of Weymouth bay, portrayed in a well-known picture by John Constable. The main sandy holiday beach is in Melcombe Regis. Weymouth harbour opens into Radipole lake, a bird sanctuary, which lies behind the esplanade and railway line and into which flows the Wey river.

Bronze weapons and Roman interments have been found there, but the first mention of Waymuth occurs in a Saxon charter of King Aethelstan, dated 938. By Weymouth's first charter, granted in 1252 by the prior and convent of St. Swithin, Weymouth was made a free borough and port for all merchants. As early as 1293 trade was carried on with Bayonne, and six years later a receiver of customs in wool and woolfells is mentioned at Weymouth, which then imported wine from Aquitaine. In 1347 the port supplied Edward III with 15 ships and 264 men, an indication of its importance at this time. Early in the 14th century the town suffered at the hands of the French, though in 1404 the townsmen were victorious over a party which landed in the Isle of Portland. In 1586 sugar is mentioned as an import. Two years later Weymouth sent six ships against the Spanish Armada and at least one Spanish ship, the "San Salvador," was brought into the harbour. Weymouth ships took part in many of the trading ventures with North America during the 17th and early 18th centuries. Commercial disputes with Melcombe Regis had led to amalgamation in 1571 and in 1616 the town received its charter from James I. During the Great Rebellion it was garrisoned by parliamentary troops in 1642, taken by the Earl of Camarvon in 1643 and surrendered in 1644. By 1750 the port was but a simple fishing village.

Weymouth's reputation as a watering place dates from the mid-18th century, and in 1789 George III paid the first of a series of visits which established its growing popularity. During the 19th century the prosperity of the port revived with the expansion of trade with the Channel Islands. Today the principal imports are potatoes, flowers and tomatoes, while the exports are mainly grain, fertilizers and building materials. In 1944 Weymouth was one of the principal embarkation ports for the invasion of Europe by the Allies.

Its various admiralty establishments, and certain light industries (*e.g.*, instrument making) provide additional employment to that of the holiday trade.

WEYPRECHT, KARL (1838–1881), German polar explorer who discovered Franz Josef Land, was born on Sept. 8, 1838, at Konig in Odenwald. In 1856 he became a cadet in the Austrian navy and in 1861 an officer. He made several voyages to the orient and to America and spent two years on a coast survey of Dalmatia. With Julius Payer he took part in two'expeditions to the arctic, sponsored by the Austrian government, with the object of exploring northeast of Novaya Zemlya and discovering a northeast passage. The first, in 1871, was a reconnaissance in the seas between Spitzbergen and Novaya Zemlya and reached latitude 78° 48' N. In the second, 1872–74, his ship, the "Tegetthoff," was beset and drifted north and west for over a year. On Aug. 30, 1873, Franz Josef Land was discovered and the party spent the next year exploring in the area. Eventually the ship was abandoned and the party returned to Novaya Zemlya by sledge and small boat, a journey occupying 96 days. On his return to Austria he advanced a scheme for investigating the polar regions at an international level, proposing that interested governments should establish one or more stations at which scientific work could be done simultaneously according to a previously co-ordinated plan. An International Polar commission was formed and organized the first International Polar year in 1882–83. Eleven countries set up 12 stations in the arctic and 2 in the antarctic. The result of the field work at these stations was published by the commission. The venture was followed by a second International Polar year in 1932–33 and the International Geophysical year in 1957–58.

Weyprecht published *Die Metamorphosen des Polareises* (1879) and *Praktische Anleitung zur Beobachtung der Polarlichter und der magnetischen Erscheinungen in hohen Breiten* (1881). The best account of the Franz Josef Land expedition is the translated account of his lieutenant, J. Payer: *New Lands Within the Arctic Circle,* 2 vol. (1876). He died in Michelstadt on March 29, 1881.

See also H. Littrow, *Karl Weyprecht, Erinnerungen und Briefe* (1881). (L. M. Fs.)

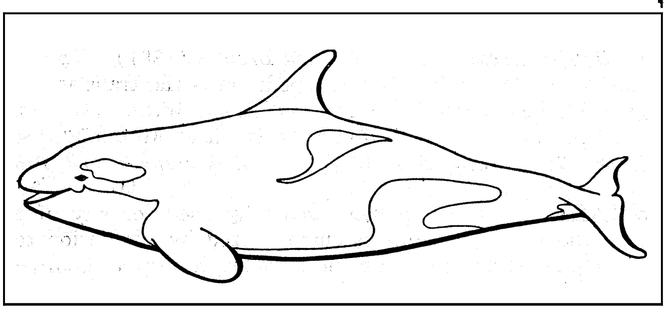
WHALE, the common name generally used for any of the Cetacea, an order of mammals characterized by adaptation to a completely aquatic form of life and divisible into three suborders: Archaeoceti, exclusively fossil, heterodont- (differentiated-) toothed cetaceans; Mysticeti, baleen or whalebone whales; and Odontoceti, homodont- (simplified-) toothed cetaceans comprising the sperm, bottle-nosed, beaked, killer. false killer and pilot whales and the dolphins and porpoises. The term "whale" is more an indication of large size than of zoological classificatory significance. The size range of cetaceans is between 4 and 100 ft., with an adult weight range of about 100 lb. to 150 tons. Cetaceans are extremely ancient as such and probably arose very early from a relatively undifferentiated mammalian ancestral stock. They are warm-blooded, lung-breathing animals with skeletal, vascular, alimentary, respiratory, sensory and reproductive features fundamentally the same as those in other mammals and not as in fishes, despite their superficial general resemblance to the latter. They have exploited all the available aquatic habitats: the oceans and the seas connected with them, estuaries and rivers; one species (Lipotes vexillifer) lives in a lake of the Yangtze river 600 mi. from the sea.

Whales yield several products of commercial value around which has grown the whaling industry (see WHALE FISHERIES). Whale meat, eaten for centuries by the Chinese and Japanese, has become a food specialty in other parts of the world. Whale oil (*q.v.*), whalebone and ambergris (*q.v.*) are other products that find uses in many industries. (F. C. FR.)

Whales in Legend and Literature. — The vast size and inaccessibility of the great whales in the oceans has always aroused men's curiosity and exercised their imaginations. A stranded whale must have been a boon to hungry primitive man. The whale has become the symbol of everything enormously huge, and the term is so used even in modern slang. In addition to mention of the whale among the writers of antiquity and in the Bible, it enters into many traveler's tales of later date, with stories of ships being stranded upon sleeping whales, of sailors landing upon them in mistake for islands and of ships being engulfed by furious whales. Apart from casual mention by many later writers and poets, from Shakespeare on, the whale reached its zenith in fiction with Herman Melville's *Moby-Dick; or,* the Whale (1851). *Moby-Dick,* like several later works of other authors, was based upon real life experiences of the author.

It is however the smaller whales, the dolphins, that have been the subject of the most charming legends. Aristotle, Pliny and other classical writers reiterated the belief that dolphins are the friends of man and that they delight in bearing his ships company and running races with them however fast they sail. Dolphins were supposedly especially attached to boys, and there are many stories of tame dolphins that came to hand when called and even carried their young friends upon their backs daily to and from school. (These legends are probably founded on the truth, for several modern instances are known of dolphins fraternizing with bathers and allowing youngsters to ride upon their backs.) Pliny told how dolphins entered the Nile river and battled with crocodiles. Among the fishermen of the Spanish- and Portuguese-speaking peoples a belief persists that dolphins attack and drive sharks away. The sculptured dolphins so frequently included in the statuary of fountains are a mixture of fish and cetacean (see DOLPHIN), generally with the emphasis on the piscine features. Both the whale and the dolphin have constellations named after them. (L. H. M.)

External Form. — The general body shape is fusiform or spindle-shaped with the head end modified variously into a more or less attenuated beak, rounded, bluff or flattened (fig. 1). The tail



AFTER LUTKEN

FIG. 1.—KILLER (ORCINUS ORCA), THE LARGEST OF THE DOLPHINS

end is always produced into two horizontal fleshy lobes, the flukes, which, by nicely adjusted inclination of their surfaces and the mainly vertical movement of the tail stock. propel the body through the water (fig. 2). The forelimbs (flippers) are paddle-shaped and subserve the functions of equilibrating and steering. A

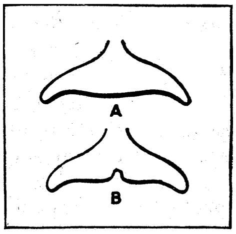


FIG. 2.— TAILS
(A) Tail of Ziphioid
(B) Tail of dolphin

fleshy dorsal fin is generally present, situated about the middle of the body length in smaller cetaceans and about two-thirds of the total length in larger species. Unlike the flippers, which enclose the recognizable elements of the mammalian forelimb skeleton. neither dorsal fin nor flukes have bony support. All three forms of appendages are alike in tapering from a thick, rounded leading edge to a thin trailing edge. No external trace remains of the hind limbs and no ear pinnae are to be distinguished adjacent to the inconspicuous entrance of the external ear tube. The nostrils (blowholes) are remote from the snout tip (except in the sperm whale), being situated near or on the highest part of the head (fig. 3). Eyes are present and usually fully functional, but vision is said to be reduced in some river dolphins. The skin is exceedingly smooth and devoid of hair, except for occasional remnants on the snout and lower jaw (mandible). Near the beginning of the hinder third of the body are found the reproductive opening and the vent. The position of these openings roughly defines the otherwise undeterminable root of the tail. Near the reproductive opening of the female is a pair of evertible teats, each usually concealed in a groove.

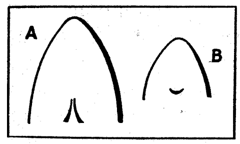
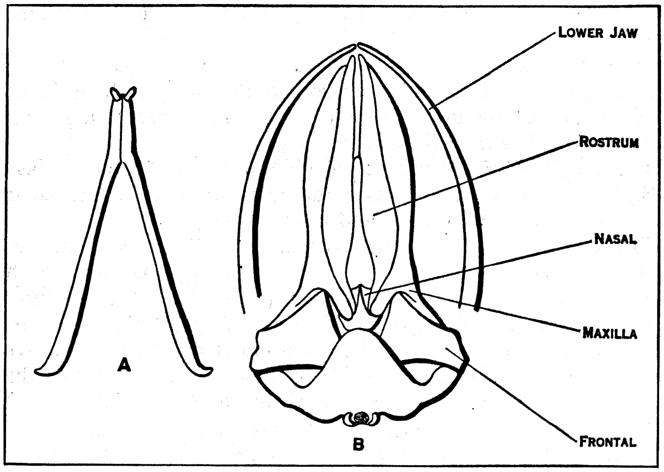


FIG. 3.—BLOWHOLES, FROM ABOVE
(A) Baleen whale
(B) Dolphin



AFTER ESCHRICHT AND REINHARDT

FIG. 4.—(A) LOWER JAW OF TOOTHED WHALE (ZIPHIUS, MALE); (B) SKULL OF BALEEN WHALE (MEGAPTERA) FROM ABOVE

Other Characteristic Anatomical Features. — The facial part of the skull is elongated into a rostrum the maxillary bones of which. at their hinder ends, are squamous (wide-spreading) and override the frontal bones in the toothed whales and, to a nearly similar degree, extend under the orbital processes of the frontals in baleen whales (fig. 4[B]). This "telescoping" of the cetacean skull, and the laminated bony structure so produced, together with a high, short, broad brain case result in a skull form that is far removed from the conventional mammalian pattern. To these features must be added the enormous development of the bony processes from the cranium — maxillary, supraorbital and zygomatic—and the unique asymmetry of the rostral and nasal regions of the toothed cetaceans.

The orbit is bounded massively above by the outer limit of the orbital process of the frontal; below, the boundary formed by the zygomatic process of the jugal is contrastingly slender. The nose tubes at first pass nearly vertically downward in front of, and subsequently underneath, the brain box, their extent being emphasized by the backward prolongation of the hard palate, the hinder end of which bounds the air passage ventrally. The shell-like, massive, tympanic bullae are fused by slender bony pillars to the associated periotics (bony casing of the inner ear), but these combined elements are themselves never united with the adjacent cranial bones. Sinuses, distinguishable as maxillary. frontal or ethmoidal, are lacking in all cetaceans.

The neck vertebrae, seven in number, are short and are often blended together to a greater or lesser extent. The thoracic vertebrae vary in number from 8 in Hyperoodon (the bottle-nose whale) to 17 in *Caperea* (the pigmy right whale). In the baleen whales the ribs differ greatly from those of other Mammalia in their extremely loose connection both with the vertebral column above and the sternum below. In the toothed whales the ribs are long and slender. the first four or five are normal in having the head, neck and tubercle; the posterior ribs are articulated solely by the tubercle to the transverse process. The breastbone is greatly reduced in size in the baleen whales and is of variable shape. In the toothed whales the presternum is very broad and is followed by two or three mesosternal segments, all elements fusing into a single bone in the adult. Thoracic vertebrae are followed posteriorly by lumbar vertebrae, generally distinguished by the increased height of the neural spines and the increasing length of the transverse processes, both attaining their maximum development in this region. No part of the backbone is specially modified to form a sacrum. The caudal (tail) vertebrae are characterized by progressively diminishing dimensions of their neural spines and transverse processes and by association of their centre with ventrally situated simple chevron bones. The shoulder blade is fan shaped, with both acromion and coracoid (wanting in *Megaptera*) situated near or on the anterior border.

The forearm, wrist and fingers are incapable of independent movement; the whole limb is hinged at the shoulder. The upper arm bone (humerus) is short, stout and robust; the forearm bones (ulna and radius) are more elongated, but still short by comparison with the combined length of the mosaiclike carpal region, metacarpals and digit bones. In some of the fingers the bones are more numerous than they are in the fingers of other mammals.

The greatly reduced pelvis is represented by a pair of slender, irregularly curved bones, remote from the backbone, embedded in flesh in the vicinity of the reproductive opening. In some of the larger whales bony or cartilaginous remnants of the hind limb skeleton still persist as attachments to the pelvis.

The brain is large and typically mammalian in general structure, but the globular shape, complex convolutions of the cerebral hemispheres and large size of the cerebellum combine to distinguish the cetacean brain from that of any other mammal. The olfactory lobes are greatly reduced or altogether absent.

The system of arteries and veins is much the same as in other mammals, but the retia *mirabilia* (subdivision of parts of the vascular system into plexuses of vessels) are remarkable .in their profusion. The blood supply to the brain is unconventional: the internal carotid arteries are greatly reduced, and their function of carrying blood to the brain is performed by the spinal meningeal arteries, which pass forward into the cranial cavity from the thorax region through the passage formed by the arches of the thoracic vertebrae. The kidneys consist of many small lobes, each renal mass being composed of many smaller kidneys (*reniculi*) numbering up to about 3,000 in the blue whale. The male organ can be retracted into a pouch within the general contour of the body. The testes are within the abdomen. The uterus is bicornuate and the placenta diffuse.

Respiration. — The single nostril (blowhole) of toothed cetaceans and the paired slits of the baleen whales are, with one or two exceptions, situated on the top of the head remote from the snout tip. The blowhole apertures are closed muscularly, more simply in baleen whales, and by a complicated arrangement of plugs. valves and air-filled cavities in the toothed cetaceans. A continuous air passage from blowhole to lungs is effected by the insertion of the spoutlike prolongation of the larynx into the hinder end of the nasal cavity, in which the prolongation is held by powerfully developed palatal muscles. Food going from mouth to esophagus has to pass on either side of this narially inserted, elongated larynx (fig. 5). The system of supporting rings of cartilage in the trachea (windpipe) is continued through the bronchi into the bronchioles, the latter being furnished with muscular sphincters

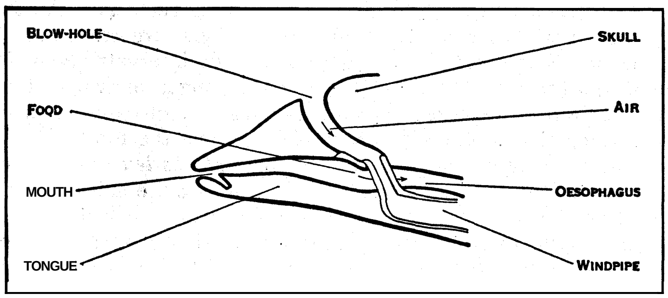


FIG. 5.— MEDIAN SECTION OF THE HEAD OF A PORPOISE. TO SHOW THE COURSE TAKEN BY AIR AND BY THE FOOD

except, according to E. J. Slijper, in the sperm and baleen whales (see Bibliography).

Although whales sometimes idle at the surface, blowhole above water, the normal respiratory pattern is one in which the whale, after a period of submergence, comes to the surface a number of times in quick succession, exhaling (blowing) and inhaling on each occasion. This period of successive respirations alternating with shallow dives is succeeded by a period that commences with the final inspiration of the preceding phase, includes a much deeper dive and more prolonged time of submergence and terminates with the ascent to the surface again.

The blow (spout) of the bigger whales is conspicuous and can be detected at a considerable distance. Its shape is used by experienced whalers to distinguish different kinds of whales: in the rorquals it is single, vertical and plumelike; in the humpbacks, low and bushy; in the right whales, double and directed obliquely forward; and in the sperm whales, single and directed obliquely forward. The blow is made visible by the condensed moisture due to sudden expansion and therefore cooling of the exhaled breath together with a certain amount of waste matter from the respiratory passages and adjacent air spaces. It is not as is popularly believed a fountain of water as such.

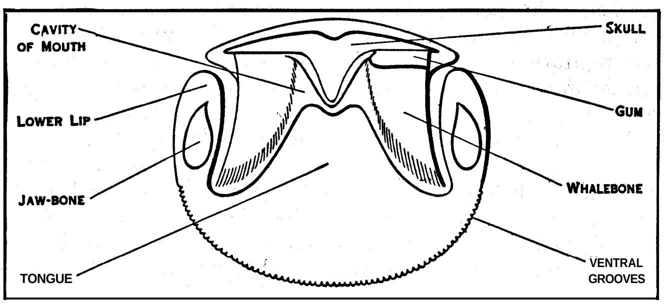
During submergence the whale is subjected to the pressure conditions imposed by the depth attained. The question of the whale's immunity from caisson disease (the bends) was answered by P. F. Scholander, who showed that the essential difference between the cetacean and the human diver is that the former dives with only the air that is in its lungs, while the latter has a constant replenishment of air throughout' the diving period. with all' the implications of increased nitrogen solution in the blood under pressure and the subsequent gasification if relief from pressure is too rapidly achieved. The accommodation of the air contained in the lungs when the whale is submerged is linked with the obliquity of the diaphragm. As the water pressure increases with depth, the air in the lungs is compressed, and the space so created in the thoracic cavity is occupied by the pushing forward of the diaphragm by the pressure of the abdominal viscera and perhaps also by the compression of the rib basket.

It is thought that delicate terminal small cavities (alveoli) of the lungs are evacuated under conditions of pressure and that the lung air is lodged in the more rigid, thick-walled, cartilage-strengthened wind pipe and its branches and in the nasal passages. Since the walls of these cavities have little capacity for absorbing nitrogen, in this way also the whale avoids the potential harmful effect of even that proportion of the gas that is contained in the air in the lungs when the animal submerges.

The myoglobin in cetacean muscles is an important reservoir for the storage of oxygen, in addition to the oxygen accumulated during successive respirations and stored in the blood and in the air contained in the lungs. Even these combined supplies are not believed to be adequate provision for a whale swimming actively and submerged for a period up to half an hour. It is suggested that the muscles may function anaerobically (without replenishment of oxygen) during the dive and that the retia *mirabilia* may act as a shunt. ensuring that while the muscles may be deprived of their oxygen supply, the brain is adequately supplied during the whole period of submergence.

Hair, Baleen and Blubber. — Hair. — Hair in the form of a pelt or protective coat is not found in any existing cetacean. Among the baleen whales hairs, in countable numbers, are restricted to the head. Single hairs are dispersed at wide intervals along the snout; on the chin from 20 to 40 hairs, arranged in two'vertical rows, have been recorded, with further sparsely distributed single hairs along the side of each mandible. Among the toothed cetaceans the beluga or white whale (Delphinapterus leucas) and the narwhal (*Monodon* monoceros) are said to be quite hairless at all stages of development and growth. The white-beaked dolphin (Lagenorhynchus albirostris) carries a few bristles on the sides of the snout during late fetal and early postnatal life but about weaning time these are shed and not replaced. Throughout life the amazon dolphin (*Inia geoffrensis*) bears a few scattered bristle hairs on its slender snout. A tactile function has been suggested for the bristles.

Baleen.—The Mysticeti, or baleen whales, are distinguished from others by the possession, within the mouth, of a double series of triangular horny plates (fig. 6), one set or "side" on each half of the palate. Since these plates do not consist of true bone, the term "baleen" should be used in preference to "whalebone" to



AFTER DELAGE

FIG. 6.— TRANSVERSE SECTION OF A RORQUAL'S HEAD TO SHOW WHALEBONE

avoid confusion. The baleen plates are anchored in the roof of the mouth and are spaced apart by a brief interval from one another, their plane surfaces being at right angles to the long axis of the head The smallest side of the triangular outline is inserted in the jaw, the outer (labial) side is smooth and the inner (lingual) is frayed out into a fringe of bristles. The fringes combine to form a matted sieve or strainer for collecting the planktonic animals on which baleen whales depend for nourishment. The plates are longest (to 12 ft.) in the right whales, and shorter, broader and less flexible in the rorquals A "side" may be composed of upward of 300 plates. Essentially baleen does not differ from hair, and. like the latter, has its origin in the skin. Horn tubes. and compacting horn between these, are enveloped, except at their outer ends (the fringe), in a covering layer. These components combine to form a plate. Between adjacent plates is a pad of softer horn, the intermediate substance. The foregoing description of the plates applies also to the transverse rows of small subsidiary plates situated on the inner aspect of the larger ones.

Blubber.—The body of the whale is enveloped in a layer of subcutaneous fat called blubber. The outermost layer of the skin (stratum *corneum*) is paper-thin and delicate; beneath this is a problematical even thinner layer, the *stratum lucidum.* Still deeper is a thick layer, the *stratum germinativum,* into which penetrate the papillae of the dermis. The dermis merges into the hypodermis, the blubber layer in the restricted sense. The blubber layer is, relative to the other layers, of immense thickness; it is a white. rubbery, tough layer, composed of fat cells and fibrous tissue. It functions as an insulating layer for the retention of body heat in animals whose temperature is always higher than the water in which they live. The internal temperature of a whale (92° F. in a stranded fin whale) is not much different from that of a man. But with the exertion of active swimming. the heat generated beneath the insulating blubber layer tends to increase. In order to maintain its normal body temperature the whale must dissipate the mounting heat. The whale lacks the system of sweat glands common to land mammals and is deprived, by the intermittance of its breathing, of the cooling effect that, for example, a dog obtains from panting. It has been suggested. however. that the flippers, dorsal fin (when present) and flukes, being without blubber, act as radiators and that a system of arteries, each surrounded by a meshwork of veins, acts in combination as a counter-current heat regulating arrangement, conserving the body heat when the whale is inactive and dissipating it from the surface of the appendages when vigorous muscular action tends to make the body temperature increase. In addition to its insulating function the blubber serves also as a food reserve in which fat accumulates when the whales are actively feeding and from which it is withdrawn when food is scarce.

Feeding Adaptations and Food.—The digestive tract and the feeding apparatus show several special features associated with feeding habits. Food enters the large gape and passes unchewed through the esophagus and into a specialized several-chambered stomach. This specialization of the stomach is related to the simplification of dentition, which requires that the food, swallowed whole, undergo prolonged digestion in the various chambers. On analogy with the dentition and food of the crabeater seal the serrate-edged teeth of even the earliest of the archaeocetes may be said to be adapted for dealing with gregariously occurring macroplanktonic species such as the shrimplike crustaceans known as krill, or even smaller fishes, rather than for a carnivorous diet of larger animals. In those cetaceans that are carnivorous (in the generally accepted sense), the teeth are simple, uniform, peglike and single rooted, and frequently exceed the primitive mammalian number, with the top teeth interdigitating, when the mouth is closed, with those of the lower jaw. The teeth are used for seizing prey, which is not chewed before being swallowed.

Generally, dolphins and porpoises eat fishes. but the common dolphin at least also adds cuttlefish to a diet that includes herring and pilchards. Some of the larger delphinids, for example the false killer. the pilot whale and Risso's dolphin, feed either exclusively or predominantly on cuttlefish. The last-named dolphin has teeth reduced to two to six on each side of the lower jaw and none in the upper. This reduction of teeth in association with a cuttlefish diet is even more emphasized in the bottle-nosed and beaked whales whose slender jaws bear a pair (at most two pairs) of functional teeth in the mandible and none in the upper jaw (except in *Tasmacetus*). The sperm whale, in which functional teeth are restricted to the lower jaw, eats large squids almost exclusively, but fishes may also be taken. The killer is exceptional in eating marine mammals (dolphins, porpoises and seals) and aquatic birds such as penguins in addition to salmon, sharks and other large fishes, but squid are also taken. The baleen whales are plankton feeders, including in their diet crustaceans such as krill (euphausians), copepods (*Calanus finmarchicus*) and fishes such as herring, sardines and capelin. The nourishment of these great whales is dependent on the swarming habit of the food animals involved.

Ambergris, a waxlike concretion formed in the intestine or stomach of the sperm whale. is a valuable substance used in the manufacture of perfumes. It is a debated point whether ambergris is a normal or pathological product and whether it is released during life or after death. Some believe that squid beaks cause an inflammation of the intestinal tract and stimulate the formation of ambergris.

Sense Organs.—Smell.—The sense of smell is almost or altogether lacking. The baleen whales still retain a reduced olfactory organ with a nerve supply from the olfactory lobes of the brain passing through a recognizably sievelike cribriform plate; but in the odontocetes the olfactory lobes have atrophied, the cribriform exit from the skull has been shut off by an overgrowth of the ethmoidal bone and the olfactory organ has disappeared.

Sight.—The lens of the eye is modified to accommodate vision to aquatic conditions: the sclerotic capsule is enormously thickened; the optic nerve is ensheathed in thick connective tissue and a network of blood vessels; the conjunctiva is composed of horny epithelium; and the lachrimal glands produce a waxy, not watery, exudation. The anterior chamber of the eye has provision for a rapid inflow and outflow of the liquid it contains, and both aqueous and vitreous humour have a diminished freezing point. The muscles of the eye are functional and of conventional number and disposition.

Hearing.—The sense of hearing is without question the dominant long-range perceptor, cetaceans depending principally on their ears for awareness of their surroundings. The reception of sounds is by a system of hearing comparable with that used by terrestrial mammals, but with modifications of the structural components needed for receiving and transmitting water-borne instead of air-borne sounds. The external aperture of the ear is minute in toothed cetaceans and inconspicuous in even the largest whales. There is no external ear flap (pinna). The cartilages that normally support the pinna are withdrawn under the skin and blubber but still provide insertions for functional "external" ear muscles required for adjustment of tension of the ear tube, which the cartilages partially surround. The ear tube is a duct openly extending to the eardrum in the odontocetes; in the baleen whales it is at first open but deep to the blubber the space is obliterated and it passes some way toward the ear drum as a solid cord. Nearer to the beginning of the middle ear the diameter of the passage increases and the tube is filled internally with a solid laminated mass of desquamated epithelium (flaked skin) and wax. The number of laminations of the ear plug is a guide to the age of the baleen whale. The ear plug fits like a dunce's cap over the grossly enlarged flaccid membrane of the ear drum. In the toothed cetaceans the flaccid membrane is of approximately normal proportions. The fibrous part of the tympanic membrane is ligamentous, not membranous, in structure. It is attached at its inner end to the tip of the "handle" of the malleus. The latter is fused by its channel-girder-shaped *processus* gracilis to the edge of the tympanic bulla. a process to which it gives support along one edge (the sigmoid process). Incus, stapes and cochlea are of conventional mammalian form.

The form of the tympanic ligament. the mode of its attachment to the malleus and the anchoring of the malleus to adjacent bone provide the means for vibrations transmitted along the ligament to be converted into greatly amplified, rotational. molar vibrations of the head of the malleus. The amplification is such that it makes good the difference between the displacement amplitude of sounds in water and in air (1:60). Similarly, by the ratio of the area of the foot of the stapes to that of the distal end of the tympanic ligament and the leverage of the ossicles, there is compensation for the loss in power due to the ossicular leverage, so that the vibrations presented by the foot of the stapes at the oval window are in all ways comparable with those received by the cochlea of a terrestrial mammal. By a system of foam-filled air sacs extending from the middle ear, the hearing mechanism of cetaceans is acoustically isolated from the effects of sound vibrations extraneous to those transmitted along the meatus. The air sacs also perform the function of maintaining a constant balance between external hydrostatic pressure and middle-ear gaseous pressure by a reciprocal adjustment of the amount of blood in the vessels lining the sacs to the varying hydrostatic, pressure-dominated volume of the air-sac spaces. The foam in the middle-ear sacs, while compressible in response to ambient pressure variations. still maintains its gaseous content and. therefore, also the sound-isolating function of the air sacs, at whatsoever depth the cetacean happens to be.

The range of sounds perceived is much greater in cetaceans than in terrestrial mammals. with an upper limit of about 120 kc. (the human upper threshold lies between 15 and 30 kc.).

Sound **Production.**—Cetaceans emit a considerable range of sounds. from low "creaking gate" noises to high-pitched whistles, which can be related to various activities such as feeding, breeding, aggressive display and communication. The dolphin calf starts emitting high-pitched whistles as soon as it is born. That some of the sounds emitted are used in echo-location has been proved, and it has been shown that bottle-nosed dolphins can range in. from a distance, on a comparatively small target in circumstances under which hearing is the only sensory means available for detection. The animal picks up its target by the transmission and reception of an intermittent pulse with a variable recurrence frequency. much as the bat locates its food and avoids obstructions while in flight in' the dark. The dolphin may be said to obtain an assessment of its environment predominantly by auditory impressions, for many of them live in turbid estuaries or river water, while some of the bigger cetaceans descend to depths of extreme light attenuation, conditions in which vision is of, at most, extremely limited use.

Breeding and Reproduction.—Most whales are gregarious during certain times: for example, during migration or at the breeding season schools numbering several hundred individuals may be seen. Smaller groups are referred to as pods or gams. Whales are often found alone as well. The Cetacea are in all respects mammalian in reproduction. The uterus is bicornuate and the placenta of the developing fetus is diffuse. Fetal life generally extends to about a year, but in the humpback whale it is 11 months and in the sperm whale 15 months. The larger cetaceans are usually sexually mature in their fifth to sixth year and produce young in alternate years.

Many of the smaller cetaceans give indication that parturition and pairing are accomplished in the early summer; and although in the bigger whales these activities may occur over a wide period of months, there are nevertheless indications, so far as parturition at any rate is concerned, of a period of maximum frequency. A single calf is normally produced, but twins occur, and there is fetal evidence of occasional larger numbers. The size of the newly born calf is large in relation to that of the parent; for 'example, in the common porpoise the calf is just over 2 ft. long at birth from a parent of about $5\frac{1}{2}$ ft. There is a recorded measurement of $24\frac{1}{2}$ ft. for a full-term fetus of a blue whale from a parent 93 ft. long.

Growth is fairly rapid; a sperm whale calf, for example. may double its length in the first year and may attain adult size in two or three years. The average life span is about half that of a human being.

The calf is delivered in the water and is able to swim as soon as it is born. It is suckled for a period of several months, up to one year in humpbacks. keeping close to the mother until weaning time. Suckling is accomplished as in other mammals. but with the provision for doing so under water. The milk secreted by the mammary gland flows through large channels (galactophorous sinuses) and collects in the lacteal duct. The mammary gland lies between superficial skin muscles and deeper body muscles, which, by their contraction, force the milk out of the lacteal duct and through the nipple. Suckling can thus be accomplished speedily. The tongue of the calf is provided with a strong muscular ridge along each side of its upper surface with an intervening longitudinal depression that widens out into a basin behind the tip of the tongue. When the tongue is applied to the palate a tubular passage is formed so that, when the calf grasps in its mouth the everted nipple of its parent, the milk, free of any surrounding sea water, can be swallowed.

Migrations.—The principal movements of many whales are largely connected with the two functions of feeding and reproduction. For example, the large baleen whales are found in the high latitudes of the Arctic and Antarctic during the summer months, when they become fat from the food they eat. Correspondingly, in the winter time they disperse into the warmer subtropical waters where pairing takes place and where the young are born. Some of the migratory movements of the whales—as, for example, those of the Californian gray whale along the west coast of America and of the humpback along the coast of New Zealand, on their journeys to and from the Antarctic—are predictable within fairly narrow time limits.

CLASSIFICATION

The following taxonomic scheme is one of several in general use:

Suborder Archaeoceti (extinct)
Family Basilosauridae
" Dorudontidae
" Protocetidae
Suborder Mysticeti, baleen or whalebone whales
Family Eschrichtidae, gray whale
" Balaenidae, right whales
" Balaenopteridae, rorquals, etc.

Suborder Odontoceti, toothed whales
Family Ziphiidae, beaked or bottle-nosed whales
" Physeteridae, sperm whales
" Monodontidae, narwhal, etc.
" Platanistidae, river dolphins
Subfamily Platanistinae
" Stenodelphininae
" Iniinae
Family Phocaenidae, porpoises
" Delphinidae, dolphins, etc.
Subfamily Orcinae
" Lissodelphinae
" Cephalorhynchinae
" Delphininae
Family Stenidae

Suborder Archaeoceti.—The Basilosauridae, Dorudontidae and Protocetidae, of the Eocene and Oligocene periods constitute this group. The Archaeoceti are believed by some to be derived from the Creodonta, primitive fossil members of the Carnivora; but W. K. Gregory thinks that they may have descended from Insectivora of the kind represented by *Pantolestes*. G. G. Simpson's opinion, the creodont hypothesis already mentioned, should be borne in mind however, so that the lack of differentiation common to the eutherian ancestral stock is not itself taken as an indication of affinity between one and another existing order. The skull characters of the archaeocetes are intermediate between those of their supposed ancestors and those of recent Cetacea in the position of the nostrils; the relations of the maxillae; and the dentition, which consists of three incisors, one canine, four premolars and two to three molars on either side of each jaw. The first four or five teeth are conical and single rooted; the other teeth are double rooted with serrated crowns. A milk dentition is found.

The teeth of the recent Cetacea are not differentiated into incisors, canines and molars. Whether the dentition of the odontocetes represents the milk or permanent series is debatable. The *Squalodontidae* (Oligocene to Pliocene), included in the Odontoceti, are believed to have descended from the archaeocetes and to hdve given rise to some at least of the recent toothed whales. The origin of the Mysticeti is uncertain but it may be a pointer to an odontocete ancestry that their fetal teeth are. in each tooth row, greatly in excess of the number conventional in primitive mammals.

Suborder Mysticeti.—Baleen or whalebone whales. Baleen present. Teeth lacking in the adult; numerous and vestigial in the embryo. Lower jaw large, the paired mandibles bowed outward and loosely united in front. Blowholes, two posteriorly divergent longitudinal slits. Skull symmetrical; the nasal bones relatively well developed; posterior extension of maxillae below the supraorbital processes of the frontals. First pair of ribs alone joining the sternum, which consists of one piece. The females are slightly larger than the males (some of the whales described below are compared with the size of an elephant in fig. 7).

Family Eschrichtidae.—*Eschrichtius glaucus,* the Californian or Pacific gray whale (45 ft.). Head small. less than one quarter the total length. No dorsal fin; flippers four-fingered. Hairs are scattered over entire head and loner jaw. Baleen blades are short and relatively few (138–174 in a "side"). Neck vertebrae not fused. Pelvis large. Ventral grooving of the skin in the throat region restricted to two or three in number. The gray whale prefers shallow water, swimming even in the surf, and occurs in the North Pacific, from California to the Arctic ocean. and off Japan and Korea.

Family Balaenidae.—Right whales. Skull much arched. Baleen long. narrow and flexible. No ventral grooves. Neck vertebrae fused.

Caperea marginate, pigmy right whale (20 ft.). Zygomatic and supraorbital processes less extended than in other representatives of the family; rostrum less arched: head smaller (one-fifth total length). Contrastingly specialized in relation to its relatives in having dorsal fin and only four digits in each flipper. Baleen typically right whale shape, about 230 plates in each "side." It is known from New Zealand. Austria and South America.

Balaena, Dorsal fin wanting; flippers broad, with five fingers. Head one-quarter to one-third total length.

Balaena mysticetus, Greenland right whale or bowhead whale (60 ft.). Head enormous, nearly one-third total length. Rostrum greatly arched to accommodate baleen plates having an average length of 10–11 ft., about 300 plates in each "side." Body colour predominantly black or dark gray, but the white chin and front portion of lower jaw are diagnostic (sometimes the tip of the upper jaw and associated baleen is white); black may shade into gray in vicinity of eye and of axillary region. Arctic, circumpolar and formerly abundant off Spitzbergen, both sides of Greenland and North Pacific to Beaufort sea.

Balaena glacialis, the Biscayan or North Atlantic right whale (maximum 60 ft.). Head less arched. Baleen shorter than in Greenland right whale and lower lip shape different. No constant white patch at tip of lower jaw; generally black all over but irregularly distributed white patches occasionally on the under surface of the body. Formerly common in the Bay of Biscay. and along the eastern coast of the United States and in Icelandic, Norwegian and British waters, its northern range coinciding nearly with the southern limit of the Greenland whale; but, like other right whales, it avoids the tropics.

Bnlaena australis, the southern right whale, not conclusively distinguishable from *B. glacialis*. Occurs in southern waters off Australia, New Zealand. Kerguelen, South Georgia, South Shetlands, Gough Island, Tristan da Cunha and South Africa. *B. japonica,* frequenting seas off Japan. Like *B. australis,* this is not certainly a distinct species.

Family Balaenopteridae.—Rorquals and the humpback. Rostrum much less arched and broader than in Balaenidae. Baleen blades shorter, broader and less flexible. Dorsal fin present. Skin covering throat has numerous conspicuous longitudinal grooves; flippers narrow. Neck vertebrae free.

Balaenoptera, rorquals. Body relatively slender. Dorsal fin well marked; flippers small, narrow and pointed.

Balaenoptera musculus, blue whale or Sibbald's rorqual (maximum 100 ft.) is the largest of all animals. Dark slate-blue colour predominating over whole body, including both surfaces of the tail flukes, but lighter flecking may be widely distributed. Cosmopolitan. on the assumption that (as in others of the family) the northern and southern races belong to the same species, from polar to temperate seas, occasionally reaching equator. Food, chiefly krill (euphausians).

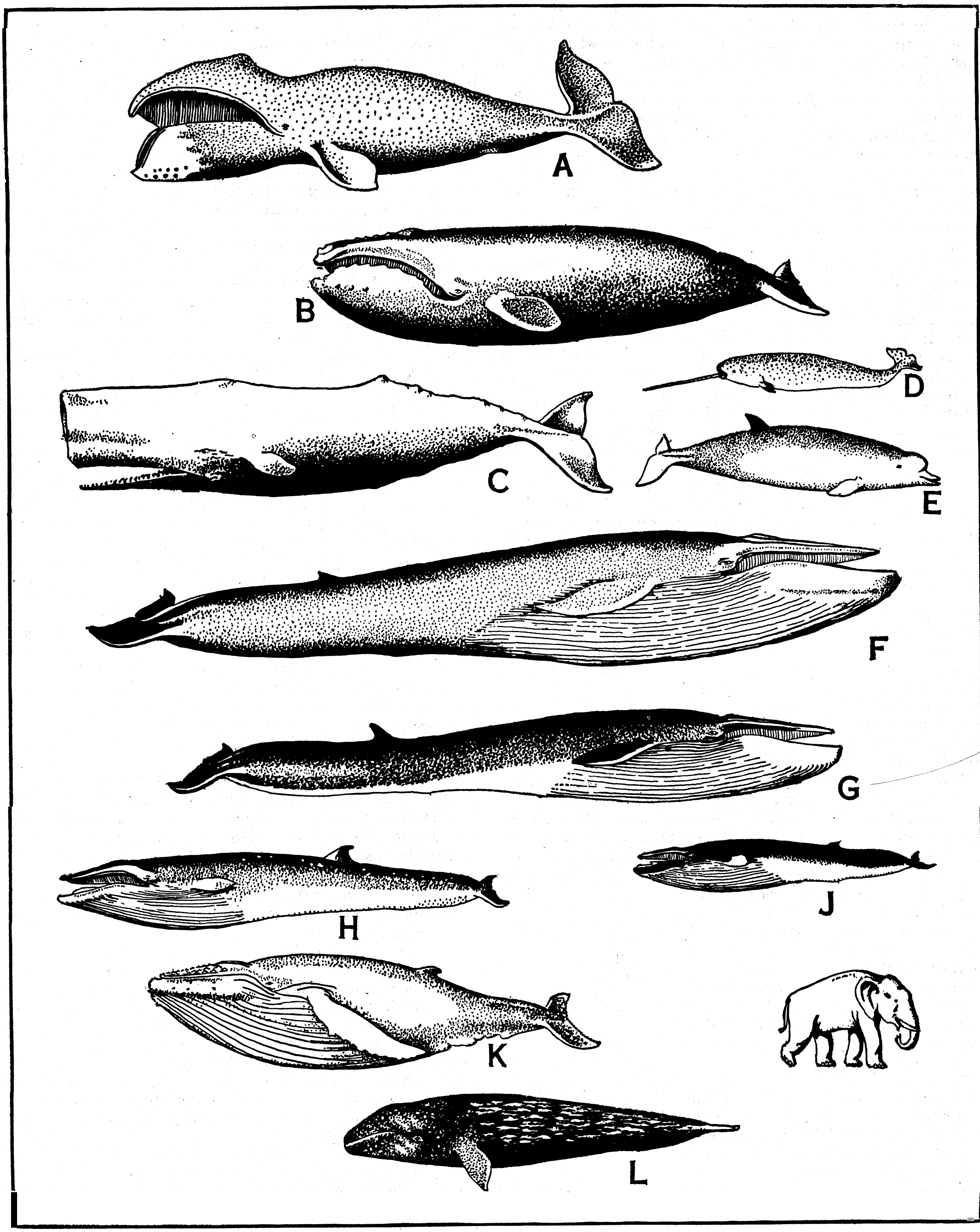
Balaenoptera physalus, fin whale, finner, common rorqual or razorback (maximum about 80 ft. in south). Dark above, pure white below, including the lower surface of the tail flukes and inner side of flippers. Right lower jaw white externally, left pigmented externally, with reverse arrangement inside mouth. Baleen blades anterior third of right side of mouth white, remainder on right and the left sides Blue-gray with streaks of white and yellow; all baleen fringes white. Cosmopolitan in distribution with (as in others of the family) seasonal migrations from lower to higher latitudes and vice versa.

Balaenoptera borealzs, Sei whale or Rudolphi's rorqual (maximum about 60 ft.). Bluish-black back, belly and tail; white area from chin to varying distance along belly but never to tail; lower surface of tail flukes dark. Baleen black. with white, silky. curling fringes, fine in texture. Food, euphausians, sardines and the copepod *Calanus.*

Balaenoptera acutorostrata, lesser rorqual, minke whale or piked whale (maximum 33 ft.). Coloration much as in the fin whale but lacking asymmetrical features. A conspicuous white area on the outer side of the flipper. Baleen and its fringes uniformly yellowish white. Food, largely fishes including herring, cod, capelin and planktonic crustaceans. Temperate and polar latitudes of both hemispheres, including British and North American coasts.

B. bonaerensis and *B. huttoni,* the former from Buenos Aires, the latter from New Zealand. Together with a small number of specimens from the Antarctic, these forms are uncertainly specifically different from *B. acutorostrata,* but flipper colour and baleen colour suggest a distinction.

Balaenoptera brydei, Bryde's uhale. Comparable in size and in many other features with Sei whale. Differing from the latter



FROM (B) ALLEN. 'WHALEBONE WHALES OF NEW ENGLAND,' (C) SCAMMON 'MARINE MAMMALS OF N.W AMERICA ' (E) "NATUURKUNDIGE VERHANDELINGEN " (F, G, J, K) "CHRISTIANIA VIDENSKAPSSELSKAPS FORHANDLINGEN,' (H, L) ANDREWS. "MEMOIRS OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 7.— VARIOUS TYPES OF WHALES

(A) Greenland whale (after Scoresby); (B) Atlantic right whale; (C) sperm whale; (D) narwhal (after Scoresby); (E) bottle-nosed whale (after Vrolik); (F) blue whale (after Sars); (G) fin whale (after Sars); (H) Sei whale; (J) lesser rorqual (after Sars); (K) humpback whale (after Sars); (L) Pacific gray whale (African Elephant, "Jumbo," 11 feet high, reproduced to same scale) principally in the quality of the baleen, the fringes of which are coarser in texture and the individual bristles larger, thicker and stiffer, average length of blades is less than for Sei whale Food, chiefly fishes including herring and mackerel. South and west Africa, West Indies.

Megaptera novaeangliae, humpback (maximum about 50 ft.). Body thick. Dorsal fin ill-defined: flippers enormously long, nearly one-third body length Colour black and white in variable proportion and distribution. Baleen and its fringes black Flippers sometimes pure white and always characteristically knobby on their anterior edge. Head likewise distinctively knobby Food, krill and small fishes. Cosmopolitan; migratory between higher and lower latitudes, tending to use inshore waters in the neighbourhood of land masses.

Suborder ODONTOCETI.—Toothed whales. Teeth present throughout life, No baleen. Lower jaw more or less triangular in outline (fig. 4[A]), the front part often narrow, the two halves firmly united in the adult. Blowhole single (fig. 3). Skull asymmetrical; nasals reduced; maxillae squamous above the supra-orbital processes of frontals. Several pairs of ribs joining the sternum, which consists of several elements in the young, fusing to form a single bone only in the adult.

Family **Ziphiidae.**—Bottle-nosed or beaked whales. Functional teeth greatly reduced in number. one to two pairs in lower jaw (fig. 8) (except *Tasmacetus, see* belo); vestigial teeth not uncommon in either jaw. A pair of longitudinal grooves in the throat region Dorsal fin at beginning of posterior third of body length; tail not notched at the middle of the posterior margin (fig. 2 [A]); flippers small. Food, cuttlefish. The rostrum becomes consolidated into a dense bony mass in *Ziphius* and *Mesoplodon* and fragments of these have been found in British Late Tertiary deposits, in Western Australia and from the sea bottom off South Africa.

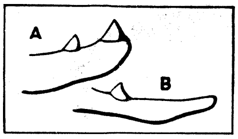


FIG 8 —FRONT ENDS OF LOWER JAWS
(A) Berardius
(B) Mesoplodon bidens

Berardius has two pairs of laterally flattened large teeth at the front end of the lower jaw (fig. 8[A]). *B. bazrdz* (40 ft), occurring in the North Pacific, is the largest existing ziphioid. *B. arnuxi* (about 30 ft.), found off New Zealand and Argentina, is not uncommon in Antarctic waters.

Ziphius cavirostris, Cuvier's whale (26 ft.) has one pair of teeth at the tip of the lower jaw, concealed in the gum in the female and pyriform. or pear-shaped. and prominent in the male. Cosmopolitan and not infrequently stranded on the British coast,

Hyperoodon ampullatus, bottle-nosed whale (male 30 ft., female about 24 ft.). Teeth small. one pair (occasionally a second smaller pair behind the first) at the tip of the lower jaw, alike in both sexes. remaining concealed till a late period. but piercing the gum, at least in old males. A large bony boss. increasing spectacularly in massiveness with age, on each maxilla, producing a progressive alteration of the forehead. which becomes enormous and gibbous (fig 9[B]) Common in the North Atlantic and frequently stranded on the British coasts, but rare in the eastern United States

Hyperoodon planifrons, the southern bottle-nosed whale. found off Australia, New Zealand. Argentina. Falkland Islands and South Shetland Isles, is distinguished from *H. ampullatus* by its lesser development of maxillary crests.

Mesoplodon — Teeth, one pair, smaller in females and usually remaining beneath the gum, according to species variously placed at the jaw tip or near the angle of the mouth

Mesoplodon mirus, True's beaked whale; rarely found Two teeth at the extreme tip of the lower jaw, inserted obliquely forward, robust and characteristically laterally flattened in the male.

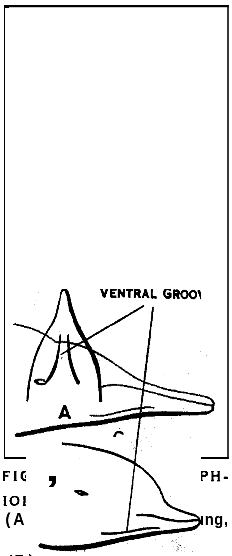


FIG PH-
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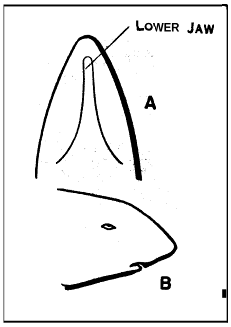
(A ng,
(B) Hyperoodon, side view
(C) Mesoplodon bidens, adult female

Mesoplodon bidens, Sowerby's whale (fig. 8[B]; 15 ft) has its pair of teeth set at about a third of the length of the lower jaw from the front end: teeth are laterally flattened. hidden in the gum of the female but exposed as short, triangular prominences in the male Those of the males of M. *densirostris, M stegnegeri, M. bowdoini* and *M. ginkgodeus* are similarly situated but greatly enlarged. In *M layardi* of South Africa. Australia and New Zealand. the teeth curve over the beak, nearly meeting and preventing the mouth being opened to more than a small extent. *Mesoplodon* species are oceanic and mostly very inadequately known.

Tasmacetus shepherdz, Oliver's beaked whale, distinguished from all other living ziphioids by having 19 functional teeth in each upper jaw row and 26 similar teeth in lower jaw rows, with a pair of larger bulbous teeth at the tip. New Zealand.

Family **Physeteridae.**—Sperm whales Teeth numerous in lower jaw; vestigial or absent in upper jaw in recent forms. Mandibular symphysis long.



AFTER ESCHRICHT AND REINHARDT
FIG. 10 — WHALE HEADS (A) HEAD OF SPERM WHALE FROM BELOW; (B) HEAD OF A KOGIA WHALE FROM THE SIDE

Physeter catodon, sperm whale, cachalot; male up to 63 ft.. female to 35 ft. Head about one-third the total length; snout massive, truncated and extended beyond the narrow ventrally situated mouth (fig 10[A]). Lower teeth 20–26 on each side, of great size, up to 8 in in length. conical; vestigial upper teeth much smaller, variable in number. The single blowhole on left side of head near the front end. Dorsal fin a low hump succeeded tailward by a further series of diminishing size. Colour dark gray or brownish on back, lightening on sides toward silvery gray, sometimes white belly, variable. The sperm whale occurs in all tropical waters but stragglers, nearly always old males, reach both polar seas Polygamous. The spermaceti organ, occupying much of the snout, consists of a fibrous "case" containing up to a ton or more of clear, colourless oil. The sperm whale can dive to great depths in search of its main food, cuttlefish, although fishes are also eaten. Produces ambergris.

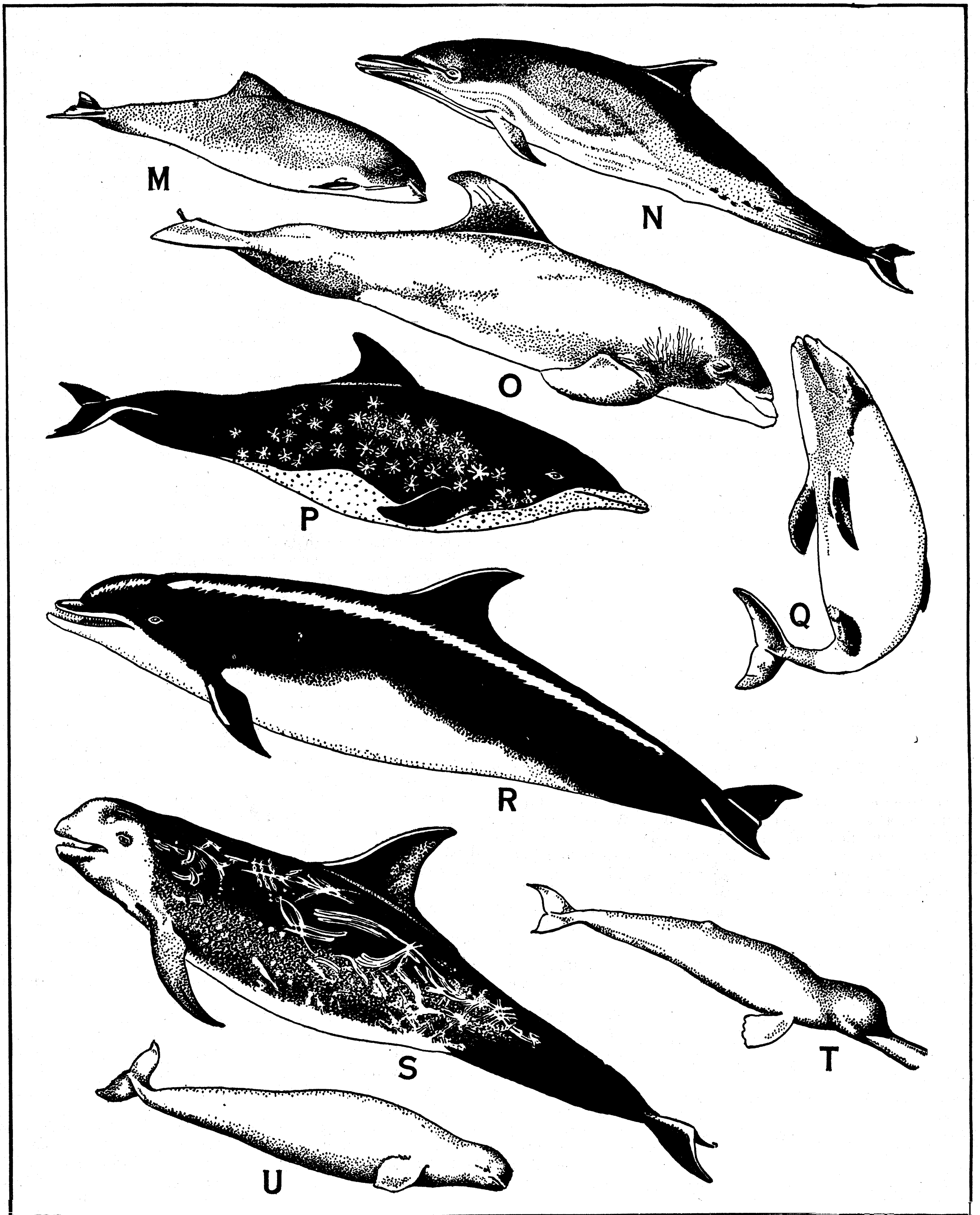
Kogia breviceps, pigmy sperm whale (about 10 ft.) resembles *Physeter* in general characters, but head length only about one-sixth total length (10[B]). Flippers tapering not rounded; dorsal fin well defined and falcate (curved). Blowhole an asymmetrically situated single air passage. Lower teeth 9–14 in each row, long, slender and curved.

Family **Monodontidae.**—No dorsal fin. Neck vertebrae free. Flippers broad and bluntly rounded distally. Partial lateral bony lamina of pterygoid.

Monodon monoceros, narwhal (maximum about 15 ft.). Colour varying with age from bluish gray when young to gray-white with darker mottling when adult. Teeth unlike those of any other animal, reduced. except for concealed vestiges, to a single pair. In the female these are concealed in deep sockets in the rostrum the left one only exceptionally erupting; in the male the right tooth remaining similarly concealed but the left growing out as a straight, spirally marked tusk up to 9 ft. 43 in long (occasionally both teeth equally developed). Long. low ridge in situation of dorsal fin. Food. mainly cuttlefish but also fishes and crustaceans. Arctic. rarely reaching Britain.

Delphinapterus leucas, white whale. beluga (fig 11; 18 ft). Colour dark gray in juvenile, pure white in adult. Teeth 8–10 in each side of upper and lower jaws. Dermis of skin more developed than usual (used as "porpoise hide"). Food, fish of considerable size. cuttlefish and crustaceans. Gregarious Arctic and circumpolar. reaching the St Lawrence river and (rarely) the British coast.

Family **Platanistidae.**—River dolphins Skull less compressed from front to back than in delphinoids. Neck vertebrae all free. Eight pairs of double-headed ribs usual. Breastbone



BY COURTESY CI (M, O) THE TRUSTEES OF THE BRITISH MUSEUM (N, Q) FROM 'TRANSACTIONS," 1880 (ZOOLOGICAL SOCIETY OF LONDON!. (P) LUTKEN. VIDENSK SELSK. SKRIFTER" (DET KONGELIGE DANSKE VIDENSKABERNES SELSKAB. COPENHAGEN); (R, S) W H. FLOWER IN "TRANSACTIONS (ZOOLOGICAL SOCIETY OF LONDON): (U) R. COLLETT. 'NORGES PATTEDYR (H. ASCHE-HOUG & CO. OSLO)

FIG. 11.— COMMON PORPOISE. WHITE WHALE AND TYPES OF DOLPHINS

(M) Common Porpoise (a'fter Harmer) ; (N) Common Dolphin (after Flower) ; (O) White-beaked Dolphin (after Harmer) ; (P) Steno rostratus; (Q) Commerson's Dolphin (after Harmer) ; (R) Bottle-nosed Dolphin; (S) Risso's Dolphin; (T) Susu (after Anderson) ; (U) White Whale well developed. Flippers short and broad. Sight reduced or lacking. Snout and lower jaw very long and slender; mandibular symphysis extremely long.

Subfamily Platanistinae.—Lateral lamina of pterygoid entire.

Platanista gangetica, gangetic dolphin, susu (maximum 8 ft.). Dorsal fin a very low ridge. Blowhole a longitudinal slit. Large bony, maxillary crests at the base of the rostrum. Teeth 30 on either side of each jaw. Food. mud-frequenting fishes and crustaceans. Rivers Ganges. Indus and Brahmaputra, to far up stream.

Subfamily Stenodelphinae.—Lateral lamina of pterygoid fenestrated. Dorsal fin well developed.

Stenodelphis blainvillei, La Plata dolphin (5 ft.). Beak attenuation extreme. Teeth 50–60 in each row of upper and lower jaws. Blowhole crescentic; only 3–4 pairs of double-headed ribs. La Plata estuary.

Subfamily Iniinae.—Lateral lamina of pterygoid absent. *Inia geoffrensis,* Amazonian dolphin (8 ft.). Teeth 26–30 in each row, hinder ones with distinct internal heel. Beak with numerous scattered hairs. Blowhole crescentic, transverse. Dorsal fin long, low, triangular; flippers broad and cumbersome. Amazon river to 1,500 mi. from the sea.

Lipotes vexillifer, Chinese river dolphin (8 ft.). Grayish or blue-gray on the back, white on the belly. Rostrum curving upward. Teeth 33–36 in each row. Blowhole asymmetrical to the left side. Food, fresh-water fishes. Tung Ting lake, about 600 mi. from the mouth of the Yangtze river.

Family **Phocaenidae.**—Porpoises. Head with rostrum (fig. 12[D]). Dorsal fin, when present, triangular. Teeth with expanded spade-shaped crown. Tail notched posteriorly.

Phocaena phocaena, common porpoise (fig. 11; 6 ft.). Black above, white below. Dorsal fin often with small tubercles on front edge. Male reproductive opening usually far forward. Teeth 22–26. Food, mainly fishes, but also crustaceans and cuttlefishes. Coastal and estuarine. Widely distributed in European waters. and off West Africa to Dakar.

Phocaena spinipinnis, Burmeister's porpoise; and P. *dioptrica,* spectacled porpoise. South American, the range of the latter to South Georgia. P. *spinipinnis* colour entirely black. Teeth 16–17 in each row. *P. dioptrica* back black; belly and both surfaces of tail white: eye encircled by white. Teeth 19–21 in each row.

Phocaenoides, with species in North Pacific *P. truei* and *p. dalli.* Vertebrae numerous, 95–98 as compared with 64–67 in *Phocaena phocaena.*

Neomeris phocaenoides, finless black porpoise or Indian porpoise (maximum 4 ft. 6 in.). Black or dark brown. Without dorsal fin. Narrow longitudinal, depressed, finely tuberculated area mid-dorsally. Food. fishes, prawns and cuttlefish. India and Japan, marine and Yangtze river to beyond the Tung-T'ing lake.

Family Delphinidae.—Dolphins and whale-named dolphins.

Subfamily Orcinae.—No well-defined beak. Forehead globose or gibbous. Dorsal fin present: flippers tapering (except *Orcinus*). Tail notched posteriorly (fig. 2[B]).

Pseudorca crassidens, false killer (19 ft.). Teeth 8–10, massive, round in cross section. Completely black. Sporadic mass strandings in various places from Tasmania to Kiel.

Orcinus orca, killer, grampus (fig. 1; male 30 ft., female 16 ft.). Dorsal fin falcate and large in female and in young of both sexes, prominent and triangular to 5½ ft. in older male. Colour, distinctive black and white, sharply defined: a conspicuous white patch above and behind the eye; a grayish "saddle" behind the dorsal fin, Flippers rounded and, like dorsal fin and tail flukes, increasing disproportionately in the male with age. Teeth massive, pointed, with transversely oval cross section. 10–12 in each row. Food, fishes, marine birds and mammals including even the big whales; extremely voracious. Cosmopolitan; not uncommon in British and American waters.

Orcaella brevirostris, Irawadi dolphin (7½ ft.). Forehead prominent. Dorsal fin low. Teeth 12–19 in each row, small. Colour slate blue. Irrawaddy river. Burma to 900 mi. from the sea, Bay of Bengal, off Singapore and Borneo.

Globicephala, pilot or caa'ing whale, blackfish (maximum 28 ft.). Forehead greatly swollen and prominent (fig. 12[C]).

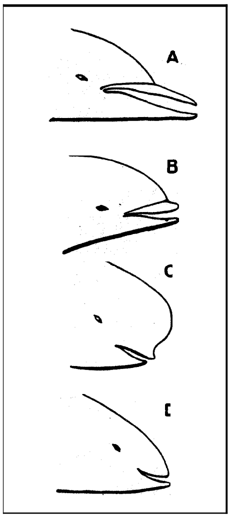


FIG. 12.— DOLPHINHEADS
(A) Delphinus
(B) Lagenorhynchus
(C) Globicephala
(D) Phocoena

Flippers long and narrow. Teeth 7–11, large at front end of the jaws. Highly gregarious to more than 1.000 in a school. *G. melaena,* northern seas. Black except for restricted white throat patch and light belly colour. Commercially hunted in Faeroe Islands and, formerly. Shetland Islands. Southern ocean. G. *edwardii* doubtfully distinct. A tropical species, *G. macrorhyncha,* Atlantic and Indian oceans, with no white patch; flippers shorter: and head more globose than in *G. melaena.*

Feresa, pigmy killer (73 ft.). F. *attenuata.* Rounded forehead, less prominent than in *Globicephala.* Teeth 10–13 in each row. Flippers moderate. falcate. Colour, dark gray except for white lips and vent. Only four specimens known. Japanese seas, Senegal.

Subfamily Lissodelphinae.—Right whale dolphins, No dorsal fin.

Lissodelphis peroni, southern right whale dolphin (6 ft.). Strikingly black and white. black of back not extending to snout, tail or flippers. Teeth small! pointed, 43–44 in each row. Southern seas.

L. borealis, North Pacific. More generally pigmented but with white ventral area.

Subfamily Cephalorhynchinae.—Small porpoiselike dolphins. Beak ill defined. Teeth 25–31 in each row. conspicuously marked.

Cephalorhynchus commersoni, Commerson's dolphin (fig. 11) or piebald porpoise, coloured as latter name. *C. heavisidei, C. hectori, C. albiventris,* like Commerson's; all are southern forms.

Subfamily Delphininae.—*Lagenorhynchus.* Beak short, plowsharelike (fig. 12[B]). Dorsal fin prominent. Vertebrae very numerous, 73–92. Usually oblique light areas on sides. *L, albirostris* (9–10 ft.), white-beaked dolphin (fig. 11); teeth 22–25, diameter 7 mm. *L. acutus,* white-sided dolphin (9 ft.); teeth 30–34, diameter 4 mm., North Atlantic species. coasts of northern Europe and eastern United States. *L. obliquidens,* like *L. albirostris,* North Pacific to California. *L. cruciger,* in general form like *L. acutus,* South Pacific. *L, obscurus,* the dusky dolphin; and *L. australis,* Southern ocean. *L. electra,* probably cosmopolitan.

Lagenodolphis hosei, form intermediate between *Lagenorhynchus* and *Delphinus,* known only from skeleton. Off Borneo.

Grampus griseus, Risso's dolphin (fig. 11; 13 ft.). Grayish, lighter below. Beak lacking. Forehead prominent. Flippers long. Teeth usually absent in upper jaw; lower teeth 2–7 confined to front end of jaw, diameter to 14 mm. Apparently cosmopolitan; not uncommon in British waters. Food, cuttlefish.

Tursiops truncatus, bottle-nosed dolphin (fig. 11). Beak well defined, 2–3 in. long. Teeth 20–22 in each row. in both jaws, diameter 9 mm. Dark brownish on back, belly white. Back fin prominent. falcate. Common in British seas and off the eastern United States. *T. gilli,* a closely related North Pacific form. *T. aduncus,* more heavily pigmented, tropical Indian and South Pacific; smaller, may be distinct. *Stenella,* with many species, often spotted or with distinctive dark narrow flank line. is oceanic. Beak 4–5 in. long, separated from rest of head by a distinct groove. General body shape and size as in *Delphinus,* but palate of skull not grooved.

Delphinus delphis, common dolphin (fig. 11; 8 ft.). Beak, as in *Stenella,* with similar well-defined groove (fig. 12[A]). Mainly black dorsally. white ventrally, but with overlapping. waved, longitudinal streaks of white. brown, yellow or gray on sides. Palate of skull with two deep longitudinal grooves. Teeth 40–50 in each row. Cosmopolitan; common in Atlantic and Mediterranean; one of the commonest British species.

Family Stenidae.—This family includes *Steno* (fig. 11), *Sousa* and *Sotalia,* long snouted dolphins of doubtful affinities inhabiting tropical waters. oceanic. estuarine and fluviatile.

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(F. C. FR.)

WHALE FISHERIES. Whales provide food and oil. and they have long been hunted for one or both of these. although the emphasis shifted with time. In Europe, in the middle ages and earlier, they provided food, whereas between the 17th and 19th centuries the oil was important for lighting and soapmaking. There was also a demand for whalebone. In the 20th century the emphasis was again on food, for most whale oil is converted into margarine. In the early 1960s the annual world whale-oil production was about 500,000 tons, roughly equal in weight to about one-third of the butter produced. The oil production, together with about 140,000 tons of by-products for food or fertilizers, came from a world catch of nearly 55,000 whales taken by about 360 whalecatchers operating from more than 20 factory ships and nearly jo shore stations. Nearly all the factory ships operated in the antarctic, which became the major field. accounting for about 80% of the world production, but most of the shore stations were outside the antarctic. scattered along the coasts of temperate, tropical and arctic seas, for the highly mechanized industry is also world-wide in operation. Its methods andscale have such potential for destruction of the whale stocks that the industry is regulated by international agreement.

Early **Whaling.**—It is likely that Stone Age man hunted the smaller whales and dolphins. Certainly the Eskimos and North American Indians whaled from ancient times with weapons of bone and horn. flint and slate; one Alaskan whale hunting settlement has been dated back to A.D. 100 or 200. In Europe. the cradle of whaling as it subsequently developed. the earliest records concern Norway and Flanders in the 9th century. but the first important development was the enterprise conducted by French and Spanish Basques from the shores of the Bay of Biscay. Begun about the 10th century. this hunt for the Biscayan or Atlantic right whale flourished in late medieval times! was in decline by the middle of the 17th century and died out in the 18th. Meanwhile. by 1400, some of the Basques were pioneering the whaling voyage. Leaving the harbours and watchtowers of the shore fishery, they built ships which eventually followed the Biscayan whale to Newfoundland, the Gulf of St. Lawrence and, in the 16th century, to Iceland. where they found Icelanders and Norwegians already engaged in the business. By 1joo. however, the Biscayan whale in the eastern North Xtlantic was a much depleted species. But somewhere in their far northern voyages the Basques fell in with the Greenland or arctic right whale, which was more massive than the Biscayan whale, and had thicker blubber and longer whalebone.

The Greenland whale came to support a new enterprise. the northern whale fishery, which continued for three centuries after 1611 when the Muscovy company sent Thomas Edge with the "Mary Margaret" and the "Elizabeth" of London on the first Spitsbergen whaling voyage. The Basque whalemen were mostly engaged in the north under foreign flags, for they were much sought after as harponeers and expert flensers (blubber-strippers) by the British. German, French and especially Dutch vessels which came to exploit the Greenland fishery.

At first whales were killed in the Spitsbergen bays and the blubber flensed from them was boiled out in coppers (large kettles) on the beach; the populous Dutch seasonal settlement called Smeerenburg (Blubbertown) belonged to this period. Bay whaling. however, declined after 1635 and the ships began to whale along the ice between Spitsbergen and Greenland, and in the Davis strait; they flensed the whales at sea and casked the blubber for "trying-out" (melting) at home. After 1840 this ice fishery in turn began to decline. The last phase belonged to the Scottish steam and sail whalers. and these sailed as much for the long whalebone (in great demand for use as stays in corsetsj as for the oil. The last Dundee whaler came home "clean" in 1913. In the Pacific, north of Bering strait and in the Okhotsk sea, the arctic right whale had a last stronghold which was breached by American whalers after 1843; they called this whale the "bowhead." The bowhead fishery was prosecuted so vigorously that it was finished by 1908.

Turning again to the Atlantic right whale. there was a fishery on the western side of the North Atlantic started by New England settlers before 1645. This flourished for a time but was moribund by 1800. Meanwhile it had given rise to one of the greatest maritime ventures in history: this was the Xmerican sperm-whale fishery. begun in 1712 when a shore whaler. blown off the coast in a storm, fastened a sperm whale and got it safely home. Oil from the sperm whale was found to be a much superior illuminant to that from whalebone whales, while the spermaceti from the head made the finest wax candles. More and more vessels sailed from New England ports to "whale out in the deep for sperm whales." The whaleships "cut-in" (removed the blubber fromj their whales alongside. and tried out the blubber at sea. They were at the Azores in 1765, on the coast of Brazil in 1774 and in the Indian ocean by 1789. Although Great Britain (in 1788) was first after sperm whales in the Pacific, the monopoly of this world-wide industry was American; in the peak year of 1846 there were 729 Yankee whaleships at sea. The slow decline which followed (although the last sperm-whaling voyage was not made until 1925) was due to several causes. including the discovery of petroleum in Pennsplvania in 1859. The sperm-whale fishery was the only old-style venture which may not have ended through overfishing.

As a consequence of the sperm whalers' explorations, two further species were exploited. The southern right whale. at first taken in great numbers around the southern continents and subantarctic islands. fared like its congener in the north and was greatly reduced by 1900. The Pacific gray whale. hugging the California coast on its winter migration. suffered great depredations in the breeding lagoons from the boats both of whaleships and shore stations.

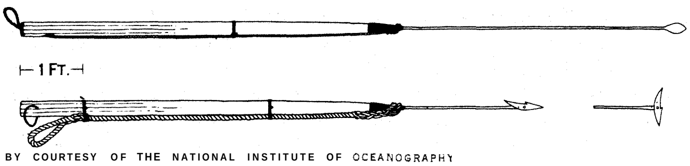
Old-style shore whaling, although extinct or moribund on the east and west Xtlantic seaboards. was carried on elsewhere during the 19th century. Excluding Japan (which had stations for gray, right and humpback whaling by a netting method evolved independently of the European tradition) there were settlements in California. South Africa. Australia, New Zealand and Tasmania. By the 1950s these settlements had disappeared except in the Azores. where a shore fishery for sperm whales existed since 1832, and in Madeira where the Xzores whaling spread in 1941. There the Portuguese islanders hunt in open boats with hand harpoon and lance as did their forebears who learned the trade in Yankee whaleships long ago.

Modern **Whaling.**—In the 1860s, when right and gray whaling were already in decline from overfishing. the industry received a new lease of life which it still enjoys. The Norwegian sealing captain. Svend Foyn. developed a method of hunting the great rorquals. including the blue and finback whales. which swim too fast for pursuit in open boats. Svend Foyn' used a cannon, firing a heavy grenade harpoon. mounted in the bow of a steam vessel. His methods revolutionized whaling and have remained unaltered in their essentials.

The new steam whaling,, which by 1900 was conducted from many stations in the North Atlantic and arctic, soon spread to Japan, Korea, British Columbia and, after about 1910, to the coast lines of the southern continents. The varying fortunes of this modern shore whaling (which continues widespread) before World War II were usually associated with periods of local overfishing. In Norway, after 1900, a growing scarcity of whales, and legislation hostile to the steam whalers and designed to protect the Norwegian cod fishermen: caused the industry to look to the antarctic where expeditions between 1892 and 1904 had reported abundant rorquals. In 1904 Capt. C. A. Larsen started whaling at Grytviken in South Georgia. The antarctic industry had begun.

Antarctic Whaling. — Whaling from Grytviken and other stations prospered at South Georgia, and soon spread to the other antarctic islands of South Orkney and South Shetland, where the first factory ships operated. Their heyday was the period from 1906 to 1927. They were really mobile shore stations, for they flensed their whales alongside and therefore could not work on the high seas but had to seek the shelter of some island bay or the calm of the ice-locked Ross sea. Then in 192j the steamship "Lancing" was fitted with a slipway in the stern so that whales could be hauled on deck. Her success opened the great era of pelagic (open sea) whaling. Factory ships could operate wherever their whale-catchers found whales in the Southern ocean. They could also operate outside territorial waters where no governments at that time could control their activities by licences or whaling regulations. Tankers were rapidly converted with stern slipways for pelagic whaling. Other tankers were used as transports, bringing fuel oil to factories in the ice and taking home cargoes of whale oil, so that the factories could work a protracted season. In the season 1930–31, within five years of the "Lancing's" voyage. 41 factory ships operated to produce 3,500,000 bbl. of oil. At mid-20th century this antarctic production, and by consequence world production also, remained the highest in the history of whaling.

Technique. — Except for the introduction of electronic aids and reconnaissance aircraft, the whaling technique developed by 1931 changed little after 1945. A typical pelagic expedition comprised a factory ship of about 16.000 gross tons which operated about 11 or 12 steam whalecatchers each of about 550 tons, although newer catchers attained 900 tons and had diesel engines. They operated within about 100 mi. of the factory ship. Helicopters sometimes helped the search. Experiments with scouting aircraft in the antarctic were first made in 1929, but it was not until 1950 that, in the form of helicopters, they were used effectively. The search from the catcher is still the job of the lookout at the masthead, but he is often helped by the echo-whalefinder, developed from wartime asdic (a sonar device). The whale scarer, another sonar device, frightens whales into flight with ultrasonic vibrations, so that, getting out of breath, they blow more often and are more easily followed. Whales are shot with the grenade harpoon. (Before and after World War II there were experiments with an electric harpoon, which yields an unspoiled carcass and is claimed to be more rapid and more humane than the grenade harpoon.) The dead whale, winched back on the Manila whaleline, is then inflated to prevent sinking and marked with a flag. At the end of the day the flagged whales are collected and towed back to the factory ship or shore station. Flags are sometimes missed due to fog, heavy seas or nightfall and, therefore, radio buoys that transmit a continuous signal to the catchers have been introduced: Flags with radar reflector cones, which can be detected on the catcher's radar screen, are also used.



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LANCE (ABOVE) AND HAND HARPOON (BOTTOM) STILL USED IN THE AZORES IN THE 1950S AND AS USED BY AMERICAN WHALEMEN IN THE 19TH CENTURY

A whale delivered to a factory ship is heaved through the stern slipway with a steel clan- attached to hawsers dragged by two 50- or 60-ton winches. The claw, a giant pair of pincers dropped over the whale's tailstock, mas first used in 1932–33. On the afterdeck the blubber is removed in three enormous strips. The flensed carcass is hauled through the midships gantry to the meat-and-bone deck. There, using steam bonesaws and wires strained around winches and capstans, the butchers and bone-sawyers work with anatomists' precision, removing and sectioning the skull, opening the chest and separating the ribs. stripping meat from the backbone and separating the vertebrae. There is no wastage: only the entrails and stomach are turned overboard. Blubber. meat and bone are stuffed into separate cookers. the mouths of which are flush with the deck. A proportion of the lean meat is usually not pressure cooked for oil extraction but is fed into the meat meal plant. Little more than 45 min. is taken to dispose of a blue whale weighing over 100 tons, and 30 min. suffice for a finback n-hale. The work goes on day and night, as long as whales are waiting at the stern.

Products. — Modern whaling! besides producing edible whale oil (*q.v.*) from rorquals. also produces sperm oil which. although inedible and no longer used as an illuminant, has increasing uses in industry. (The largest catches of sperm whales are made in the antarctic and off the coasts of Peru and Chile.) The by-products of whaling became more important after World War II. They include meat meal for cattle cake, bone meal and guano for fertilizers. frozen whalemeat for human and fox food, meat extracts and liver meal, liver oil rich in vitamin A. and a certain amount of ductless gland for hormone extracts. Ambergris. still important in perfumery, is occasionally found in sperm whales. Whalebone, hardly worth saving for brush manufacture between World Wars I and II. began again in the 1950s to find a market in the corset industry. See WHALE; WHALE OIL.

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(RT. CE.)

WHALE OIL.

WHALE OIL. Whale oil is used mainly as raw material for margarine and compound cooking fat. Sperm nhale oil. which is really a liquid wax, can be employed only for such purposes as the manufacture of lubricants and fatty alcohols. The two will be considered separately.

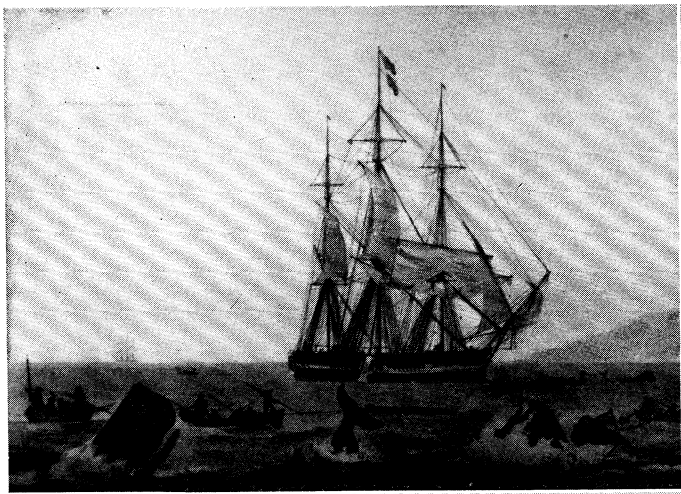
Whale Oil and **By-products.**—Two discoveries played important parts in the history of whaling and the use of whale oil The first was in the mid-19th century when petroleum was first discovered. Before that time whale oil had been in demand as a burning oil for lamps and as a lubricant for machinery. Between that date and the discovery of hydrogenation of fatty oils and its commercial application in 1908, nhale oil fought a losing battle since it could not be produced at anything like the low cost of mineral oils and could not, therefore, compete with them as an illuminant or as a lubricant. During that period the whaling industry declined year by year.

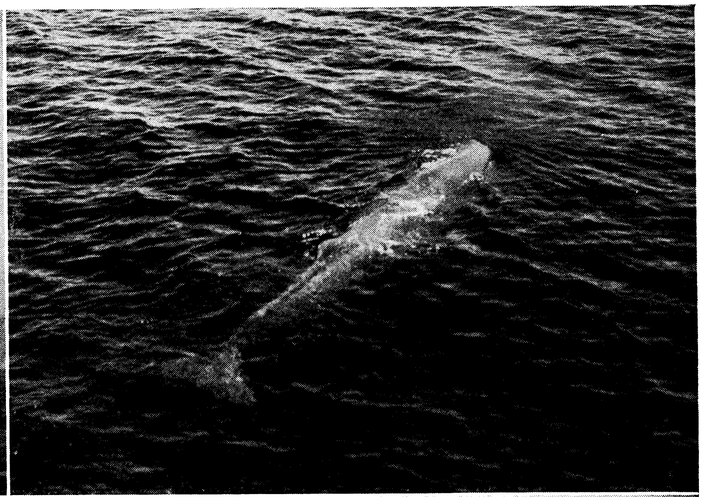
Hydrogenation of oils is the addition of molecules of hydrogen to molecules of fatty matter which takes place in the presence of a nickel catalyst. The effect in the case of whale oil is to convert it from a somewhat strong-smelling fishy liquid oil into a bland, odourless. tasteless, stable, solid fat. The discovery of this process came about at a time when soapmakers and margarine manufacturers were searching for solid fats; there were adequate supplies of liquid oils but a great scarcity of solid fats. The soapmaker required solid fats to make a hard soap because the liquid oils were capable of making only soft soaps. while the margarine manufacturer required solid fats to produce a product with the characteristics of butter, which was again impossible from liquid oils.

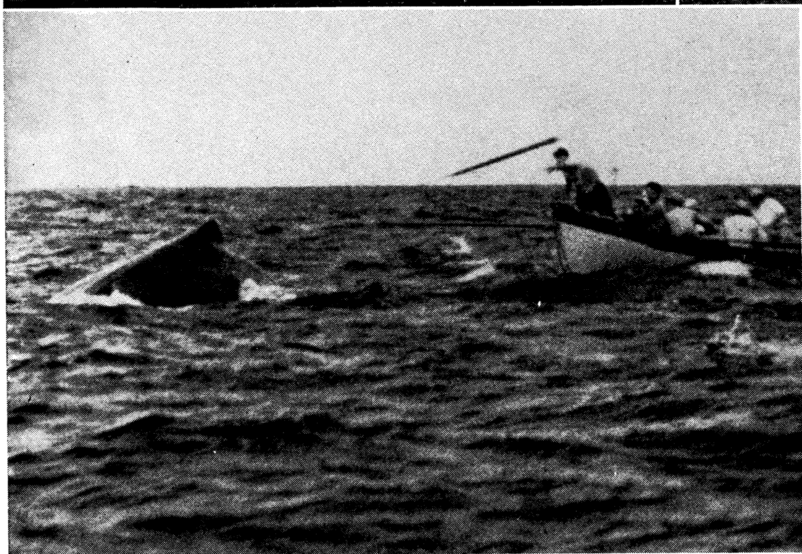
Whale oil is a true fat oil consisting almost entirely of triglycerides—one molecule of glycerol in combination with three of fatty acids. Such oil can be converted into an excellent edible fat, as well as a high-grade soapmaking material.

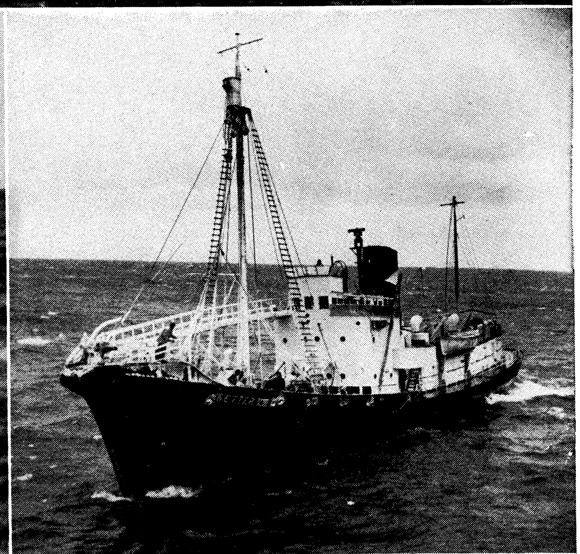
Most of the whale oil (or sperm oil) is contained in the blubber. The blubber consists of subcutaneous tissue into which fat is deposited and from which it may be taken back for the process of in-

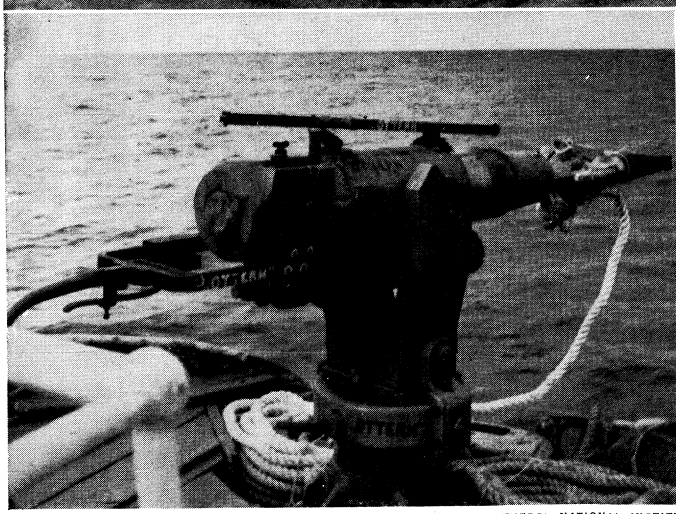
WHALE FISHERIES











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WHALING

Top *left:* The whale ship days. Detail from a print of 1825 by W. J. Huggins showing a British sperm whaler in the Pacific

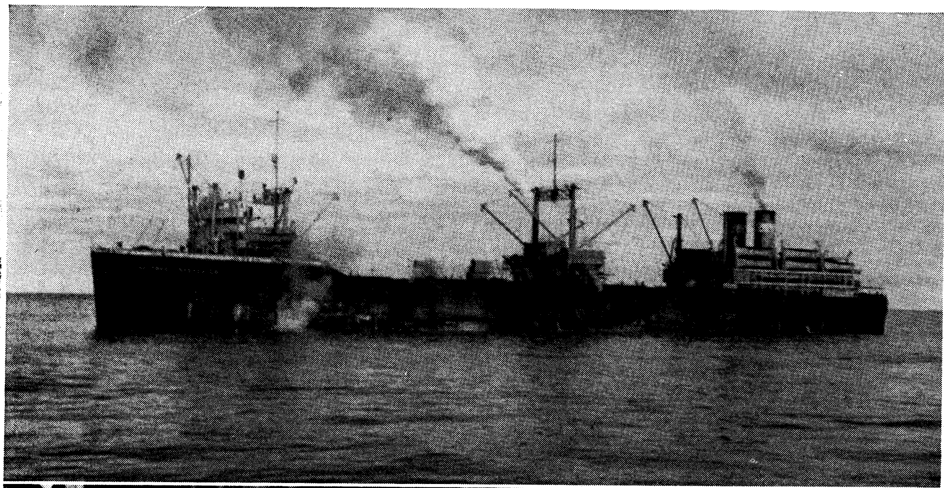
Top right: Sperm whale photographed from a helicopter. Most species of whales do not adopt this unflexed, extended posture, but it is typical of sperm whales when drifting undisturbed at the surface

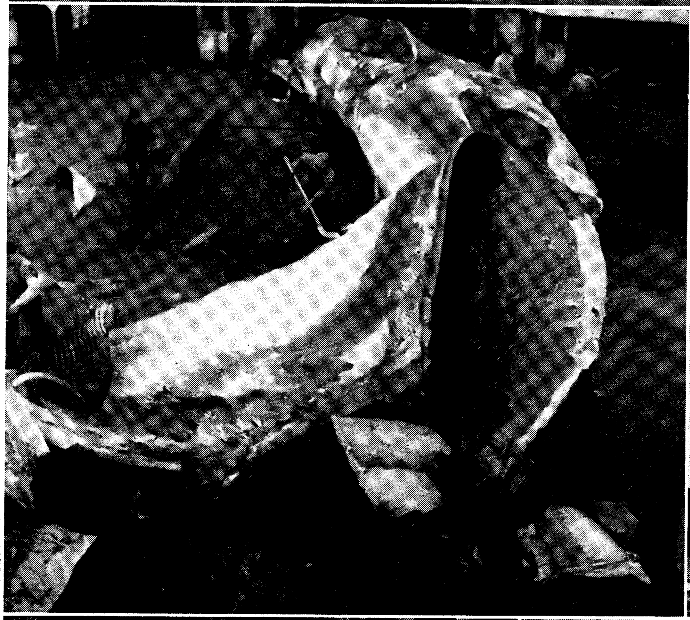
Centre left: Harpooning a 53-ft. bull sperm whale from an open boat. This method of whaling, a legacy from the American sperm whale fishery, is still practised along the coasts of the Azores and Madeira

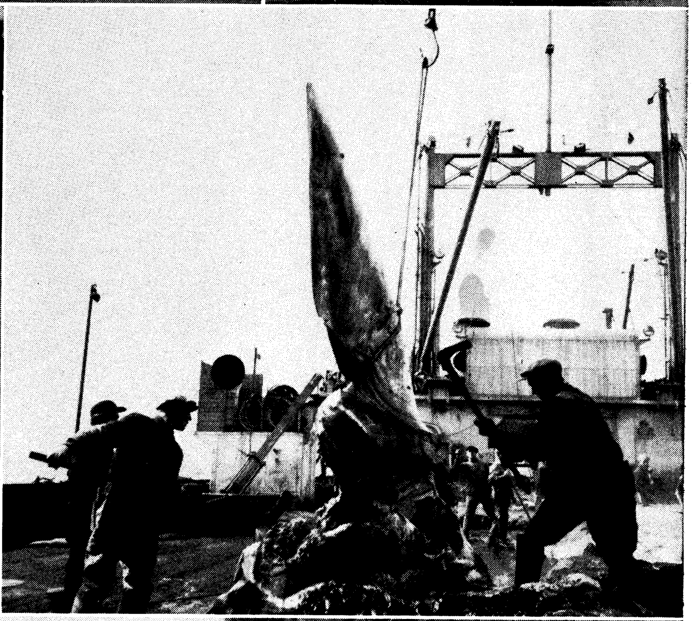
Centre right: Modern whalecatcher. These ships are 500–900 tons burden and have speeds up to about 17 knots. The masthead lookout barrel and the catwalk between the gun mount and the bridge are features of all whalecatchers

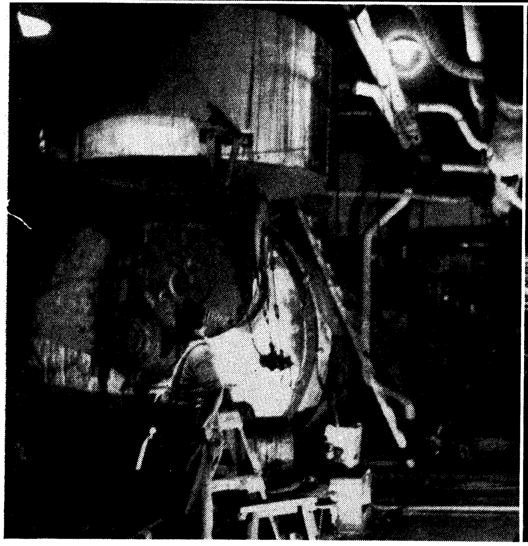
Bottom left: Harpoon gun. The harpoon (shown loaded into the muzzle) weighs about 160 lb., is 6 ft. long and bears 4 hinged barbs. The grenade head is filled with black powder which explodes by a time fuse just after hitting the whale

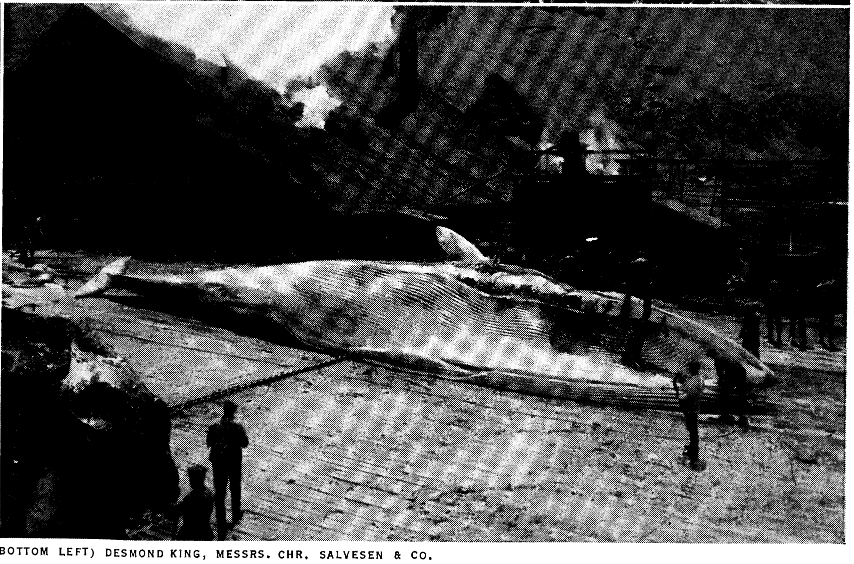
Bottom right: Harpoon hitting a whale and exploding. Bottom line is from a previous shot











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WHALING

Top left: Pelagic whaling. A factory ship on the Antarctic whaling grounds. Flensing (removal of the blubber) takes place on the afterdeck. The stripped carcass is then hauled through the midships gantry to the foredeck where it is completely dismembered into meat, bone and entrails
Top right: View of a pelagic factory ship from the stern showing the slip-way through which whale carcasses are hauled by winches to the flensing deck
Centre left: The flensing deck. A blue whale is being flensed: the blubber is removed in three strips much as a banana is peeled. Note the whale-claw (attached to the tail) used for hauling the whale through the slip-way
Centre right: The meat-and-bone deck. Whalers are shown trimming the shoulder blade from a blue whale's flipper
Bottom left: The factory deck. Blubber, meat and bone, loaded into cookers from the open deck above, are cooked under steam pressure. A Hartmann apparatus for cooking meat is shown
Bottom right: Shore whaling. A female fin whale, 72 ft. long, on the flensing platform at a shore station on the island of South Georgia

ternal metabolism. The thickness of the blubber depends on the size and the state of nutrition of the whale and varies for different species. Normally it increases in proportion to the length of the animal. Seasonally, baleen whales get fatter the longer they stay in their arctic or antarctic plankton areas. Whalers usually estimate an oil yield averaging 50% to 80% of the weight of the blubber. Important as the blubber is as a fat-bearing raw material, it is not the only one—the body also deposits fats in all the meat tissues, and finally in the bones. It has been estimated that whale meat may contain from 2% to 8% oil, with an average of 6% to 7%; and bones from 10% to 70%, with an average of 40% to 60%.

Sperm Oil.—The oil from the sperm whale is not a true fatty oil but is, in fact, one of the liquid waxes, Since it consists mainly of fatty acids in combination with higher monohydric aliphatic alcohols, and only small traces of glycerides. This precludes it from being an edible product because the fatty alcohols are quite indigestible. The number of uses to which sperm oil is put, however, is constantly extending as it has become the basis of an important chemical industry manufacturing derivatives from the separated fatty alcohols.

Crude sperm oil is a very valuable lubricant and is used as such for the cold rolling of steel. Treatment with sulphur gives a sulphurized oil which has exceptional properties for the preparation of extreme pressure lubricants. Sperm oil may be hardened in the same way as other marine oils and in this form is used for its lubricating qualities in the preparation of textile sizes and wax compositions or directly as a metal-drawing lubricant. The crude oil is used directly and in conjunction with other marine oils as a leather dressing. When supplies permit and the price is very low, it can be used as a soapmaking material by a process which involves the conversion of the fatty alcohol portion to fatty acids, but the process is expensive.

Sperm oil is normally refined by a chilling or wintering process followed by filtration so as to remove the solid portion or spermaceti. The spermaceti is pressed and refined to yield a white crystalline solid which finds considerable use in the preparation of textile finishes and thread lubricants, cosmetics and candles.

The saponification of sperm oil under carefully controlled conditions separates the constituent fatty acids and fatty alcohols. The fatty acids so prepared are suitable for soapmaking and for the many other uses to which fatty acids are normally put. The fatty alcohols are used in the manufacture of cosmetics and hair preparations and also in detergents.

As far as antarctic whaling is concerned, sperm oil is largely a by-product, and, compared with whale oil production, sperm oil is only of secondary importance. (J. C. G.)

WHALLEY, EDWARD (*c.* 161j–*c.* 1675), English regicide, risked death by flight rather than trust indemnity after the revolution. He was the second son of Richard Whalley, who had been sheriff of Nottinghamshire in 1595, by his second wife. Frances Cromwell, aunt of Oliver Cromwell. On the outbreak of the Great Rebellion he took up arms for the parliament, became major of Cromwell's regiment of horse and fought with distinction in the campaigns of 1643 to 1647. When the king was seized by the army, he was entrusted to the keeping of Whalley and his regiment at Hampton court. Whalley refused to remove Charles's chaplains at the bidding of the parliamentary commissioners, and treated his captive with due courtesy, receiving from Charles after his flight a friendly letter of thanks. In the second Civil War (1648) Whalley again distinguished himself as a soldier. and when the king was brought to trial he was chosen to be one of the tribunal and signed his death warrant. He took part in Cromwell's Scottish expedition, was wounded at Dunbar, and in the autumn of 1650 was active in dealing with the situation in southwest Scotland. Next year he took part in Cromwell's pursuit of Charles II and was in the fight at Worcester (Sept. 3) which defeated Charles's army. He followed and supported his great kinsman in his political career, presented the army petition to parliament (Xug. 1652), approved of the Protectorate and represented Nottinghamshire in the parliaments of 1654 and 1656, taking an active part in the prosecution of the Quaker James Naylor (*q.v.*). He was one of the administrative major generals, and was responsible for Lincoln, Nottingham, Derby, Warwick and Leicester. He supported the Humble Petition and Advice (March 1657). except as regards the proposed assumption of the royal title by Cromwell, and became a member of the newly constituted house of lords in Dec. 16j7. On the protector's death. at which he was present, he in vain gave his support to Richard; his regiment refused to obey his orders, and the restored Long Parliament dismissed him from his command. In Nov. 1659 he undertook an unsuccessful mission to Scotland to arrange terms with George Monk. At the Restoration, Whalley, with his son-in-law, Maj. Gen. William Goffe, escaped to America, and landed at Boston on July 27, 1660, living successively at New Haven and at Hadley, Mass., the government at home failing to procure his arrest.

See Mark Noble, *Lives of the English Regicides* (London, 1798), *Memoirs of the Protectoral House of Cromwell,* vol ii, 2nd ed (Birmingham, 1787); Ezra Stiles, *History of Three of the Judges of Charles I* (Harttord, Conn, 1794) The article by C H. Firth in the *Dictzonary of National Bzography* is an admirable summary.

WHARTON (FAMILY). The Whartons of Wharton were an old north of England family, and in 1543 THOMAS WHARTON (1495–1568) was created a baron. The 5th baron. THOMAS WHARTON (1648–1715), was created in 1706 earl and in 1714 marquess of Wharton.

The 1st marquess is famous as the author of the political ballad, *Lilliburlero,* which "sang James II out of three kingdoms." Wharton was lord Keutenant of Ireland in Anne's reign, and incurred the wrath of Snift, who attacked him as Verres in the *Examiner* (no. 14), and drew a separate "character" of him, which is one of Swift's masterpieces. Addison dedicated to him the fifth volume of the *Spectator,* giving him a very different "character" from Snift's. His first wife. ANNA WHARTON (1632–85), was an authoress. whose poems, including an *Elegy on Lord Rochester,* were celebrated by Walter and Dryden. His son, PHILIP WHARTON (1698–1731), duke of Wharton, succeeded to his father's marquessate and fortune, and in 1718 was created a duke. But he earned for himself. by his profligacy and reckless playing at politics. Pope's satire of him as "the scorn and wonder of our days" (*Moral Essays,* i, 179). After spending his large estates he went abroad and gave eccentric support to the Old Pretender. He was outlaued in 1729, and at his death the titles became extinct.

For the history of the family *see* E. R. Wharton, *Whartons of Wharton Hall* (1898).

WHARTON, EDITH NEWBOLD (1862–1937), **U.S.** author whose fiction is marked by its concern for form and for the moral significance of subject and treatment and by the irony with which it responds to every symptom of social pretentiousness and stupidity. Born in New York city on Jan. 23. 1862. the daughter of George Frederic Jones, who was independently wealthy, she was educated privately at home and in Europe. In 1885 she married Edward Wharton, a Boston banker, and a few years later resumed the literary career she had begun tentatively as a young girl. The best of her early tales were collected in *The Greater Inclination* (1899). In 1905 the critical and popular success of her second novel, *The House of Mirth,* established her as a leading writer; and in the next two decades, before the quality of her work began to decline under the demands of writing for women's magazines, she wrote such distinguished novels as *The Reef* (1912), *The Custom of the Country* (1913), *Summer* (1917) and the Pulitzer prize-winning *The Age of Innocence* (1920). Her best-known work, however, was the long tale *Ethan Frome* (1911), exploiting the grimmer possibilities of New England farm life. She also wrote many short stories and poems, several books of travel reflecting her interest in architecture and landscape gardening, and a manual, *The Writing of Fzction* (1925). The most ambitious project of her later years was the novel *Hudson River Bracketed* (1929) and its sequel *The Gods Arrive* (1932), but her best writing of that period was in the posthumous *The Buccaneers* (1938). In the beginning an admirer of Henry James's fiction, and always one of his closest friends, she disapproved of his later manner. Her autobiography, *A Backward Glance,* appeared in 1934.

After 1907 Mrs. Wharton lived in France, visiting the United States only at rare intervals. In 1913 she was divorced from her husband. She died on Aug. 11, 1937, and was buried at Versailles. Her literary and personal papers were presented to the Yale university library.

Mrs Wharton was the first woman to be granted an honorary doctor of letters by Yale university (1923) and the gold medal of the National Institute of Arts and Letters (1924), and the second woman to be elected to membership in the American Academy of Arts and Sciences (1934).

See P. Lubbock, *Portrazt of Edith Wharton* (1947); B. Nevius, *Edith Wharton: a Study of Her Fzction* (1953). (B R. N)

WHARTON, HENRY (1664–1695), British writer, descended from Thomas. 2nd Baron Wharton (1520–1572), was born at Worstead on Nov. 9, 1664 and studied at Gonville and Caius college, Cambridge. In 1686 he entered the service of the ecclesiastical historian, William Cave (1637–1713), whom he helped in his literary work. In 1687 he was ordained deacon and in 1688 he met the archbishop of Canterbury. William Sancroft, under whose patronage some of his literary work was done He died on March j. 1695, and was buried in Westminster abbey.

Wharton's most valuable work is his *Anglia sacra,* a collection of the lives of English archbishops and bishops, which was published in two volumes in 1691. Some of these were written by Wharton himself; others were borrowed from early writers His other writings include, in addition to his criticism of the *History of the Reformation, A Treatise of the Celibacy of the Clergy* (1688); *The Enthusiasm of the Church of Rome Demonstrated in Some Observations Upon the Life of Ignatius Loyola* (1688); and *A Defence of Pluralities* (1692). In the Lambeth library there are 16 volumes of Wharton's manuscripts.

A life of Wharton was included in George D'Oyly's *Life of W Sancroft* (1821)

WHATELY, RICHARD (1787–1863), English logician and theological writer, archbishop of Dublin, was born in London on Feb 1. 1787 He was educated at a private school near Bristol, and at Oriel college. Oxford. In 1811 he was elected fellow of Oriel, and in 1814 took orders. During his residence at Oxford he wrote his *Historic Doubts Relative to Napoleon Bonaparte,* a very clever *jeu d'esprit* directed against excessive scepticism as applied to the Gospel history. After his marriage in 1821 he settled in Oxford, and in 1822 was appointed Bampton lecturer The lectures *On the Use and Abuse of Party Spirit in Matters of Religion* were published in the same year. In Aug. 1823 he removed to Halesworth in Suffolk, but in 1825, having been appointed principal of St. Alban hall, he returned to Oxford. In 1825 he published a series of *Essays on Some of the Peculiarities of the Christian Religion,* followed in 1828 by a second series *On Some of the Difficulties in the Writings of St. Paul,* and in 1830 by a third *On the Errors of Romanzsm Traced to Their Origin in Human Nature.* While he was at St Alban hall (1826) the work appeared which is perhaps most closely associated with his name—his treatise on *Logic,* originally contributed to the *Encyclopaedia Metropolitana.* It gave a great impetus to the study of logic throughout Great Britain. A similar treatise on *Rhetoric,* also contributed to the *Encyclopaedia,* appeared in 1828. In 1829 Whately became professor of political economy at Oxford.

His tenure of office was cut short by his appointment to the archbishopric of Dublin in 1831. One of his first acts was to endow a chair of political economy in Trinity college out of his private purse.

Whately's appointment by Lord Grey to the see of Dublin was a great surprise, for though a decided Liberal, Whately had from the beginning stood aloof from all political parties. The Evangelicals regarded him as a dangerous latitudinarian, while his view of the church was diametrically opposed to that of the High Church party. From the beginning he was the determined opponent of the Tractarian movement. The appointment was challenged in the house of lords. but without success. In Ireland it was immensely unpopular among the Protestants. Whately's blunt outspokenness and his "want of conciliating manners" prevented him from ever completely eradicating these prejudices, while at the same time he met with determined apposition from his own clergy. He opposed them from the first by connecting himself prominently with the attempt to establish a national and nonsectarian system of education. He enforced strict discipline in his diocese, and he published a strong statement of his views on the Sabbath (*Thoughts on the Sabbath,* 1832).

He took a small country place at Redesdale. 4 mi. out of Dublin, where he devoted himself to the questions of tithes, reform of the Irish church and of the Irish poor laws and, in particular, the organization of national education. He was also interested in other public questions, for example. the subject of transportation and the general question of secondary punishments.

In 1837 he wrote his well-known handbook of *Christian Evidences,* which was translated during his lifetime into more than a dozen languages. At a later period he also wrote, in a similar form, *Easy Lessons on Reasoning,* on *Morals,* on *Mind* and on the *British Constitution.* Among his other works may be mentioned *Charges and Tracts* (1836), *Essays on Some of the Dangers to Christian Faith* (1839) and *The Kingdom of Christ* (1841). He edited Bacon's *Essays* and William Paley's *Evidences* and *Moral Philosophy.* His cherished scheme of nonsectarian religious instruction was defeated by the opposition of the new Catholic archbishop of Dublin, and Whately felt himself constrained to withdraw from the education board. From the beginning Whately was a keen-sighted observer of the condition of Ireland question. and gave much offense by openly supporting the state endowment of the Catholic clergy as a measure of justice. He died on Oct. 8, 1863.

Whately often offended people by the extreme unconventionality of his manners. When at Oxford his white hat, rough white coat and huge white dog earned for him the sobriquet of the White Bear. With a remarkably fair and lucid mind, his sympathies were narrow, and by his blunt outspokenness on points of difference he alienated many. With no mystical fibre in his own constitution, the Tractarian movement was incomprehensible to him, and was the object of his bitter dislike and contempt. Whately's qualities are exhibited at their best in his *Logic,* which is as it were, the quintessence of the views which he afterward applied to different subjects.

In 1864 his daughter published *Miscellaneous Remains* from his commonplace book and in 1866 his *Life and Correspondence* in two volumes. *The Anecdotal Memoirs of Archbishop Whately,* by W. J. Fitzpatrick (1864), enliven the picture.

WHATMOUGH, JOSHUA (1897–), U.S linguist, in 1926 was appointed professor of comparative philology at Harvard university, nhere he founded and directed a department of linguist distinguished by its development of statistical and mathematical methods. Born on June 30, 1897, in Rochdale, Eng., he was educated at the University of Manchester and Emmanuel college. Cambridge. He became a U.S. citizen in 1942.

Whatmough originated the theory of selective variation to explain equilibrium in language. He wrote five major works and over 450 articles and critical reviews (complete bibliography in *Studies Presented to Joshua Whatmough on His Sixtieth Birthday,* The Hague, 1957). He served as president of the Linguistic Society of America, became a member of the Comité International Permarlent des Linguistes, and won an outstanding international reputation among linguists (E. Pm.)

WHAUP: *see* CURLEW.

WHEAT. About one-half of the 2,600,000,000 ac. of cultivated land in the world is used in the production of cereals which provide 80% of food calories produced. About two-fifths (450,000,000 ac.) of the cereal acreage is used for wheat production. There are more pounds of wheat produced than of rice, but more people use rice as their chief food. Wheat is used for human food principally as leavened bread, cakes and pastries, and macaroni, spaghetti and other semolina products. Wheat is best adapted to loam or clay soils that are well supplied with organic matter and are in the temperate, drier regions of the world Cultivation and harvest are fairly simple procedures. The grain is easily stored and transported.

This article is divided into 12 sections discussing the relation between wheat and civilization and covering the principal aspects of nheat as an agricultural product. In addition to cross references to related articles given under the various headings of this article, *see* also AGRICULTURE BREAD CEREALS, FLOUR For production and marketing statistics for particular regions *see* also separate articles on individual countries and on the several states of the United States

Following are the main divisions of this article.

I History
II Origin
III Species
 1 Einkorn (one grain)
 2 Emmcr
 3 Common
IV Characteristics
 1 The Grain
 2 The Plant
 3 Winter Wheat and Spring Wheat
V Production
 1 Land Preparation
 2 Seeding
 3 Fertilizers
 4 Harvesting
VI Diseases
VII Insects
VIII Storage
IX Varieties
X Cses of Wheat
XI. Processing
XII. Marketing

I. HISTORY

Nearly all important civilizations are considered to have been founded upon the production of cereals. Wheat was probably one of the first cereal crops grown by man. Wheat and other cereals provide a nutritious food containing the important elements needed for an adequate diet, and it is a food product that can be easily stored. Wheat production requires planting and harvesting on an annual basis and consequently. in order to cultivate wheat. man had to settle in permanent locations if he was to depend on cereals as his major source of food. It can be assumed that when certain groups of people stopped their nomadic life and resorted to cereals as the major source of food they had time to use part of their energy for other purposes than securing food. Thus, civilization and the culture of cereals probably began simultaneously. Evidence indicates that cereal culture did not occur during the Paleolithic period (stone age) but began with Neolithic man probably as recent as 6,000 to 7,000 years ago. Wheat is not suitable material for preservation from the archaeological standpoint and evidence from this source is not entirely reliable so that the approximate date of the beginning of wheat culture can only be estimated.

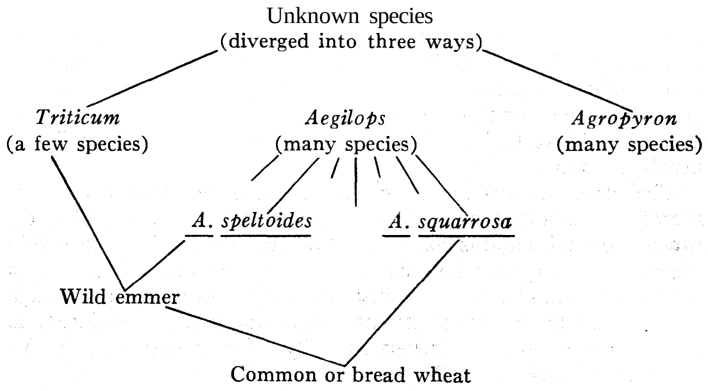
The origin of cereals is still a mystery to 20th century biologists as it was to the Greeks who attributed the cereals to a gift of Demeter. the goddess of agriculture. The Romans gave credit to the goddess Ceres. and some of them identified her with Demeter. A spring wheat variety adapted to the Northern Great Plains of North America mas named Ccres and was a valuable variety for many years, giving protection against the ravages of stem rust The Egyptian goddess. Isis, was supposed to have discovered wheat growing promiscuously in Phoenicia (Lebanon) As early as 2800 B C in China elaborate ceremonies were conducted in the spring honoring the cereals It appears that wheat has been grown prior to or at least since recorded history

The evolution of wheat production occurred very slowly and a farmer of about 4000 B C moved forward to any year prior to A D 1800 probably could have continued wheat production without any appreciable change All that was needed or used was a few seeds, a pointed stick some type of sickle and perhaps a beast of burden. There are still areas in the norld where wheat production remains as primitive as it was 6,000 years ago. After 1800 many remarkable changes occurred Improvement of machinery. relieving man as the source of power resulted in increased nheat production. (*See* TILLAGE MACHINERY; HARVESTING MACHINERY; CROP-PROCESSING MACHINERY; TRACTORS) During the first 50 years of the 20th century much progress in wheat culture was made and a number of countries went from wheat famine to surplus Early settlers in the state of Kansas, which is in the centre of one of the largest nheat producing areas of the world did not produce enough wheat flour to provide for their needs When the proper kind of nheat (Turkey hard red ninter) was introduced into the Great Plains of North America in the 1870s. this nheat became the "gold" of the plains which Coronado so diligently had sought for 230 years earlier Machinery, poner, cultural methods and the proper kind of wheat have made it possible to produce nheat in abundance throughout the world nhen all these factors are properly applied.

II. ORIGIN

Wheat is a grass. of the Gramineae family and of the genus *Triticum.* Two wild species of *Triticum* are still growing in Asia Rlinor and Syria. One of these. wild einkorn. is a simple species, while the other. wild emmer, is more complex in that it originated from two species. The most important group of the genus *Triticum* is made up of three species and contains common bread wheat. No wild bread nheat types have been found.

In addition to the genus *Triticum,* there are two closely related weedy grasses and forage grasses. *Aegilops* and *Agvopyron.* Crosses can be made among all three of these genera. Originally it was thought that common wheat was a combination of all three of these genera. Hitoshi Kihara, a Japanese geneticist, proposed that a single species of *Aegilops* had united with the emmer to produce the common wheat. In 1944 this species was found and its centre of origin appears to be Afghanistan. The species that united with einkorn was thought to be an *Agropyron.* E. R. Sears suggested in 1948 that it might be another *Aegilops.* In 1956 this was partially confirmed by geneticists in the United States and Japan. This information suggests that the *Triticum* species originated some place in the area from Asia Minor to Afghanistan. This also corresponds with the present-day wild species. The ancestry of common wheat can be illustrated as follows:



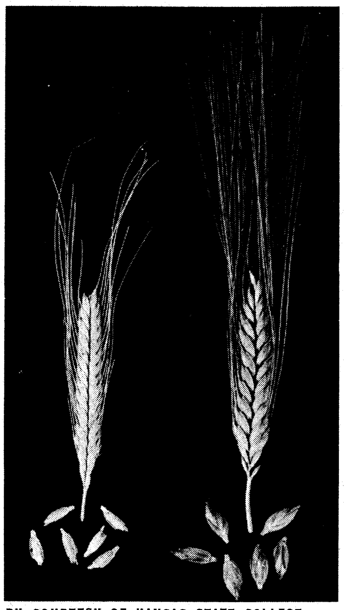
III. SPECIES

It has been known for a long time that the wheat species were originated by combining several different species. They form three groups. according to the number of chromosomes. The chromosomes are the dark-staining bodies found in the nucleus of young cells. The hereditary traits or genes are carried on these chromosomes and the genera *Trztzcum, Aegilops* and *Agropyron* are built up in units or sets (genomes) of seven chromosomes each. The species names have changed occasionally and the information presented is adapted from systems suggested by James MacKey (1954) and Sears (19j6). There are two main ways in which the seed of wheat is disseminated. In the first. the spike (the ear or head) is brittle and breaks up, leaving the kernels tightly enclosed in the hull or glumes. The other way is for the kernels to thresh free from the hulls.

1. Einkorn (one grain).— Members of this group have seven pairs of chromosomes or two sets and are called the diploids. The heads are bearded, small and flat, and break up so that the kernels remain in the hull. These species are rarely cultivated and. if grown, are used for livestock feed. There are two recognized species.

Triticum boeoticum, the wild form or wild small spelt.

Trztzcum monococcum, the cultivated form, einkorn or small



BY COURTESY OF KANSAS STATE COLLEGE

FIG. 1.—EINKORN (LEFT) AND EMMER WHEATS

spelt.

2. Emmer.—The species included in this group have 14 pairs of chromosomes or four sets and are called tetraploids. All eight species and their varieties, except for a very few, are bearded. Wild emmer *(Triticum dicoccoides)* and Timopheevi wheat *(T. timopheevi)* are the wild forms. The heads are generally flattened, the kernels are narrow and pointed at each end; they remain in the hull when threshed. The wild emmer is still found growing in Syria. *T. dicoccum* is the cultivated emmer, similar to the mild type in that the kernels remain in the hull. Archaeological evidence from the Jarma site in eastern Iraq dated about 5000 B.C. indicates emmer-type wheat was grown at that time. It undoubtedly was used for human food. Little emmer has been grown since 1900 and what is grown usually is used for livestock feed. The other five species are free-threshing and are grown extensively in some areas: durum or macaroni wheat (T. *durum*); poulard, rivet or cone wheat *(T. turgidum)*; Khorason wheat (T. *turanicum*); Polish wheat *(T. polonicum)*; and Persian wheat *(T. carthlicum)*.

Durum wheat is the most important species of this group. The kernels are large, pointed at each end, with a hard and translucent endosperm. It is especially suited for the manufacture of macaroni and spaghetti. Ethiopia and the Mediterranean region were the centres of origin of this species. It is still grown extensively there, especially in Italy, and in the north central United States and nearby Canada.

The other species of this group are of little importance commercially. Poulard type wheat is grown in some of the Mediterranean countries and is common in the mixture of wheats grown in Mexico. This type, which has been known for many years, has a branched spike (fig. 3). Because this spike appears to have a high potential yield, it repeatedly has been fraudulently exploited in the United States and internationally (for example by T. D. Lysenko of the U.S.S.R.) as a wonderful new variety of wheat. Periodically, Polish wheat has also been advertised widely. It has an unusually long, large, lax head, sometimes six or seven inches in length. The kernels are large and hard, the glumes are unusually long, thin and papery in texture.

BY COURTESY OF KANSAS STATE COLLEGE

FIG. 2.—DURUM (LEFT) AND SPELT WHEATS

3. Common.—The members of this group have 21 pairs of chromosomes or six sets and are called the hexaploid wheats. This group contains the most widely grown types. At one time, this group was classified into a number of different species. They have been interbred so profusely that species distinctions are no longer valid, except as subspecies. There are no wild species in this group. Probably there never were any, as the first ancestors of these wheats were presumably not capable of existing in the wild and only could be propagated with the aid of man. Common wheat has been synthesized by crossing wild emmer and the weedy grass *A. squarrosa* and doubling the chromosome number of the hybrid.

BY COURTESY OF KANSAS STATE COLLEGE

FIG. 3.—POULARD (LEFT) AND POLISH WHEATS

The subspecies of the common wheats *(Triticum aestivum)* can be classified as follows:

spelta, spelt or dinkel wheat
macha, a spelt type
vavilovi
vulgare, free threshing bread wheat
compactum. free threshine club wheat
sphaerococcunz, free threshing shot or Indian dwarf wheat

The two subspecies *spelta* and *macha* do not thresh free and are grown only to a limited extent. The subspecies *vavilovi* and *sphaerococcunz*, although they thresh free, are not grown extensively. The common or bread wheat *(vulgare)* and the club wheat *(compactum)* are the two species that are widely grown.

Bread wheat is the most important subspecies and includes all the kinds from which the world bread supply is derived. There are many varieties of bread wheat differing in morphological characters. They are grown extensively in the United States. Canada, the U.S.S R., Argentina, India, Australia and in nearly all other countries where wheats are grown.

Club wheat is similar in most respects to bread wheat except that the heads are very short and compact. This type of wheat is grown only to a limited extent in the Pacific northwest of the United States and in central Asia.

IV. CHARACTERISTICS

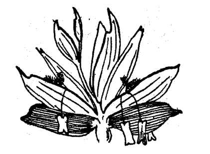
1. The Grain.—This is a single seed or nutlike fruit called a caryopsis. A grain or kernel of wheat is covered by a thin shell. the pericarp, and several other cell layers often referred to as the bran.

The bran coat is generally reddish-brown in colour and varies from light to dark depending on the texture of the interior of the kernel and the intensity of the pigment in the bran. When the colour is absent, the kernel varies from a creamy yellow to white depending on the texture of the interior. Inside the bran coat is the endosperm. the storage organ of food for the embryo or young plant. Sometimes the outside layer of cells of the endosperm may be purple, as found in certain Abyssinian wheats. The endosperm consists largely of thin-walled cells filled with starch, which is imbedded in a protein called gluten, an elastic protein substance present only in wheat and, to a limited extent, in rye. Gluten is essential for making light or leaven breads. The embryo or germ is at the base of the grain under the wrinkled patch of bran. The other end of the kernel generally has hairs. The dorsal or backside is convex and the opposite side is a crease or suture. The embryo is a miniature plant and the rudimentary roots and leaves are present and ready to develop into a plant when proper moisture, light and temperature conditions prevail.

BY COURTESY OF KANSAS STATE COLLEGE

FIG. 4.—COMMON (LEFT) AND CLUB WHEATS

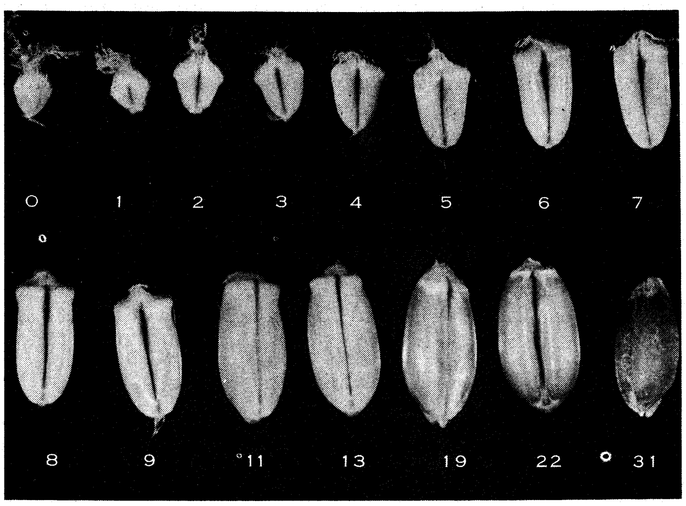
Wheat is largely grown for human food and the wheat grain is an important source of energy. The composition of the kernel varies considerably because of the differences in climate and soil in which it is grown. On the average, the kernel contains about 12% water, 70% carbohydrates, 12% protein, 2% fat, 1.8% minerals and 2.2% crude fibres. A pound of wheat contains about 1,500 cal. (100 g. contains about 330 cal.). Thiamine, riboflavin, niacin and small amounts of vitamin A are present, but the milling processes remove the bran and germ, where these vitamins are found in the greatest abundance.



FROM GROOM, ELEMENTARY BOTANY" (G. BELL & SONS, LTD)
FIG 5 —A SPIKELET OF WHEAT

2. The Plant. — When the kernel is placed in moist soil at 6j° F. or less germination will occur in three to four days The root (radicle) develops first and is soon followed by the shoot (coleoptile). The leaves follow in rapid succession and develop into the main shoot. At the base of this shoot. there are buds that develop into other shoots or tillers. Each tiller terminates in a head or spike. The area where these tillers arise is called the crown and a set of roots also develops from this place The number of tillers that develops depends on the variety of wheat, time of sowing, rate of planting or spacing of plants and other environmental factors. The leaves are long and slender but do vary in length and width. They may be covered profusely with hairs or have none at all. The early growth of leaves is near the ground and they form a rosettelike appearance. When the stems elongate rapidly, these lower leaves die. The stem is made up of sections called internodes mhich are separated by the nodes, or thickened swellings on the stem. The diameter and length vary considerably and the height of the stem (straw) ranges from about 15 in. (40 cm.) to 75 in. (190 cm.) The stems are generally hollow, but some of the durum (tetraploid) wheats have solid stems. At maturity, most of the leaf blades have dropped off. The stems are generally yellow or straw colour. Some varieties may have purple stems; however, this colour generally disappears before harvest.

The head eventually emerges from the last leaf By this time a very important change has taken place in that the plant has changed from vegetative growth to the reproductive phase. There are varying numbers of flowers per head or spike, ranging from 20 to 100. The flowers are grouped together in spikelets and each



BY COURTESY OF KANSAS STATE COLLEGE

FIG. 6.— GROWTH OF A WHEAT KERNEL. NUMBERS INDICATE DAYS AFTER POLLINATION

spikelet has two to six flowers. The spikelets are enclosed in glumes (chaff, hulls). The outer glumes terminate in a tooth or beak that is relatively short. One of the glumes that surround the seed may have an awn (bristlelike extension). Those heads that have awns are called bearded or awned varieties. The awn varies from being nearly imperceptible to several inches in length. The glumes may be coloured white or reddish-brown, and in some cases may have black imposed upon these two colours. In most spikelets. two to three flowers are fertilized and develop a grain. The flower is very simple, consisting of three stamens (the male organs) and a feathery ovary with a branched style (the female organs). The flowers begin to bloom slightly below the middle of the head and proceed both upward and downward. This process is completed in two to four days. The individual flower opens in about three minutes. The glumes are forced apart by the swelling of two scalelike organs called lodicules. The anthers mhich develop and contain the pollen are forced out by elongation of the stalk (filament) bearing the anthers. While this movement is going on, the anthers break open and the pollen is dispersed. The pollen grains fall on the feathery styles and germinate and a tube grows down within the style to the ovary. The pollen grains contain the sperm (male) which eventually unites with the egg (female) and thus starts the development of another kernel. The process of pollination takes less than five minutes and the consequent fertilization of the egg occurs within 24 hours. The newly fertilized egg (zygote) develops into the embryo or new plant, and the surrounding tissue into the endosperm and bran. This growth takes place very rapidly and a kernel is generally fully developed in about 24 to 27 days, when it contains about 35% to 40% water. The kernel then dries at various rates depending on environmental conditions. This ripening period may be 30 days or less in the Great Plains area of North America and up to 60 days or more in areas such as England.

3. Winter Wheat and Spring Wheat are the two major classes of nheat, based on their growth habit. The severity of the winter determines whether the wheat grown is a winter or spring type. Winter wheat is always sown in the fall. Spring wheat is generally sown in the spring, but where the winters are mild, as in Mexico, spring wheat varieties can be sown in the fall. As the area of wheat production progresses either north or south of the equator, the types grown are spring varieties sown either in the fall or spring at the higher altitudes. At about 30° to 45° latitude, the winter types produce best. For example, in northern Texas winter uheat is sown in October and November, in Oklahoma in October, in Kansas in September and October, and in Nebraska, Wyoming and Montana in August and September. Some winter wheat is grown in Canada and generally it is sown in August. As the latitude or altitude increases, the winters become so severe and long that wheat cannot survive. Then the spring wheat varieties are grown. Wherever winter wheat survives the winter, it will generally produce more than spring types.

Temperature, latitude, altitude and length of day all influence the development of the wheat plant. Varieties of winter wheat from North America sown in Colombia (latitude j°) at 13,000 ft. elevation grow slowly and head very poorly in 14 to 15-months. At lower elevations, the same varieties remain as grassy plants and never head. The winter types require a certain amount of cold before they will head, as well as varying day length nhich does not occur in Colombia.

There is a gradual change from one type to another and for this reason each area of wheat production has special selected types adapted to its conditions. A winter wheat satisfactory to the southern Great Plains of North America will be killed by the winter in the northern Great Plains, but both types of winter wheat require cold in order to develop to maturity. Spring wheats grown near the Arctic circle have a shorter growing period under long days and do poorly farther south.

V. PRODUCTION

Wheat is grown under a wide range of climates and soils but is best adapted to the temperate regions where the rainfall is between 12 and 35 in. and between latitudes 30° to 60°. This roughly corresponds to the original large grassland areas of the temperate regions of the world. Although these regions provide the best conditions, wheat can be gronn in areas of less than 12 in. rainfall and up to 70 in., up to the Arctic circle and down to the equator. and from below sea level up to 10,000 ft. The rather heavy, deep, well-drained, dark-coloured soils, well supplied with organic material. of the chernozems and chestnut-bronn groups are the most favourable for wheat production. The prairie soils of the United States, Canada and the U.S.S.R. are excellent examples of good wheat soils. Wheat is not adapted to sandy and peat soils.

During 1945–55 about 400,000,000 to 480,000,000 ac. of wheat were sown annually in the world. with a production of 6,000,000,000 to over 7,000,000,000 bu. or about 200,000,000 short tons. Comparable acreage and production of other important cereals are: rice, 233,000,000 ac. and 176,150,000 tons; corn, 215,000,000 ac. and 146,944,000 tons; oats 128,000,000 ac. and 62,142,000 tons; and barley. 118,000,000 ac. and 45,000,000 tons.

The yield of wheat varies widely throughout the world. In the drier areas, yields are often as low as 8 to 10 bu. per acre while in certain areas in northern Europe and Japan, yields have been as high as 70 to 80 bu. per acre. Yields have been reported as high as 12j bu. per acre under irrigation.

Wheat Acreage and Production by Areas and Major Producing Countries

Area	Acreage (in 000,000 ac.)		Production (in 000,000 bu.)	
	1945–49	1955	1945–49	1955
North America*	97	71	1,581	1,463
United States	71	47	1,202	938
Canada	25	21	362	494
Europe*	66	72	1,263	1,790
France	10	11	238	390
Italy	11	12	227	350
Spain	10	11	117	150
West Germany	2	3	67	124
Asia*	117	143	1,587	1,815
China	54	—	864	
India	23	27	212	319
Turkey	9	18	125	261
Pakistan	10	11	129	118
U.S.S.R. (Europe & Asia)*	82	—	885	—
South America*	16	18	265	300
Argentina	11	—	194	190
Oceania*	13	11	183	203
Australia	12	10	178	200
Africa*	14	17	134	190
World Total*	406	481	5,898	7,285

*Estimated total, includes allowances for missing data.
Source: U.S. Department of Agriculture, *Agricultural Statistics 1956*.

1. Land Preparation.— Production practices also vary widely throughout the world. In the extensive wheat production areas of North America. Australia, Argentina and the U.S.S.R., a high degree of mechanization is used.

Wheat in the drier areas of these major producing regions generally is grown on the same land without a rotation of crops. A process called summer fallowing is used to store moisture in the soil with as little cultivation as possible, especially where the annual rainfall is less than 15 to 18 in. throughout a growing season. The soil surface is kept rough to absorb rain, prevent wind erosion -and weed growth (see DRY FARMING). Under dry land conditions, enough moisture generally can be stored to grow a good crop every other year. When the soil contains moisture to a depth of 48 in. a crop of wheat is generally assured

Where more than 15 to 18 in. of rainfall occurs, wheat is often brown continuously, and in the more humid areas wheat is grown in rotation with other crops. In semihumid areas, early cultivation (plowing) is an important factor in successful wheat production. Plows or other cultivator tools follow immediately behind the combine harvesters. Early cultivation conserves moisture, controls weeds and increases the amount of nitrates, an important plant food.

In the humid areas, wheat often follows other crops such as soybeans and corn, and the land is often prepared for seeding only by disking. Careful seedbed preparation generally results in higher yields.

Preparation of wheat seedbeds in many parts of the world is still carried on by primitive methods in which the soil surface is merely scratched with inadequate tools. Many more bushels of wheat could be grown in the world if all land was prepared for wheat using modern equipment and procedures.

2. Seeding.— Good seed and equipment for planting are essential to successful crop production. Grain drills are adapted to mechanized farming and large tractor-drawn outfits can sow 100 ac. per day. There are a number of types of drills but the principle is the same in all, in that the seed is distributed uniformly and at an even depth. The depth of seeding varies from $1\frac{1}{2}$ to 3 in. and the amount of seed varies from as little as 20 lb. up to 120 lb. per acre. Broadcast seeding, that is, throwing the seed on the land by hand or with simple equipment, is wasteful of seed because it cannot be covered to uniform depth and uneven stands occur. Machine seeding is highly recommended even on small areas (see PLANTING MACHINERY).

The date of seeding also varies. Wheat is a cool season crop and it is sown as early in the spring as the weather permits. Winter wheat is sown early enough in fall to enable a good root system to develop before cold weather stops growth.

A close sown crop, like wheat, is rarely cultivated except under intensified farming and where hand labour is readily available. If weeds become a problem, they can often be controlled by using chemical sprays that are selective in their action, killing the weeds and not seriously damaging the wheat.

3. Fertilizers.— In the humid areas of wheat cultivation, wheat responds to fertilizers. The most commonly required plant foods are phosphorus (P_2O_5), nitrogen (nitrates and ammonium compounds) and potassium (potash). The amounts required for optimum yields vary with each farm and locality. Commercial fertilizers are widely used where they are available. Other manures are used and the growing of legumes in the rotation will supply nitrogen. Phosphorus is the plant food most commonly needed and it is effective in increasing wheat yields even in the semihumid areas. Proper use of fertilizers increases yield 20% to 200%. Fertilizers generally are not needed in the greater part of the major dry land wheat-producing areas.

Wheat responds to irrigation and the combination of adding fertilizers and water increases the yield three to four times. In the dry land farming areas of the United States, irrigation has expanded rapidly. An entirely new agricultural industry is developing in the Sonora state of Mexico with the use of irrigation and fertilization of wheat. Wheat can be grown as a winter crop and corn or cotton as a summer crop. This double cropping is also common in Japan, where the cool season wheat is grown during the winter months and rice during the summer.

4. Harvesting.— Harvesting of wheat has also become highly mechanized. Combine harvesters are used wherever the area is large enough to handle such machinery. The wheat is cut and threshed by the combine passing through the field only once. In a number of areas, the wheat does not dry rapidly enough, so the wheat is cut and arranged in a windrow to dry and is picked up several days later with a combine. In the large producing areas the wheat is often piled on the ground, as rain does not occur often during harvest. This procedure is followed in order to harvest the standing grain as rapidly as possible to prevent field losses from storms. Most of the grain in these large producing areas is stored in local elevators or moved by railroad to large terminal storage areas. These storage facilities generally are available only in the surplus producing regions.

The production of wheat in the major area of North America had become so mechanized that about three man-hours were needed to handle one acre of wheat in 1957 compared with about fifty hours 100 years previously.

VI. DISEASES

The Romans attributed rust of cereals to the god Robigus, who imposed this damage upon the crops of wicked people. It was about A.D. 1800 before it was understood that rust of cereals was a disease caused by a fungus. There are three rusts that attack wheat: stem rust or black stem rust (Puccinia *graminis* tritici), leaf or brown rust (P. *triticina*) and yellow or stripe rust (P. glumarum). Stem rust is the most destructive, causing severe shriveling of the grain of susceptible varieties, so that in severe cases the crop is not harvested. Stem rust is world-wide in its distribution. It does not occur every year in epidemic proportions but it is the feared rust disease of many wheat growers. The rust organism belongs to the same group of plants as the mushrooms and produces spores of two types: red or uredospores and black or teliospores. The red stage is the one most commonly observed in the field. These spores can be easily blown about and alight on a wheat leaf. If there is high humidity, dew and the proper temperature, the spore germinates and the germ tube enters the breathing pores (stomata) of the leaf and a mass of growth occurs within the leaf. In 8 to 12 days a rupture (pustule) of the leaf epidermis occurs and thousands of new red spores are liberated which are capable of infecting other living wheat plants. This process is repeated as often as there is green wheat to infest and proper climatic conditions prevail. These red spores are also called summer spores. as they cannot live over the ninter. except in mild climate like Mexico's. However, the rust can travel north in the spring and summer in North America from Mexico to Canada, and then travel back south again in the fall on winter wheat or volunteer (self-sonn) wheat. This same pattern is followed in all the major wheat-producing areas of the world. so the rust can live continuously in the red stage. When the wheat begins to ripen the spores formed in the pustules are black or dark bronn. These are the winter spores and they can live over on the wheat straw under very cold conditions. In the spring these black spores germinate and produce small spores (sporidia); these cannot infest wheat but can develop only on the alternate host, the barberry bush (*Berberis* species) and closely related species (*Mahonia* species). This is the part of the life cycle of the rust called the sexual phase. New recombinations occur by crossing on the barberry leaves, and result in many new races (varieties) of stem rust. Control of stem rust is possible by growing resistant varieties and eradicating the barberry bush.

Leaf rust is also world-nide in distribution and has a life cycle similar to stem rust but it has a different alternate host, the meadow rue (Thalictrum species). In Korth America the alternate host is resistant so the leaf rust is entirely dependent upon the summer or red spores. The red spores can uithstand colder temperatures and can overwinter in many areas where winter wheat is gronn This rust is not as spectacular in its damage, but is more prevalent than stem rust and, on the average, does as much or more damage. Control is practical only through the use of resistant varieties of mheat.

Yellow or stripe rust is not as widespread, as it is generally limited to higher altitudes and cooler temperatures. Control of this disease is also only practical by the use of resistant varieties.

Another group of serious diseases is the smuts The important species are bunt or stinking smut (*Tilletia* caries and T. foetida) and loose smut (Cstilago tritici). Stinking smut replaces the kernel with black spores and they are called smut balls. The disease got its name from its fishy odor. The loose smut is evident at blooming time and replaces the head except for the central stem. This smut is not seen at harvest time. Control of stinking smut is possible by seed treatment and the use of resistant varieties. No practical seed treatment has been available to control loose smut, so the use of resistant varieties has been the most practical means of control.

There are many other diseases that cause damage to mheat, such as scab, which is serious in the humid areas. Virus diseases that occur in the soil or are transmitted by insects are often serious. There are other diseases that cause rot of the roots and crown of the plant and damage the leaves. (See also PLANTS AND PLAST SCIENCE)

VII. INSECTS

There are several insects which are injurious to wheat. The Hessian fly (*Phytophaga destructor*) is one of the most serious insect pests, particularly in the eastern half of the United States. The name mas derived from the belief that it was introduced into the United States in the straw used for bedding by the Hessian mercenaries who were brought over from Europe by the British during the Revolutionary War. This insect is a fly which lays its eggs on the leaves of young wheat plants. The hatched larvae (maggots) crawl do n to the base of the plant nhere they extract plant juices and also inject a substance that is toxic to the plant. As a result, winter wheat becomes more subject to winter killing and in the spring the straw breaks over. Control can be obtained on a community basis if all farmers where winter wheat is gronn plant after the main brood of flies has emerged. Sowing of resistant varieties is rnost effective and such varieties were becoming available by 1950.

The wheat-stem sawfly (*Cephus cinctus*) is a serious pest in western Canada and adjacent areas in the United States. The loss occurs by the larvae chewing a ring around the stem from the inside which causes the stem to fall over. Deep plowing and the use of resistant varieties are control measures.

Other insects causing occasional damage are wheat jointworms, wheat strawworms, chinch bugs. green bugs (aphid) and grasshoppers. The last three can be controlled by the use of insecticides.

VIII. STORAGE

Wheat can be stored almost indefinitely without deterioration under conditions whereby it is kept clean, cool, dry (only 12%–13% moisture) and free of insects. Insects that damage stored wheat are not active below 40° F. and multiply rapidly only at temperatures above 70° F. Insects can be controlled readily in proper storage facilities by the use of insecticides that are not detrimental to the quality or use of the wheat. Except in subsistence farming areas. much of the wheat produced moves rather promptly from the farm to the country elevator, then to the great terminal markets from which the demand of the larger mills and the export market are served. Substantial modern storage facilities for wheat and other grains exist not only at the major terminal markets, but at major ports of exit and in importing countries. In addition, the milling industry itself provides a considerable part of its storage facility needs. In the United States and in some other areas the governments have encouraged the erection of additional storage facilities on the farms and at the terminals.

IX. VARIETIES

Extensive programs of wheat improvement have been undertaken in almost all the wheat-groning regions of the world, particularly after 1900 when Mendel's laws of inheritance were recognized. Prior to this time, there were many varieties of wheat available which enterprising farmers had selected from their fields. Some of the first concentrated selections of wheat varieties were begun by the French seed firm of Vilmorins about 1850. The world-recognized Swedish Seed association at Lund was started in 1886. William Farrar in Australia began a planned breeding program as early as 1880. Most of the early breeding work nas selection of pure lines among the variations present in the commonly groan wheats. Seed from individual plants or heads was grown in short rows, the promising lines were studied in successive generations and the best lines increased and distributed to farmers. Such a practice does not create new genetic combinations, so plant breeders have resorted to crossing different varieties.

One of the first and also greatest achievements of breeding wheats by crossing was the development of Marquis spring wheat in Canada. Charles and Arthur Saunders carried on this work. An early variety. Hard Red Calcutta from India, was crossed with Red Fife. a wheat from Poland. In order to cross nheats, the plant breeder removes (emasculates) the anthers (male organs) from the flower before they are mature and protects the head from pollination by covering it with a small paper or plastic bag. Several days later he transfers anthers with live pollen from the selected male parent to the stigma (female organs) in the emasculated floner Plants derived from such matings are first-generation hybrid plants and are uniform. In subsequent generations, especially the second and third, many new recombinations occur. The desired plants are selected and increased. This process requires ro to 15 years. The cross from which Marquis nas selected was made in 1892and not until 1907 was there an appreciable amount of seed (less than one bushel). Once released for general production, if the variety is desirable. it will increase very rapidly. By 1918 there were over 300,000,000bu. of Marquis mheat produced in Canada and the United States. Many similar stories can be told for most parts of the world.

The breeding of rust-resistant spring wheats for winter sowing along nith proper irrigation and fertilizer practices has made wheat production in Mexico profitable where formerly little or no wheat could be grown. In Japan. remarkable achievement was made in breeding wheats that had short stiff straw and responded well to high fertility practices for winter production on the rice paddies. Enrique Klein of Argentina developed many varieties suitable for that country. Nazareno Strampelli in Italy developed durum wheat varieties that have been adapted to much of the Mediterranean area. Pawnee, a winter wheat, was grown on over 7,000,000 ac. ten years after it was released to farmers in Kansas and Nebraska. Thatcher wheat, developed in Minnesota. spread widely over the northern Great Plains and was the leading variety grown in Canada during the late 1940s and early 1950s. The rapidly changing variety pattern and a constant annual release of new varieties make any up-to-date account of all the notable achievements throughout the world impossible.

There are many problems of wheat production that can be partially solved by breeding. Man has created his own problems by growing wheat so extensively and continuously in certain areas. When one variety is widely grown, it offers an immense field for specific diseases to attack the plant. Thus, it is a never-ending battle for the wheat research man to compete with the constantly changing diseases.

There are other objectives in wheat breeding besides disease resistance. The major objectives are stronger straw, insect resistance, good quality for specific uses, cold resistance. heat resistance and higher yields. Achievement of these objectives is often difficult, but along with improved machinery and better cultural practices, breeding better varieties is one of the best ways of increasing wheat production and eventually increasing the world standard of living.

X. USES OF WHEAT

Wheat is not a homogenous commodity but is divided in the United States into various market classes primarily on the basis of use. These classes can be recognized morphologically on examination of the grain. Hard red minter wheat comprises about 60% of the marketed grain in the United States; hard red spring. 20%; soft red ninter, 10%; uhite wheat. 6%; and durum. 4%. Most wheat is grown for use as human food. Houever, about 10% is needed for seed, and small quantities are used for production of starch, paste, malt, dextrose, gluten (a source of monosodium glutamate). alcohol and other products. Inferior and surplus wheat are used for livestock feed. For this purpose, wheat is about equal to corn in nutritive value but it requires grinding for most livestock except poultry. By-products of the milling process are generally used for livestock feeds.

The chief food use is flour in the form of a baked product. The hard red uinter and hard red spring uheats are used primarily for bread flours. Soft wheats are used moatly for cake, crackers, cookies, pastry and family flours. Durum wheat semolina is used mostly for making spaghetti and macaroni and other pasta products. Breakfast foods are also made from wheat and the puffed wheat foods are made from varieties with large white kernels like the Baart variety of the Pacific northwest and certain durum varieties.

Cereal grains are a high energy food source. The grain not only includes the young plant (the embryo) but also the food necessary to nourish this young plant when it begins to grow. Therefore, these grains of wheat are like eggs and milk which also are foodstuffs designed by nature to nourish the young. If the uhole grain is used for food, five important items are supplied: carbohydrates, protein, fats, minerals and some vitamins.

Even though wheat products are a highly nutritious and inexpensive human food, consumption of wheat in a number of countries has declined as the standard of living has increased. largely due to the increased use of other foods that are more expensive but perhaps more tasteful. In the United States in 1910, 482,000,000 bu. of wheat were processed for food and there were 92,000,000 people. Comparable figures for 1956 were 483,000,000 bu and 168,000,000 people. These figures can be further expressed as 216 lb. of wheat per capita consumption in 1910 and 123 lb. in 1956.

XI. PROCESSING

Some wheat is eaten like a porridge or a broth or pudding, prepared by merely soaking the grain and cooking it. Most uses of wheat, however, require some processing before it is used as food. The grain is cleaned at the mill or processing plant to remove chaff, weed seeds and other material, and then it is scoured mechanically to remove the hairs and any dirt. Sometimes it is necessary to mash the wheat. Wheat is tempered or conditioned by adding water to it so that the kernel will break up properly. The dampened bran adheres together in large flakes. In the milling process, the grain is first cracked and then passed through a series of rollers, and each time as the smaller particles are sifted out, the coarser particles are passed on to other rollers for further reduction. About 72% of the milled grain is recovered as white flour. If a higher per cent is extracted, the flour is darker in colour. In Europe and Japan during World War II, the flour extracted was 78% to 85%. The whole wheat flour is called graham flour and includes the whole kernel. As most of the fat in the grain is in the germ, graham flour becomes rancid when stored for any length of time. As white flour does not contain the germ, it is an easily stored product. New processes of milling are being experimented with in the United States in which the flour is separated into various fractions by air separations. Two turbo mills mere in operation in 1957, and by this process it is possible to extract certain fractions from hard wheat flour that are more suitable for soft mheat uses than the soft wheat varieties themselves. This milling process may result in wheat products more competitive with other foods.

Most of the flour produced is used for breadmaking. For this purpose, the protein content should be about 12.5% and of good quality. The quality refers to the ability of the gluten to be elastic and to retain gas in the leaven loaf. The wheats grown in the drier areas, the hard red winter and hard red spring types, generally have a higher protein content (11% to 15%) and also a "stronger" gluten. The wheats grown in the humid areas are soft wheats and the protein content is often 8% to 10% and the gluten is "weak." However, this type of nheat produces flour suitable for special purposes. As the quantity of protein and sometimes the quality vary, the flours of different wheats are blended together to make flours suitable for many purposes. In the United States about 80% of the flour is used by commercial bakeries. New bakeries were being built and some were in operation in the U.S. in the late 1950s in which the breadmaking process was continuous. This automatic procedure produces a slightly different textured bread but of a character that appears to be readily accepted by the public.

XII. MARKETING

Most wheat moves off the farm on which it was produced, except that used for feed or seed. Wheat grain enters the local, national and international trade. The problem of marketing is not the same in all areas, as the use of the wheat is different and the types will reach different markets. Specific grain standards have been established and each lot of wheat that reaches a terminal market is examined and given a grade determined by the weight of a unit measure; condition of the grain; moisture content; presence of insects, stinking smut, other crops and foreign material. The grain may either be bought by grade alone or on sample.

Wheat grown in the semihumid areas, the hard wheats, are the ones produced in surplus. Most of the soft wheats and durum are used in local areas in the countries where they are produced.

Prices are determined in the United States by the price at Chicago, Ill. In the surplus areas, the price is less because of the cost of transportation to Chicago. On the other hand, in those areas to uhich wheat is shipped, the price is higher than at Chicago. There is a variation of pricing where wheat is shipped to seaports for international trade.

In many countries of the world, the production of wheat is under some government control either to increase production in deficient producing countries or to restrict it in surplus producing countries. Some of these activities have been successful in increasing production in countries that are attempting to become self-sufficient in nheat, but acreage and price controls in the surplus producing countries have not decreased production or given the farmers adequate returns for their uheat.

In the U S . Kansas, Nebraska and Oregon have organized wheat commissions financed by a small tax on each bushel of wheat produced in the state. These commissions are attempting to develop new markets as well as to increase exports to areas already using wheat products. Information and demonstrations concerning the use of wheat as human food have been made in areas of the world where the people are not accustomed to this commodity.

The principal export countries after World War II were the United States, Canada, Argentina, Australia and, in some years, France. Prior to World War II, Canada was the leading country. The principal import countries of wheat after World War II were the United Kingdom, the German Federal Republic, Brazil, the Netherlands, Belgium and Luxembourg.

See also Index references under "Wheat" in vol. 24.

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WHEAT BELT: *see* AGRICULTURE: *United States: Type-of-Farming Regions: Wheat Areas.*

WHEATEAR *(Oenanthe oenanthe)*, one of the earliest spring migratory birds in Europe, often reaching England by the end of February. The cock, with his bluish-gray back and light buff breast, set off by black ear coverts, wings and part of the tail, is rendered conspicuous in flight by his white rump, from which comes the name, a corruption of "white rear." Both sexes have a sharp monosyllabic note that sounds like "chat." The nest is placed underground; a large amount of soft material is collected, and on it from five to eight pale-blue eggs are laid. Wheatears were formerly trapped for eating in enormous numbers on the downs. The wheatear ranges throughout the old world. It also breeds in Greenland and arctic North America. About eight species are found in Europe, but the majority are inhabitants of the drier parts of Africa. They are sometimes seen in northern Alaska, the Pribilof Islands and, rarely, in eastern Canada. Wheatears feed on small insects and on seeds and on the small fruits of *Saxifraga*.

ERIC HOSKING

WHEATEAR (OENANTHE OENANTHE), IN FLIGHT, DISPLAYING ITS CONSPICUOUS WHITE REAR

Among allied genera is Saxicola which includes two well-known British birds, the stonechat (*q.v.*) and whinchat (*q.v.*). The wheatear and its allies belong to the family Turdidae, the thrushes (*q.v.*). (HT. FN.)

WHEATON, HENRY (1785–1848), U.S. jurist and diplomat, made significant contributions to international law. Born at Providence, R.I., on Nov. 27, 1785, he graduated from Rhode Island college (now Brown university), Providence, in 1802; was admitted to the bar in 1805; and, after a year of study abroad, practised law at Providence from 1806 to 1812 and, in New York city, edited the Republican *National Advocate* from 1812 to 1815.

A judge advocate of the army in 1814, he published a *Digest of the Law of Maritime Captures and Prizes* (1815). He was a justice of the marine court of New York city from 1815 to 1819. As reporter of the U.S. supreme court in Washington from 1816 to 1827, he was distinguished for the learnedness of his annotations. He was a member of the convention to write a new constitution for the state of New York in 1821; a member of the assembly in 1823; and in 1825, a member of a three-man commission to revise the laws of New York. His diplomatic career began in 1827 with an appointment to Denmark. where he served as chargé d'affaires until 1835. He was also chargé d'affaires and then minister to Prussia from 1835 to 1846. *Elements of International Law* (1836), his most important work, was translated into many languages, including Chinese and Japanese, and became a standard work. *Histoire du progrès du droit des gens en Europe*, written in 1838 for a prize offered by the French Academy of Moral and Political Science, was expanded and translated into English in 1845 as *History of the Law of Nations in Europe and America*. His *History of the Northmen* (1831; expanded in French, 1844) did much to arouse European interest in Scandinavian history.

Wheaton's general theory of international law is that it consists of "those rules of conduct which reason deduces, as consonant to justice, from the nature of the society existing among independent nations, with such definitions and modifications as may be established by general consent." He died at Dorchester, Mass., on March 11, 1848.

See F. C. Hicks, *Men and Books Famous in the Law*, ch. viii and bibliography, p. 245 (1921).

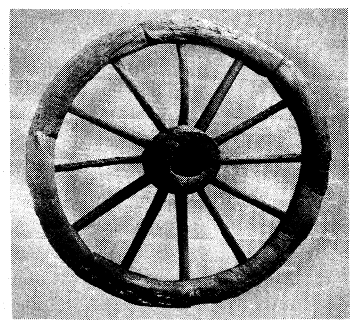
WHEATSTONE BRIDGE: *see* INSTRUMENTS, ELECTRICAL MEASURING: *Indicating Instruments.*

WHEEL. In ancient times the invention of the wheel probably took place in one locality from which its use spread over the ancient world. The saws and other tools of an advanced metal-using community would be necessary for working the wood, and archaeological evidence suggests that it was in ancient Mesopotamia, following the invention of the potter's wheel, that wheeled vehicles first came into use. The earliest wheels found in graves at Kish arid Susa date from the second half of the 4th millennium B.C., and are made of three shaped planks, clamped together with copper clasps across their greater length. The central plank bore a thick hub and the wheels were kept in position by linchpins piercing the extremities of the stationary axle. Rims of these wheels were sometimes bound with metal hoops heavily studded, and fixed to the wheel with long metal clasps which also acted as braces, keeping the planks in position.

The consistency of this tripartite solid wheel form in the ancient near east and in prehistoric Europe constitutes a strong argument for the diffusion of the wheel from a hlesopotamian or other western Asiatic source, and can be followed in the history of the cart. Nowhere is the spoked wheel attested before the 2nd millennium, but shortly after 2000 B.C. spoked wheels occur on clay models in northern Mesopotamia, central Turkey and northeast Persia. By the 15th century B.C. spoked wheels were in use on chariots in Syria, Egypt and the western Mediterranean, and in China they were fitted to chariots used in the first historical Shang dynasty about 1300 B.C. *(See* CART AND WAGON.)

In Europe, miniature four-spoked wheels were used in the Late Bronze Age as mountings for wheeled cauldrons in Bohemia and Denmark, and solid cast bronze wheels of similar broad felly, or peripheral rim, survive from the central European Iron Age. A four-spoked wheel is represented on a chariot carved on a chieftain's grave at Kivik in Sweden about 1000 B.C., from which time spoked wheels were common in northern and western Europe.

Meanwhile the solid wheel was commonly used for agricultural purposes. Tripartite wheels with crescentic openings on both sides of the hub mere in use in the Bronze Age in Denmark, Germany and northern Italy, probably for carts, and are identical with nheels still in use in the Indus valley. Both Etruscan and Roman country carts had solid wheels made either of simple slices of thick tree trunks filled with small, square metal hubs, or of shaped planks nailed onto a square frame behind. Tripartite wheels with circular openings, solid slice wheels and solid plank wheels were in use in modern times in Spain, Sardinia, southern Italy, Wales, Ireland and Orkney, while solid wheels of three arc-shaped pieces uniting at the hub were known in antiquity and can still be seen on modern Anatolian carts.



BY COURTESY OF NATIONAL MUSEUM OF ANTIQUITIES, EDINBURGH

WHEEL FROM ROMAN CAMP AT NEWSTEAD, SCOT., WITH COMPOSITE FELLY

Multiplication of openings in the solid wheel probably did not give rise to the invention of spokes, but a wheel of the crossbar type commonly used in classical Greece and Cyprus, and much earlier in northern Italy, appears to be transitional, or at least to preserve an attempt to provide a spoked wheel with the simpler joinery of the solid wheel.

The fellies of the earliest spoked wheels are made of a single piece of wood bent in a full circle by heat. An Egyptian chariot from Thebes (1435 B.C.) has a felly of a single piece of ash into which the spokes are fitted by a mortice joint after a manner depicted in Egyptian wall paintings. The thick fellies of European Bronze Age wheels were probably made up of several doweled pieces kept in position by a metal tire. Improvement in wheel design was probably the speciality of Celtic wheelwrights of Roman times; not only has Latin several Celtic loanwords for wheeled vehicles, but some of the finest surviving wheels are those found in Roman sites in Celtic areas and southern Gaul. Celtic wheels in Europe have up to 14 spokes and are sometimes fitted with iron tires, shrunk on to the wood while the metal was still hot. Chinese wheels of similar date have up to 40 spokes.

The problem of avoiding the wearing of the hubs in these early wheels was met in Roman times by lining them at both sides with bronze rings, but the hubs of the Celtic wagons preserved in the bog at Dejbjerg, Den., are the earliest with roller bearings, formed by channels inside the hub in which lay rods of wood which turned between hub and axle.

A number of dark age and medieval cart wheels have survived in Denmark. These have broad rims of six or seven fellies with one spoke passing through each to take the strain. Wheels of this type, usually with large hubs, are illustrated in medieval drawings both on carts and plows. Some were fitted with metal tires, banned in most medieval towns for the ruts they made.

The final development in wheel construction was "dishing," an arrangement in use by the 16th century for making the spokes in a flat cone, necessary because of the great increase in size of wheels in medieval times and for the counteraction of swaying loads on rough roads The wheel was one of man's most important inventions and has had a profound effect on cultural diffusion. Insoiar as is known, the Peruvian and Aztec civilizations of America were ignorant of its use until the Spanish conquest. Although a number oi wheeled animal figures are known to have been made in Mexico *c.* A.D. 1000, it is not certain whether wheeled vehicles also were evolved and it is generally thought wheels were not put to practical use in America until the Spanish conquest.

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WHEEL, BREAKING ON THE, a form of torture (*q.v.*) or of execution formerly in use in France and Germany, where the victim was placed on a cart wheel and his limbs stretched out along the spokes. The wheel was made to revolve slowly, and the man's bones broken with blows of an iron bar. Sometimes it was mercifully ordered that the executioner should strike the criminal on chest -or abdomen, blows known as *coups de grâce,* ahich at once ended the torture; in France he was usually strangled after the second or third blow. A wheel was not always used. In some countries the victim was stretched upon a frame shaped like St. Andrew's cross. The punishment was abolished in France at the Revolution, but it was employed in Germany as late as 1827. A murderer was broken on the row or wheel at Edinburgh in 1604, and two of the assassins of the regent Lennox thus suffered death. (R. G. CL.)

WHEELER, BENJAMIN IDE (1854–1927), U.S. philologist and university president, was born at Randolph, Mass., on July 15, 1854. and was educated at Brown university, Providence, R.I. (A.B., 1875). After four years as a high-school teacher in Providence and two as an instructor in Greek and Latin at Brown, he spent four more as a student in Germany, graduating with a Ph.D. in comparative philology at Heidelberg in 1885. His doctoral dissertation formulated a law of Attic Greek accentuation of nouns and adjectives that still goes by his name.

After a year (1885–86) at Harvard university he went to Cornell university, Ithaca. N.Y.. as professor and served there until. in 1899. he was elected president of the University of California; he retired 20 years later. His tenure saw not only a natural growth of the university, but a directed growth, over which Wheeler had exercised a guiding and controlling hand. He was the Theodore Roosevelt professor at the University of Berlin in 1909–10 and the liking for Germany and admiration of German scholarship which he had formed in his student days was strengthened and led eventually to difficulty and embarrassment when the United States entered World War I against Germany.

The promise of distinguished scholarship given in his youth was cut short by his duties as university president; otherwise he would be counted as one of the foremost philologists ever produced by the United States. (J. WH.)

WHEELER, WILLIAM ALMON (1819–1887), vice-president of the United States from 1877 to 1881, was born in Malone, N.Y., June 30, 1819. After two years at the University of Vermont. Burlington. he studied law, was admitted to the bar and practised successfully six years. He turned to banking and in 1853, as trustee of mortgage holders, took charge of a railroad.

As a Whig, Wheeler had been elected county attorney in 1846 and New York state assemblyman in 1850. Joining the new Republican party he was elected state senator and president pro tem of the senate in 1858, was a member of congress, 1861–63, and president of his state's constitutional convention, 1867–68. In 1869 he was returned to congress where, in 1875. on a committee investigating a disputed state election in Louisiana, he devised the "Wheeler compromise" which recognized William P. Kellogg as governor and the election of such candidates as gave majorities to the Republicans in the state senate and the Democrats in the louer house. In 1876 he was Rutherford B. Hayes's running mate in the disputed election decided by the electoral commission. (W. E. BY.)

WHEELER, WILLIAM MORTON (1865–1937), U.S. zoologist who was noted for his work on the taxonomy, ecology and behaviour of ants, mas born at Milwaukee, Wis., March 19. 1865. He graduated from the German-American Normal college, Milwaukee, in 1884; received his Ph.D. degree, 1892, from Clark university, Worcester, Mass.; and doctor of science from The University of Chicago, 1916. He was assistant professor of embryology, The University of Chicago, 1896–99; professor of zoology. the University of Texas, .Austin, 1899–1903; curator of invertebrate zoology, American Museum of Natural History, New York city, 1903–08. In 1908 he was made professor of entomology at Harvard and in 1915 became dean of Bussey institution. He was a member of the National Academy of Sciences. His publications include *Ants, Their Structure, Development and Behaviour* (1910); *Social Life Among the Insects* (1923); *Foibles of Insects and Men* (1928); and monographs on numerous species of ants. He was also noted for his humorous and satirical writings, included in *Essays in Philosophical Biology* (1939). (A. E. E.)

WHEELING, a city of West Virginia, U.S., and the county seat of Ohio county, is located on the Ohio river about 40 mi. S.W. of Pittsburgh, Pa.. in an industrial area which includes western Pennsylvania, the West Virginia panhandle and eastern Ohio. More than 400 industries are located within the Wheeling area with metallurgy, glass manufacture. tobacco products, pottery and textile manufacturing heading the list of economic activities. Pop. (1960) city, 53,400; Wheeling standard metropolitan statistical area (Marshall and Ohio counties in West Virginia and Belmont county in Ohio), 190,342. (For comparative population figures *see* table in WEST VIRGINIA: *Population.)*

The city operates under a council-manager type of government. Educational facilities include Linsly Military institute, established in 1814; Mount de Chantal academy, established in 1848; and Wheeling college, a liberal arts institution operated by the Society of Jesus and founded in 1954. Cultural and educational programs are afforded through the operations of Oglebay park, which supports a historical and arts museum and sponsors concert and lecture series. Oglebay institute, another affiliate of Oglebay park, is operated by the college of agriculture of West Virginia university. Wheeling has two daily newspapers, the *Intelligencer* and the *News Register,* three radio stations and one television outlet.

Wheeling was founded in 1769 by Ebenezer Zane of Virginia. who later also helped settle Zanesville, O., and was the site of Ft. Henry, an important outpost of the Virginia frontier. During the Revolutionary War the fort was attacked several times by Indian bands, and was the scene of the last battle of the Revolution in Sept. 1782.

The town, incorporated in 1806, and chartered as a city in 1836, benefited economically from its position as western terminus of the National road for several years after 1818, and was further stimulated by the completion of the Baltimore and Ohio railroad in 1852. During the Civil War Wheeling was a centre for the unionist movement in western Virginia and was the seat of the restored government of Virginia from 1861 to 1863. With the admission of' West Virginia into the union in June 1863. Wheeling became the first capital of the new state and served as such until 1870. From 1875 to 1885 the state capital was again located in Wheeling. (GE. E. M.)

WHEELOCK, ELEAZAR (1711–1779), American educator, founder and first president of Dartmouth college, mas born at Windham. Conn., April 22, 1711. He graduated from Yale in 1733, studied theology and in 1735 became a Congregationalist preacher at Lebanon. Conn. He was a popular preacher throughout the period of the Great Awakening. He also took young men into his house to fit them for college. One of these was a Mohegan Indian. Samson Occom, who made such excellent progress that Wheelock decided to found a free school where both whites and Indians could be educated. With aid from various sources he conducted such a school at Lebanon from 1754 to 1768. but without a large attendance. When the school eventually failed, Wheelock accepted the governor of New Hampshire's offer of a township of land on the Connecticut river. He went there with about 30 students in 1770. and, with other settlers, founded the town of Hanover. The new college was named Dartmouth college in honour of the earl of Dartmouth. For the remaining nine years of his life. which included the turbulent Revolutionary War period. Wheelock worked for the college, supervising building, preaching, teaching and raising money.

Wheelock died at Hanover, April 24, 1779.

His eldest son. JOHN WHEELOCK (1754–1817), succeeded him as president of Dartmouth.

WHEELWRIGHT, WILLIAM (1798–1873), U.S. businessman, promoter and pioneer railroad builder who spent nearly all of his adult life in advancing commerce and technology in South America. He was born in Newburyport, Mass.. Mar. 16, 1798. Wheelwright first went to Chile in 1824 and returned in 1830 to enter business. In 1840 he established a steamship line between Valparaiso and Liverpool, Eng., and subsequently obtained permission to operate a line along the South American west coast. He won numerous concessions from the Chilean government for railroads, telegraphs and public utilities. He built the Caldera-Copiapó railroad (1850–51), often regarded as the first commercial carrier in South America. He also directed the construction of the Valparaiso-Santiago telegraph (1852) as well as the first section of the Valparaíso-Santiago railroad.

His enterprise led to the introduction of modern public utilities in a number of Chilean cities, notably Valparaíso. In 1863 he transferred his interests to Argentina where he directed the construction of the Rosario-Cordoba railroad. Although a U.S. citizen, Wheelwright depended almost entirely upon British financing for his projects. In appreciation of his contributions the Chilean people, in 1877, erected a statue to him in Valparaiso.

He died in England Sept. 26, 1873. (J. J. J.)

WHELK, a common name applied to many species of small to fairly large carnivorous marine snails belonging to several closely related families. They all have a powerful rasping tongue (radula), and have large horny teeth adapted for tearing animal tissue. Whelks commonly feed on clams, worms, barnacles and snails and occasionally on fish, lobsters and crabs caught in commercial traps. These active mollusks crawl about by means of a large muscular foot. A long siphonal tube protrudes from under the edge of the shell and directs water into the mantle cavity for respiratory purposes. The proboscis with the radula at its anterior end can be greatly extended and inserted betneen the valves of a clam, the animal on which whelks most frequently feed. A flattened plate (operculum) attached to the dorsal surface of the foot closes like a lid over the open end of the shell when the animal retires into the shell. The sexes are separate and the male specimens may be readily distinguished by the large external verge or copulatory organ which arises on the right side of the neck but is folded back and lies within the mantle cavity except during copulation. Fertilization is internal and the eggs are deposited in chitinous capsules arranged in clusters or strings and attached to rocks, wood, shells. etc.

The common whelk (*Buccinum undatum*) reaches about 4 in. in length and occurs on the coasts of northwestern Europe and northeastern North America. Used by British fishermen as bait for long lines, common whelks are dredged or are caught in traps baited with crabs. They are food for many bottom-feeding fishes such as cod, and by starfish.

Murex species are sometimes called rock shells or rock whelks. They are distributed throughout tropical and temperate seas: living on or under rocks or on oyster bars, from the intertidal zone to considerable depths. The Tyrian purple of the Phoenicians came from the Mediterranean rock whelks; for example, *Murex brandaris* and *Murex trunculus*. The dog whelks belong to the family Thaisidae; *Thais lapillus* is the common species of the New England and north European coasts. *Thais haemastoma* and various subspecies which occur in southeastern Cnited States and the Caribbean area may be very detrimental to oyster beds. *Busycon* species are also referred to as whelks; they range from southern Massachusetts to Yucatan, living on clam beds and oyster bars usually below the low tide line in shallow water to depths of several fathoms. They are the largest of the whelks, some of them reaching about 16 in. in length.

See also SNAIL.

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WHETSTONE, GEORGE (1551?–1587), British author, was a son of Robert Whetstone, prosperous London haberdasher After Robert Whetstone's death (1557) his widow lived near 'Stamford. Thus young Whetstone came to know the Burghleys, to whom several of his works are addressed. Fiction and autobiography are inextricably mingled in his writings (*e.g.*, *The Rock of Regarde*, 1576), but it seems probable that he studied at one of the inns of court and became acquainted with writers and scribblers. His play *Promos and Cassandra* (1578) was one or' the sources of Shakespeare's *Measure for Measure;* the dedication is a venture into dramatic theory. Whetstone joined Sir Humphrey Gilbert's abortive voyage of 1578. In 1580 he visited Italy. His *Heptameron of Civill Discourses* (1582; re-issued as *Aurelia*, 1593) attempts to follow the Italian pattern of interlacing tales and debates. His subsequent works are didactic compilations. His *Mirour for Magestrates of Cyties* and *Touchstone for the Time* (1584; re-issued as *The Enemie* to *Unthryftinesse*, 1586) censures civic corruption; his *Honorable Reputation of a Souldier* (1585) is a conduct book for soldiers in the Low Countries; his *English Myrror* (1586) enjoins civil obedience; his *Censure of a Loyall Subject* (1587) moralizes on the executions following the Rabington conspiracy. In Aug. 1587 Burghley made Whetstone a commissary of niusters in Holland under Sir Thomas Digges. In September, Whetstone was killed by Capt. Edmund Udall in a duel at Bergen-op-Zoom. (T. C. I.; M. M. Ls.)

WHEWELL, WILLIAM (1794–1866), British philosopher, remembered for his work on the theory of induction and for his interest in the physical sciences. was born at Lancaster on May 24, 1794. He secured an exhibition at Trinity college, Cambridge, became second wrangler in 1816 and subsequently a fellow and tutor of his college. He was a fellow of the Royal Society by the age of 26. At Cambridge, Whewell was professor of mineralogy from 1828 to 1832 and professor of moral philosophy (then called moral theology and casuistical divinity) from 1838 to 1855. Master of Trinity college from 1841, he was vice-chancellor of Cambridge university in 1842. He died at Cambridge on March 6, 1866.

From the 1820s on Whewell was a distinguished figure in the academic world. His changing interests were reflected by early works on mechanics and dynamics, followed by studies of the history and philosophy of science, by exhaustive researches on tides and, after 1850, by writings on moral theology. His close study of Kant gave him considerable advantages over other contemporary British philosaphers. Although his work on the theory of induction was overshadowed by that of J. S. Mill, Whewell's lasting reputation rests on his History of the Inductive Sciences, 3 vol. (1837), and his Philosophy of the Inductive Sciences (1840), the latter being eventually expanded into three books, The History of Scientific Ideas, 2 vol. (1858), Novum *Organon* Renovatum (1858) and Philosophy of Discovery (1860).

WHIG AND TORY, names used to denote two opposing political parties in England, were terms of abuse introduced in 1679 during the heated struggle over the bill to exclude James, duke of York, from the succession. "Whig" whatever its origin in Scots Gaelic—was used of cattle and horse thieves and was thence transferred to Scottish Presbyterians. Its connotations were Presbyterianism and rebellion; and it was applied to those who claimed the power of excluding the heir from the throne. "Tory" was an Irish term suggesting a Papist outlaw and was applied to those who supported the hereditary right of James in spite of his Roman Catholic faith. The revolution of 1688–89 greatly modified the division of principle between the two parties, for it was a joint achievement. Thereafter most Tories accepted something of the Whig doctrines of limited constitutional monarchy rather than absolutist divine right monarchy, and under Queen Anne they represented the resistance, mainly by the country gentry, to religious toleration and foreign entanglements. Toryism became identified with Anglicanism and the squirearchy, Whiggism with the aristocratic landowning families and the financial interests of the wealthy middle classes. The death of Anne in 1714, the manner in which George I came to the throne as a nominee of the Whigs, and the flight of the Tory leader Lord Bolingbroke (*q.v.*) to France, conspired to destroy the political power of the Tories as a party (see ENGLISH HISTORY). There followed nearly 50 years of rule by aristocratic groups and connections, regarding themselves as Whigs by sentiment and tradition. The die-hard Tories were discredited as Jacobites, though about 100 country gentlemen, regarding themselves as Tories, remained members of the house of commons throughout the years of the Whig hegemony. As individuals and at the level of local politics, administration and influence, such "Tories" remained of great importance.

The reign of George III brought a new phase in the shift of meanings of the two words. There was no Whig party, only a series of aristocratic groups and family connections operating in parliament through patronage and influence. There was no Tory party, only Tory sentiment, tradition and temperament surviving among certain families and social groups. The so-called "king's friends," from whom George III preferred to draw his ministers (especially under Lord North, 1770–82), came from both traditions and from neither. It was only by 1784, after more profound political issues, which deeply stirred public opinion, had arisen about such controversial matters as the Wilkes case of 1768–69 (see GEORGE III) and the American Revolution, that real party alignments could take shape.

After 1784 the younger Pitt emerged as the leader of a new Tory party. This broadly represented the interests of the country gentry, the merchant classes and official ministerial groups. In opposition a revived Whig party, led by Charles James Fox (*q.v.*), came to represent the interests of dissenters and industrialists, and a desire for electoral, parliamentary and philanthropic reforms. The French Revolution and the wars against France further complicated this division, for a large section of the more moderate Whigs deserted Fox and supported Pitt. After 1815 there followed a further period of party confusion, from which emerged eventually the conservatism of Robert Peel and Benjamin Disraeli, and the liberalism of Lord John Russell and W. E. Gladstone. Although the label Tory continued to be used of the Conservative party, Whiggism ceased to have much political meaning. See CONSERVATIVE PARTY, BRITISH; LIBERAL PARTY. See also Index references under "Whig and Tory" in vol. 24.

See K. G. Feiling, *History of the Tory Party, 1640–1714* (1924) and *The Second Tory Party, 1714–1832* (1938) ; L. B. Namier, *England in the Age of the American Revolution* (1930). (D. TN.)

WHIG PARTY, one of the two major political parties in the United States from about 1834 to 1854. Though its lineage may be traced back through the National Republicans, led by John Quincy Adams and Henry Clay (*qq.v.*), to the Federalists under George Washington and Alexander Hamilton, the party as such was formed in 1834 following the overwhelming victory of the Democrats in electing Pres. Andrew Jackson to a second term in 1832, chiefly on his issue of "killing" the second Bank of the United States by refusing to renew its charter.

Drawing strength and support from three main groups—eastern capitalists, western farmers and southern plantation owners—the Whigs generally espoused the cause of propertied and professional people (without, however, being antilabour) and, above all, the cause of national unity. In the beginning they were united by their bond of opposition to "executive usurpation" under President Jackson and by winning to their ranks the great bulk of the membership of the Anti-Masonic party (*q.v.*). A twofold strategy lay behind the choice of the term Whig: to avoid the handicap of functioning any longer under a name identified with the disastrous defeat of 1832, especially since the loser in that campaign, Clay, was one of their main leaders; and, by implication, to fasten on the Jacksonian Democrats the odious label of Tories.

Senators Clay of Kentucky and Webster of Massachusetts gave the Whigs their best and most sustained leadership; yet Gen. William Henry Harrison (1840) and Gen. Zachary Taylor (1848), neither of whom represented any well-known political views, were their only successful presidential candidates—and both men died in office, with serious consequences for the party. Sen. John C. Calhoun of South Carolina, spokesman of the great slaveowners of the south, supported the Whigs until the close of the 1830s, primarily because of Jackson's ruthless opposition to nullification (*q.v.*); but Calhoun later returned to the Democratic fold.

Not yet fully organized by 1836, the Whigs supported three candidates in that election (Webster in the east, Harrison in the west and Hugh L. White in the south), but in 1840 they nominated the old Indian fighter Harrison and John Tyler, a leading Virginia planter. This was the famous "log cabin and hard cider" campaign of "Tippecanoe and Tyler too." The Whigs won, but Harrison died within a month after his inauguration as president; Tyler, a southern Whig, proved to be so much more concerned about states' rights (*q.v.*) and slavery than about the program of either the Clay or Webster factions, that these factions secured Tyler's formal ejection from the party. In 1844 the Whigs nominated Clay as their standard-bearer and drafted their only real platform, one stressing the need for a well-regulated currency, a tariff for revenue, distribution to the states of the proceeds from the sale of public lands, limitation of the president to a single term, and reform of executive usurpation—all in line with Clay's "American system" of tariff protection and internal improvements proposed in the 1820s. Perhaps, however, because of his indecisive position on the "reannexation of Texas," the key issue of the Democrats, Clay lost and James K. Polk won.

In 1848 the Whigs again offered a military hero, General Taylor of Mexican War fame, as their candidate and succeeded a second time in gaining the White House. only to have their leader die in July 1850. On the accession of Millard Fillmore to the presidency the greatest question before the country was that of the extension or prohibition of slavery in the newly acquired territories. Faithful to the key Whig principle of preserving national unity, Fillmore sided with Clay in the effort of the "great compromise" to forge a final solution to this irrepressible issue. When the Clay-sponsored compromise of 1850 (*see* COMPROMISE MEASURES OF 1850) became law, the Whigs hailed it as a lasting settlement and looked forward with confidence to the next campaign. Their strategy in 1852, based on the assumption that the slavery question had been solved, was to allow the southern states'-rights wing to write the platform while the northern nationalist wing selected the nominee. Passing over Webster and Fillmore, either of whom would have symbolized the party's great achievements, they for a third time nominated a general. \\'infield Scott proved. however, to be so inept a candidate that the Whigs not only went down to defeat but did so in a manner foreshadowing both their own extinction as a party and the dissolution of the union.

The year 1856 witnessed the gathering of a few "silver gray" or "cotton" Whigs to draft a platform calling for "unalterable attachment to the Constitution and the Union" and emphasizing the "absolute necessity of avoiding geographical parties." When it came to nominating a ticket, however. they chose for their candidates the nominees of the "Know-Nothing" or American party (*q.v.*). This was in effect a confession that the bulk of their members had already gone over either to that party or to the new Republican party, which was to win the presidency under Abraham Lincoln. a former Whig. four years later.

See also UNITED STATES (OF AMERICA). THE: History; DEMOCRATIC PARTY (U.S.); REPUBLICAN PARTY (U.S.).

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WHINCHAT (*Saxicola rubetra*), a European bird related to the wheatear and stonechat (*qq.v.*). A summer migrant, the whinchat is about five inches long and somewhat larger than the stonechat, which it resembles in behaviour and appearance. being distinguished by a prominent eye-stripe, white patches at the base of the tail and a !ess upright pose.

The whinchat ranges over Europe and western Asia, wintering in Africa.

It nests in coarse grass, often at the foot of a small bush or large plant.

WHIP. This article considers first the whip in the English parliament and second. in the U.S. congress.

England. — In English parliamentary usage. whip denotes a party official chosen to assist his leaders in the management of the party. the term being supposedly derived from the "whipper-in" at a hunt. The party whips are expected to secure the attendance of their followers on all necessary occasions, and especially for divisions. If a member finds it difficult or impossible to attend, the whips may arrange a "pair" with a similarly situated member of the opposing party. It is the whips' business to persuade their followers to vote with the party and to speak in accordance with party policy, and they act as a channel of information and complaint between the rank and file and the party chiefs. In the Conservative party the chief whip, deputy chief whip and junior whips are appointed by the leader of the party personally: in the Labour party the chief whip is elected annually by the parliamentary Labour party. and he in turn appoints the other whips. The government and opposition chief whips are the "managers" of their respective parties in the house of commons. They are "the usual channels" through which are negotiated the complicated arrangements for the daily conduct of parliamentary proceedings; these negotiations are said to take place "behind the speaker's chair."

The government chief n-hip is responsible, in collaboration with the leader of the house of commons. for securing the smooth flow of government business. and for ensuring that legislation proceeds in accordance with the plan approved by the cabinet at the beginning of each session. He traditionally holds the office of parliamentary secretary to the treasury. for which he receives a salary of £3,750. He is still popularly known as the "patronage secretary." a reference to the time when public offices were freely bestowed as a reward for parliamentary support, and he is usually consulted by the prime minister when the latter is forming or reconstituting a government. The deputy chief whip and four junior whips are appointed lords commissioners of the treasury; others are paid as officers of the royal household. One or two holders of "household" offices are government whips in the house of lords. There are also, usually. a number of unpaid assistant whips. The opposition whips receive no payment other than their salaries as members of parliament.

The term is also used derivatively to denote the written summons sent out from the whips' office each week (or oftener if required) informing members of the parliamentary program, the importance of the proceedings being indicated by the number of lines underscoring the text. Failure to respond to a "three-line whip" is taken as a serious breach of party loyalty unless an adequate reason is forthcoming. Receipt of the neekly whip is evidence of party membership; hence expulsion (or resignation) from the parliamentary party is commonly referred to as "withdrawal" (or resignation) of the party uhip."

See H. Morrison, *Government and Parliament,* pp. 100 ff. (1954). (JK. W. G.)

United States. — In the 20th century. U.S. congressional party whips, who function much as in the English parliament, came to he used in both houses and both political parties. The first person officially known as a whip in congress was Republican Rep. James E. Watson of Indiana. so designated by his party in 1899. In the senate the first official Democratic whip was Sen. James H. Lewis of Illinois. named in 1913. Two years later the Republicans designated Sen. James W. Wadsworth, Jr.. of New York as their whip.

The Democratic "whip organization" in the house of representatives consisted in the later practice of the 20th century of a chief whip, appointed by the Democratic floor leader, and 15 assistant whips selected on a regional basis by the democratic representatives. The house Republican "whip organization" included a chief whip, chosen by his party's committee on committees; a deputy whip; and 4 regional and 1j area whips, selected by the chief whip. In the senate the whip machinery was smaller, consisting on each side of a single senator, elected by his party conference, and a party secretary. The secretaries to the majority and minority parties performed most of the whip functions in the senate.

The whips send out week-end "whip notices" to party members about the following week's legislative program; conduct polls of party members through a "whip check" to estimate the prospective vote on bills; round up members for the actual votes; arrange voting "pairs" between opposing members: and serve as assistant floor leaders in the absence of their leaders. With the growth of insurgency and factionalism in the congressional parties and the decline of party regularity after 1900, the whips' task steadily increased. (G. B. GY.)

WHIPPING: *set:* FLOGGING.

WHIPPLE, GEORGE HOYT (1878–), U.S. physician, educator and Nobel prize winner, noted for his studies of the liver in its essential relation to blood formation. was born on Xug. 28. 1878, the son of a physician in Ashland, N.H. After graduation from Yale in 1900. he received his M.D. from the Johns Hopkins university. Baltimore. Md., in 1905, where he continued his training in pathology under William H. Welch. He became associate professor of pathology at Johns Hopkins in 1911. From 1914 to 1921 he was professor of research medicine at the University of California. Berkeley, and director of the Hooper Foundation for Medical Research. His discovery during this period that liver is essential for blood formation. together with the demonstration by George Minot and William P. Murphy of Harvard that liver is curative in pernicious anemia. led to the Nobel award, given jointly to these three workers in 1034.

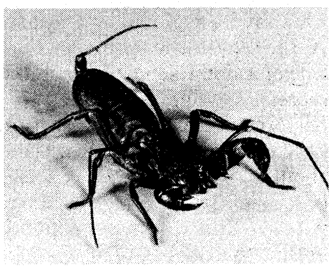
In 1921 Whipple went to the University of Rochester, N.Y., to become the first dean and organizer of its new medical school. He gave basic design to the construction of what has become a world-famous integrated medical centre. combining university hospitals and medical school under one roof. During this period he continued and greatly extended his researches on the liver. (W. S. McC.)

WHIPPOORWILL, common night bird, *Caprimulgus vociferus,* of the hardwood forests of eastern Korth America; the name is taken from its call. It belongs to the world-wide family Caprimulgidae, which also includes nightjars, goatsuckers, poorwills, chuck-mill's-widows and nighthawks. The whippoorwill, about 10 in. long, has a very small bill but a big head, large eyes, a bristle-fringed gape that extends back under its ears, tiny feet and very long wings. In colour the bird is variously patterned in rich browns, tans and black, and the male has a white throat band and white tips to its outer tail feathers.

During the day the whippoorwill sleeps on the ground, where its colour harmonizes with the dead leaves. At night it feeds by watching for insects from some perch or pursuing them swallowlike and snapping them up in its huge maw. Its loud, three-syllable whistled call is heard in the darkness more often than the bird is seen and may be repeated hundreds of times in quick succession, often when the bird is perched on a branch. To some people the call is tiresomely monotonous.

No nest is made; the two plain white or lightly spotted eggs are laid on the ground among the leaves where they are conspicuous if the parent leaves them. The young is down-covered, and though able to walk about some is cared for by the parents in the vicinity of the nest site. In winter the birds go south, some as far as Costa Rica. (A. L Rd)

WHIP SCORPION, a common name applied to any representative of the order Pedipalpida (Thelyphonida) of the class Arachnida (*q.v*). A certain superficial resemblance between true scorpions and whip scorpions is responsible for the name of the latter. But unlike scorpions they are not poisonous and their tail or flagellum is a harmless, tactile appendage. They have powerfully developed pedipalpi, by means of which they grasp beetles and other insects on which they feed, and with which they can inflict a painful prick if picked up carelessly. When irritated they produce a gaseous secretion from glands opening at the base of the tail. The odour of this secretion, resembling vinegar, caused the Mexican people to give the name "vinegaroon" to *Mastigoproctus giganteus,* the common whip scorpion found in Mexico and the southwestern United States. The chemical composition of this secretion is not known, but it is highly irritating to mucous membranes and is quite effective as a means of defense. The first pair of legs is not used in locomotion, but like the tail is a tactile organ.



ROBERT C HERMES FROM NATIONAL AUDUBON SOCIETY

WHIP SCORPION (THELYPHONUS CAUDATUS), FOUND IN JAVA

Whip scorpions are inhabitants of tropical and hot countries. They live under stones, in crevices of rocks, in termite nests, in burrows in the ground and in dark or deserted buildings. The females carry the eggs in a glutinous secretion on the underside of the abdomen until they are hatched. The young climb on the back of their mother and stay there for five or six days when they moult and desert h e parent to lead an independent life. It is not known how long they can live, but it is certain that their life lasts at least several years. Whip scorpions are a comparatively small order. Only ten genera are usually recognized and of these only two belong to the American continent. The rest are found in the eastern hemisphere. The oldest known of these is *Thelyphonus caudatus* from Java, first described by Linnaeus. Its defensive secretion smells of formic acid. A very active creature, half as large as the Mexican whip scorpion, it is, like the latter, occasionally found in dwellings. The courtship and mating of an allied species, *Thelyphonus sepiaris,* of Ceylon and India, has been described by Gravely in the *Records* of the Indian museum of Calcutta. (A. Ph ; X.)

WHIRLPOOL, a rotary flow of ocean currents around a depressed central area, created by the head-on meeting of a rising tidal current with the return-ebb current of the preceding tide. Whirlpools are of common occurrence in the narrow passages between island groups and mainland shores, as in the fiords of Norway, the Hebrides and Orkney Islands off the coast of Scotland. In some cases the rotary flow becomes accentuated and changes to a spiraling flow with downward draft into a deep centre, characteristic of vortex flow (*see* below). This phenomenon is known to occur where tidal inflow through a narrow passage having considerable depth meets ebb-tide outflow, as in the Naruto strait connecting the Inland sea of Japan with the Philippine sea. (*See* "Cruising Japan's Inland Sea," by Willard Price, *National Geographic Magazine,* Nov. 1953, p. 623.) In general, the reversal of tides, which is primarily responsible for the conditions mentioned, is linked with the relative positions of sun and moon, occurring approximately every six hours. The moon, being nearer the earth, exerts by far the stronger force in the formation of the tides and of the resulting tidal currents. Their regularity of occurrence is a material aid to navigators, especially to fishermen in sailing vessels, except when sudden winds of gale force, blowing in a direction contrary to or at an angle with that of tidal flow, create high waves or "choppy" waters that have been responsible for the loss of ships and of life and hence are greatly feared by navigators. Only high-powered steamships and motor-driven boats can withstand their onslaught.

Whirlpools occur in many parts of the world. Among the better known are the whirlpools of Charybdis, along the Calabrian coast, and of Messina, in the Strait of Messina (first described by Homer) between the island of Sicily and the mainland of Italy. The Maelstrom (Dutch for "whirling stream") between the islands of Moskenes and Mosken of the Lofoten Islands, which are off the coast of Norway, is peculiarly subject to "rough water" in windy weather.

Direction of rotary flow in whirlpools is independent of rotation of the earth, as the result of superior control by coast lines and bottom obstructions. However, unhampered strong vortex flows of the type occurring in the Naruto strait, Japan, above described, are controlled by the rotation of the earth turning counterclockwise in the northern hemisphere and clockwise in the southern hemisphere.

The term whirlpool was coined in the early days of small sailing vessels. It is often confused with other rotary forms of flow, notably with vortexes and kolks. A whirlpool in the open ocean is nothing more than a large-scale eddy; *i.e.,* a simple rotary flow, not always truly circular in form because of irregularity of coast lines. Inability on the part of sailors to steer out of whirlpools for lack of favourable wind often resulted in their vessels being either driven against rocky shores or held in a whirlpool's centre. Popular sagas notwithstanding, the centre of a whirlpool in the open ocean is free from suction or downward draft.

Differing distinctly from the steady whirlpool type of rotary flow is vortex flow, which spirals downward into a depressed shaftlike hole at a high rate of speed, entraining floating objects including small vessels.

Different, also, is the river kolk (term borrowed from the Dutch, used also in Germany), which is a short-lived spasmodic upward displacement of bottom water with swiftly whirling vortex motion at stream bed where its strong suction entrains bottom sediment upward. Commonly seen in river bends during high-rising stages, kolks dissipate at the surface in the form of nonrotating "boils" with slightly bulging surfaces. By lifting river-bed materials such as clay and sand and scattering these in the flowing river water, kolks constitute the primary agency that actively deepens streams along the concave shores of bends. (G. H. M.)

WHISKY (**Whiskey**), a potable alcoholic beverage obtained from the distillation of a fermented mash of cereal grains, suitably aged in wood, usually white oak. It is whisky in Scotland and Canada; whiskey (with an "e") in Ireland and the U.S.

The whiskies produced in each country are distinctive in character because of difference in method of production, type and character of the cereal grains and, most important, the quality and character of the water employed. For example, Scotch whisky is inimitable because only in Scotland can be found the spring water that rises through a red granite formation and then passes through peat moss country.

For the same reason the three principal distilling centres in the conterminous United States are located where they are because of the water obtained from springs that rise through limestone rock. The limestone mantel runs along western Pennsylvania, cuts across southern Indiana and over into Kentucky; there is another limestone outcropping in Maryland.

There is no precise record of when whisky was first distilled in either Scotland or Ireland. The earliest direct account is found in the Scottish exchequer rolls of 1494 which lists: "Eight bolls of malt to Friar John Cor wherewith to make aquavitae." There must have been knowledge of the art long before, since Albukassen. the Arabian alchemist had described the distillation process in his writings of the 10th century. The Latin term used to describe distilled spirits was *aquavitae,* "water of life." The Scotsmen and Irish translated this literally into their own Celtic as uisgebeatha, eventually shortened and anglicized into "whisky."

Scotch Whisky. — In the beginning, every Highland laird had his own pot still. The whiskies produced were rough and harsh. with a smoky pungency only Caledonians could appreciate—and they paid no taxes. Commercial distillation dates only from 1814 when excise taxes were levied and stills of less than 500-gal. capacity were prohibited. Even then consumption of Scotch whisky was very much local. A similar situation prevailed in Ireland. The principal contributing factor to the eventual world-wide popularity of Scotch whisky was Robert Stein's invention in 1826 of the column still. a continuous distillation process. In 1832 Aeneas Coffey obtained patents on improvements of this process. The column still is known today as the patent or Coffey still. This improvement made possible the distillation of more refined, lighter-bodied whiskies at higher proofs than was possible with a pot still. Today all Scotch whisky is a blend of pot-still and Coffey-still distillations. Scotch whiskies are fairly light bodied but have a distinctive smoky malt flavour.

Production. — Pot-still or malt whisky is distilled only from a fermented mash of malted barley. Patent-still or grain whisky is distilled from a fermented mash of barley malt and other (unmalted) cereal grains.

Pot-Still Whisky. —The steps in the pot-still process are: (1) cleaning the barley by screening out all foreign matter; (2) malting; (3) drying and grinding; (4) mashing; (5) fermentation; (6) maturation; and (7) blending.

The clean barley is steeped for two or three days in tanks of water, called steeps. It is then spread on the concrete malting floor to germinate under conditions of warmth and moisture for some 8 to 12 days. During this time the grain is constantly sprinkled with water and periodically turned over with wooden shovels. The barley sprouts, the starch in the grain is modified by the enzyme cytase, and the enzyme diastase, which is secreted, converts the starch in grain into maltose and dextrin, fermentable sugars. When the sprouts are some $\frac{3}{4}$ in. long, the water is turned off and the grain is known as green malt.

For drying, the green malt is transferred to a kiln, where it rests on a screen directly above a peat and coke fire. The acrid and oily smoke from the peat swirls around the grain so impregnating it that the aroma is carried over into the distilled spirit. The kilned malt is screened to remove the culm, or dried sprouts, and then ground into a meal, or grist.

In mashing, the grist is thoroughly mixed with hot water in a mash tub. and allowed to soak until the water has liquified all of the starches, and the diastase has converted the starches into maltose and dextrin. When the liquid has absorbed all the goodness from the grain, it is known as the wort which is drawn off the husks or draff (which, being rich in proteins, is dried for cattle feed). It is cooled and pumped into the fermenting vats.

In fermentation, vessels holding from 2,000 to 10,000 gal. are used. Pure cultured yeast is added to the wort and fermentation begins. The yeast causes the sugars in the wort to split into equal parts of alcohol and carbonic acid gas, the latter of which escapes, or is recovered as a by-product, the alcohol remaining in the liquid. The yeast continues to work until all of the sugar has been converted, usually some 48 hours. Simultaneously other subsidiary fermentations take place that are responsible for many of the flavours of the whisky! characteristic of each particular distillery. When fermentation is completed the liquid is known as beer or wash. To this point the process is identical with brewing ale and beer, except for the omission of hops.

For distillation, the beer goes into a pot still (see ALCOHOLIC BEVERAGES. DISTILLED) known as the wash still. The result of the first distillation is a distillate of low alcoholic strength called low wines. The first distillation separates the alcohol from the liquid and eliminates the residue of yeast and unfermentable matter. Also, a further cooking of secondary constituents occurs within the still. The low wines pass into a second pot still, known as the spirit still, where they are redistilled. The first and last part of the distillation, the heads and tails, are called the feints; they are separated from the useful or middle portion and are returned to the wash still for redistillation with the next charge of beer. Pot-still distillation is an intermittent process.

The useful or middle-run spirit that is distilled off at between 140 and 142 proof, now malt whisky, flows into a receiving vat.

Grain Whisky.—The second type of whisky distilled in Scotland, follows the same general production steps outlined above. Grain whisky differs from malt whisky in several respects. A mixture of malted and unmalted cereal grains are mashed, then fermented, and the resultant beer is distilled in a patent or column still in a continuous distillation operation. Grain whiskies are distilled off at slightly over 180 proof. Scotch grain whiskies are very light in body and flavour.

For a discussion of maturation, see ALCOHOLIC BEVERAGES, DISTILLED: *Maturing.* Cask sizes for maturing vary from 33 to 145 gal. capacity. The length of time needed varies with the character of the individual whisky, the size of the cask and the climatic conditions where it is stored. However, the Immature Spirits act of Great Britain establishes that no distilled spirits, such as whisky, rum or brandy, may be sold for public consumption unless they have been matured in wood for at least 3 years.

Blending is a high art, requiring great experience, a very keenly trained nose and palate. No two whiskies are the same. Each has its own particular characteristic, due in part to the geographical location of the distillery and in part to the individual distiller. The four geographical malt distilling divisions of Scotland are the Highlands, Lowlands, Campbeltown and Islay. The grain whisky distilleries are mostly in the Lowlands.

The blender must choose the proper proportion of Highland and Lowland malts for delicacy, lightness and finesse: to which he adds smaller amounts of Campbeltown and Islay malts for body and maltiness, and finally the proper blending of grain whiskies to marry with the blend of malts to produce an identical match to the aroma; flavour and character of the whisky the public has become accustomed to in the brand that is being blended. It is an intricate business, often calling for the use of upward of 40 different malt whiskies and half a dozen grain whiskies. After the blend is made, usually in a large vat, the blended whisky is rebarreled and allowed to marry for a month before bottling. At the time of bottling, the blended whisky is reduced to the proof required by the market for which it is intended. The U.S. market demands Scotch whisky of 86.6 proof, while the United Kingdom, Canada and most of the other markets of the world prefer 80 proof whisky.

Irish Whisky. — Production of whisky began at the same time as in Scotland. The methods used to produce Irish whisky are essentially the same as in Scotland, with several differences. The malted barley is kiln dried, but the kiln has a solid floor so that the smoke from the fuel used has no opportunity to come in contact with the grain. Consequently, Irish whisky does not have a "smoky" aroma or flavour.

Irish pot-still whisky is triple distilled. Irish whisky must be matured a minimum of five years before it can be sold to the public. Irish whiskies are nearly always all pot-still whisky, although patent-still grain whiskies are also used. Irish whiskies are usually bottled as a blend of whiskies of the same distillery, but straight, unblended whisky is also marketed. Irish whiskies vary from medium body and flavour to very full bodies and full malty flavour.

Canadian Whisky. — The first Canadian distilleries at Quebec in 1769 and two at Montreal by 1787 distilled rum (*q.v.*), made from molasses imported from the West Indies. Grain distilling did not develop until the early 19th century, when it resulted from the influx into Canada of United Empire Loyalists after the American Revoiution. Being farmers, they mere soon producing surpluses of grain, which were easier to sell and transport in the form of whisky. Practically every grist mill became a distillery and by 1850 there were 200 distilleries in the province of Ontario alone, whereas in the second half of the 20th century there were only 21 distilleries in all of Canada.

Production Methods.—Canadian whisky distilling techniques and practices are generally similar to those employed in the conterminous United States, described below. There are some differences. Canadian lam establishes that Canadian whisky must be produced from cereal grain only: corn, rye, wheat, barley and malt. The Canadian Excise Tax bureau exercises the customary rigid controls to assure collection of the tax, but allows the distiller complete latitude in detail as to grain formulas, distilling and maturation procedures. Consequently each distiller varies the proportions of the grains mashed, distills off some of his whiskies at low proofs—140 or even lo er—to retain flavouring congeners, and others at over 180 proof, to assure lightness of body, and matures his whisky in either new or reused charred oak or uncharred oak barrels. All Canadian whisky is blended. No straight Canadian whisky is marketed. Legally, no Canadian whisky may be sold until it has been aged in wood for at least two years, but in practice it is usually aged six years. Canadian whisky is bottled at 86 to 90.4 proof. Canadian whisky is always a lightly flavoured, light-bodied, blended whisky.

United States.—The distilling industry in the United States began in the 17th century in the New England colonies, the product being rum, obtained from molasses imported from the West Indies. Distillation of whisky began in colonial times with the settler's grist mills, during the 17th century centred about western Pennsylvania and in Maryland, although some was carried on in Virginia. Gen. George Washington had a commercial distillery at his Dogue farm, near Mount Vernon, Va., and was very proud of the quality of rye whisky he produced there. Thomas Jefferson also distilled whisky. The whiskies produced mere obtained almost entirely from rye grain.

The whisky-distilling industry received its greatest impetus in 1791 during Washington's administration. The newly established federal government, needing revenues with which to conduct its business, imposed an excise tax on whisky. Resented and resisted by the Pennsylvania distillers, President Washington was obliged to order the militia to quell the stormy rioting (see WHISKY INSURRECTION, THE). Many of the disgruntled Dutch, Scottish and Irish farmer distillers decided to move beyond the reach of the tax collectors and so went farther west into Indian territory. They found proper water for distilling in what is today southern Indiana and Kentucky. They also found that maize grew better and more abundantly than rye, and it became the grain the distillers employed.

The first distillery in Kentucky is attributed to Evan Williams in 1783 at Louisville, while the first whisky distilled in Bourbon county is credited to the Rev. Elijah Craig in 1789. Other early distillers of the period were Jacob Spears, John Hamilton and Daniel Stewart. The corn whisky they produced was sweeter to the taste and lighter in body than the rye whisky of Pennsylvania. Soon people were demanding whisky from Bourbon county and bourbon whisky eventually became the most popular type of whisky in the United States.

The United States is the world's largest producer and consumer of whisky. The federal treasury department has regulated and established detailed standards of identity for whiskies, but basically there are only two broad types of U.S. whiskies: straight and blended.

Production **Methods.**—U.S. production methods are basically the same as those employed in Scotland for the making of grain whiskies. Malted and unmalted grain is milled into a fine meal, which is mashed, cooked and fermented. The resultant beer or wash is then distilled in a column still, known as a beer still, but more graphically described as a whisky separating column.

In some distilleries the distillate from the beer still passes into a second column, known as a doubler. In principle, a doubler is like a pot still since the heat employed to vapourize the alcohol is applied externally, from a steam jacket surrounding it, as opposed to the beer still where the rising steam is in direct contact with the beer or wash. In either case, the straight whisky is distilled off at 160 proof or less.

To obtain more highly rectified whiskies or neutral spirits, *i.e.*, distillates of 190 proof or more, multiple column stills are used. These may consist of three or more rectifying columns (sometimes five).

U.S. regulations governing whisky production are the most specific in the world. In addition, to insure the collection of the revenue and until the internal revenue tax is paid, every production step is under close supervision by treasury agents. Thus, the government agents fiscalize the weight of the grain received, the milling, mashing, fermenting, distilling and barreling operations. The agents also hold the keys of the many locks and padlocks on the stills and to the federal bonded store rooms on the distillery property.

Straight Whisky.—Under U.S. regulations, a straight whisky is one that is distilled off at 160 proof or less, barreled at no less than 80 or no more than 110 proof and aged for a minimum of 24 calendar months. If it is distilled from a fermented mash composed of a minimum of 51% rye grain it can be marketed as straight rye whisky; if at least 51% of the grain mash fermented is corn (maize) it can be marketed as straight bourbon whisky. Such whiskies may be reduced in proof by the addition of water only, at the time of bottling to 80 proof, but no lower.

Bottled-in-Bond.—The Bottled in Bond act was passed by congress in 1894 to permit a distiller to bottle his whisky and to hold it in U.S. government bonded storage as bottled whisky, without having to pay the excise tax upon it until it was withdrawn for marketing, provided it was straight whisky, was at least 4 years old and was bottled at 100 proof.

The term "bottled-in-bond" is not a guarantee of quality by the U.S. government, nor does the government assume any responsibility in this respect.

Blended Straight Whisky.—On the whole, quite full-bodied and full-flavoured straight whiskies may be blended together. Such a blend will be labeled "a blend of straight whiskey." If 51% of the blend is bourbon whiskey, it can be labeled "blended bourbon whiskey" or "blended rye whiskey," if 51% is rye whisky.

Blended Whisky.—However, the blended whisky that is most popular is a blend or mixture of a minimum of 20%, 100-proof straight whisky together with neutral spirits (usually grain spirits).

Very light bodied and mildly flavoured, blended whiskies consist of two or more—sometimes in excess of 30—straight whiskies of different flavours and characteristics, which usually make up 27.5% to 35% of the blend, married with 65% to 72.5% of grain neutral spirits.

U.S. grain neutral spirits are essentially highly refined grain whiskies. However, the neutral spirits in a blended whisky need not be aged and generally are not. (I-I. J. GN.)

WHISKY INSURRECTION, THE, an uprising of farmers in western Pennsylvania in the summer of 1794 against the federal government sparked by efforts to enforce an excise tax on distilled liquors enacted March 3, 1791. Alexander Hamilton, secretary of the treasury. had proposed the excise with two purposes in mind: to raise money to help pay the national debt and to assert the power of the federal government. The small farmers of the interior who commonly converted their surplus grain into whisky that they could easily transport and sell, resisted the tax. Leaders such as Albert Gallatin and Hugh Henry Brackenridge protested strongly and under popular agitators such as David Bradford, the farmers resorted to violence. They attacked federal revenue officers, who attempted to collect the tax, and tarred and feathered some.

A law of June 5, 1794, designed to compel noncomplying distillers to pay the tax, touched off what appeared to be organized rebellion.

In July about 500 armed men attacked the home of Gen. John Neville, regional inspector of the excise, and burned it.

Some of Hamilton's followers saw in the insurrection a plot to destroy the federal government. Hamilton himself apparently saw it as the first opportunity to test the strength of the federal government against local defiance. Under authority granted by congress, Pres. George Washington on Aug. 7, 1794, issued a proclamation ordering the rebels to return to their homes and calling for militia from Virginia, Maryland, New Jersey and Pennsylvania.

After negotiations between the federal commissioners and rebel leaders proved fruitless, Washington ordered some 13.000 troops into Pennsylvania's western counties. Opposition melted away and no battle ensued. The troops occupied the region, captured some of the rebels and held them for trial. Two were convicted of treason and pardoned by Washington.

Many Americans, particularly members of the opposition Republican party, were appalled by the overwhelming force used by the government. They considered it unnecessary and feared that Hamilton sought to use the suppression of the insurrection as the first step to absolute power. To Federalists, however, the most important result was that federal authority had triumphed over its first rebellious adversary and had won the support of the state governments in enforcing federal law within the states.

(A. De C.)

WHISPERING BELLS (*Emmenanthe penduliflora*), a North American herb of the waterleaf family (Hydrophyllaceae), known also as yellow bells and golden bells, is native to mountain slopes from central California to Utah and southward to Mexico. It is a low, much-branched, sticky-hairy annual, 10 in. to 20 in. high, with deeply cut leaves and bell-shaped cream-coloured or yellow flowers: one-half inch long, borne on slender, pendulous stalks in loose clusters. This characteristic plant of the chaparral (*q.v.*) is grown in gardens for its showy, persistent flowers. When dry after fruiting these give forth a slight rustling sound.

WHIST, a member of a long line of card games embracing essential common features, much celebrated in history and legend. The essential features of whist family games are: four always play. two against two as partners; a full 52-card pack is dealt out evenly so that each player holds 13 cards; and the object of play is to win tricks, each trick consisting of one card played by each player. The succession of whist family games, from the earliest game to the latest. has included triumph, trump, ruff and honours (or slam). whisk (or whist) and swabbers. whist. bridge, auction bridge and—latest and most popular member—contract bridge (see BRIDGE).

It is generally conceded that whist is of English origin. Unmistakable references to triumph are found in a sermon preached by Hugh Latimer at Cambridge in 1529; in *Gammer* Gzirton's Needle; and in Shakespeare's *Antony and* Cleopatra, iv. 12, 12–20. In a poem (1621) by John Taylor, one line reads, "Ruffe, slam, trump, nody, whisk, hole, sant, new cut." Charles Cotton's Compleat Gamester (1674) says, "*Ruff* and *Honours* (alias *Slamm*) and Whist, are games so commonly known in England in all parts thereof, that every child almost of eight years old hath a competent knowledg (sic) in that recreation."

First a game of the lower classes, whist was taken up in the early 18th century by gentlemen in London's coffeehouses. Primarily because of the publication in 1742 of Edmond Hoyle's Short Treatise on *Whist*, the game became an unprecedented success in fashionable circles, soon spreading to the continent and to America. It developed an extensive literature. This pre-eminence among card games it never surrendered until replaced by its own progeny, bridge.

Procedure of Play.—All four players draw cards to determine partners. who face each other across the table. The player drawing the lowest card deals first; after which the turn to deal passes in rotation (which is always clockwise). The cards are shuffled, cut by the player at the dealer's right and dealt one at a time: face down, in rotation until the last card is reached; this is turned up and every card of its suit becomes a trump. The dealer takes it into his hand when it becomes his turn to play to the first trick.

The player at the dealer's left plays first (leads). He may lead any card. Each player in rotation thereafter must play one card, following suit (playing a card of the suit led) if possible, but playing any card he chooses if he cannot follow suit.

The cards of each suit rank downward: ace, king, queen, knave (jack), 10, 9, 8, 7, 6, 5, 4, 3 (trey), 2 (deuce). Any trick containing a trump is won by the highest trump; any trick not containing a trump is won by the highest card of the suit led. The winner of each trick leads to the next.

Scoring is possible only for the side which wins the odd trick (that is, its 7th trick out of 13). Each trick over 6 counts 1 point for that side.

Laws of Whist.—The first standard laws were those published by Hoyle in 1742; with minor revisions made in 1760, these laws were followed until revised in 1864 by the Arlington and Portland clubs. A different code of laws issued in 1893 by the American Whist league became standard for the United States.

The principal difference was in scoring. Under English laws, 5 points constituted a game (short whist, as distinguished from the long whist, 10 points for the game, of Hoyle). Final settlement was by rubber points: 3 for each game won 5 to 0; 2 for each game won 5 to 3 or less; 1 for any other game won; and 2 for being the first side to win two games.

Skillful Play.—The science of whist was complex but not profound. Its ponderous literature so devoutly embraced the established dogma that even minor changes in tactics were considered radical and any challenge of the prevailing strategy was considered too heretical to treat with gravity.

Hoyle and a group of worthy successors including William Payne (*Maxims*, 1770), Thomas Mathews or Matthews (**Advice** to *the* Young *Whist* Player, 1804), James Clay, Guillaume Deschapelles (according to his contemporaries, the finest of all whist players) and finally "Cavendish" (pseudonym of Henry Jones, best known and most respected authority and most prolific writer that whist produced) all assumed the wisdom of playing a "long-suit game" and leading first from one's longest and strongest suit. Their analysis was therefore devoted to signaling devices wherewith one's partner might be informed of one's holdings.

The principal signaling device was the selection of a conventional card to lead; its nature gave information as to the leader's holding. "American leads," a complex schedule devised by Nicholas B. Trist in 1883, were enthusiastically supported by Cavendish and soon were generally adopted on both sides of the Atlantic because they revealed so many more specific combinations of cards than had the "English leads."

The trump signal, proposed by Lord Henry Bentinck in 1834, was another standard device. By playing an unnecessarily high card, and later a lower card of the same suit, one requested one's partner to shift to the trump suit at his first opportunity.

The "rule of eleven" was formulated by Robert F. Foster in 1889, and mas based on the custom of leading the fourth-highest card of a long suit. By subtracting the number of the card led from 11, one knew the number of higher cards not held by the leader.

Preoccupation with the development of signaling devices prevented adequate analysis of the best methods for winning tricks, so that even the best whist players sacrificed trick after trick without discernible care—usually without even noticing that by better play those tricks might have been won instead of lost. Paradoxically, the greatest improvement in whist play came after the turn of the century when bridge. the successor game, had already arrived and whist was moribund.

(E. Cul.; A. H. Md.; H. St. J. I.)

Solo Whist.—This is a combination of whist, bridge and nap. Four players is the usual number, but five can make up a "school"; the player behind the dealer sitting out for that particular deal. Value and number of cards are as in whist, but the deal is slightly different. Three cards are given to each player in rotation for the first 48 cards, and the last 4 are dealt singly, with the last card again turned up as trumps. As will be seen later, trumps can change.

Starting with the player on dealer's left, each must make a bid (or call). Calls in order of value and rank are: pass, proposal, solo *misère,* abundance, open *misère,* declared abundance. Proposal: here the caller contracts to make eight tricks, with any other player who accepts—whatever the position of the players at the table. Solo: the caller to make five tricks with the other three players against him. *Misère:* the caller must not take a single trick. The other three players are against him. There are no trumps. Abundance: a call when declarer contracts to make nine tricks on his own, naming any suit as trumps. Abundance in the original trump suit has preference over abundance calls in other suits. Open *misère:* the player here declares to make no tricks and exposes his hand on the table as soon as first card is led. Declared abundance: caller contracts to make all 13 tricks, naming the trump suit. The original trump suit has preference.

If a player has made a bid and has been overbid by another player, he can amend his call to any still higher call; *e.g., A* calls solo; *B* calls *misère; A* amends his call to abundance. Any player proposing may amend his call to another if no player accepts him. Stakes are in the following proportions. Proposer and acceptor each receive or pay two points. For all individual calls, the other three players pay or receive: solo, 4 points; *misère,* 6 points; abundance, 8 points; open *misère,* 12 points; and declared abundance, 16 points. By agreement, proposal and acceptance may be omitted from the game, and the individual calls then operate.

(H. St. J. I.)

WHISTLER, JAMES ABBOTT McNEILL (1834–1903), **U.S.** painter, was born at Lowell, Mass., on July 10, 1834. Part of his boyhood was spent in court circles at St. Petersburg, Russia, where his father, a military engineer. was in charge of railway building for the tsar. After a brief and unsuccessful period at the United States Military academy. West Point; S.Y., he spent a year as a draftsman and map engraver in the coast and geodetic survey, Washington. D.C., undoubtedly absorbing traditions of technique and surface layout of value in his later work. In 1855 he went to Paris to study painting in the studio of Charles Gleyre. Through A. Legros and H. Fantin-Latour he became aware of the teaching methods of their master, Horace Lecoq de Boisbaudran, which depended on intensive training of the visual memory; such methods made a permanent impression and seem to have counteracted an enthusiasm for the realism of Gustave Courbet which Whistler shared with the young painters of 1855. He also studied in the Louvre, copying from artists as varied as Rembrandt and François Boucher, and from the Manchester exhibition of 1857 gained more knowledge of Velazquez than could be had in France.

The massive forms and sombre tones of Courbet dominate the early works of Whistler, though "At the Piano" (1859; Boston, Mass.) shows that these were combined with a stress on surface arrangement. Works of this period brought Whistler to the notice of Charles Baudelaire, who before 1860 praised his ability to treat fog and darkness on the Thames with something more than a documentary eye. Having settled in London in 1859. he found his work acceptable to the Royal Academy, where "At the Piano" was shown in 1860. Shortly after, Whistler and his now close friend D. G. Rossetti began to introduce into London the taste for Japanese prints and bric-a-brac already current in Paris; and it is not surprising that in such an environment Whistler began to break with the realism of Courbet, with whom he had little fundamentally in common but an unflagging hostility to authority. His "White Girl," shown at the Salon des Refusés of 1863, still showed adherence to Courbet, but was described as "Symphony in White No. 1," the first of the famous series of musical titles indicating a leaning toward abstract harmonies of colour not necessarily dependent on what was to be seen in the model. This consideration militates strongly against attempts to place Whistler with the Impressionists, to whom ocular scrutiny of the subject was vital. By 186j Japanese mannerisms had brought Whistler to the verge of pastiche, as the "Gold Screen" of that year makes clear; but the "Little White Girl," hung at the Royal Academy in the same year, shows that he could extract from Japanese art qualities of composition and line which could be blended with the draftsmanship and tonal interests he had already mastered.

Late in the 1860s his medium became extremely fluid and delicate and his subjects more and more removed from the earlier realism; such works included the "Symphony in White No. 3" (1867; Barber institute, Birmingham), and lie at the roots of the English "aesthetic" movement. By the 1870s, however, a more robust manner emerged, revealing an assimilation of all the various sources discussed; his most famous work, "Mrs. George Washington Whistler" (1872; Louvre, Paris), combines a scrupulous regard for surface harmony with a strong and direct tonality owing much to the art of Velazquez. Whistler called this picture "Arrangement in Grey and Black No. 1," but in view of his known regard for his mother it is hard to support the commonly held view that such titles necessarily indicate a disregard for subject matter. It has also been said that this disregard brought immediate hostility in England; but there is at least one instance of a work of his being refused at the Salon and accepted, as were many others, by the Royal Academy. There is no doubt that Whistler, a close friend of Edgar Degas, was in touch with the Impressionist movement in France, but he did little to foster its success in England and was contemptuous of its brilliance of tone and palette. Following the portrait of his mother and forming his most important group of portraits were the "Thomas Carlyle" (1873; Glasgow) and "Miss Cicely Alexander" (1873; National gallery, London), the former following Velázquez even more clearly than the portrait of his mother, and the latter pointing forward to a phase of English portraiture in which carefully observed tone and agreeable harmonies of line and colour replaced the solemnity and stress on personal character of early Victorian portraiture. Whistler's later portraits. such as the "Yellow Buskin" (1878; Philadelphia Museum of Art) or the "Sarasate" (1884; Carnegie institute Pittsburgh), demonstrate this phase as well as do the works of the younger generation; but it is also noteworthy that W. R Sickert, the dominant figure of that generation in England, was his pupil during the execution of the latter picture, having entered his studio in 1882.

BY COURTESY OF NATIONAL GALLERY. LONDON

"MISS CICELY ALEXANDER" BY JAMES WHISTLER. IN THE NATIONAL GALLERY, LONDON

Meanwhile in landscape Whistler had developed in the 1870s his famous series of "Nocturnes" in which reliance on visual memory rather than on factual observation, and on a preconceived harmony of colour rather than on an imitation of local colour, prevails; his choice of nocturnal urban subjects shows the remoteness of his aims from those of the Impressionists. It was Whistler's artificiality, his dark tones and his supposed unwillingness to scrutinize the matter before him which John Ruskin singled out for attack in his report on the "Nocturne in Black and Gold: the Falling Rocket" (1874; Detroit), shown at the Grosvenor gallery in 1877, which was the cause of the Whistler-Ruskin libel action of 1878. It could thus be argued that Impressionism, which depended on a complex form of naturalism, had more common ground with Ruskin than with Whistler, and that the latter looked forward more to the antinaturalistic reaction of late 19th-century France. It is interesting to find that on his final move to Paris in 1892 he was lauded by J. K. Huysmans and became a friend of Marcel Proust. Whistler was bankrupted after the 1878 trial and from Sept. 1879 to Nov. 1880 lived in Venice. where he reverted to his old craft of etching. On his return to London he was more favourably received by the increasingly hedonistic society of those years; his Venetian etchings were popular and his portraits fashionable.

In 1885 he delivered his famous "Ten O'Clock" lecture which summarized his attitude toward naturalism and the musical analogies suggested by the titles of his works. From 1886 he was president of the Royal Society of British Artists, which during his two years of office was successful in bridging the gap between British and French art, and in setting a new high standard in the display of pictures. In 1891 the portrait of his mother was bought by the city of Paris, and his growing reputation there led to his return in 1892, though he died in Londbn on July 17, 1903.

Whistler's "Ten O'clock" lecture was published in 1880 and his *The Gentle Art of Making Enemies* appeared in 1890.

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WHISTON, WILLIAM (1667–17j2), English theologian and mathematician, was born at Norton in Leicester on Dec. 9, 1667. He was educated privately and at Clare college. Cambridge, where he studied mathematics and obtained a fellowship in 1693. He next became chaplain to John Moore, bishop of Norwich, from whom he received the living of Lowestoft in 1698. His *New Theory of the Earth* (1696) received the praise of both Newton and Locke. In 1701 he resigned his living to become deputy at Cambridge to Sir Isaac Newton, whom he succeeded, two years later as Lucasian professor of mathematics. In 1707 he was Boyle lecturer. For several years Whiston continued to write and preach with considerable success. However, his study of the *Apostolical Constitutions* had convinced him that Arianism was the creed of the primitive church and his heterodoxy soon became notorious. In 1710 he was deprived of his professorship and expelled from the university. He vindicated his estimate of the *Apostolical Constitutions* and the Arian views he had derived from them in his *Primitive Christianity Revived* (j vol., 1711–12). In 1713 he produced a reformed liturgy. and'soon afterward founded a society for promoting primitive Christianity.

One of the most valuable of his books, the *Life of Samuel Clarke,* appeared in 1730. His useful and often reprinted translation of Josephus, with valuable notes and dissertations, was printed in 1737, and his *Primitive New Testament* appeared in 1745. His best-known opinion is his advocacy of clerical monogamy, immortalized in the *Vicar of Wakefield.* He died in London on Aug. 22. 1752, leaving a memoir (3 vol., 1749–50) noteworthy for its illustrations of the religious and moral tendencies of the age.

WHITBREAD, SAMUEL (1758–181j), English politician, well-known as a social reformer and as the opponent of abuses of all sorts, was the son of the founder of the famous London brewery, and was born at Cardington, Bedfordshire, in 1758. He was educated at Eton. at Christ Church. Oxford, and at St. John's, Cambridge. After managing the family business for several years, in 1789 he married Elizabeth, daughter of the 1st Earl Grey and sister of his old schoolfellow, afterward prime minister. Taking to politics, he was elected M.P. for Bedford in 1790 as a supporter of Fox; he sat for that borough until his death. His campaign for purity in public life effectively started in 1805 when he led the attack on Lord Melville, who was suspected of malpractices in the naval department; and he was one of the managers of the impeachment. In 1809 he attacked the duke of York, the commander in chief, who was implicated in the Mrs. Clarke scandals; and in 1810 he ruined the reputation of Lord Chatham when he attacked him for mismanaging the Walcheren expedition.

He was an uncompromising pacifist, favouring a negotiated pence with Napoleon. The poor had no greater friend in parliament. He favoured a statutory minimum wage for agricultural labourers, elementary schools for all and a reformed poor law. He continued to advocate parliamentary reform and Catholic emancipation at a time when many Whigs, in view of the unpopularity of these questions, desired to shelve them. He committed suicide in London on July 6, 181j, as a result. it was thought, of ill-health caused by anxiety in connection with his efforts to rebuild Drury Lane theatre, which had burned down in 1809. (A. AL.)

WHITBY, a market town, holiday resort and urban district in the Scarborough and Whitby parliamentary division of the North Riding of Yorkshire, Eng., 46 mi. N.N.E. of York by road. Pop. (1951) 11,674. Area 4 sq.mi. Situated on the cliff-bound northeast coast, backed by some of the most magnificent moorland scenery in the county, Whitby is divided by the mouth of the river Esk, where it flows into the harbour. The old town clusters on the slopes of East Cliff, dominated at its summit by the ruined abbey; the modern, residential quarter, with promenades and the Spa Floral pavilion, etc., is mainly on West Cliff, with nearly 3 mi. of sands below. Whitby is the seat of a bishop suffragan in the diocese of York. Bede mentions that the town called Streanaeshalch, the Saxon name for Whitby, was the seat of a religious house, founded on the site of the abbey in 656. It included establishments for monks and, until the Conquest, for nuns of the Benedictine order. Its abbess, Hilda, opposed the claims of Rome at the synod of Whitby in 664. Caedmon, the cowherd who became a lay brother and the "father of English sacred song," died there in 680, the same year as St. Hilda. The abbey ruins remaining comprise parts of the Early English choir, the north transept of slightly later date and a richly Decorated nave. The south side of the nave fell in 1763 and the tower in 1830. On the south side were the cloisters and domestic buildings. Adjoining the abbey is the Abbey house, built about 1580 from the materials of the monastic building. A little below the abbey is the parish church of St. Mary, originally Norman.

Whitby owes its present name to the Danes. who sacked the town in the 9th century, subsequently refounding it as a Danish colony. William the Conqueror destroyed it again, after it had become the most prosperous town in the district. Henry I made a grant of a burgage to the abbot and convent of Whitby and, toward the end of the 12th century, the abbot granted the town a free burgage to the burgesses. In 1220 King John, bribed by them, confirmed this charter, but afterward, on being bribed by the abbot, quashed it as injurious to the dignity of the church of Whitby. The struggle continued until the 14th century. when a trial resulted in judgment against the burgesses. At the beginning of that century Sir Alexander Percy claimed the hereditary right of buying and selling in Whitby without payment of toll. After the reign of Henry VI the weekly market was held on Saturdays. In 1629 Whitby petitioned for incorporation and received letters patent giving it self-government. In 1674–75, however, the crown restored to the lords of the manor all liberties ever enjoyed by the abbots of Whitby. Having been a port since the 12th century at least. Whitby ranked seventh in England in 1828. Capt. James Cook, R.N., the circumnavigator, lived there, and it was Whitby that constructed the ships for his voyages to Australia in 1769–7j.

Since medieval times, herring fishing has formed the staple industry; although whale fishing began in 1753. The Whitby fleet is joined during the season by Scottish herring boats, and an annual "blessing of the sea" takes place in August. Alum, from the surrounding rocks. was manufactured there between the 17th and 19th centuries. Jet, which was once mined locally, is now only used by a few remaining craftsmen. Deposits of potash near R'hitby are estimated as sufficient to meet Great Britain's need at least until the end of the 20th century. The Chapman wings, added to the Pannett Art gallery and Whitby museum, were opened in 19j3.

WHITCHURCH, a market town and urban district in the Oswestry parliamentary division of Shropshire, Eng.. 20 mi. N.N.E. of Shrewsbury by road. Pop. (1951) 6,856. Area 9.5 sq.mi. It is a residential town for an agricultural community with biweekly cattle markets, a museum and art gallery. a grammar school founded in 1j50 and St. Alkmund parish church in which are commemorated John Talbot, 1st earl of Shrewsbury, Sir Edward German! the composer, and Randolph Caldecott, the humorous artist. Whitchurch has made turret clocks since the mid-17th century. In the middle ages Whitchurch with its fortress Weston castle was a military stronghold guarding the Welsh Marches.

WHITE, ANDREW DICKSON (1832–1918), U.S. educator and diplomat, founder and first president of Cornell university, Ithaca, N.Y., was born in Homer, N.Y., on Nov. 7, 1832. He graduated from Yale (A.B.) in 1853 and studied in Europe for the next three years, serving also as attaché at the U.S. legation at St. Petersburg during 1854–55. He returned to the United States to become professor of history and English literature at the University of Michigan, Ann Arbor. In 1865 White's dream of a state university for New York—based on liberal principles in regard to religion, coeducation, race and science—was realized when Cornell university was chartered, with the aid of a gift of money from Ezra Cornell and a land grant from the state, under the Morrill act. As Cornell's first president, White devoted his best energies and much of his wealth to assure its success and future growth. White served on numerous government commissions and was United States minister to Germany (1879–81) and Russia (1892–94) and ambassador to Germany (1897–1903). In 1899 he was president of the U.S. delegation at the Hague peace conference. The most outstanding of his completed works are *A History of the Warfare of Science With Tlzeology in Christendom* (1896) and *Seven Great Statesmen in the Warfare of Humanity With Unreason* (1910). He died at Ithaca, N.Y., on Nov. 4, 1918. The rich collection of books that he gave Cornell university is housed in a special room in the main library.

WHITE, EDWARD DOUGLASS (1845–1921), US. jurist, first associate justice of the supreme court to become chief justice of the United States. White's career was filled with striking contrasts; a Confederate veteran. a Roman Catholic and a southern Democrat, he mas appointed chief justice by the Republican and Unitarian president, William Howard Taft, nhose family had been loyal to the Union. Essentially a conservative, White, through his major decisions, helped to free the law from outmoded concepts. A vigorous exponent, while senator from Louisiana, of legislation to protect special interests, as chief justice he struck at legal interpretations which would advance the economic good of one section at the expense of another.

White's ancestry was English and Irish; from both his father and mother he inherited a tradition of allegiance to Roman Catholicism. The elder Edward Douglass White was trained as a lawyer and became a judge, a member of congress and seventh governor of the state of Louisiana. The second Edward Douglass White. the youngest of four children, was born Nov. 3, 1845, on the family plantation near Thibodaux, Lafourche parish. La, and attended a Jesuit school in New Orleans and Mount St. Mary's, Emmitsburg. Md., before enrolling at Georgetown college, D C., in 1857. When the American Civil War began, the 15-year-old boy left college unceremoniously and never again attempted to secure a formal education After a short career and capture in the Confederate army, White entered the law officeof Edward Bermudez in New Orleans and was admitted to practise in Louisiana in 1667. His training was in the Roman, or civil, law; White never formally studied philosophy, and later allegations that he was a probabilist undoubtedly derive partially from his style and partially from his civil-law training.

White's legal career was successful; he also joined the Democratic party and participated in turbulent state politics. He was elected state senator in 1874 and again in 1876 and was then named associate justice of the state supreme court in 1878. Two volumes of *Louisiana Annotated Reports* contain White's decisions. From 1881 to 1891 his interest in politics remained active, although he held no office. During this period he associated himself with the formation of Tulane university and with other civic programs.

In 1891 White was elected to the United States senate and served there until his nomination as an associate justice of the supreme court by Pres. Grover Cleveland in 1894. White accepted the nomination but remained in the senate until the Wilson-Gorman tariff safely included a bounty for domestic sugar producers sure to benefit his constituents.

On the supreme court bench, from 1894 to 1910, White's distinction lay in his dissenting opinions in the *Income Tax Cases* and in his concurring and dissenting opinions in the *Insular Cases*, in which he was chiefly responsible for formulating the doctrine of incorporated and unincorporated territories. The White doctrine has remained as the operative principle in congressional and judicial handling of territorial questions. White also wrote opinions or dissents in cases involving interpretation of the Interstate Commerce act. His writing in this field, believed to include his greatest contributions to the law, spanned his entire period of service on the bench and assisted in the formation of American administrative law.

In 1910, upon the death of Chief Justice Melville Weston Fuller, White was appointed his successor by President Taft. As chief justice he aroused comment for his decisions in the *Standard Oil* and *American Tobacco* cases. White declared that the Sherman act's phrase "restraint of trade" had to be interpreted according to the "rule of reason." This rule was the standard applied by reasonable men to the manufacture or distribution of goods. White was castigated for importing from scholastic philosophy into law a dictum so nebulous and was defended on the ground that his use of the phrase was neither novel nor condemnable; his construction has continued to be invoked.

While chief justice, White acted as arbitrator in a boundary dispute between Panamá and Costa Rica; the line fixed by him was not questioned during his lifetime. He handed down decisions in *Knowlton* v. *Moore*, an income-tax case following the adoption of the 16th amendment, and in *Arver* v. *United States* (better known as the *Selective Draft Law Case*). These he regarded as among his best decisions: both of them, like the bulk of the cases in which he wrote—there were nearly a thousand—reflected a conservative and nationalistic attitude, rather than the liberal one then noticeable in other jurists or the states'-rights attitude he might have been expected to adopt.

White died in Washington on May 19, 1921. All his papers had been destroyed during his lifetime, but his law library was given to Loyola university, New Orleans. Outside the Cabildo, in that city, there is a statue of White, and another was Louisiana's choice for one of the state's representatives in the statuary collection in the Capitol in Washington. The University of Chicago named a law lecture hall for him; Louisiana State, Tulane and Georgetown universities have sponsored series of lectures in his honour. Letters scattered through manuscript collections of prominent figures of his time indicate that he numbered among his friends Pres. Theodore Roosevelt and James Cardinal Gibbons; Oliver Wendell Holmes and Charles Evans Hughes spoke of him with respectful affection.

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(M. C. K.)

WHITE, SIR GEORGE STUART (1835–1912), British soldier who commanded the British force which nithstood the siege of Ladysmith (*q.v.*) during the South African War, was born at Whitehall, County Antrim, on July 6, 1835. Educated at Sandhurst, he joined in 1853 the Inniskillings, with whom he served during the Indian mutiny in 1857. In the second Afghan War (1878–80) he was second in command of the Gordon Highlanders, whom he led at the battle of Charasiah, receiving the Victoria cross. After Sir Frederick (afterward Lord) Roberts had left Burma in 1887, White suppressed the dacoits there. Promoted major general in 1889, he succeeded Lord Roberts in 1893 as commander in chief in India, in which office he directed the Chitral expedition in 1895 and the Tirah campaign in 1897. Returning to England in 1898 he became quartermaster general, and on the outbreak of the Boer War in 1899 was given command of the forces in Natal, defeating the Boers at Elandslaagte on Oct. 21, 1899, and at Reitfontein on the 24th; but the superior numbers of the Boers enabled them to invest Ladysmith, which he defended in a siege from Nov. 1, 1899, to Feb. 28, 1900, during which he turned down Sir Redvers Buller's suggestion that he should arrange terms of capitulation with the enemy.

After the relief of Ladysmith, White returned to England and became governor of Gibraltar (1900–04). He was made field marshal in 1903 and received the order of merit in 1905. He died in London on June 24, 1912.

See T. F. G Coates, *Sir George White* (1900).

WHITE, GILBERT (1720–1793), English naturalist, famous as the author of *The Natural History and Antiquities of Selborne,* was born at Selborne, near Alton, Hampshire, on July 18, 1720, and died there on June 26, 1793. The eldest of 11 children, he was educated at Basingstoke grammar school and Oriel college, Oxford (1740–43), of which he became a fellow for half a century, nonresident except for his probationary year and 1752–53, when he served as junior proctor of the university. Unlike his grandfather, who bore the same name, he never became vicar of Selborne, where he served intermittently as curate. He never married, suffered no serious illness except smallpox and, although he traveled often, seems never to have gone beyond the southern and midland regions of England. Although by no means a recluse, he took little part in affairs or in movements of opinion, and was defeated in his most ambitious venture as candidate for the provostship of Oriel in 1757. It was probably a scientific neighbour in Hampshire, Stephen Hales (*q.v.*), who persuaded him to keep a journal in 1751, and this was originally devoted to events in his garden. In 1765 it evolved into a *Calendar of Flora and the Garden* and in 1768 into *The Naturalist's Journal,* in a form of book designed and sent to him by the antiquary and naturalist the Hon. Daines Barrington, whom he first met in London the following year, and who became his friend and correspondent. To him and to Thomas Pennant (*q.v.*) the main substance of what became *The Natural History of Selborne* was addressed in the form of private letters over about 14 years, often answering some query put to White by his two pertinacious correspondents. Both, in letters written by 1771, suggested his publishing something. To one of these White replied on July 19 in that year:

> As to any publication in this way of my own, I look upon it with great diffidence, finding that I ought to have begun it twenty years ago. But if I was to attempt anything it would be somewhat of a Nat: history of my native parish. . .

Encouraged by the Royal society's favourable reception of his papers on swallows and martins in 1774, he actively prepared to go into print, but not until 14 years later, in 1788 (dated 1789), was the *Natural History of Selborne* published. Its simple charm and timeless nierit were instantly recognized, and its consistent appeal is shown by the steady flow of reprints and editions. It consists of 44 letters addressed to Pennant and 66 to Barrington, but reference to the original correspondence shows many suppressions, rewritings, additions, rearrangements, changes of date and use as letters of essays written specially.

White's extensive yet curiously unsystematic editing of his material can be traced in detail but can hardly be explained satisfactorily. As a natural history the work is very incomplete even on the basis of what White himself is known to have had at hand in his journals. In one late addition to Letter XL to Pennant, White states that Selborne parish "has produced more than one hundred and twenty species" of birds, but these are nowhere listed, nor is the status of many made clear. Anecdotes were sought out and included to balance and relieve the more solid observations and analyses. The letter form is disarming and makes *Selborne* an easy and pleasant book to dip into. Controversy and enthusiasm are played down, and the reader is skillfully led to identify himself uith the author's good-tempered and patient but very human endeavours to find out the truth by methods available to all.

It is in this capacity for communicating the pleasures and the simple and enduring means of pursuing natural history studies that the *Natural History of Selborne* excels. While Gilbert White made a number of important discoveries in natural history which are described in his work, these play little part in keeping alive the keen interest of successive generations of readers. He appeals, without rhetoric or artificiality, to man's sense of wonder about nature and to the desire to know how to find out more about it at firsthand. The work's many shortcomings as a comprehensive and accurate account of its ostensible subject matter little; it still achieves what it was meant to achieve.

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WHITE, HENRY (1850–1927), U.S. diplomat, was born in Baltimore, Md., on March 29, 1850. He was educated privately and spent much of his early life in England, Italy, Germany and France. He entered the diplomatic service in 1883 as secretary at the United States legation in Vienna and in the following year was transferred to London, where he served until 1893, and from 1897 to 1905. He was U.S. representative at the International conference in 1887–88, and in 1905 was U.S. delegate to the International Conference on Agriculture. He was appointed ambassador to Italy in March 1905 and from 1907 to 1909 served as ambassador to France. In 1910 President Taft appointed him chairman of the U.S. delegation to the 4th Pan-American conference in Buenos Aires. As a member of the U.S. delegation to the Paris Peace conference in 1918–19 he worked for U.S. entry into the League of Nations. He died on July 15, 1927.

See Allan Nevins, *Henry White: Thirty Years of American Diplomacy* (1930).

WHITE, HENRY KIRKE (1785–1805), English poet, was born at Nottingham, the son of a butcher, on March 21, 1785. He was articled to a lawyer. Capel Lofft encouraged him to publish *Clifton Grove, a Sketch in Verse, with other Poems,* dedicated to Georgiana, duchess of Devonshire. The book was violently attacked in the *Monthly Review* (Feb. 1804), but White was in some degree compensated by a kind letter from Robert Southey. Through the efforts of his friends, he was entered as a sizar at St. John's college. Cambridge. spending a year beforehand with a private tutor. Close application to study induced a serious illness, and fears were entertained for his sanity, but he went into residence at Cambridge, with a view to taking holy orders, in the autumn of 1805. The strain of continuous study proved fatal, and he died on Oct. 19, 1806. He was buried in the church of All Saints, Cambridge. Much of his fame was due to sympathy inspired by his early death, but Byron agreed with Southey in forming a high estimate of the young man's promise.

His *Remains,* with his letters and an account of his life, were edited by Robert Southey, 3 vol. (1807–22). *See* prefatory notices by Sir Harris Nicolas to his *Poetical Works* (new ed., 1866) in the "Aldine Edition" of the British poets; by H. K. Swann in the volume of selections (1897) in the *Canterbury Poets;* and by John Drinkwater to the edition in the "Muses' Library." *See* also J. T. Godfrey and J. Ward, *The Homes and Haunts of Henry Kirke White* (1908).

WHITE, HUGH LAWSON (1773–1840), U.S. statesman, was born in Iredell county (N.C.), Oct. 30. 1773. In 1787 he crossed the mountains into East Tennessee (then a part of North Carolina) with his father, James White (1737–1815). Hugh became in 1790 the secretary to Gov. William Blount, and in 1792–93 served under John Sevier against the Creek and Cherokee Indians, and according to the accepted tradition, killed with his own hand the Cherokee chief, Kingfisher. He studied in Philadelphia, and in 1796 he was admitted to the bar at Knoxville. He was a judge of the superior court of Tennessee (1801–07), a state senator (1807–09), and (1809–15) was judge of the newly organized supreme court of errors and appeals of the state. From 1812 to 1827 he was president of the State Bank of Tennessee, the only western bank that in the trying period during and after the War of 1812 did not suspend specie payments. In 1821–24 he was a member of the Spanish Claims commission and in 1825 succeeded Andrew Jackson in the U.S. senate, serving until 1840 and being president *pro tem.* in 1832–34. In the senate he supported in general the measures of President Jackson, though his opposition to the latter's indiscriminate appointments caused a coolness between himself and Jackson. In 1830, as chairman of the committee on Indian affairs, he secured the passage of a bill looking to the removal of the Indians to land west of the Mississippi. He was opposed to Van Buren, Jackson's candidate for the presidency in *1836,* was himself nominated in several states as an independent candidate, and received the *26* electoral votes of Tennessee and Georgia. About *1838* he became a Whig in politics, and when the Democratic legislature of Tennessee instructed him to vote for Van Buren's subtreasury scheme he objected and resigned (Jan. *1840).* His strict principles and his conservatism won for him the sobriquet of "The Cato of the United States senate." He died at Knoxville, April *10, 1840.*

WHITE, RICHARD GRANT (1821–1885), U.S. scholar, philologist and essayist, best known for his editions and criticisms of Shakespeare, was born in New York city on May *23, 1821.* He graduated from the University of the City of New York in *1839,* studied medicine and then law, and was admitted to the bar in *1845.* He contributed musical criticism to the *New York Courier and Enquirer,* of which he was coeditor from 1851 to 1859, and was briefly on the staff of the *New York World* when that paper was established in *1860.* He then obtained appointment as a chief clerk in the New York customhouse (1861–78). In *1853 Putnam's Magazine* published his destructive, anonymous criticism of the Shakespeare folio manuscript emendations of John Payne Collier (*q.v.*) a criticism which mas republished with other papers in his *Shakespeare's Scholar (1854).* During the Civil War, under the pseudonym "A Yankee," he contributed a series of articles to the *Spectator* (London) which greatly influenced English public opinion in favour of the North; his satire *The New Gospel of Peace According to St. Benjamin (4* vol., *1863–66)* was an influential answer to pro-Southern propaganda. White's Shakespearean scholarship includes a 12-vol. edition of Shakespeare *(1857–66)* containing textual notes, and an *1883* edition in *3* vol. appending a more elaborate historical and critical commentary. In *Memoirs of the Life of William Shakespeare (1865)* he rejected the idea that Shakespeare revealed a central moral philosophy in his plays. White died in New York on April *8, 1885,*

Stanford White (*q.v.*), the architect, was White's son.

WHITE, STANFORD (1853–1906), U.S. architect, *a* member of the most successful and influential architectural firm in American history, was born in New York city on Nov. *9,* 1853, the son of the literary critic Richard Grant White (*q.v.*). His instinct for decoration was inspired, and he was carefully trained as a draftsman by H. H. Richardson while the latter was completing Trinity church, Boston. In *1879* he joined Charles Follen McKim and William Rutherford Mead to found McKim, Mead & White. Until *1887* the firm excelled at informal shingle buildings, and White designed one of the subtlest of these, the Casino *(1881)* at Newport, R.I. In later years the firm championed the formal tradition of the Renaissance. Among the celebrated examples of the formal planning of White are the Villard houses, New York city, completed as early as *1885,* and four other New York landmarks, the Century club, the Herald building, Madison Square Presbyterian church and Madison Square Garden.

On June *25, 1906,* he was murdered at the Garden by Harry Thaw, who was adjudged insane.

See Charles C. Baldwin, *Stanford White* (1931) ; also Wayne Andrews, *Architecture, Ambition & Americans* (1955). (W. As.)

WHITE, SIR THOMAS (1492–1567), founder of St. John's college, Oxford, was a son of William White, a clothier, and was born at Reading. He became a merchant in London and a member, and then master of the Merchant Taylors' company; growing wealthier he became an alderman and sheriff of the city of London. One of the promoters of the Muscovy company, he was knighted in *1553,* and chosen lord mayor. He defended the city against Sir Thomas Wyat and his followers, and took part in the trial of the rebels, as he had done in the case of Lady Jane Grey. In 1555 White received a licence to found a college at Oxford, which, dedicated to the Virgin Mary and St. John Baptist, was opened in *1560.* He died at Oxford on Feb. *12, 1567,* and was buried in the chapel of St. John's College. White had some share in founding the Merchant Taylors' School in London.

WHITE, WILLIAM (1748–1836), American Protestant Episcopal bishop, the first consecrated for the American church by the English bishops and the first presiding bishop of the Protestant Episcopal Church, was born on April *4, 1748,* in Philadelphia. His whole life and ministry was spent in that city during the years that it served as the cradle of American liberty. He was educated at the College and Academy of Philadelphia (later to become the University of Pennsylvania), a school founded by Benjamin Franklin to train men for citizenship at a time when most colleges in America were devoted to the training of men for the ministry.

The influence of White's education was reflected in his pamphlet *The Case of the Episcopal Church in the United States Considered* (1782), in which, referring to the fact that before the Revolution Americans went to England for ordination, he suggested that if the American church could not obtain bishops from England it would have to establish its own episcopate. Overnight White became one of the recognized leaders of the Church of England in America, respected both by those who did and those who did not agree with him. After the war with Britain the scattered remnants of the Church of England in America organized themselves as the Protestant Episcopal Church and sent White and Samuel Provoost (*q.v.*) to England for consecration as their native bishops *(1787).* Because Samuel Seabury (*q.v.*), who had been refused consecration by the English bishops and had gone to the nonjuring bishops of Scotland for ordination (1784), was not recognized by some sections of the American church, a division of the church appeared to be imminent. When a third American, James Madison, of Virginia, had been consecrated by the English bishops, White was able to create unity by bringing the four together in *1792* to consecrate the first bishop on American soil, Thomas Claggett.

White was influential in shaping the new American church and in the revision of the Prayer Book. He was presiding bishop in *1789* and again from *1795* until his death, on July *17, 1836.* His interests were doctrinal as well as practical, and he wrote pamphlets and contributed articles to church periodicals on doctrinal subjects throughout his long life.

BIBLIOGRAPHY.—Complete bibliographies of White's works are available in: Bird Wilson, *Memoir of the Life of the Right Reverend William White* (1839) ; William White, *Life and Letters,* ed. *by W.* H. Stowe (1937) ; S. A. Temple, Jr., *The Common Sense Theology of Bishop White* (1946). *See* also William White, *Memoirs of the Protestant Episcopal Church in the U.S.A.* (1820) ; J. H. Ward, *The Life and Times of Bishop White* (1892) ; *W.* W. Manross, *William White,* Pamphlet (1934). (S. A. T., JR.)

WHITE, WILLIAM ALLEN (1868–1944), U.S. journalist, whose mixture of generous tolerance and provincialism made him the epitome of the small-town American, was born in Emporia, Kan., on Feb. 10, *1868.* He left the University of Kansas to become business manager of the *El Dorado* (Kan.) *Republican.* In *1891* he went to Kansas City as an editorial writer on the *Star;* in *1895* he purchased the *Emporia Daily and Weekly Gazette.* An editorial written in *1896* entitled "What's the Matter With Kansas?", an impassioned plea against Populism, made him and his paper nationally famous. Three books of short stories, *The Real Issue* (1896), *The Court of Boyville (1899)* and *Strategems and Spoils (1901)* and a volume of sketches, In *Our Town* (1906), gave him a wide reputation as an interpreter of rural life in the middle west. In *1909* he published his first novel, *A Certain Rich Man,* which passed through many. editions. Then followed *The Old Order Changeth* (1910), *God's Puppets* (1916), *In the Heart of a Fool (1918)*; *The Life of Woodrow Wilson* (1924), *Calvin Coolidge: the Man Who Is President* (1925), *Masks in a Pageant (1928)* and *A Puritan in Babylon (1938).* In *1937* he published the autobiographical *Forty Years on Main Street,* and in *1939, The Changing West.* His best editorials mere collected by Helen 0. Mahin in *The Editor and His People (1924).* White's *Autobiography* appeared in *1946,* followed a year later by Walter Johnson's *Selected Letters, 1899–1943.* White won the *1923* Pulitzer prize for editorial writing.

White was active for *40* years in the Republican party; he served on many committees and commissions, but refused to run for political office. He died in Emporia on Jan. *29, 1944.*

See Walter Johnson, *William Allen White's Anzerica* (1947).

WHITE, WILLIAM HALE: *see* RUTHERFORD, MARK.

WHITE, SIR WILLIAM HENRY (1845–1913), English naval architect who revolutionized the design of all British warships, was born at Devonport, Devon, on Feb. 2, 1845. In 1881 he became chief constructor at the admiralty and was also instructor at the Royal School of Naval Architecture, London, and later at the Royal Naval college, Greenwich. His lectures were embodied in his *Manual of Naval Architecture* (1877). In 1883 he left the admiralty to organize the shipyards of Armstrong and Co., at Elswick, Northumberland. for the construction of large warships but returned to the admiralty in April 1885 as director of naval construction and, until his retirement in 1902, was responsible for the design and construction of all ships (more than 200) added to the British navy. His ideas were also nidely adopted abroad. He was active in support of W. Froude, nho established ship propulsion on a scientific basis, and also contributed largely to papers read and discussions held before the Institution of Naval Architects. White was elected a fellow of the Royal society in 1888 and made knight commander of the Order of the Bath in 1895. He was president of the Institution of Civil Engineers in 1903 and died in London on Feb. 27, 1913.

(L Wo)

WHITE ANT: *see* TERMITE; SOCIAL INSECTS.

WHITEBAIT (Fr. *Blanchaille*), the name given to the fry of the herring and sprat, and formerly erroneously thought to be a distinct species, *Clupea alba*. These young fish, which are much esteemed for the table, are found in large numbers in estuaries (Firth of Forth, Thames. etc.) and at certain times along the coast, but it appears that the large concentrations which make the fishery a commercial success occur only in estuaries.

In spite of the large numbers of whitebait caught, it is improbable that this has any noticeable effect on the subsequent herring fisheries In America the young of a species of silverside (*Menidia beryllina*) are similarly sold as whitebait.

WHITE FATHERS (SOCIETY OF MISSIONARIES OF AFRICA), a Roman Catholic international missionary society of priests and brothers nhose sole field of activity is Africa, was founded in North Africa in 1868 by the archbishop of Algiers, Cardinal Charles M A Lax-igerie (*q v*). The society's first missions were in northern Algeria. In 1878 its members founded the first Catholic missions in the Great Lakes region of central Africa, and in 1895 the society extended its work to West Africa. Final papal approval was granted the society in 1908, and in 1952 the general headquarters was transferred from Algiers to Rome. The American province was established in 1948.

See Glenn D Kittler, *The White Fathers* (1957). (J. A. RI.)

WHITEFIELD, GEORGE (1714–1770), a great preacher of the Evangelical Revival in both Great Britain and America, who as a young man worked with the Wesley brothers, was born on Dec. 16, 1714. at Gloucester. In 1732 he entered as a servitor at Pembroke college, Oxford, where he came under the influence of the Methodists (*see* WESLEY, JOHN).

Whitefield was made deacon and took his degree in 1736, and then was invited by Wesley to go as a missionary to the colony of Georgia. Before leaving in 1738, he preached to great crowds in some of the principal London churches. After three months at Savannah he returned to England to receive priest's orders and to raise contributions for an orphanage. As the clergy did not welcome him to their pulpits because of his connection with Methodist societies, he began to preach in the open air. His addresses soon attracted crowds, held spellbound by his fervour and dramatic action, while his homely pathos broke down all resistance. He preached in Wales and the west country before embarking in Aug. 1739 for America, where he spent two years preaching in all the larger towns of the English colonies. His journals give a detailed account of these journeys.

On his return to England in 1741, Whitefield found that Wesley was diverging from Calvinist doctrine? so he withdrew from the Wesleyan Connexion. Thereupon his friends in London built for him a wooden church, named the Moorfields tabernacle. A reconciliation was soon effected between the two evangelists, but each henceforth went his own way. Whitefield then paid a visit to Scotland but refused to limit his ministrations to one sect, the Seceders, who had invited him. He broke with them and continued his tour, being received everywhere with enthusiasm. Next he went to Wales, where he married a widow named Elizabeth James. After a second visit to Scotland (1742) and a tour through England and Wales (1742–44) he spent four years in America (1744–48). On returning to England he was appointed one of the chaplains to Selina, countess of Huntingdon (*q.v.*).

The remainder of Whitefield's life was spent chiefly in extensive and exhausting evangelizing tours in Great Britain, Ireland and America. In 1753 he compiled his hymnbook, and in 1756 he opened the Congregational chapel which bears his name in Tottenham Court road, London. In 1769, worn out by his labours, he returned to America and arranged for the conversion of his orphanage into Bethesda college. He died on Sept. 30, 1770, in Nenburyport, Mass.

His influence on religious life in both America and Great Britain was immense. "The Congregational Churches of New England, the Presbyterians and the Baptists of the Middle States, and the mixed colonies of the South, owe their later religious life and energy mostly to the impulses given by his powerful ministrations" (Abel Stevens, *The Centenary of American Methodism*, 1865). His work is said to underlie the founding of some 50 colleges and universities in the United States (including Princeton and Pennsylvania universities). In England he was often criticized and depreciated. but as a preacher he had great influence in awakening the religious conscience of the 18th century. An Anglican priest, he nas a pioneer of all the characteristic forms later adopted by Methodism, and made an important contribution to Calvinistic Methodism in Wales and to Presbyterianism in Scotland. *See* also REVIVALISM.

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WHITEFISH, the name of fishes of the genus *Coregonzrs* of the salmon family. These are silvery fishes with rather large scales, and with a small toothless or feebly toothed mouth; they feed on minute crustaceans. Marine species, entering rivers to breed. are chiefly arctic, but fresh-water species inhabit Europe and North America. especially in lakes. Few species of *Coregonus* reach a length of more than 18 in. For the British species *see* GWYNIAD; VENDACE; *see* also SALMON AND SALMONIDAE.

WHITEHALL, a residential city of Franklin county in central Ohio, U.S., immediately east of Columbus. The name is derived from the White Hall tavern, a stagecoach stop on the National road after it was extended to Columbus in 1833. The hamlet that eventually arose in the vicinity became known as Whitehall. Organized as a village in 1947. Whitehall could claim only 4.877 residents in 1950. In 1956, however, it was incorporated as a city after a special census revealed the population to be nearly 20.000. (For comparative population figures *see* table in OHIO: *Population.*) Chiefly responsible for this remarkable increase was the construction of hundreds of small homes and several large multiple-dwelling rental developments within easy reach of the industries, businesses and offices of Columbus. Water coolers and dehumidifiers are the principal manufactures of Whitehall. Several large shopping centres and the Columbus general depot. a U.S. army installation, are also located there. (J. S. ST.)

WHITEHAVEN, a seaport, market town and municipal borough in the Whitehaven parliamentary division of Cumberland, Eng., 39 mi. S.W. of Carlisle by road and on the Solway firth. Pop. (1961) 27,541. Area 6.7 sq.mi. The harbour has a large dock, a tidal harbour and extensive quayage and exports principally coal and detergents.

From early times it was regarded as the port for St. Bees and ultimately passed into the possession of the priory. It was eventually acquired by Sir John Lowther for his son Christopher, who built the first pier there in 1634. Its real expansion began after 1660 under Sir John Lowther who developed the coal mines and the Irish coal trade. Toward the end of the 17th century a tobacco trade was opened with Virginia and Maryland that made Whitehaven a thriving port and thus brought on the famous raid on the town by John Paul Jones on April 23, 1778.

Shipbuilding and pottery industries flourished until the close of the 19th century. Besides the collieries, which extend beneath the sea, there are engineering works, iron foundries, a silk mill and extensive chemical works.

WHITEHEAD, ALFRED NORTH (1861–1947), British-U.S. philosopher and mathematician, was born Feb. 15, 1861, at Ramsgate, Kent. He specialized in mathematics at Cambridge and became a fellow of Trinity college. He taught mathematics and served as dean of science at University college, University of London. In 1924 Whitehead went to Harvard university as professor of philosophy.

He collaborated with Bertrand Russell in writing *Principia Mathematica* (3 vol., 1910–13), a fundamental study of the structure of mathematical and logical thought. *The Concept of Nature* (1920) is an example of his critical examination of the basic concepts of natural science. Other specific problems in which he was interested are indicated by the following titles: *Religion in tlze Making* (1926), *Tlze Aims of Education* (1929). *The Function of Reason* (1929). At Harvard, Whitehead formulated, in tentative fashion, an organic philosophy. It provided a set of general ideas designed to describe and unify adequately all the complex components of the world. He focused his attention not only on the data of mathematics and the natural sciences but also on the data of the social sciences and, as well, on aesthetic, moral and religious experience. Thus he tried to correct a contemporary overemphasis on natural science and hence provide a more effective guide for civilized living.

Whitehead stressed individuality, creative interaction, change, endurance, value and God. The most complete expression of this, his mature philosophy, is found in his stimulating, nontechnical works, *Science and the Modern World* (1925), *Process and Reality* (1929) and *Adventures of Ideas* (1933).

Whitehead's work in mathematics and logic exerted a decisive influence in symbolic logic. His philosophy of education was efficacious in England. The value of Whitehead's comprehensive philosophical system, however, is still debated. His ideas were sometimes expressed in abstruse language, but they were supported by illuminating references to history and everyday life. He died Dec. 30, 1947, at Cambridge, Mass. *See* also references under "Whitehead, Alfred North" in the Index volume.

See A. H. Johnson, *Whitehead's Theory of Reality* (1952), introduction to *The Wit and Wisdom of Whitehead* (1949), *Whitehead's Philosophy of Civilization* (1958). (A. H. J.; X.)

WHITEHEAD, ROBERT (1823–1905), English inventor, was born at Bolton-le-Moors, Lancashire, on Jan. 3, 1823, the son of James Whitehead, owner of a cotton-bleaching business. In 1837 he was apprenticed to a firm of engineers in Manchester, and in 1844 joined his uncle at the works of Philip Taylor and Sons, Marseilles. In 1847 he set up a business of his own in Milan, later joining the staff of the Austrian Lloyd company at Trieste, where he was manager from 1850 to 1856. In 1856 he began to work for the Stabilimento Tecnico Fiumano, building several Austrian warships, and carrying out preliminary experiments for the Whitehead torpedo, completed in 1866. In 1872 Whitehead bought the Stabilimento Tecnico Fiumano, converting the works entirely to the production of torpedoes and their accessories. *(See* TORPEDOES.) In 1876 he improved his torpedoes with the "servo-motor," and gradually increased their speed. His work was perfected in 1896 by Obry's invention, subsequently acquired and improved by Whitehead, of the gyroscope, which guaranteed precision of aim.

See G. E. Armstrong, *Torpedoes and Torpedo Vessels* (1901).

WHITEHEAD, WILLIAM (1715–1785), English poet laureate who "simply lived — and just as simply died." A prosperous baker's son, born at Cambridge early in Feb. 1715, he was educated at Winchester college and Clare hall, Cambridge. His epistle "On the Danger of Writing Verse" appeared in 1741. In 1745 he became tutor to the son of the earl of Jersey, through whose influence he was appointed poet laureate on Colley Cibber's death in 1757. Obliged each year, as he wrote in his "Pathetic Apology for All Laureats Past, Present and to Come," to compose two odes "As innocent as a Gazette," he produced, in Horace Walpole's phrase, "no more poetry than is necessary for a laureate." After the success of his best play, *The School for Lovers* (1762), he read plays for David Garrick. He died in Westminster, April 14, 1785. He was a modest man and, unlike many earlier laureates, not a party propagandist.

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WHITE HORSE, VALE OF, the name of the valley of the Ock, which joins the Thames from the west at Abingdon, Berkshire, Eng. The vale is flat and well wooded, contrasting with the close-cropped turf covering the chalk of the White Horse hills on the south. On the north a lower ridge separates it from the upper Thames valley; but local usage sometimes extends the vale to cover all the ground between the Cotswolds (on the north) and the White Horse hills. Wantage is the only town in the heart of the vale, but upon the lower hill slopes villages are numerous. Toward the west, above Uffington, the hills reach a culminating point of 856 ft in White Horse hill. In its northern flank, a gigantic figure of a horse is cut, the turf being removed to show the white chalky subsoil beneath. This figure gives name to the hill, the range and the vale. It is 374 ft. long and of the rudest outline, the neck, body and tail varying little in width. Its origin is unknown. The figure, with others of a similar character elsewhere in England, is considered to be of high antiquity, dating from the late Iron Age. Many ancient remains occur in the vicinity of the Horse. On the summit of the hill there is an extensive and well-preserved circular earthaork known as Uffington castle. Within a short distance are Hardwell castle, a square work, and, near Ashdown park, a small camp traditionally called Alfred's. A smooth, steep gully on the north flank of White Horse hill is called the Manger, and to the west of it rises a bald mound named Dragon's hill. The name, properly Pendragon, is a Celtic form signifying "chief of kings," and may point to an early place of burial. To the west of White Horse hill lies a megalith called Wayland Smith's cave. The White Horse itself has been carefully cleared of vegetation from time to time, and the process, known as the "Scouring of the White Horse," was formerly made the occasion of a festival. A grassy track represents the Ridgeway, an ancient road along the crest of the hills. Other earthworks in addition to those near the White Horse overlook the vale, such as Letcombe castle above Wantage. Among interesting village churches in the vale is the fine Early English one at Uffington. The length of the vale, from Shrivenham to Abingdon, is about 17 mi.

WHITE HOUSE, the official residence of the president of the United States. Located at 1600 Pennsylvania avenue in Washington, D.C., it looks. out over landscaped lawns to Lafayette square on the north and, on the south, across the fenced grounds and the open space known as the Ellipse to the Washington monument beyond.

In 1791, after the first congress under the new constitution had voted to establish a federal capital and had authorized President Washington to select a site for it on the Potomac river, the president engaged Maj. Pierre Charles L'Enfant, a French engineer who had served with him during the Revolution, to map out a plan for the city. L'Enfant chose for the location of the "President's Palace" a ridge of ground rising above a small creek that debouched into the river at the present-day intersection of Constitution avenue and 17th Street. In a public contest to choose the most suitable design for the residence, Thomas Jefferson and others submitted drawings, but James Hoban, an Irish-American resident in Philadelphia, won the competition and the $500 prize. His plan displayed the characteristic features of the late 18th-century English country house, not, as hearsay later declared, a replica of the Duke of Leinster's seat in Ireland. The harmonious proportions of Hoban's design constituted its chief distinction. The principal ornamentation lay in the fenestration — on the first story a series of large windows with alternating arched and triangular pediments, on the second, smaller rectangular nindows, while balustrading concealed from view the windows of the third floor. The floor plan included a spacious entrance hall, a large ceremonial room on the east balanced by a state dining room on the west, and three smaller drawing rooms between. The cornerstone, of pale gray limestone from nearby quarries in Virginia, was laid on Oct. 12, 1792. The residence is thus the oldest federal building in Washington. It is a three-story structure with a total of more than 100 rooms.

In Nov. 1800, when congress convened for the first time in the new capital, President and Mrs. John Adams became the first occupants of the executive mansion. Mrs. Adams ruefully remarked upon the damp plaster, the lack of bell pulls, and the dearth of firewood that left the large rooms cold and drafty. She hung the family washing in the still unfinished East Room. When Thomas Jefferson moved into the residence in March 1801, his hospitality, as generous as it was lacking in pomp, quickly made the house the gathering place of the most intiresting people in the little city; at the New Year's day levees and the 4th of July celebrations people of all sorts came to pay their respects. In a cage on the 16-ac. grounds about the building Jefferson kept the grizzly bears that Capt. Meriwether Lewis brought back from his 4000-mile expedition to the far west. President and Mrs. Madison introduced somewhat greater formality into official entertaining but, thanks to "Dolly's" inimitable skill as hostess, all Washington's social life centred about the president's house. It was coming to be called the White House by 1809, for its whitish limestone contrasted strikingly with the red brick of the other public buildings and private dwellings in the vicinity. Not until Theodore Roosevelt's time would the president's stationery carry the heading The *White House,* but the name was in use well before the fire-blackened walls left standing after the British army burned the house in Aug. 1814 received a coat of white paint.

In Sept. 1817 the White House, rebuilt under the direction of Hoban and completely refurnished, was ready for occupancy by President and Mrs. Monroe. Having extended the original house by adding an east and a west terrace opening out upon the south lawn. Hoban built the semicircular south portico in 1824 and the imposing colonnaded north portico at the beginning of Andrew Jackson's presidency. John Quincy Adams devoted time and his botanical knowledge to planting a garden and obtained an appropriation for fencing the grounds; President Van Buren further embellished them. During the rest of the 19th century changes to the exterior of the house and to the grounds were few. Rater from a spring a mile to the north was piped into the house in 1832, and shortly thereafter a sewer was laid to drain waste into the canal that skirted the foot of the President's Square along the bed of the little tidal creek. James Polk in 1848 was the first president to enjoy the luxury of gas lighting, and Franklin Pierce the first to have central heating. In 1850 Andrew Jackson Downing, the most famous American horticulturist of his day, undertook the landscaping of the grounds in the then popular romantic style.

While congress yearly appropriated small sums for maintenance of house and grounds and allotted each new president some money for redecorating, by Abraham Lincoln's time the residence was badly in need of basic repairs, such as pointing up the masonry foundations to stop the infestation of rats. Other improvements had to wait. Not until 1872 was the problem of adequate sanitation resolved by substituting for the open sewer emptying into the tidal marsh beyond the Washington Monument a bricked-in culvert carried far out into the Potomac, where the current ran strong enough to prevent backwash on incoming tides. A single telephone line was introduced in 1880 and electric lighting a dozen years later.

Despite some physical inconveniences, the White House over the years served its purpose well. The graciously proportioned rooms witnessed weddings, receptions and state dinners attended by the most eminent Americans and the most notable foreign visitors of each generation. By the 20th century, however, the heightened responsibilities of the chief of state of a nation that had become a world power led Pres. Theodore Roosevelt to request additional space for offices and the release for living quarters of the second-floor rooms that presidents from Lincoln onward had had to use for official business. To the architectural firm of McKim, Mead and White fell the task of designing the new executive office building and rebuilding part of the interior of the main house. Uneasiness lest the changes mar the harmonious lines of the original proved unfounded, and for approximately 40 years the remodeled residence sufficed as it was except for rewiring, new plumbing and the installation of air conditioning.

While large additions to the office building were necessary to accommodate the expanding staff of the 1930s and early 1940s, not until after World War II was the residence itself subjected to renovation. In 1948, when President Truman had a balcony built on the south portico and proposed further changes, a board of architects reported that extensive structural repairs were imperative. The cost would be greater than construction of an entirely new house but, as public sentiment opposed the very thought of abandoning the historic executive mansion, the multi-million-dollar rebuilding was undertaken. It was completed before the inauguration of President Eisenhower in 1953. Over the years the White House has become a major American shrine and each year more than 1,000.000 visitors walk through its public rooms. *See* also WASHINGTON, D.C.

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WHITE LEAD: *see* PAINTS, CHEMISTRY *OF*: *Pigments.*

WHITELEY, WILLIAM (1831–1907), English merchant, who developed one of the first large department stores in London, was born at Agbrigg, near Wakefield. Torkshire, Sept. 29, 1831. In 1851 he went to London and in 1863 opened a small shop for the sale of fancy drapery. He made a practice of marking the prices of all goods clearly and of dressing his shopwindow attractively, both being unusual features in the retail trade of that time. He was satisfied with small profit margins and was able to expand his operations until he could call himself "The Universal Provider" and boast that there was nothing which his shops could not supply. He died in London. Jan. 23, 1907. (J. R. LT.)

WHITELOCKE, BULSTRODE (1605–1675), English lawyer and parliamentarian, eldest son of Sir James Whitelocke, was born on Aug. 6, 1605, and educated at Merchant Taylors' school and at St. John's college. Oxford, where he matriculated on Dec. 8. 1620. He was called to the bar in 1626 and chosen treasurer of the Middle Temple in 1628. He was M.P. for Stafford in the parliament of 1626 and was appointed recorder of Abingdon (*c.* 1631) and Henley. In 1640 he was chosen member for Great Marlow in the Long parliament. He took a prominent part in the proceedings against the earl of Strafford. He drew up the bill against the dissolution of the Long parliament without its own consent, and supported the Grand Remonstrance and the action taken in the commons against the illegal canons; on the militia question, however, he advocated a joint control by king and parliament. On the outbreak of the Civil War he took the side of the parliament. He was sent to the king at Oxford in 1643 and 1644 to negotiate terms, and the secret communications with Charles on the latter occasion were the foundation of a charge of treason brought against Whitelocke and Denzil Holles (*q.v.*) later. He was again one of the commissioners at Uxbridge in 1615. Nevertheless, he opposed the policy of Holles and the peace party and the proposed disbanding of the army in 1647, repudiated the claims of divine authority put forward by the Presbyterians for their church. and approved of religious tolerance. He thus gravitated toward Oliver Cromwell and the army party. Under the Commonwealth he was nominated councillor of state and became a commissioner of the new Great Seal. In 1653 he went on a mission to Christina, queen of Sweden. to conclude a treaty of alliance and to secure the freedom of the Sound. On his return he again became a commissioner of the Great Seal, and also a commissioner of the treasury. In 1654 and 1656 he sat as M.P. for Buckinghamshire.

As a lawyer: Whitelocke supported a bill introducing the use of English into legal proceedings. drafted a new treason law. and introduced modifications into chancery procedure. His resistance to the ill-considered changes in the court of chancery proposed by Cromwell and the council, however, led to his dismissal from the commissionership of the Great Seal. He still advised Cromwell on foreign affairs, and was chairman of the committee to urge Cromwell to accept the crown. In Dec. 1657 he became a member of the new house of lords. He was again a commissioner of the Great Seal under Richard Cromwell, and was a member (May 14, 1659) and president (Aug. 1659) of the council of state. On the expulsion of the Long parliament, in which he had a seat, he was included in the committee of safety which superseded the council. He again received the Great Seal on Nov. 1.

On the failure of his plan to persuade Charles Fleetwood to forestall George Monk by making terms with Charles II, he retired to the country. He died at Chilton, in Wiltshire, July 28, 1675.

He was the author of: *Memorials of the English Affairs from the Beginning of the Reign of Charles I . . .* (published 1682 and reprinted; a compilation abounding in errors); *Journal of the Swedish Embassy* (1772; re-edited by Henry Reeve in 1855); *Notes on the King's Writ for Choosing Members of Parliament* (1766); *Memorials of English Affairs from the Supposed Expedition of Bruce to this Island to the End of the Reign of James I* (1709); *Essays Ecclesiastical and Civil* (1706); *Quench Not the Spirit . . .* (1711); and some theological treatises which, like his most valuable work, his *Annals,* remain in manuscript. *See* also the article by Sir Charles Firth in the *Dictionary of National Biography,* vol. xxi (1922).

WHITE MOUNTAINS, a mountainous upland located in north-central New Hampshire and extending slightly into Maine. The northeastern end of the region is marked by the Androscoggin and Ammonoosuc valleys. The region is 87 mi. long and 15 to 20 mi. wide and contains the highest elevations in the northeastern United States. The mountains do not constitute a distinct range but form a broad upland region roughly trending northeast-southwest. There is no distinct alignment of ridges and valleys. Noteworthy features are the many rounded passes, locally termed notches, that were excavated by local mountain glaciers during waning stages of Pleistocene glaciation.

The geologic structure of the region is complex. Granites predominate among the igneous rocks that comprise the higher, more rugged terrain. The Paleozoic shales in the region that antedate the Acadian intrusions have been altered into mica schists. phyllites and slates. The highest elevations, mostly between 5.000 and 6,000 ft., occur in a linear series of distinct peaks that are named for U.S. presidents and make up the Presidential range. The highest point is Mt. Washington (6,288 ft.). The region southwest of Crawford notch is termed locally the Franconia mountains.

Predominantly a recreational region, a large part of the wooded White mountains is included in the White Mountain National forest (715,379 ac.). Only the highest summits extend above the timberline. A highway and cog railway provide access to Mt. Washington during the summer. Over 1,000 mi. of nature trails and numerous campsites make the region a favourite summer vacation area. It also has some of the finest ski slopes and facilities for winter sports in eastern North America, including those at Franconia (Cannon mountain), Conway (Mt. Cranmore) and Mt. Washington. (J. E. V. R.)

WHITE PLAINS, a city of eastern New York, U.S., is located on the Bronx and Hutchinson rivers midway between the Hudson river and Long Island sound, 10 mi. N. of the Bronx (New York city); the seat of Westchester county. It is both the hub of Westchester's transportation system and one of the leading suburban residential and shopping centres in the U.S. Known to the Siwanoy Indians, a Mohegan tribe, as "Quarropas" (the white plains) from the white balsam in the area, White Plains was purchased from them first by John Richbell of Mamaroneck in 1661. The Indians then sold the same site to a group from Rye township in 1683. Long litigation upheld the Rye title in 1721. During the American Revolution the provincial congress met there on June 30, 1776, after moving from New York city, and on July 9, having received the Declaration of Independence from Philadelphia, proclaimed the creation of the state of New York and themselves as the state legislature. At the battle of White Plains, fought on Oct. 28, 1776, Gen. William Howe, unable to force or feint Washington's army out of strongly prepared positions to the north, disengaged and retired to Dobbs Ferry. White Plains became the county seat in 1778, an incorporated village in 1866 and a city in 1916. Major manufactures include hearing aids, aircraft instruments, food products, women's clothing, electroplating, engraving, precision machine parts, plastics, artificial flowers and electronic devices. With a population (1960) of 50,485, White Plains is part of the New York standard metropolitan statistical area. (RI. D. HH.)

WHITE RIVER, the name of several rivers in the U.S. The White river in Arkansas and Missouri is a 690-mi. stream that rises in the Boston mountains of Arkansas, flows northeast into south-central Missouri, where it bends southeast and flows into the Mississippi and Arkansas rivers, above Arkansas City, Ark. Most of the river's descent is in the upper course, where it exceeds 25 ft. per mile. Through the Boston mountains and the Ozark plateau of southern Missouri, the White is deeply entrenched with elaborate windings that occupy gorges not much wider than the river. Much of its middle course is a valley over 500 ft. deep. At Newport, Ark., the White emerges from the highlands on to the flood plain of the Mississippi river. There the stream gradient is less than 3 ft. per mile, with numerous meanders, abandoned stream channels, flooded land and swampland. Major tributaries are the King, Black and Little Red rivers.

In Colorado and Utah the White river rises on the White river plateau. 12,000 ft. high, in western Colorado. The river is 250 mi. long, flows toward the west and empties into the Green river at Ouray, Utah. Its annual discharge of 500,000 ac.ft. supplies a substantial quantity of water to the Colorado river system.

The White river of Nebraska and Dakota rises on the Pine Ridge escarpment in northwestern Kebraska. In its 325-mi. course the river flows northeast into South Dakota. turns east and empties into the Missouri, near Chamberlain, S.D. In the upper course. light rainfall, sparse vegetation and geologic conditions have created the Big Bad Lands. There the numerous, small, intermittent tributaries entering the White have carved a labyrinth of pinnacles, valleys, slopes and fantastic features into the soft clay formations. The lower course is a sand filled, braided, meandering channel over a mile wide.

The New Mexico-Texas White river rises in eastern New Mexico, in Quay county. It flows southeast 110 mi. and joins with the Double Mountain river, near Rule, Tex., to form the Brazos river. Most of the course of the White is across the extremely flat Staked plains of eastern New Mexico and northwest Texas, where the stream bed is dry.

See Nevin M. Fenneman, *Physiography of Western United States* (1931), *Physiography of Eastern United States* (1938). (M. J. L.)

WHITE RUSSIA: see BELORUSSIAN SOVIET SOCIALIST REPUBLIC.

WHITE SAPOTE, a fruit produced by the tree *Casimiroa edulis,* of the citrus family (Rutaceae). The ancient Aztecs called this species *cochiztzapotl,* "sleep-producing sapote," which would imply a reputation as a soporific.

The white sapote, originally a tree of the Mexican highlands, where it is commonly seen in dooryards: has been carried to numerous tropical and subtropical regions, especially to southern California, where local seedlings, which produce fruit of superior quality, have been named and propagated by grafting, using the shield-bud method. (*See* PLANT PROPAGATION.) Pike: Suebelle, Wilson and Coleman are among the best varieties offered by nurserymen.

The tree, which is somewhat more frost resistant than the orange and tolerant of poor soils and drought, is characterized by palmately compound leathery leaves and small inconspicuous racemes of yellowish flowers. The round, yellowish-green, thin-skinned fruits are the size of an orange; they contain one to three (occasionally five) large oval seeds, surrounded by soft, yellowish-white, sweet flesh of not very pronounced flavour. They often appear in the markets of the Mexican highlands, but rarely in other parts of the world, and are eaten fresh.

The *matasano* of the Central American highlands is either a geographical form of the white sapote or a closely allied species, *Casimiroa tetrameria.* (W. Po.)

WHITE-SLAVE TRAFFIC. "White-slave traffic." renamed by the League of Nations in 1921 "traffic in women and children" in order to include all races, may be defined as an organized business, national and international, carried on for the purpose of supplying the trade of prostitution (*q.v.*). The term denotes enforced prostitution.

Contagious Diseases Acts; First International Congress.—The international movement to abolish the traffic began in 1864 with the British parliament's passage of the first of the Contagious Diseases Prevention acts, followed by those of 1866 and 1869. This introduction of state regulation of vice in England was caused by the extremely high incidence of venereal disease among soldiers and sailors and was designed primarily for their protection. It permitted the arrest of women by special police on mere suspicion, registration and police supervision of prostitutes, compulsory medical examination and detention in special hospitals for those found infected. It was modeled upon the French system, with the difference that the latter was not based upon law but was merely a police measure. French brothels were chiefly known as *maisons tolérées; i.e.,* houses tolerated or licensed by the police or municipal authorities. Passage of these acts precipitated a powerful movement for their repeal. Two groups developed: one regarded prostitution as a necessary evil to be regulated and controlled by law; the other opposed this view and the acts theinselves on the ground that they inflicted a grave injustice on women of the most helpless class and failed as health measures. Josephine Butler (*q.v.*) rose as the leader of the abolitionists and began the campaign to abolish state regulation of prostitution and the white-slave traffic. She founded the British: Continental and General Federation for the Abolition of Government Regulation of Prostitution (later known as the International Abolitionist federation). At its first world congress, held in Geneva, Switz., in 1877. the federation adopted a series of reports and resolutions which formed the basis of subsequent work for abolition of state regulation of prostitution and of white-slave traffic. The Contagious Diseases acts were suspended in 1883 and repealed in 1886.

Later International Conferences.—An international congress held in 1899 developed the International Bureau for the Suppression of Traffic in Women, of which William A. Coote was head. The French government called a conference in Paris in 1902 which resulted in an international agreement signed in 1904 by 13 states—Belgium, Denmark, France, Germany, Great Britain, Italy, the Netherlands, Norway and Sweden, Portugal, Russia, Spain and Switzerland (Austria adhered in 1905 and the U.S. in 1908). The signatories recommended a central authority in contracting states to co-ordinate and exchange information concerning the traffic. In 1910 France called another conference in I'aris, resulting in a convention which went further than the agreement of 1904. It was signed by 13 nations, including Brazil, and undertook to make procurers of women punishable and extraditable. Other nations adhered later.

National Enactments.—Important national laws were the British Criminal Law Amendment act of 1885, amended in 1912 and 1922. which made procuration or attempted procuration a misdemeanour with severe penalties; the Children (Employment Abroad) act of 1913; and laws passed by the United States. An investigation made in 1908–1909 by the U.S. Immigration commission revealed that a large number of alien women and girls were then being imported and distributed through the states for purposes of prostitution, and that they were purchased by letters or through agents sent to Europe and Asia. This investigation was followed by an amendment of the immigration law for the protection of alien women and girls and the passage of the White-Slave-Traffic act (Mann act) in 1910, which imposed severe penalties for interstate or foreign traffic in women or girls. These national measures were followed by a number of state laws.

League of Nations.—Publication in 1914 of *Prostitution in Europe* by Abraham Flexner shattered the claim of "safe" regulation and segregation. World War I. however, temporarily ended further international work. The war caused a great increase in venereal disease and raised doubts as to the effectiveness of official control of prostitution and white-slave traffic. One of the earliest acts of the League of Nations after its inauguration on Jan. 10. 1920. was to appoint a permanent official to keep in touch with everything connected uith the traffic. A conference convened by the council in Geneva in 1921 was attended by delegates from 34 nations, thereby extending the area of the movement. At the second ordinary session of the assembly on Sept. 30. 1921. a new convention was opened for signature and by July 24, 1926, had been signed by 33 states (including Japan, China and India), most of which had also ratified it. The United States expressed its support but did not sign on the ground that legislation on prostitution was largely left to the states This convention extended and strengthened provisions of the convention of 1910.

Formation of the advisory committee to the council on all matters relating to traffic in women and children was another important outcome of the conference of 1921. At the committee's request in 1923, the council of the League conducted a special investigation nhich indicated a strong movement for the abolition of the system of licensed houses and of regulation.

One of the most far-reaching accomplishments of the advisory committee was the nomination of a body of experts to conduct an investigation of the world's traffic. With the co-operation of the governments. this group investigated 112 cities and 28 countries in Europe, north Africa, North America and Central and South America. Its report (1927) proved the existence of a highly organized and well-financed national and international traffic.

The League's many inquiries and publications on the two problems of prostitution and traffic helped develop national public opinion and a consciousness of the need for international action in attacking the evils. General European conferences were frequent

A diplomatic conference for the protection of women of full age was held in 1933; in October the 1921 convention was extended by a new convention providing penalties for procuring, enticing and leading away women of full age, even with their consent, for purposes of prostitution in another country.

In 1936 the Advisory Committee on Traffic in Women and Children and the Child Welfare committee were merged into the Advisory Committee on Social Questions. This committee's campaign against the traffic included efforts to obtain new ratifications to the conventions. to abolish licensed brothels and to increase employment of women police. The Social Questions committee also drew up the draft convention of 1937 for the suppression of the exploitation of prostitution. This convention was the first to provide protection for persons of full age of either sex against being procured for profit, even with their consent and when they were not taken beyond national boundaries. The onset of World War II prevented its ratification.

The Far **East.**—Following the investigations of the advisory committee, a conference of central authorities of eastern countries to consider repression of the traffic in women and children was held at Bandung, Java, Feb. 2–13, 1937. It aimed to attain swifter exchange of information between the police and other authorities responsible for preventing the heavy traffic in the east. Migrations of Russian women refugees and other displaced persons in the far east in danger of becoming victims of the traffic, and the existence of licensed and tolerated brothels, were other problems considered.

World War 11.—Such was the prospect for suppression of prostitution and control of traffic in women and children as war approached. Despite the waning of its political power. the League continued its educational work during the prenar and war years wherever avenues of communication remained open. Areas of military operation created new problems of traffic in women, prostitution and increase in venereal diseases. A United Nations report of 1947 stated that the Germans took hundreds of French women and girls to Germany and other occupied countries and placed them in brothels. Similar actions, on both sides, had always been an accompaniment of warfare.

In the United States, the May act of 1941 gave the military and naval authorities power to outlaw prostitution in zones around military and naval areas. Its administration, with the co-operation of local civil and health authorities in closing brothels, was successful; the lowest rate of venereal disease infection in the history of the U.S. armed forces was achieved.

Experience in World War II, according to investigators, undoubtedly made clearer to governments that eradication of prostitution must be accompanied by eradication of its causes. It also made clear that the evils of prostitution and traffic in women cannot be removed, even temporarily, by action against prostitutes.

Postwar Trends. — With the war's end, however, public indifference returned. The exploiter of vice and the trafficker in women, forced underground by the wartime drive, again emerged. According to the American Social Hygiene association, the increase in prostitution began in 1945 when the war ended. By 1949. 38% of the U.S. cities surveyed were found tolerating bad conditions while 12% more were rated as poor. Federal authorities estimated that at least one out of every four communities that had padlocked brothels as a war measure allowed them to reopen a few years later.

Mexico and certain Central and South American countries adopted governmental programs to suppress commercialized prostitution and the increasing spread of venereal diseases, following organization of the International Cooperative Health plan of the 21 American nations. The support of the International Association of Chiefs of Police and other influential bodies was pledged to this objective.

In Europe and Asia, prostitution and submission to traffickers became a chief means of support for impoverished women and their families. Cases of international traffic from China of Chinese natives were registered in the Republic of the Philippines from time to time. In Palestine, according to a report of the United Nations (1946–47), there were many convictions of traffickers in women. Extensive air traffic conducted by specially trained pilots was reported.

The United Nations. — By action of its Economic and Social council on Aug. 14, 1947, and further action of its general assembly on Oct. 20, 1947, the United Nations voted to assume "the functions and powers of the League of Nations" under the International convention of Sept. 30, 1921, for the suppression of traffic in women and children; the International convention of Oct. 11, 1933, for the suppression of the traffic in women of full age; and the functions formerly performed by the French government under the International agreement of May 18, 1904, and the International convention of May 4, 1910, for the suppression of the white-slave traffic.

The Economic and Social council's Social commission at its fourth session in May 1949 approved a draft convention embodying the essential features of the international instruments mentioned above, under the title of the "Draft Convention for the Suppression of the Traffic in Persons and Exploitation of the Prostitution of Others." The convention was based as far as possible on abolitionist, as opposed to regulationist, principles, subject to the requirements of domestic law. The draft convention was approved by the UN general assembly on Dec. 2, 1949. As of Sept. 1, 1958, 24 states had deposited an instrument of ratification or accession.

Another aspect of the world organization's activity was the periodic publication in the *International Review of Criminal Policy* of information submitted by member states in their biennial replies to a questionnaire on traffic in persons drawn up by the United Nations. *See* also PROSTITUTION.

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WHITETHROAT, a name given to two European birds belonging to the Sylviidae or warblers (*q.v.*). They are about $5\frac{1}{2}$ in. long. The common whitethroat or nettle creeper, *Sylvia cinerea,* is widely spread over Great Britain and is in some places common. It is a restless bird, and in spring the male often gives his song on the wing. The lesser whitethroat, *Sylvia curruca,* is less often seen. The plumage is smoky gray above and white below. Its song is unusual, consisting of a series of repeated notes. the usual warble being reduced to a short preface inaudible at a short distance. The nests of each of these species are built of bents or other plant stalks and usually lined with horsehair; the eggs are spotted with olive brown. (HT. FN.)

WHITGIFT, JOHN (1530?–1604), English archbishop, was the eldest son of Henry Whitgift, merchant of Great Grimsby, Lincolnshire, where he was born. He was educated by his uncle, Robert Whitgift, abbot of the neighbouring monastery of Wellow, then at St. Anthony's school, London, and finally at Cambridge, where he became a fellow of Peterhouse in 1555. Having taken orders in 1560, he became chaplain to the bishop of Ely, who collated him to the rectory of Teversham, Cambridgeshire. In 1563 he was appointed Lady Margaret professor of divinity at Cambridge, and in 1564 regius professor of divinity. He became master first of Pembroke hall and then of Trinity. He had a principal share in compiling the statutes (1570) of the university, and in November of the same year was chosen vice-chancellor. Macaulay's description of Whitgift as "a narrow, mean, tyrannical priest, who gained power by servility and adulation," is unjust, but he was intolerant and arbitrary. Whitgift, with other heads of the university, deprived Thomas Cartwright in 1570 of his professorship, and in Sept. 1571, as master of Trinity, deprived him of his fellowship. In June of the same year Whitgift was nominated dean of Lincoln. In the following year he published *An Answere to a Certain Libel intituled an Admonition to the Parliament,* which led to further controversy with Cartwright. On March 24, 1577. Whitgift was appointed bishop of Worcester, and during the absence of Sir Henry Sidney in Ireland (1577) he acted as vice-president of Wales. In Aug. 1583 he was appointed archbishop of Canterbury. Although he wrote a letter to Queen Elizabeth I remonstrating against the alienation of church property, Whitgift always retained her special confidence. In his policy against the Puritans, and in his vigorous enforcement of the subscription test, he thoroughly carried out the queen's policy of religious uniformity. He drew up articles aimed at nonconforming ministers, and obtained increased powers for the court of high commission. In 1586 he became a privy councilor. His action gave rise to the Marprelate tracts, in which the bishops and clergy were bitterly attacked. Through Whitgift's vigilance the printers of the tracts were discovered and punished; and in order more effectually to check the publication of such opinions he got a law passed in 1593 making Puritanism an offense against the statute law. In the controversy between Walter Travers and Richard Hooker he interposed by prohibiting the preaching of the former and he moreover presented Hooker with the rectory of Boscombe, Wiltshire, in order to afford him more leisure to complete his *Ecclesiastical Polity,* a work which, however, cannot be said to represent either Whitgift's theological or his ecclesiastical standpoint. In 1595 he, in conjunction with the bishop of London and other prelates, drew up the Calvinistic instrument known as the Lambeth articles. which were not accepted by the church. Whitgift attended Elizabeth I on her deathbed, and crowned James I. He was at the Hampton Court conference in Jan. 1604, and died at Lambeth on Feb. 29 of that year. He was buried in the church of Croydon. Whitgift was noted for his hospitality, and was ostentatious in his habits, sometimes visiting Canterbury and other towns attended by a retinue of 800 horsemen.

Whitgift left several unpublished works, which are included among the manuscripts *Angliae.* Many of his letters, articles, injunctions, etc., are calendared in the published volumes of the "State Paper" series of the reign of Elizabeth I. His *Collected Works,* ed. for the Parker society by John Ayre (3 vol., 1851–53), include, besides the controversial tracts already alluded to, two sermons published during his lifetime, a selection from his letters to Cecil and others, and some portions of his unpublished manuscripts.

WHITHORN, a royal and small burgh in the Machers peninsula of Wigtownshire, Scot., 62 mi. S.E. of Dumfries by road and 18 mi S. of Wigtown. Pop. (1961) 986. St. Ninian or

Ringan, the first Christian missionary to Scotland, landed at the Isle of Whithorn, 3 mi. S.E. of the town, where he built (397) a whitewashed stone church, which, out of contrast with the dark mud and wattle huts of the natives, is said to have been called Candida Casa (Hvit-aern), the "white house." Ninian is buried in the church. The Magnum Monasterium, or monastery of Rosnat, was founded at Whithorn 100 years later and in the 8th century became the seat of the bishopric of Galloway. It was succeeded in the 12th century by St. Ninian's priory, built for Premonstratensian monks by Fergus, "king" of Galloway, of which only the chancel (used as the parish church till 1822) and other fragments remain. There is a museum containing many Christian and other monuments.

WHITING, a city of Lake county in northwestern Indiana, U.S., on the shore of Lake Michigan, immediately S.E. of Chicago and part of the Gary-Hammond-East Chicago standard metropolitan statistical area. The city was started in 1889 when the Standard Oil company, unable to find a site in Chicago, constructed a large refinery there. Although the plant was put into production in 1890, incorporation of the community was delayed until 1896. Whiting was the birthplace of the Standard Oil Company of Indiana and was for many years the capital of that oil empire. In addition to petroleum. Whiting manufactures metals, chemicals, soap and food products. Surrounded by Chicago, Hammond, East Chicago and Lake Michigan, Whiting's area remained small and the population, which reached a peak of 10,880 in 1930, gradually declined after that time. For comparative population figures see table in INDIANA: Population. (P. ME.)

WHITING, a name originally applied to a European marine food fish (*Gadus* merlangus) of the cod family (Gadidae); it ranges from Spain to Norway and Iceland. A closely related species, often called blue whiting (*Gadus poutassou*), is common in and about the Mediterranean; it occurs as far north as Norway and Iceland and a few specimens have been taken in the deep water of the New England banks. In North America the name whiting is applied to several other species, perhaps because of some fancied similarity of form to the European species. On the Atlantic coast of North America the silver hake (*Merluccius* bilinearis) is usually called whiting in the fish trade. It occurs on the continental shelf of eastern North America from North Carolina to the Grand Banks off Newfoundland. Over 90,000,000 lb. are caught annually in the trawl fisheries. Several species of the drum or croaker family (Sciaenidae) are sometimes called whiting; for example, the California corbina (California whiting, Menticirrhus *undulatus*), occurring from the Gulf of California to central California; the northern kingfish (king whiting, Menticirrhus saxatilis), occurring from Massachusetts to the Gulf of Mexico; and the southern kingfish (*Menticirrhus americanus*), occurring from New Jersey to Texas.

"Whiting" is sometimes applied to lake whitefish (*Coregonus clupeaformis*), of the Great Lakes region: and in Australia generally to species of Sillaginodes and *Sillago,* which are small! slender shallow water fishes of the Indo-Pacific region belonging to the family Sillaginidae. (L. A. WD.)

WHITLEY COUNCIL: see INDUSTRIAL RELATIONS.

WHITLOCK, BRAND (1869–1934), C.S. diplomat and writer, was born at Crbana. O., March 4, 1869. As a political reporter on the Chicago *Herald* and as assistant in the office of the Illinois secretary of state, Whitlock came in contact with John P. Altgeld, governor of Illinois, who, like "Golden-Rule" Jones, mayor of Toledo, did much to develop his political idealism. He was admitted to the Illinois bar in 1894, and to the bar of Ohio in 1897. From that year until 1905 he practised law in Toledo and then as an Independent became mayor for four terms, in 1911 refusing nomination a fifth time. The record of his labours for the "Free City" of which he dreamed is told in his autobiography, Forty Years of *It* (1914, new edition 1925).

In 1913 he was appointed U.S. minister (later ambassador) to Belgium. Before he had been in Belgium a year World War I broke out and the German invasion took place. Although the other diplomatic bodies followed the Belgian court to Le Havre, Whitlock insisted on remaining in Brussels. It was largely because of his urgent advice that Brussels did not resist, and thus escaped devastation. In the early days of the war he gave protection to many German residents who had been unable to leave the country. By his firm attitude toward the German military officials he saved many innocent Belgians from death; but his activities on behalf of Fd th Cavell nere unavailing as he was misled at the last moment through false promises by the Germans. After the formation of the Commission for Relief in Belgium. its operations were placed wholly under his direction. His ceaseless work on their behalf won the gratitude of all Belgians and was rewarded by many honours. Whitlock resigned Feb. 1. 1922. An account of his experiences is given in *Belgium*, a Personal *Narrative* (1919).

R'hitlock himself spoke of vacillating "between an interest in letters and an interest in politics," and there is no doubt that his early literary work, at least. reflected this duality of tastes. The *13th* District (1902) revealed the insidiously corrupting influence of certain phases of politics; and *The Turn* of *the Balance* (1907), a poignant exposure of social injustices, was written "out of the contemplation of the misery, the pathos, the hopelessness of the condition" of the victims during his police court experiences. A fruit of his administrative work is the monograph On *the* Enforce*ment* of Law in *Cities* (1913). His later novels, such as J. *Hardin and* Son (1923) and Uprooted (1926). are less concerned with ethical problems. His technique at all times, however, revealed his admiration for the ideals and methods of William Dean Howells. In 1929 he published La Fayette, a biography.

He died at Cannes, Fr., May 24, 1934.

WHITMAN, MARCUS (1802–1847), missionary to American Indians and pioneer settler in Oregon, was born at Rushville, N.Y., Sept. 4, 1802. He studied medicine with a local physician and earned a degree from Berkshire Medical college (Pittsfield, Mass). He then practiced medicine for four years in Canada and briefly thereafter in western New York

In 1835 Whitman offered his services to the American Board of Commissioners for Foreign Missions and was immediately sent out nith the Rev Samuel Parker to explore the possibility of founding missions in Oregon. The tno missionaries traveled as far as the Green river rendezvous in western Wyoming. Whitman then returned east for additional recruits while Parker proceeded westward to investigate potential mission sites. In September of the following year Whitman and his bride Narcissa Prentiss, accompanied by Henry H. Spalding and his wife, W. H. Gray (a lay helper) and two Indian boys, arrived at Fort Vancouver, Wash. Acting upon the advice of John McLoughlin of the Hudson's Bay company. Whitman decided to found a mission among the Cayuse Indians at Waiilatpu, 25 mi. west of the present Walla Walla, Wash. Spalding established himself among the Nez Percés at Lapwai, Idaho, on the Clearwater river, 125 mi northnard. Progress at both missions was slow and disappointing. Whitman and Spalding helped the Indians to build houses for themselves and shoned them how to till their fields and irrigate their growing crops. They also taught them how to erect mills to grind their corn and wheat and hon to cultivate gardens and orchards.

In 1842, the American Missionary board decided to abandon the southern Oregon missions and concentrate on those in the Spokane area Alarmed, Whitman determined to go to Boston and urge the board to reverse its decision. He hoped also to acquaint officials at Washington nith conditions in Oregon and to encourage federal support for the rapidly increasing Oregon immigration. This occasioned Whitman's celebrated 3,000-mi. journey on horseback to Boston during the winter of 1842–43. Whitman's mission was entirely successful The board agreed to continue the Waiilatpu and Lapwai missions and President Tyler promised his support of federal aid. Returning to Oregon, Whitman joined up with nhat became knonn as the "great western migration," a caravan of nearly 900 immigrants, and guided them safely across the mountains. Whitman's compelling personality aroused great interest in the Oregon country and this in turn led directly to the rapid advance of American settlement there.

In 1847 a severe epidemic of measles broke out among the Cayuse Indians Many of the sick were being nursed at the Whitman mission. Several of the Indians became terror-stricken, and, believing themselves to have been deliberately poisoned by the whites, attacked the residents of the mission with frenzied fury. The Whitmans and 12 others were murdered on Nov. 29. Some 50 others were taken captive, but were soon rescued thanks to the efforts of Peter Skene Ogden, factor of Hudson's Bay company, who transferred them to Fort Vancouver.

See also OREGON: *History*.

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WHITMAN, WALT (WALTER) (1819–1892), U.S. poet, whose *Leaves of Grass* was a landmark in the history of American literature, was born May 31, 1819, at West Hills, a little farming community near Huntington, Long Island, N.Y. Christened Walter, he did not start calling himself Walt until 1855. His ancestry was typical of the region, his mother, Louisa Van Velsor, being Dutch (with a strain of Welsh) and his father, Walter Whitman, of English descent. Both the Whitmans and the Van Velsors were simple farm people, with little formal education. The Whitman family had moved from Connecticut to Long Island in the 17th century, and at one time owned a large tract of land, but it was so diminished by the time Walt was born that his father had taken up carpentering, though still living on a small section of the ancestral estate. In 1823 Walter Whitman, Sr., moved his growing family to Brooklyn. which was enjoying a boom. There he speculated in real estate and built cheap houses for artisans, but he was a poor manager and had difficulty in providing for his family, which increased to nine children, one of whom died in infancy.

Walt, the second child, attended public school in Brooklyn, began working at the age of 12 and learned the printing trade. He was employed as a printer in Brooklyn and New York city. taught in country schools on Long Island and became a journalist. At the age of 23 he edited a daily newspaper in New York, and in 1846 became editor of the *Brooklyn Eagle,* a fairly important newspaper of the time. Discharged from the *Eagle* early in 1848 because of his support of the free-soil faction of the Democratic party, he went to New Orleans. La, where he worked for three months on the *Crrscent*. Some biographers have constructed a fanciful love affair with a Creole woman, but there is no evidence for it. After another abortive attempt at free-soil journalism in Brooklyn, he built houses and dabbled in real estate from about 1850 until 1855. During these years he read extensively at home and in the New York libraries, and began experimenting with a new style of poetry. While schoolteacher, printer and journalist he had published sentimental stories and poems in newspapers and popular magazines, but they showed almost no literary promise.

By the spring of 1855 he had enough poems in his new style for a thin volume. Unable to find a publisher, he sold a house and printed the first edition of *Leaves of Grass* at his own expense. Little appreciated in 1855. it was warmly praised by Ralph Waldo Emerson ("I greet you at the beginning of a great career") in a personal letter to the poet which he used in the following year to advertise the second edition—also a financial failure. Once again Whitman edited a daily newspaper, the *Brooklyn Times,* but was unemployed by the summer of 1859. In 1860 a Boston publisher, Thayer & Eldridge, brought out the third edition of *Leaves of Crass,* greatly enlarged and rearranged, but the outbreak of the Civil War bankrupted the firm. In 1862 Whitman went down to a battlefield in Virginia to find his wounded brother, George, and stayed on in Washington to assist in the care of the wounded. supporting himself by doing secretarial uork and writing articles for Brooklyn and New York newspapers. After the war he secured a clerkship in the U.S. department of the interior, but was discharged on June 30, 1865, for being the author of *Leaves of Grass,* which was considered a notorious book; hou-ever, he was immediately reemployed in the office of the attorney general, where he remained until stricken by paralysis in Jan. 1873. He left Washington to live with his brother George, in Camden, N.J. His mother died a few months later and this uas the darkest year of his life.

Meanwhile he had continued to print new editions of his poems, a collection of war poems called *Drum-Taps* in 1865, and revised editions of *Leaves of Grass* in 1867, 1871 and 1876. Partly recovered from his illness by 1879, he made a trip by train as far west as Denver, and the following year visited Ontario. Canada. The seventh edition of *Leaves of Crass* was published in Boston in 1881 by James R. Osgood, who soon relinquished the book, however, after the attorney general of Massachusetts threatened criminal prosecution because several poems were regarded as obscene. Osgood suggested a new issue with the objectionable poems omitted. but Whitman refused to make a single change. He quickly found a new publisher in nearby Philadelphia. first in Rees Welsh and company, and then David McKay, who reissued the seventh edition. Newspaper publicity had created interest in the book and it sold better than any previous edition. As a result, Whitman was able to buy a modest little cottage in Camden on Mickle street, where he lived until his death on March 26, 1892, from multiple diseases of the lungs, stomach, liver and kidneys.

As a young man Walt Whitman was unusually robust in appearance, being large, tall and florid in complexion. In the early editions of *Leaves of Grass* he gave symbolical values to health, physical stamina and vigorous ancestry in such poems as "Song of Myself," and "I Sing the Body Electric." Despite the fact that he was disease-ridden in old age, he did have natural stamina, but his family mas not a healthy one. His youngest brother was feeble-minded, one brother died in a mental institution, another died of "tuberculosis of the throat" (possibly cancer) and a sister was neurasthenic. He was remarkably loyal to his family and gave generously of his devotion and income to any member who needed help, but especially to his mother, to whom he was strongly attached. and to his feeble-minded brother, whom he supported and for whom he provided in his will. For personal intimates he preferred uneducated workingmen and mas so affectionate toward several that some critics accused him of being homosexual There is no evidence of perversion, but he made no secret of his love for these men. and celebrated it in the "Calamus" section of *Leaves of Grass* and some war poems in *Drum-Taps*. On the basis of his compassion for the weak and needy and affection for simple men, his first biographers, with his encouragement. created the myth of a saintly carpenter-poet, or poet-messiah.

The Poet.—Under the influence of the romantic age in literature and art, Whitman held the theory that the chief function of the poet was to create and express personality. The first edition of *Leaves of Grass* also appeared during the most nationalistic period in American literature, when critics were calling for a literature commensurate with the size, natural resources and potentialities of the North American continent (Whitman himself expected the eventual annexation of Canada and Mexico to the United States). "We want." shouted a character in Longfellow's *Kavanagh* (1849), "a national literature altogether shaggy and unshorn, that shall shake the earth. like a herd of buffaloes thundering over the prairies." With the same fervour. Whitman declared in his 1855 preface. "Here are the roughs and beards and space and ruggedness and nonchalance that the soul loves."

It was partly in response to this nationalistic ideal, and partly in accord with his own personal ambition to cultivate and express his own personality as an example, that the "I" of his poems asserted a mythical strength and vitality and assumed an appearance as shaggy and unshorn as Longfellow's buffalo. For frontispiece to the first edition he used a picture of himself in work clothes, posed nonchalantly with cocked hat and hand in trouser pocket. as if illustrating a line in his leading poem, "Song of Myself" (untitled in 1855): "I cock my hat as I please indoors or out." In this same poem he also characterized himself as, "Walt Whitman. an American, one of the roughs, a kosmos,/Disorderly fleshy and sensual . . . eating drinking and breeding./ . . . Divine am I inside and out, and I make holy whatever I touch or am touched from. . . ." From this time on throughout his life he attempted to dress the part and act the role of the shaggy. untamed poetic spokesman of the proud young nation. For the expression of this symbolical ego he also created a prosodic form without rhyme or metre, but abounding in oratorical rhythms and chanted lists of names and objects. He learned to handle this primitive, enumerative style with great subtlety and was especially successful in creating empathy of space and movement, but to most of his contemporaries it seemed completely "unpoetic." Both the content and the manner of his verse also caused Whitman's first biographers, John Burroughs, R. M. Bucke and even the poet himself, to confuse the symbolical self of the poems with their physical creator. In reality Whitman was quiet, gentle, courteous; neither "rowdy" (a favourite word) nor lawless. In sexual conduct he may have been unconventional, though no one is sure, but it is likely that the six illegitimate children of whom he boasted (and never identified) in extreme old age were begotten by his imagination. He did advocate greater sexual freedom and tolerance ("Spontaneous Me," "A Woman U'aits for Me"), but sex in his poems is also symbolical—of Rousseauistic innocence. "the procreant urge of the world," and the regenerative power of nature. In some of his poems the poet's own erotic emotions may have confused him, but in his greatest, such as parts of "Song of Myself," and all of "Out of the Cradle Endlessly Rocking," sex is spiritualized. His two greatest themes are death and rebirth ("When Lilacs Last at the Dooryard Bloom'd"), and his poems are filled with the "unflagging pregnancy" of nature: sprouting grass, mating birds, phallic vegetation, the maternal ocean and planets in formation ("the journey-mark of stars"). The poetic "I" of *Leaves of Grass* annihilates time and space, binding past and present and intuiting the future, illustrating Whitman's belief that poetry is a form of knowledge, the supreme wisdom of mankind.

The Book.--Whitman is known primarily for one book, *Leaves of Grass,* though he also published several volumes of prose, notably *Specimen Days* (1882), which contains some fine realistic descriptions of Civil War scenes and some vivid reminiscences. But *Leaves of Grass* is actually more than one book. During his lifetime it went through nine editions, between 1855 and 1892, and each had its own distinct virtues and faults. Whitman compared the finished book to a cathedral long abuilding. and on another occasion to a tree, with its cumulative rings of growth. But both metaphors are misleading because he did not construct his'book unit by unit or by successive layers, but constantly altered titles, diction and even motifs and shifted poems—omitting, adding, separating and combining. Beginning with the third edition (1860), he grouped his poems under such titles as "Chants Democratic," "Enfans d'Adam" (later "Children of Adam"), "Calamus." "Poems of Joy" and "Sea-Drift." Some of his later group titles were highly connotative, such as "Birds of Passage." "By the Roadside," "Autumn Rivulets," "From Noon to Starry Night" and "Songs of Parting," suggesting a life allegory. But only the titles were biographical in sequence; chronology (in order of composition) was not followed at all. After 1881 Whitman made no further shifts in groups or revisions of poems within the groups, merely adding the poems of "Sands at Seventy" (first published in *November Boughs,* 1888) and "Good-Bye My Fancy" (from the book by this title, 1889) as first and second annexes in 1892. Whatever else may be said of Whitman's groupings, some of his best imagery is in his group titles and his first lines. The arrangement gave him personal satisfaction and he specified on his deathbed that the 1892 edition was definitive and only it should be reprinted after his death.

Reoutation.— At the time of his death Whitman was more respected in Europe than in his own country. This European reputation began in 1868, when William Rossetti edited a British edition of selected poems. Ferdinand Freiligrath was then in exile in England and through him Whitman became known in Germany. Mrs. Anne Gilchrist, widow of the famous biographer of William Blake, became so enamoured of the personality in the poems that she fell in love with the poet. wrote critical appreciations. promoted the sale of his books and eventually went to America with the intention of marrying him. During the remainder of his life Whitman received much encouragement, financial and psychological. from leading writers in England. In 1872 he began to attract notice in France, and at the same time in Denmark and Norway. In these countries liberals greeted him as "the poet of democracy," while conservatives denounced him as a dangerous influence. Swinburne addressed an ode to the American poet of freedom, but later criticized his poetry for its excessive didacticism.

It was not as a poet, indeed, but as a symbol of American democracy that Whitman first won recognition, even in his own country. When he lost his government position in 1865, William Douglas O'Connor's defense in *The Good Gray Poet* (1866) aroused sympathy for the victim of injustice and contributed to Whitman's reputation as a social prophet. The naturalist John Burroughs, R. M. Bucke, Horace Traubel and William S. Kennedy—the "hot little prophets," Bliss Perry called these American disciples—tried to form a cult around Whitman; and later he was quite literally worshipped in Germany in the late 19th century and after World War I. There is, of course, a kind of oriental mysticism in Whitman's poetry which several Indian scholars and poets, including Sir Rabindranath Tagore, have recognized. But he is still better known abroad as "the poet of democracy" than simply as a poet, though appreciation of his poetry has grown with the improvement in translations. The complete *Leaves of Grass* (1892) was translated into French, German, Italian, Spanish and Japanese, and selected poems appeared in nearly every civilized language. In the U.S.S.R. many editions exist of Whitman's selected poems and prose. His influence on other poets was slight, but he is admired in many countries. However, he is more of a "musicians' poet" than a "poets' poet." Many of his poems were set to music (*e.g.*, by Frederick Delius, Vaughan Williams, Gustav Holst, Percy Grainger, Howard Hanson, Roy Harris and others) and several symphonic compositions were based on his work. perhaps the most famous being Paul Hindemith's "When Lilacs Last in the Dooryard Bloom'd." Twentieth-century scholars and critics find Whitman's social thought less important than his artistry. T. S. Eliot says, "When Whitman speaks of the lilacs or the mockingbird his theories and beliefs drop away like a needless pretext" (in a review of Emory Halloway's *Whitman,* in *The Nation & Athenaeum,* xl, p. 426 [Dec. 1926]; copyright *New Statesman).*

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The fullest biographies are: G. W. Allen, *The Solitary Singer: a Critical Biography of Walt Whitman* (1955); Roger Asselineau, *L'Evolution de Walt Whitman* (1954); briefer, H. S. Canby, *Walt Whitman, an Anzerican* (1943).

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WHITNEY, ELI (1765–1825), U.S. inventor of the cotton gin, was born on a farm in Westboro. Mass., on Dec. 8. 1765. He exhibited unusual mechanical ability at an early age. After attending Yale college, where he graduated in 1792. he went to Savannah, Ga., where through the friendship of Mrs. Nathaniel Green, the widow of the revolutionary general. he was introduced to some men who were discussing the desirability of a machine that would separate the short staple upland cotton from its seeds. In a few weeks Whitney produced a model consisting of a wooden cylinder encircled by rows of slender spikes, set half an inch apart, which extended between the bars of a grid set so closely together that the seeds could not pass although the lint was pulled through by the revolving spikes; a revolving brush cleaned the spikes and the seeds fell into another compartment. The machine was worked by hand and could clean 50 lb. of lint a day. A patent was granted on March 14, 1794.

Meanwhile Whitney had formed a partnership with Phineas Miller, and they built at New Haven, Conn., a factory for the manufacture of the gins. They were unable to supply the demand for gins, and country blacksmiths constructed many machines. A patent, later annulled, was granted May 12, 1796, to Hogden Holmes for a gin that substituted circular saws for the spikes. Whitney spent much time and money prosecuting infringements of his patent and in 1807 its validity was settled. Disgusted with the struggle, Whitney began the manufacture of firearms near New Haven in 1798 and secured profitable government contracts. His introduction of the concept of interchangeable parts and utilization of the principle of division of labour in his musket factory were perhaps his most significant contributions.

See J. Mirsky and Allan Nevins, *The World of Eli Whitney* (1952); Constance Green, *Eli Whitney and the Birth of American Technology* (1956). (W. E. Hd.)

WHITNEY, WILLIAM COLLINS (1841–1904), U.S. financier who served as secretary of the navy under Pres. Grover Cleveland. He was born at Conway, Mass., July 5, 1841. After graduating from Yale in 1863, he studied law at Harvard and began to practise in New York city. He actively allied himself with the anti-Tammany organization which successfully opposed the Tweed ring, and aided in the election of Samuel J. Tilden as governor in 1874. As corporation counsel of New York city (1872–82) he contested some 3,800 suits against the city. inherited from the Tweed regime, and he saved the municipality about $12,000,000. He did much in the way of organization to secure the election of Cleveland in 1884, and under him became secretary of the navy (1885–89). He played an important role in creating a more modern navy, especially in the building of armour-plated ships. After his term of office he reorganized the Manhattan street railways and established the Metropolitan Street Railway company. His work in 1892 overcame the efforts of T. C. Platt and Tammany Hall, through a snap convention to prevent the nomination of Cleveland for a second time. In 1896, disapproving of the free-silver agitation, he refused to support his party's candidate, William J. Bryan (*q.v.*). One of his latest pieces of work was the organization of the New York Electric Light, Heat and Power company. He died in New York city, Feb. 2, 1904.

WHITNEY, WILLIAM DWIGHT (1827–1894), U.S. philologist nhose most notable achievements were in the study of Sanskrit, was born at Northampton, Mass., on Feb. 9. 1827. He graduated at Williams college with highest honours in 1845. Although he was at first interested in natural science. after 1848 he devoted himself with enthusiasm to Sanskrit, at that time a little-explored field. After one brief course at Yale with Edward Elbridge Salisbury, then the only trained orientalist in the United States, Whitney went to Germany (1850) and studied for three years at Berlin and at Tiibingen. In 1854 he was appointed professor of Sanskrit at Yale, and in 1869 professor of comparative philology also. In 1870 he received from the Berlin Academy of Sciences the first Bopp prize for the most important contribution to Sanskrit philology during the preceding three years—his edition of the *Tāittirīya-Prātiçākhya (Journal* of *the American Oriental Society,* vol. ix). He died at New Haven, Conn., on June 7, 1894.

Whitney edited, along with Roth. the *Atharva-Veda-Sanhitā* (1855–56); published, with a translation and notes, the *Atharva-Veda-Prātiçākhya* (1862); made important contributions to the great Petersburg lexicon; issued an index verborum to the published text of the *Atharva-Veda (Journal of the American Oriental Society,* 1881); made a translation of the *Atharva-Veda,* books i–xix, with a critical commentary, which he did not live to publish (edit. by Lanman. 1905); and published a large number of special articles on Sanskrit philology and *Sanskrit Grammar* (1879). Whitney was editor in chief of *The Century Dictionary* (1889–91).

WHITNEY, MOUNT, a California peak 14,495 ft, above sea level, the highest point in conterminous Cnited States It is the culminating summit of the Sierra Nevada, an upturned fault block range extending for more than 400 mi. in east-central California. Viewed from Lone Pine in Owens valley, Mount Whitney rises precipitously almost 11,000 ft. above the valley floor and forms one of the most spectacular mountain views in the world. The summit of Mount Whitney is a gently sloping tablelike surface that has not yet been dissected by erosion. Large angular blocks of granite that litter the surface make travel exceedingly difficult. No permanent snow fields occur on the summit because the light snowfall is largely blown away and the peak lies near the southern limit of glaciation in the Sierras. The steep sides of Mount Whitney are deeply furrowed by avalanche chutes. The deep canyon of the Kern river borders Mount Whitney on the west while short, precipitous streams tumble down the east slope into Owens valley. Mount Whitney may be approached relatively easily from all but its clifflike southeast face. It was first climbed in 1873 and bears the name of Josiah Dwight Whitney, early chief of the California state geological survey. (C. M. Z.)

WHITSTABLE, a seaside resort and urban district in Kent, Eng., in the Canterbury parliamentary division, 7 mi. N.N.W. of Canterbury by road. Pop. (1951) 17,459. Area 11.9 sq.mi. The district includes Whitstable, Tankerton, Swalecliffe and Chestfield. Whitstable has been famous for its oysters since Roman times; Roman coins and potsherds have been found there. Later the town was a port for pilgrims to Canterbury. All Saints' church, the tower of the so-called castle and the Barn house are mainly 15th century. At the time of Domesday Book, Odo of Bayeux held Swalecliffe and also Chestfield manor. The first passenger railway in southern England was opened in May 1830 between Canterbury and Whitstable.

WHITSUNDAY (Pentecost), one of the three major festivals of the Christian church, celebrated on the Sunday that marks the 50th day after Easter, to commemorate the descent of the Holy Spirit on the disciples at the Jewish Pentecost (*q.v.*) following Jesus' passion. resurrection and ascension (Acts ii). The Jewish feast was primarily a thanksgiving for the first fruits of wheat harvest, but the rabbis associated it with remembrance of the giving of the Law at Sinai. The church's transformation of the feast was thus related to belief that the gift of the Spirit was the first fruits of a new dispensation that fulfilled and succeeded the old one of the Law.

Until the 4th century, Christians usually referred the term Pentecost to the whole 50-day period following Easter, and observed the season with undifferentiated commemoration of all the Lord's redeeming acts. Baptism was administered at a vigil service at both the beginning and end of the season. But in northern Europe Pentecost became a more favoured time for baptism than Easter, doubtless because of its milder weather—hence the popular name "White-Sunday," from the special white garments worn by initiates for a week after their baptism.

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WHITTIER, JOHN GREENLEAF (1807–1892), U.S. poet and abolitionist, is best know-n as the author of *Snow-Bound,* an idyll of farm life in the rigours of a New England winter. Born Dec. 17, 1807, the son of Quaker parents who farmed the family homestead near Haverhill, Mass., he first attended district schools. As a boy he became familiar with nature and with books: the Bible, works on Quaker history and doctrine, travel and biography. His ambition to become a poet was aroused at the age of 15 when his first teacher, Joshua Coffin, lent him a copy of Burns's poems. Whittier's first poem was published June 8, 1826, in the *Newburyport Free Press,* where his sister Mary had sent it unbeknown to him. The editor. William Lloyd Garrison (*q.v.*), published other poems of his and visited him, thus beginning a friendship that led Whittier into the abolitionist movement. His poems appeared in 1827 in the *Haverhill Gazette* (later the *Essex Gazette),* and in that year he entered a newly established school, the Haverhill academy, for nhich he wrote a dedication poem. In 1828 Whittier extended his small audience by publishing poems in the *Boston Statesman.*

In 1829, through Garrison, he became editor of the *American Manufacturer* in Boston, thus beginning an editorial career that continued intermittently for 30 years. There for eight months, as he was to do in later editorial positions, he published his own poems and wrote editorials on literature and on politics, promoting the cause of Henry Clay. Because he was needed at home, he returned to Haverhill, but soon became editor of the *Essex Gazette.*

At the death of his father in June 1830, he again ran the farm, but soon became editor of the *New England Weekly Review* in Hartford, Conn., where he remained until 1832, except for a brief period spent in New York city, helping gather material for George D. Prentice's biography of Clay. As editor of the *Review* he published many of his own sketches, short stories, essays and poems; politically he sought to aid Clay by fomenting anti-Jackson sentiment. His first book, *Legends of New England,* a collection of short stories and poems, appeared in 1831. In the autumn of that year illness forced him to retire to the farm; overexertion at 17 had made him prone to illness all his life.

Whittier never married. The signs of an unhappy love affair had begun to appear in the *Review* with the publication of poems dealing with rejection of a suitor by a girl who had trifled with his affections. These poems reflected Whittier's ill-starred romance with a former classmate at Haverhill academy, Mary Emerson Smith, who Whittier believed had spurned him because she was socially above him. The theme of the possibility of marital happiness despite social barriers often figured in Whittier's poems.

In 1832 he entered politics actively, keeping the Whig candidacy of Caleb Cushing for congress alive during a party deadlock until Whittier himself reached the age required for candidacy. 25; he lost the election. At the behest of Garrison he published a pamphlet, *Justice and Expediency,* in June 1833. It cost him nomination for election to the state senate in the autumn. Whittier was a delegate to the first American Anti-Slavery convention in Philadelphia in Dec. 1833 and was thereafter engaged in propaganda work for the cause of abolition. Two early antislavery poems, "The Hunters of Men" and "Expostulation," were widely read. He persuaded Cushing, who ran successfully for congress in 1834, to support the abolitionist position, though Cushing was not an abolitionist; Cushing credited Whittier's help in his victory. In the same year, Whittier ran successfully for the state senate. He was too ill to serve after his second election.

From May to Dec. 1836 he edited the *Essex Gazette.* In July, having sold the farm, he moved to a new home in Amesbury. His work for abolition aroused his interest in free speech, and he wrote many poems and editorials on the subject. He traveled to Philadelphia, Harrisburg, Boston and New York for the abolitionist movement. In New York city in the spring of 1837, he was for six months one of the corresponding secretaries of the American Anti-Slavery society. A collection of his abolition poems was published in 1837 without his authorization by some of his friends. He served as editor of the *Pennsylvania Freeman* in Philadelphia from March 15, 1838, to Feb. 20, 1840. On May 17, 1838, Pennsylvania hall, the new building where the abolitionists had been meeting and to which the offices of the *Freeman* had been moved, was burned to the ground by a mob. In 1838 another volume, *Poems,* appeared, containing both abolitionist poems and those on other subjects.

In March 1840 Whittier returned to Amesbury in poor health and low in funds. With the split of the American Anti-Slavery society in May 1840, Whittier broke with Garrison and joined the offshoot organization, the American and Foreign Anti-Slavery society. Whittier at first gave only passive adherence to the newly formed Liberty party (*q.v.*), but supported its presidential candidate, James G. Birney, in 1840. A friendship with Lucy Hooper that had begun in 1837 ended with her death in 1841; only after her death did he realize the depths of her feeling for him. In 1841–42 he worked for the new antislavery society, editing their publications. He ran unsuccessfully for congress in 1842 on the Liberty party ticket. His poem, "Massachusetts to Virginia," against the arrest of fugitive slaves, attracted much attention in 1843. He published many other poems in 1843 and a new volume, *Lays of My Home,* his most successful book to that time, containing such notable poems as "Memories," "Lucy Hooper" and "Lines Written in the Book of a Friend" (later titled "Ego").

His antislavery activities increased in 1844. As editor of the *Middlesex* (Lowell, Mass.) *Standard* from July 1844 to March 1845, he again supported Birney's candidacy for president and opposed the annexation of Texas. He republished some of his *Standard* essays in 1845 under the title, *The Stranger in Lowell.* In 1846 Whittier swung the Liberty party votes behind John P. Hale, candidate for U.S. senator in New Hampshire, who, though not an abolitionist, was the first U.S. senator in sympathy with the antislavery cause. Whittier's antislavery poems were collected and published as *Voices of Freedom* (1846).

More and more, however, Whittier was turning to pure literature, though from 1847 to 1859 he was a contributing editor to the *National Era,* an abolitionist magazine. In 1849 the first collected edition of his poems appeared, as well as his only long piece of fiction, *Leaves from Margaret Smith's Journal of the Massachusetts Bay Colony.* Daniel Webster's "Seventh of March" speech in 1850, supporting compromise on slavery issues, inspired Whittier's stinging rebuke in the poem "Ichabod." During 1850–51 he worked hard for the nomination and election of Charles Sumner (*q.v.*) to the U.S. senate from Massachusetts. Whittier early saw the need of a new party to support the abolitionist position, and he was active in founding and promoting the Republican party.

Volumes of prose and poetry poured from his pen: *Old Portraits and Modern Sketches* (1850), *Literary Recreations and Miscellanies* (1854), *Songs of Labor* (1850), *The Chapel of the Hermits* (1853) and *The Panorama* (1856), the last containing two of his most popular poems, "The Barefoot Boy" and "Maud Muller."

In 18j6 he wrote poems for the campaign of the Republican presidential candidate, John C. Frémont, but after this year, his political and antislavery activities dwindled. As his editorial work waned, he contributed more to the *Atlantic Monthly* (founded 1857) and the *Independent* (founded 1848). A two-volume authorized edition of his poems appeared in 1857. His next. *Home Ballads and Poems* (1860), contained some of his finest work: "Telling the Bees," "My Playmate" and "Skipper Ireson's Ride."

In 1859 Whittier's last romance ended. Elizabeth Lloyd, whom he had met in Philadelphia in the '30s and whom he contemplated marrying after she was widowed in 1856, attacked some of his, and her! Quaker tenets, and he reproved her. From then on his friendships with women were purely Platonic so far as he was concerned, though he attracted the attention of many women poets and writers.

The outbreak of the Civil War placed Whittier in a dilemma: he had been a member of the electoral college that elected Lincoln, but he opposed coercing the southern states. He approved of the war but as a Quaker he was still a pacifist in principle. His early war poem, "Ein feste Burg ist unser Gott," became known as the "prohibited song" when the Hutchinson singers were ordered to stop singing it to the soldiers (President Lincoln countermanded the order). Whittier's best-known war poem, "Barbara Frietchie," was among those collected in his *In War Time* (1864). When the 13th amendment, abolishing slavery, was passed by congress in 1865, he commemorated the event with "Laus Deo."

Whittier's greatest literary triumph came in 1866 with the publication of *Snow-Bound.* The picture of winter farm life, the account of the old house, and the portraits of the members of his family and others won the hearts of U.S. readers. Though the poem depicts a life now partly outmoded, it still is of perennial interest. Rhittier became increasingly popular and was even financially successful. His prose works appeared in a collected edition in 1866, and *The Tent on the Beach* (1867) included his best-known religious poem, "Eternal Goodness."

His fame became transformed from that of a martial prophet who had defied church and state in the cause of freedom to that of the innocuous singer on harmless themes that made him the favourite of women and children. The valiant, aggressive bard became a meek and mild saint. He kept on producing volume after volume of poetry during the '70s and '80s, among them *Miriam* (1871), containing his innocent and beloved poem, "In School Days," and *Hazel-Blossoms* (1875), including some of his sister Elizabeth's poems. He also edited several works, among them *The Journal of John Woolman* (1871).

Although not active in politics, he was consulted by members of the Republican party, whose ticket he voted for the rest of his life, even when candidates were not above criticism. He no longer sided with the liberals; he opposed the railroad strike in 1877, and in his poem, "The Problem," called labour leaders "demagogues." In November 1887 he refused to join in any move ior commutation of the death sentences of the Chicago anarchists convicted for their part in the Haymarket riot.

From 1876 he lived near Danvers, Mass. His 70th birthday celebration is remembered today because Mark Twain made a speech in which he treated the New England writers with irreverence.

Whittier died on Sept. 7, 1892, at Hampton Falls. N.H., after suffering a paralytic stroke, and mas buried at Amesbury.

In a complete edition of his poetry and prose (1888–89), he classified the poems according to subject matter. In abandoning the chronological arrangement of the earlier editions, he concealed the traces of his poetical development. His final volume was *At Sundown,* privately printed in 1890 and published in 1892.

As an abolitionist, Whittier held most to his Quaker principles, but he operated well politically within them (Garrison refused to admit political action as the means to abolition).

Ranked among the favourite U.S. poets of the 19th century. Whittier mas at various periods recommended for different aspects of his work. He was adversely criticized by many for the limited resources of his art, for his uniformity of metre and for lack of imaginative vision. Such criticism he accepted gracefully and even agreed n-ith it. He was most popular in the years immediately after the Civil War and after his death. His reputation declined in the 20th century, though there were signs of its revival.

As a poet he was versatile in choice of theme, however limited the variety of his treatment. He was probably the supreme U.S. ballad writer. His poetry is that of the reiormer, the radical, the Quaker, the preacher, the farmer, the moralist, the lover, the elegist, the nature lover, the prophet, the patriot, the democrat, the hymnist, the social philosopher. He deserves still to be regarded as he n-anted to be: his "Proem" (1837), prefised to all collected editions of his works, shows him as intense a hater of tyranny and as deep and strong a lover of freedom as Milton and Marvell. "The Tent on the Beach" shows that he sought also to be considered an artistic poet, for he says that though he

> Had left the Muses' haunts to turn
> The crank of an opinion-mill. . . .
> He heard the fitful music still
> Of winds that out of dream-land blew.

He was really both a dire prophet and a gentle poet. If he suffered, and he did. from provincialism and puritanism, his love of justice and admiration of heroism permeates many poems. He was not so much loved as Longfellow, but he stands with the very man he disliked, Walt Whitman, as one of the leading advocates of U.S. democracy.

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WHITTIER, a city 13 mi. E. of Los Angeles, in southern California. U.S.. nithin Los Angeles county and the standard metropolitan statistical area. is on the slopes of the Puente hills. Founded in 1887 by Acquilla H. Pickering. Jonathan Bailey. John Painter and other members of the Society of Friends, and incorporated in 1898, Whittier was settled by Quakers principally from Iowa, Illinois and Indiana. Their plans for a Quaker community included a promotional campaign to attract fellow religionists from all parts of the U.S. as well as anybody else who wished to live in a Christian town. Real estate sold rapidly in the 1880s when railroads brought carloads of Quakers westward.

Until World War II Whittier was a small town surrounded by orange groves. walnut orchards and dairies and tied to Los Angeles by an internrhnn rail line and several highways. After 1945 residential and industrial developments (including the manufacture of oil tools. alloy steel products. auto radiators. gas and oil burners. chemicals, plastics, aircraft parts and cutlery) entirely crowded out the farms and made Whittier the centre of a vast resident community of nearly 200.000 persons by 1960, many of whom commute daily to Los Angeles. The incorporated area of Whittier retains many characteristics of a small town and depends heavily upon the larger population surrounding it for the support of its schools. churches, recreational facilities, intellectual life and light industry. Whittier adopted a council-manager form of government in 1949.

Whittier college, founded in 1891 as the Whittier academy and incorporated in 1901 as a college, was established as a nondenominational institution by its Quaker fathers. With about 1,400 students and 100 faculty members, the college offers instruction in the liberal arts, with specialization in teacher training and work for professional degrees. Richard M Nixon graduated from the college in 1934. Rose Hills Memorial park, one of the largest cemeteries in the U S., bounds the northwest part of the city Whittier was named in honour of the New England poet John Greenleaf Whittier.

For comparative population figures see table in California: *Population.* (J. A. Sz.)

WHITTINGTON, RICHARD (d 1423), mayor of London, described himself as son of William and Joan (Dugdale. *Monasticon Anglicanum,* vi, 740) This enables him to be identified as the third son of Sir William Whittington of Pauntley in Glouce~tershireph o married after 1355 Joan. daughter of William Mansel and widow of Thomas' Berkeley of Cubberley Richard was a mercer by trade, and entered on his commercial career under favourable circumstances. He married Alice, daughter of Sir Ivo Fitzwaryn, a Dorset knight of considerable property; his wife predeceased him. Whittington sat in the common council as a representative of Coleman street ward, was elected alderman of Broad street in March 1393, and served as sheriff in 1393–94. When Adam Bamme, the mayor, died in June 1397, Whittington was appointed by the king to succeed him, and in October was elected mayor for 1398. He had acquired great wealth and much commercial importance, and was ma>-or of the staple at London and Calais. He made frequent large loans to both Henry IV and Henry V, and, according to the legend, when he gave a banquet to the latter king and his queen in 1421, completed the entertainment by burning bonds ior f60.000, which he had taken up and discharged. Henry V employed him to superintend the expenses for completing Westminster abbey; But Whittington took no great part in public affairs. He was mayor again in 1406–07, and in 1419–20. He died in March 1423, bequeathing his vast fortune to charitable and public purposes. He joined in procuring Leadenhall for the city, and bore nearly all the cost of building the Greyfriars library. In his last year as mayor he had been shocked by the foul state of Newgate prison, and one oi the first works undertaken by his executors was its rebuilding. His esecutors, chief of whom was John Carpenter, the famous town clerk, also contributed to the cost of glazing and paving the new Guildhall, and paid half the expense of building the library there; they repaired St. Bartholomew's hospital, and provided bosses for water at Billingsgate and Cripplegate. But the chief of Whittington's foundations mas his college at St. Michael, Paternoster church, and the adjoining hospital. The college was dissolved at the Reformation, but the hospital or almshouses are still maintained by the Mercers' Company at Highgate. Stow relates that his tomb in St. Michael's church was spoiled during the reign of Edward VI, hut that under Mary the parishioners were compelled to restore it (*Survey,* i, 243). There is no proof that he mas ever knighted. 4 writer of the next generation bears witness to his commercial success in *A Libell of English Policy* by styling him "the sunne of marchaundy, that lodestarre and chief-chosen flower."

> Pen and paper may not me suffice
> Him to describe, so high he was of price.

Popular legend makes Dick Whittington a poor orphan employ-ed as a scullion by the rich merchant, Sir Hugh Fitzwarren, who ventures the cat, his only possession, on one of his master's ships. Distressed by ill-treatment he runs away, but turns back when he hears from Holloway the prophetic peal of Bow bells. He returns to find that his venture has brought him a fortune, marries his master's daughter, and succeeds to his business. The legend is not referred to by Stow, who would assuredly have noticed it ii it had been well established when he wrote. The first reference to the story comes with the licensing in 1605 oi a play. now lost. *The History of Richard Whittington, of His Lowe Byrth, His Great Fortune.* "The legend of Whittington," probahly meaning the play of 1605, is mentioned by Beaumont and Fletcher in 1611 in *The Knight of the Burning Pestle.* When a little later Robert Elstracke, the engraver, published a supposed portrait of Whittington with his hand resting on a skull, he had in deference to the public fancy to substitute a cat; copies in the first state arc very rare. Thomas Keightley traced the cat story in Persian, Danish and Italian folklore as far back as the 13th century.

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improve on Lysons. There arc useful references in J. H. Wylie's *History of England under Henry IV*, 4 vol. (1884–98). For the legend *see* T Kcightley's *Tales and Popular Fictions*, pp. 241–286 (1834), and H. B Wheatley's preface to his edition of *The History of Sir Richard Whittington* (first published 16j6). (C. L. K.)

WHITTLE, SIR FRANK, (1907–) British inventor and aviator who produced the first British jet propulsive unit. *(See* also JET PROPULSION.) He was born at Coventry, Warwickshire, on June 1, 1907. After attending Leamington college he entered the Royal Air Force as a boy apprentice. He was selected for training for a commission at the R.A.F. college, Cranwell, and, on qualifying as a pilot, was posted to no. 111 (fighter) squadron in 1928. Whittle was trained as a flying instructor and from 1931 to 1932 served as a test pilot at the Marine Aircraft Experimental establishment, Felixstowe. Thence he passed successively through the R.A F. engineering school and Cambridge university. He was then attached to Power Jets, Ltd., to carry out development work on gas turbines for jet propulsion of aircraft. The jet engine of his invention was fitted to the specially built Gloster E28/39 air frame and Whittle carried out the first flights in May 1941. Before the end of World War II, squadrons of jet-engined aircraft had been formed He continued to play an important part in the development of jet propulsion. He became technical adviser to the ministry of supply in 1946 and retired from the R.A.F. in 1948 with the rank of air commodore. In the same year he received knighthood of the Order of the British Empire.

See Sir Frank Whittle, *Jet: The Story of a Pioneer (1953).* (D. CR.)

WHITWORTH, SIR JOSEPH, BART. (1803–1887), British mechanical engineer, was born at Stockport on Dec. 21, 1803. On leaving school at 14 he was sent to learn the business of cotton spinning at an uncle's mill. Possibly as a result of his experience with the rudimentary mill machinery he resolved to become a skilled craftsman, and moved to Manchester in 1821 to work as a mechanic with various machine manufacturers. In 1825 he became a mechanic in Maudslap's works in London and followed this with similar posts before returning to Manchester in 1833 to start his own business as a toolmaker.

During his time as a craftsman he not only recognized the importance of exact measurement and accurate workmanship, he devised methods for improving them far beyond the standards of the time, and the development of these ideas in his own business soon made his machine tools world famous. His recognition of the virtues of standardization and reproducibility in the manufacture of machine parts, and the accuracy upon which they depend, gave rise to his greatest contributions to workshop technique.

His works in Manchester, from a modest start, grew rapidly and at the 1851 exhibition his machine tools. including screw-cutting lathes, planing, drilling, slotting and shaping machines and his millionth-part measuring machine were highly commended. At the age of 48 he was recognized as the leading machine toolmaker of the world. In 1866 his factory employed 700 men and was equipped with about 600 machine tools, all of which had been made in the works.

In 1840, at the British association meeting in Glasgow, he described his method, developed while he was at Maudslay's, of making a true plane by the scraping and matching of three plates instead of the unsatisfactory grinding operation current at the time. At the Institution of Civil Engineers in 1841 he introduced his ideas for standard screw threads to make order out of the chaos of heterogeneous shapes and pitches then in existence. Woolwich arsenal adopted his standard in the same year. In his presidential address to the Institution of Mechanical Engineers in 1856 he put forward his views on the economy in time and money resulting from standardization of designs and sizes of engine parts; he stressed the importance of interchangeability which had become practicable as a result of his development of standard gauges and measuring machines.

In 1855 he was asked to advise the government on the re-equipment of the Enfield Royal Small Arms factory. After many experiments he designed a rifle which was proved the most accurate of the time at the trials. However, the bore of 0.45 in. was considered too small and was not adopted until 1869. His interest was then turned to heavy ordnance and to the use of pressure casting of the steel for it. His success in this field enhanced his world-wide reputation.

He was equally concerned with the quality of his craftsmen. In his later years he gave much of his time and considerable fortune to furthering engineering education and to bringing it within reach of the artisan. He contributed to the foundation of the chair of engineering and laboratories at Owen's college, Manchester. In 1868 he founded the Whitworth scholarships, setting aside an annual sum of £3,000 for the purpose. and in the following year he was created a baronet. He died at Monte Carlo on Jan. 22, 1887. In addition to giving £100,000 for the permanent endowment of 30 Whitworth scholarships, his residuary legatees, in pursuance of what they knew to be his intentions, expended more than £500,000 on charitable and educational objects, mainly in Manchester and the neighbourhood. (J. DD.)

WHOOPING COUGH (PERTUSSIS) is an acute, highly communicable respiratory disease characterized in its typical form by paroxysms of coughing, followed by a long-drawn inspiration or "whoop" and ending with expulsion of clear sticky mucus, and often vomiting. The disease was first adequately described by G. de Baillou in 1578 as it then occurred in Paris; undoubtedly it had existed for a long time before that. About 100 years later the name pertussis mas introduced by Sydenham in England; other English names besides whooping cough have included chincough, hooping cough and slime cough.

In 1906 at the Pasteur institute, Jules Bordet and O. Gengou isolated the bacteria that cause the disease. At first they were called Bordet-Gengou bacilli; later, *Haemophilus pertussis;* and more recently, *Bordetella pertussis.* The small coccobacilli may be grown on a suitable culture medium inoculated either by a spasmodic cough or by a nasopharyngeal swab. These causative bacteria are found in practically all patients during the first two weeks after onset, the most infectious period. By the end of the fourth week, cultures are usually negative.

Nature of the **Disease.**—The course of whooping cough is variable, but in the usual attack several stages are recognized. Following an incubation period of approximately one week, catarrhal symptoms develop; they resemble an ordinary upper respiratory infection, with a short dry cough that is worse at night. This catarrhal stage, after one to two weeks, passes into the distinctive paroxysmal stage, which is variable in duration but commonly lasts four to six weeks. Serious complications include bronchopneumonia, usually due to secondary infection with such organisms as pneumococci, streptococci, staphylococci or influenza bacilli; persistent vomiting; suffocative attacks; and occasionally convulsions and indications of brain damage.

Second attacks. usually mild, sometimes occur, particularly in adults who may then unwittingly infect infants. Attacks of whooping cough caused by related bacteria. *Bordetella para-pertussis,* are usually milder than those caused by B. *pertussis.* Occasionally the disease is caused by B. *bronchiseptica*, an organism found sometimes in animals (*e.g.*, the rabbit).

Importance of Whooping Cough. — This disease is world-wide in its distribution and among the most important of the acute infections of children. In spite of a declining death rate, it causes more deaths every year than diphtheria, measles and scarlet fever put together. Approximately 90% of the deaths that occur are in children under age five and more than 60% of them in infants under one year of age. The severity of the disease in terms of damage to health, growth and resistance of young children is not generally realized. Also, no other infectious disease causes so many lost days of school.

The World Health organization recognized the importance of whooping cough in 1952 in its meeting of experts on diphtheria and whooping cough immunization. Continuing committees are concerned with establishment of reference materials and standards for improvement of protective vaccines throughout the world.

Specific Immunization and Treatment. — Attempts to ansner the apparently opposed results of different efforts to prevent whooping cough by vaccination stimulated the organization of carefully controlled field trials. The incidence of whooping cough in a vaccinated group during a particular period of observation was compared with the incidence in a control group as nearly like the test group as possible except for the lack of vaccine. Such methods demonstrated the protective action of certain preparations of whooping cough vaccine. Also, the study pattern suggested by these trials extended beyond the field of mhooping cough; the methods were refined and expanded in investigations of the usefulness of other preventive agents.

Treatment of whooping cough has been made more effective by the use of certain antibiotics, both by modifying the severity of the primary infection and by controlling the secondary invaders.

See W. W. C. Topley and G. S. Wilson, *Principles of Bacteriology and Immunity,* 4th ed. by G. S. Wilson and A. A. Miles (1955). (P. L. Kk.)

WHORF, BENJAMIN LEE (1897–1941), U.S. chemical engineer by profession, linguistic theoretician by avocation, Whorf gave to linguistics a brilliant and penetrating insight that led to new and original research. Born April 24, 1897, in Winthrop, Mass., he received his engineering training at Massachusetts Institute of Technology (B.S., 1918), and worked all his life for an insurance company. Following some ideas first clearly stated by Edward Sapir, he formulated what came to be known as the Sapir-Whorf hypothesis: that every language is a systematic presentation or analysis of reality as seen by its speakers, that this reality differs from every other such system, that human beings necessarily see reality only through their particular linguistic system and that the linguistic system and the reality the system represents mutually affect and interpenetrate each other. For example: in English the verb *pour* applies both to liquids and to particles, as of sand; in Russian, for liquids one uses one verb (lit') and for particles another. Not only vocabulary, but also the grammatical structure is involved: English always classifies nouns as one or more than one *(boy: boys),* but in Japanese the plurality of reference is pointed out by some other element in the sentence ("as for boy, there was a multiplicity"). In addition to his language-and-culture studies, Whorf contributed to the better understanding of the classification of American Indian languages and first determined the real nature of the Mayan hieroglyphs as a true system of writing. J. B. Carroll edited a selection of his writings, *Language, Thought and Reality* (1956).

He died at Wethersfield, Conn., July 26, 1941. (G. L. T.)

WHYMPER, EDWARD (1840–1911), British explorer, mountaineer and artist, the first man to climb the Matterhorn, was born in London on April 27, 1840. He was trained as a wood engraver and in 1860 he visited the western Alps to make a series of sketches. In 1861 he climbed Mont Pelvoux in this district, then believed to be the highest mountain of the Dauphiné. He discovered that the Pointe des Ecrins was higher and in 1864 made the ascent of that peak.

Whymper's name is chiefly associated with the Matterhorn (14,688 ft.) in the Valais. Between 1861 and 1865 he attempted this formidable peak six times, up the southwest or Italian ridge. It was by accident that he saw the Swiss ridge from the side and noted that it was not so steep as it appeared. He saw also that the strata dipped conveniently for climbing.

At the seventh attempt, on July 14, 1865, Whymper made the ascent by the Swiss ridge, while the Italian guide, J. A. Carrel, was attempting the Italian ridge. On the descent one member of the party slipped and pulled off-three more. The rope broke, thus saving Whymper and two guides. This is perhaps the best-known of all mountaineering accidents and is recorded along with many of his climbs in *Scrambles Amongst the Alps* (1871); illustrated with his own engravings.

In 1867 Whymper visited Greenland with a view to crossing the icecap, but a second expedition, in 1872, convinced him that the undertaking would be too costly. He then visited the Andes, partly to study the effects of mountain sickness. In 1880 he twice ascended Chimborazo (20,702 ft.) and spent a night on the summit of Cotopaxi. *Travels Amongst the Great Andes of the Equator* appeared in 1892. His last journeys, in 1901–05, were among the Canadian Rockies.

Whymper died at Chamonix on Sept. 16, 1911.

See T. G. Bonney in Alp. J. (Feb. 1912); G. Winthrop Young in *Alp. J.* (Nov. 1943); Frank Smythe, *Edward Whymper* (1940). (C. W. F. N.)

WICHITA, a city of south-central Kansas, U.S., on the Arkansas river near the mouth of the Little Arkansas, 200 mi. S.W. of Kansas City; the seat of Sedgwick county. Pop. (1960); city 254.698, an increase of 54.6% in the decade; standard metropolitan statistical area (Sedgwick county) 343,231, an increase of 54.4%. (For comparative population figures for the city see table in KANSAS: *Population.*)

Founded in 1864 as a trading post on the site of a village of the Wichita Indians, for whom the city was named, Wichita owed its early development to the Texas cattle trade along the Chisholm trail and to the rapid spread of agricultural settlement along the Atchison, Topeka and Santa Fe railroad, then under construction. The city was platted in 1870 and incorporated in 1871. In its early years Wichita was a stopover on cattle drives to Abilene and other points as the railroad moved west; in 1872 it reached Wichita and the city became a major cattle shipping centre. In that year 4,000 cars of cattle (80,000 head) were shipped eastward; in 1873 the number increased to 400,000 head. By 1875 settlement by farmers had intensified to such an extent that drovers found it difficult to reach the rail yards (because of fences) and thereafter the shipment of cattle diminished. The loss was more than compensated for by grain, however, and Wichita became a trade and milling centre.

The first commercial airplane made in Kansas was constructed in Wichita in 1920. ,After that, the city became the aircraft manufacturing centre of the state, with plants of several major companies. Also located nearby is McConnell air force base. The city continues to be a large grain and livestock market; the Union stockyards have extensive facilities for cattle, hogs and sheep. Grain milling is also a major activity. In addition, chemicals, pharmaceuticals, garments, precision tools, castings, petroleum products, stoves, millwork and printed materials help make up the diverse products of the city.

Wichita is well served by public and parochial schools and there is an estensive city park system. Higher education is served by the University of Wichita, a municipal institution founded in 1895 as Fairmount college and the oldest municipally supported university west of the Mississippi; and the Friends university, a Quaker institution established in 1898. Wichita has a council-manager form of government, in effect since 1917. (D. P. G.)

WICHITA FALLS, a city of north-central Texas, U.S., 105 mi. N.W. of Fort Worth on the Wichita river 16 mi. S. of the Red river; it is the seat of Wichita county. Named for the Wichita Indians who inhabited the area and a small river falls that existed there in its early days, the city was founded in 1876 and incorporated in 1889. With the arrival of the Fort Worth and Denver City railroad in 1882, Wichita Falls became a cattle centre. Oil was discovered in 1900 and in the same year irrigation projects were begun to aid agriculture in the surrounding area. In 1928 the city adopted a council-manager form of government. Wichita Falls is the centre of extensive oil and gas fields and an especially productive agricultural region, devoted to stock raising, dairying and the cultivation of wheat, cotton, alfalfa, feed grains and fruit in the fertile Wichita valley. Manufacturing industries include oil refineries and oil field machinery factories. Sheppard air force base, an important defense installation, with its unit of the strategic air command, is located at Wichita Falls. Midwestern university, Wichita Falls' municipally operated university, was established in 1922. Pop. (1960) 101,724; standard metropolitan statistical area (Archer and Wichita counties) 129,638. (V. M. S.)

WICK, a royal and small burgh, seaport, and the county town of Caithness. Scot. Pop. (1951) 7,161. It is situated on the Wick river at the head of Wick bay. on the North sea. 17 mi. S. of John O'Groats and 21 mi. S.E. of Thurso by road. The airport is an important link in the services between Orkney and Shetland and southern Scotland and England. Wick is a centre of the herring fisheries and there are hosiery and knitwear industries, a creamery, a distillery and a herring oil factory. The harbour was built by Thomas Telford in 1800. Wick *(Vik* or "bay") is mentioned as early as 1140 and became a roral burgh in 1589.

WICKLOW, a county of Ireland in the province of Leinster, bounded east by St. George's channel, north by the county of Dublin, south by Wexford and west by Carlow and Kildare. The land area is 781.6 sq.mi. Pop. (1956) 60.680. The coast is very dangerous to approach because of sandbanks. The harbour at Wicklow has a considerable trade; but that of Arklow is suitable only for small vessels. The central portion of the county is occupied by a granitic mountain range, running from northeast to southwest, the highest summits being Kippure (2,475 ft.), Mullaghcleevaun (2,788), Thonelagee (2,686), Table mountain (2,302) and Lugnaquillia (3.029). The range rises from the north by a succession of ridges intersected by deep glens, and subsides to ard the borders of Wexford and Carlow. To the north its foothills enter County Dublin. and add attraction to the southern outskirts of Dublin. The water supply of Dublin comes partly from an artificial lake on the first plateau of the foothills at Roundwood.

In the valleys there are many instances of old river terraces, especially at the lower end of Glenmalure and the lower end of Glendalough. Among the more famous of the glens are Glendalough, Dargle. Glencree, Glen of the Downs, Devil's glen, Glenmalure and the beautiful vale of Avoca or Ovoca The principal rivers are the Liffey. on the northwestern border: the Vartry. which passes through Devil's glen to the sea north of Wicklow head; the Avonmore and the Avonbeg, which unite at the "meeting of the waters" to form the Avoca, which is afterward joined by the Aughrim and falls into the sea at Arklow; and the Slaney. in the west of the county, passing southward into Carlow. The principal lakes are Loughs Dan. Bray and Tay or Luggelaw. and the loughs of Glendalough. The trout fishing is generally fair.

Wicklow was not made a county until 1606. It was the last Irish ground shired, for in this mountainous district the Irish were long able to preserve independence. Wicklow sided with the royal cause during the Cromwellian wars, but on Oliver Cromwell's advance submitted to him without striking a blow. During the rebellion of 1798 there were skirmishes at Aughrim and at Arklow and some of the insurgent leaders maintained a guerrilla resistance which gave rise to many popular ballads.

Of the ancient cromlechs there are three of some interest, one near Enniskerry, another on the summit of Lugnaquilla and a third at Donaghmore. The ruins in the vale of Glendalough, known as the "seven churches." including a round tower, owe their origin to St. Kevin, who lived in the vale as a hermit, and is reputed to have died in 618. *See* GLENDALOUGH, YALE OF.

The lower land is fertile; and the higher districts. covered with heath and turf, afford good pasturage for sheep. There is a considerable extent of natural timber as well as artificial plantations. The forestry commission has acquired Shelton abbey. Arklow. formerly the seat of the earl of Wicklow. with extensive woods. to be its main centre for training in forestry. The previous centre was at Avondale. on the slopes further inland. The principal crops of oats and potatoes have decreased. but the numbers of sheep. cattle. pigs and poultry have been maintained. A flourishing modern pottery factory exists at Arklow.

A considerable amount of gold has been extracted from the valley gravels north of Croghan Kinshela on the Wexford border. Tinstone has also been found in small quantities. Lead ore is raised west of Laragh. and the mines in the Xvoca valley have been worked for copper. lead and sulfur. the last named being obtained from pyrite. Paving setts are made from the diorite at Arklow. and granite is extensively quarried at Ballyknockan on the west side of the mountain chain. In 195j a Canadian company received a concession to rework the ancient mines of the vale of Xvoca to obtain copper and iron ores by modern methods.

Because of its proximity to Dublin and its accessibility from England. the portions of the county possessing scenic interest have been opened up to great advantage. Bray in the north is a seaside resort. Inland tourist centres are Enniskerry. west of Bray and near the pass of the Scalp: Laragh, near Glendalough, from which a military road runs southwestward across the hills below Lugnaquilla; and. on the railway south of Wicklow. Rathdrum and Woodenbridge in the Vale of Xvoca and Aughrim. A railway skirts the coast by nay of Bray and the town of Wicklow. touching it again at Arklow, with a branch line from Woodenbridge junction to Shillelagh. Another branch from Sallins (County Kildare) skirts the west of the county by Baltinglass. The administrative county of Wicklow returns three members to *dáil eireann.*

WICKLOW, an old seaport and the county town of County Wicklow. Ire., at the mouth of a lagoon which receives the river Vartry and other streams, 32 mi. S.S.E. of Dublin by road. Pop. (1956) 3,070. The harbour can accommodate vessels of 1,500 tons and has two piers, with quayage. The name shows the town to have been a settlement of the Norsemen.

WICKSELL, (JOHAN GUSTAF) KNUT (1851–1926), Swedish economist, the foremost in his generation and internationally renowned for his pioneering work in monetary theory, nas born at Stockholm on Dec. 20. 1851. In *Geldzins und Güterpreise* (1898; Eng. trans., *Interest and Prices,* 1936) and in *Föreläsningar i Nationalekonomi, del II* (1906). he propounded an explanation of price-level movements by an aggregate demand-supply analysis focused on the relations between prospective profit and interest rates. This anticipated the work of J. M. Keynes in *Treatise on Money* (1930). In *Über Wert, Kapital und Rente* (1893: Eng. trans.! *Value, Capital and Kent,* 1954), Wicksell emerged as an originator of the marginal productivity theory. There and in *Föreläsningar i Nationalekonomi, del I* (1901), he also made striking advances in capital theory. A fundamental principle of public finance, that public enterprises should apply the marginal-cost-pricing rule. was first propounded by Wicksell in *Finanztheoretische Untersuchungen* (1896). He was professor at the University of Lund. 1900–16, and died on May 3, 1926. Because of his abiding allegiance to the Swedish social reform movement, Wicksell's academic career was impeded for many years.

See T. Gardlund, *The Life of Knut Wicksell* (1958); C. G. Uhr, "Knut Wicksell: a Centennial Evaluation," *Amer. Econ. Rev.,* vol. xli (1951).
(C. G. U.)

WIDGEON, an abundant species of duck, *Anas penelope,* breeding in Europe and northern Asia and reaching northern Africa and India in winter. Intermediate in size between the teal and the mallard, the widgeon drake is a handsome bird with cream forehead. chestnut head and neck, penciled gray flanks and green and black speculum (wing bar). Its whistling cry has given it the local name of "whew duck." The widgeon collects in huge flocks on tidal waters in winter and is shot for market in large numbers. When on land it often eats grass. Two allied species occur in America. of which *A. americana,* the baldpate. inhabits northern America, reaching Central America and Trinidad in winter; it differs in that the head is green, with the top of the head white. The other species, A. *sibilatrix,* is South American.

WIDMANN, JOSEPH VICTOR (1842–1911), poet, dramatist, novelist and literary critic! was born at Nennowitz (Moravia) on Feb. 20, 1842, and died at Berne on Nov. 6, 1911. In 1880 he became *feuilleton* editor of the *Berner Bund,* and in this capacity he exercised for 30 years an authoritative sway as critic of German and German-Swiss literature. Among the most important of his own works are *Arnold von Brescia* (1867), a tragedy; *Buddha* (1869), a philosophic epic, which might be described as a forerunner of Nietzsche's *Also Sprach Zarathustra* and Spitteler's *Prometheus und Epimetheus; Mose und Zipora* (1874), an idyll: *Oenone* (1880), a drama; *Die Patrizierin* (1888), a novel of life in Berne; *Die Maikäferkomödie,* "Cockchafer Comedy" (1897), a charming allegorical play, which may possibly have furnished Rostand with the idea of *Chantecleu;* and *Der Heilige und die Tiere* (1905), another dramatic poem in which his interest in the animal world and its right to poetic existence are demonstrated. The last is his profoundest poetical utterance. Widmann was one of the first to champion the genius of Carl Spitteler (*q.v.*), with whom his friendship dated from childhood days at Liestal.

See the *Life by* E. and M. Widmann, 2 vol. (1922–24); the studies by Maria Waser (1927), Jonas Fränkel (1918), W. Scheitler (1925); and the *Briefwechsel Keller-Widmann* (1922).

WIDNES, a municipal borough (1892) in the Widnes parliamentary division of Lancashire, Eng., 14 mi. S.S.E. of Liverpool by road. Pop. (1951) 48,785. Area 9 sq.mi. It is on the north bank of the Mersey at the lowest bridgeable point. A plan was approved in 1954 to replace the famous Runcorn transporter bridge (1905) by an arched bridge. The town is wholly of modern growth, for in 1851 the population was less than 2.000. Well-placed between the Cheshire salt fields and the Lancashire coal fields, Widnes is one of the principal centres of the chemical industry and. besides having general engineering works, makes such varied products as asbestos goods, steel alloys, paper, slippers and clothing; it has a large trade in timber. The name. Wydnes in the early 13th century, meant "wide promontory."

WIDUKIND or WITTEKIND (d. after 785), leader of the Saxons. belonged to a noble Westphalian family. He probably fought the Franks before and during 776. In 778 he returned from exile in Denmark to lead a fresh rising. and in 782 the Saxons at his instigation drove out the Frankish priests and plundered the border territories. His movements in 783–784 are uncertain: but in 785 he was reconciled to Charlemagne at Xttigny and baptized, the king acting as his sponsor and loading him with gifts. The details of his later life are unknown. He probably returned to Saxony. Many legends have gathered round his memory; some would make him a devoted Christian, but it was his grandson. Walbert, n-ho first endowed religious houses on the family estates. Royal houses have sought to establish descent from him. but except in the case of Matilda, wife of the German king Henry I the Fowler, without success.

See W. Diekamp, Widukind der Sachsenfiihrer *nach* Geschichte und Sage (Munster, 1877); J. Dettmer, Der Sachsenfiihrer Widukind nach Geschich'te und Sage (Wiirzburg, 1879); H. Wiedemann, Karl der Grosse, *Widukind und* die *Sachsenbekehrung* (Miinster, 1949).

WIDUKIND, Saxon historian, was the author of Res gestae *Saxonicae*. He was a monk at the Benedictine abbey of Corvey, and he died about 1004. His Res gestae Saxonicae, dedicated to Matilda, abbess of Quedlinburg. who was a daughter of Otto the Great. is divided into three books, and the greater part of it was undoubtedly written during the lifetime of the emperor, probably about 968. Starting with the origin of the Saxons, the history comes down to the death of Otto in 997. Many quotations from the Vulgate are found in his writings, and there are traces of a knowledge of Virgil, Ovid and other Roman poets. The earlier part of his work is taken from tradition, but he wrote on contemporary events as one familiar with court life and the events of the day.

The best edition of the Res gestae is that edited by G. Waitz in the *Monumenta Germaniae historica*. Scriptores, vol. iii (Hanover and Berlin, 1826). A good edition published at Hanover and Leipzig in 1904 contains an introduction by K. A. Kehr.

WIELAND, CHRISTOPH MARTIN (1733–1813), German poet and man of letters, was born at Oherholzheim, a village near Biherach in Württemberg, on Sept. 5, 1733. His father, who was pastor in Oberholzheim. and subsequently in Biberach, took great pains with the child's education, and sent him to the *Gymnasium* at Klosterberge, near Magdeburg. Under the influence of a first love affair. with Sophie Gutermann, he planned his first ambitious work. Die *Natur* der Dinge (1752), a didactic poem in six books. In 1750 he went to Tiibingen to study law, but his time was mainly taken up with literary studies. The poems he wrote at the university—*Hermann,* an epic (published by F. Muncker, 1886), *Zwölf moralische* Briefe in Versen (1752), Anti-Ovid (1752)—are pietistic in tone and dominated by the influence of Klopstock. They attracted the attention of J. J. Bodmer. who invited Wieland to visit him in Ziirich in the summer of 1752. After a few months, however, Bodmer felt himself as little in sympathy with Wieland as, two years earlier, he had felt himself with Klopstock. and the friends parted; but Wieland remained in Switzerland until 1760, residing, in the last year, at Berne where he obtained a position as private tutor. There he stood in intimate relations with Rousseau's friend Julie de Bondeli. Meanwhile a change had come over Wieland's tastes; the writings of his early Swiss years—Der *geprüfte Abraham* (1753), *Sympathien* (1756), *Empfindungen eines* Christen (1757)—were still in the manner of his earlier writings, but with the tragedies, Lady *Johanna* Gray (1758) and Clementina von Porretta (1760)—the latter based on Richardson's Sir Charles *Grandison*—the epic fragment *Cyrus* (1759). and the "moral story in dialogues," *Araspes und* Punthea (1760), Wieland, as Lessing said, "forsook the ethereal spheres to wander again among the sons of men."

Wieland's conversion was completed at Biberach, whither he had returned in 1760, as Kanzleidirektor, or town clerk. He had access to the library of Count Stadion at Warthausen. There he met once more Sophie Gutermann, who had become the wife of the *Hofrat* La Roche, then manager of Count Stadion's estates. The former poet of an austere pietism now became the advocate of a lighthearted philosophy, from which frivolity and sensuality were not excluded. In Don. Sylvio von Rosalva (1764), a romance in imitation of Don *Quixote,* he held up to ridicule his earlier faith, and in the *Komische* Erzahlungen (1765) he gave his extravagant imagination only too free a rein. More important is the novel Gesclzichte des Agathon (1766–1767), in which, under the guise of a Greek fiction. Wieland described his own spiritual and intellectual growth. This work, which Lessing recommended as "a novel of classic taste," is a landmark in the development of the modern psychological novel. Of equal importance was Wieland's translation of 22 of Shakespeare's plays into prose (8 vol., 1762–66); it was the first attempt to present the English poet to the German people in something approaching entirety. With the poems *Musarion* oder die Philosophie der *Grazien* (1768), *Idris* (1768), *Kombabus* (1770), Der *neue Amadis* (1771), Wieland opened the series of light and graceful romances in verse which acted as an antidote to the sentimental excesses of the subsequent *Sturm* und Drung movement.

Wieland married in 1765, and between 1769 and 1772 was professor of philosophy at Erfurt. In the last-mentioned year he published Der goldene *Spiegel* oder die Konige *von* Scheschian, a pedagogic work in the form of oriental stories; this attracted the attention of duchess Anna Amalie of Saxe-Weimar, who appointed him tutor to her two sons, Karl August and Konstantin, at Weimar. With the exception of some years spent at Ossmannstedt. where in later life he bought an estate, Weimar remained Wieland's home until his death on Jan. 20. 1813. There, in 1773, he founded Der *Deutsche Merkur,* which under his editorship (1773–89) became the most influential literary review in Germany. Of the writings of his later years the most important are the admirable satire on German provinciality—the most attractive of all his prose writings—Die Abderiten, *eine* sehr *wahrscheinliche* Gesclzichte (1774), and the charming poetic romances, Das *Wintermärchen* (1776), Das *Sommermärchen* (1777). Geron *der Adelige* (1777), Die *Wünsche* oder Pervonte (1778), a series culminating with Wieland's poetic masterpiece, the romantic epic of Oberon (1780). His later work included novels, translations of Horace, Lucian and Cicero, and the editing of the Attisches Museum (1796–1803). Without creating a school in the strict sense of the term, he influenced considerably the German literature of his time. Modern editions of Wieland's Samtliche Werke are those of H. Diintzer, 4 vol. (1879–82), and the critical edition issued by the Prussian academy (1909, etc.). (J. G. R.)

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WIELAND, HEINRICH (1877–1957), German chemist, was awarded the Nobel prize in chemistry in 1927 for research on bile acids and their constitution. He was born at Pforzheim, Baden, June 4, 1877. He was educated at the universities of Berlin, Stuttgart and Munich, at the last of which he received his Ph.D. degree in 1901. He made an exhaustive examination of the reaction between double carbon linkages and the oxides of nitrogen and a study of hydrazines which led to the discovery of free radicals containing divalent and tetravalent nitrogen. Subsequent research proved that free radicals of this type and the ions with the same composition could be distinguished by a characteristic band spectrum for the free radicals. This problem is important to structural organic chemistry. Wieland proposed a mechanism by which halogens and the nitro group are introduced into the benzene nucleus and for the action of nitric acid on the hydrocarbon double bond, thus helping to unify the internal relationship between aliphatic and aromatic organic compounds. His studies of natural substances include morphine alkaloids, a yellow butterfly pigment, the bitter principles of hops and a synthesis of inosite. In addition to the clarification of the structure of the bile acids, Wieland also introduced a dehydrogenation theory of oxidation of importance to physiology, biochemistry and medicine. His revision of Ludwig Gattermann's *Die Praxis des Organischen Chemikers (Laboratory Methods* of *Organic Chemistry,* first published, 1894; 34th ed.. 1952) is a classic. Wieland was professor of chemistry at Munich; and when he retired in 1953 was head of the Chemisches Staatsinstitut, Munich. He died Aug. 5, 1957, in Munich. (V. Bw.)

WIELICZKA, a mining town in Poland, 9 mi. S.E. of Cracow. Pop. (1950) 9,000. It is built over the celebrated salt mines which are the richest in Poland and among the most remarkable in the world. Inside the mines are 16 ponds. The salt of Wieliczka is well known ior its purity and solidity, but has generally a gray or blackish colour. The date of the discovery of the mines is unknown, but they were already worked in the 11th century. The mines suffered from inundations in 1868 and 1879, and the soil on which the town is built shows subsidence.

WIEN, WILHELM (1864–1928), German physicist and Nobel prize winner, whose researches covered almost the whole sphere of physics. was born on Jan. 13, 1864, at Gaffken, East Prussia. He studied at the universities of Gottingen, Heidelberg and Berlin, and in 1890 entered the Physicotechnical institute near Berlin as assistant to Hermann von Helmholtz. In 1896 he was appointed professor at the technical high school, Aix-la-Chapelle; in 1899 he went to Giessen, in 1900 to Würzburg, and in 1920 to Munich. He wrote on optical problems; on radiation, especially black-body radiation, for which in 1911 he was awarded the Nobel prize; on water and air currents, on discharge through rarefied gases, cathode rays, X-rays and positive rays. Wien's most important contributions to black-body radiation are contained in the two laws named after him. From his formula for the energy density associated with a definite wave length at a certain temperature, he obtained what is known as Wien's displacement law: the product of the wave length at which the energy density is a maximum and the absolute temperature is a constant. Wien also developed a formula for the energy distribution of black-body radiation; this was found to hold for short wave lengths only but is important as a link in the chain which led to Planck's formula *(see* also THERMOMETRY). His work on positive rays is of great importance; he showed that these rays underwent electrostatic and magnetic deflection as early as 1898 and continued his researches on this subject. In 1913 he lectured at Columbia university on problems of modern theoretical physics. He died on Xug. 30, 1928.

Wien was the editor of the *Annalen der Physik* from vol. 21 (1906). His chief works are *Lehrbuch der Hydrodynanzik* (1900); *Neuere Probleme der theoretischen Physik* (1913); *Die Relativitätstheorie vom Standpunkte der Physik und Erkenntnislehre* (1921).

WIENER-NEUSTADT, a town in Nieder-Österreich (Lower Austria), from 1938 to 1945 the *Reichsgau* Niederdonau, at the divergence of routes from Vienna to the Semmering pass and to Hungary via the Sopron gate. Founded in 1192, it contains a 12th-century castle built by Duke Leopold V, converted by Maria Theresa in 1752 into a military academy and after 1919 a school for boys; the 13th-century Romanesque Liebfrauen church; and the 15th-century Cistercian abbey with its rich library and museum. Wiener-Neustadt became an industrial town with special interests in locomotives and railway stock, machinery, textiles and leather goods, sugar refining, paper-making and the manufacture of pottery. Trade is facilitated by a canal to the capital, chiefly used for the transport of coal and timber. Pop. (1951) 30,559.

WIESBADEN, the capital since 1945 of the *Land* of Hesse, Ger., and one of the oldest spas in Germany, lies in a valley under the southern spurs of the Taunus range. East and west the town is sheltered by chains of hills but to the south the valley runs into the plain of the Rhine. The old city is built at heights varying between 358 and 556 ft. above sea level; the suburbs Biebrich and Schierstein are situated on the river. Since 1945 Kastel, Amöneburg and Kostheim, suburbs of Mainz on the Wiesbaden rather than the Mainz side, have been administered by the city of Wiesbaden. Pop. (1950) 220,741; (1957 est.) 249,900.

The city is famous for its 27 hot springs, among them Kochbrunnen, Adlerquelle and Faulbrunnen. In addition to the Wilhelmstrasse, Langgasse and Kirchgasse are the main shopping streets, and there are many promenades and large parks. Although the city suffered destruction during World War II, some of the older buildings survived: the old town hall (1610), the new town hall (1887), the Kaiser Friedrich baths (1913), the Griechische Kapelle or Greek chapel (1855) and the castle nhich now houses the *Landtag* (administrative offices) of the *Land* Hesse. The state theatre opened as an opera house and playhouse in 1894. The municipal museum houses a picture gallery. The main railway line up the Rhine valley passes through Wiesbaden, and an overland coach service links the town with cities in France. Belgium and the Netherlands. Boats go to Cologne, Mainz and Frankfurt-on-Main.

Its varied industries include iron foundries, metal and concrete works, chemicals, textiles, printing and plastics. A noted wine centre. it is famous for its *Sekt* (German champagne).

History. — The first Roman earth fortifications, erected in 12 B.C., were superseded by stone fortifications in A.D. 83, and the Roman settlement with its important springs was known as Aquae Mattiacorum. The Roman wall Heidenmauer was built about 370. The place was the site of a Franconian palace and of St. Mauritius church, built between 750 and 775. The name Wisibada (meadow spring) appears in 829. In the mid-13th century Wiesbaden became an imperial city, passing toward the end of the century to the counts of Nassau; in 1744 it became the seat of government of the principality Nassau-Usingen; from 1806–66 it was the capital of the duchy of Nassau. when it passed nith that duchy to Prussia. The city then became capital of the Prussian district of Wiesbaden of the province Hesse-Kassau. After World War II it became the capital of the newly created *Land* of Hesse. (H. M.-WH.)

WIESER, FRIEDRICH VON (1851–1926), Austrian economist and sociologist, one of the leaders of the so-called Austrian school, which developed the marginal utility theory of economic value into a full explanation of price phenomena, was born at Vienna on July 10, 1851. He was professor at the universities of Prague and Vienna, and from 1917 to 1918 minister of commerce of Austria. Wieser realized earlier and more clearly than other marginalists (except Léon Walras) that he was formulating the laws of value not only of capitalism but of any rational economy; in this respect he anticipated ideas that came to full fruition only in the 1930s. His tendency to combine a sociological with an economic approach was a useful counterweight to the exclusive devotion to abstract economic reasoning on the part of other marginalists. Wieser's writings include *Der natürliche Wert* (1889); *Theorie der gesellschaftlichen Wirtschaft* (1914; Eng. trans., *Social Economics,* by A. Ford Hinrichs, 1927); and *Das Gesetz der Macht* (1926). He died on July 23, 1926. (C. L.)

WIG, the short form for periwig, derived from the French *perruque,* is an artificial head of hair or hair piece worn as a personal or theatrical cosmetic adornment, disguise or symbol of office.

The wearing of wigs dates from earliest recorded times, and Egyptian mummies have been found so adorned. In ancient Greece wigs were used by men and women. 4 reference in Xenophon and a story in Aristotle suggest that wigs were introduced from Persia and were in use in Asia Minor. The elaborately frizzled hair worn by some of the figures in the frescoes found at Cnossos indicates that wearing artificial hair was known to the Cretans. Lucian, writing in the 2nd century, mentioned wigs of both men and women as a matter of course. The theatrical wig was also in use in Greece, the various comic and tragic masks having hair suited to the character represented. These conventions appear to have been handed on to the Roman theatre.

In Rome wigs came into use in the early days of the empire. They were also known to the Carthaginians; Polybius said that Hannibal used wigs as a means of disguise. Juvenal described Messallina as assuming a yellow wig for her visits to brothels: Later the fashionable ladies of Rome almost universally adopted the use of hair pieces, and references in the writings of Ovid and Martial indicate that the golden hair imported from Germany was most favoured. The chief names for wigs were *galerus, galericulum, corymbium, capillamentum, caliendrum,* etc. *Galerus* meant a skullcap, or coif, fastening under the chin and made of hide or fur. worn by peasants, athletes and flamens. The first men's wigs then would have been tight fur caps simulating hair. Women continued to have wigs of different colours as part of their ordinary wardrobe and Faustina, wife of Marcus Aurelius, is said to have had several hundred. Some portrait busts, *e.g.*, that of Plautilla in the Louvre, Paris, had the hair made removable so that by changing the wig a statue would never be unfashionable.

The periwig of the 16th century merely simulated real hair, either as an adornment or to correct nature's defects. In the 17th century, in France, the peruke (*perruque*) was worn as a distinctive feature of costume. In 1620 the Abbé de la Rivière appeared at the court of Louis XIII in a periwig made to simulate long fair hair. Four years later the king himself, prematurely bald, also adopted one and thus set the fashion.

Louis XIV, who as a youth was proud of his abundant hair, did not wear a wig till after 1670. From Versailles the fashion spread through Europe. After the Restoration in England, under Charles II, the wearing of the peruke became general. Samuel Pepys records that he parted with his own hair and "paid £3 for a periwigg," and on going to church found that "it did not prove so strange as I was afraid it would." Under Queen Anne the wig attained its maximum development, covering the back and shoulders and floating down over the chest. Many varieties were perfected. Smaller, less pretentious wigs, custom-ordered from London, were also worn in the American colonies.

The differentiation of wigs according to class and profession explains why. when early in the reign of George III the general fashion of wearing wigs began to wane and die out, the practice held its own among professional men. It was by slow degrees that doctors, soldiers and clergymen gave up the custom. In the church it survived longest among the bishops. Both the French and American Revolutions saw the sweeping away of many social customs, including class distinctions indicated by hair styles and wigs. Wigs are now worn as part of the official costume only in Great Britain, by judges and barristers. Post-World War II Britain, however, saw the emergence of therapeutic prescription hair pieces or toupees as an integral part of the socialized medical program.

In the United States, with the development of television (calling for close-up cameras j and greater emphasis upon youthfulness and realism in the movies and theatre, the ancient art of wigmaking turned the full cycle. Since the early 1950s the trend toward men's hair pieces continuously gained in social custom and acceptance. The modern hair-piece industry has evolved entirely new styles and techniques of craftsmanship, in which the undetectable—yet 'secure—collegiate crew cut is the counterpart to the peruke of yesteryear.

For the theatrical use of wigs *see* also MAKE-UP (STAGE, MOTION PICTURE AND TELEVISION).

See Pearl Binder; *Muffs and Morals* (1955). (B. Z. K.)

WIGAN, a market town and a municipal, county and parliamentary borough of Lancashire. Eng., 18½ mi. W.N.W. of Manchester by road. Pop. (1951) 84.560 Area 7.9 sq.mi. The town, on the river Douglas, is the centre of the great south Lancashire coal field. A main line to Scotland runs through it as well as lines between Manchester. Liverpool and the west coast; the Leeds and Liverpool canal provides a means of transport by water. The tower of the parish church of All Saints is Iiorman. the remainder having been rebuilt in the 19th century. The beautiful octagonal war memorial was designed by Sir G. G. Scott. The grammar school, founded in 1597, occupies a new building opened in 1937. There are a mining and technical college and the Thomas Linacre Technical school (1953). Mesnes park. close to the town centre, and Haigh hall and the Plantations, purchased by the corporation in 1947, are open spaces.

It is probable that the borough occupies the site of a Roman fort, Coccium, and numerous Roman relics have been found. The name Wigan is Saxon and according to the college of heralds Wigan was made a borough under a royal ordinance of Henry I in 1100 and it is upon this that its claim to he the oldest borough in Lancashire is based. After the Conquest. Wigan became part of the barony of Newton. Before Henry III's reign, a rector secured the manorial privileges and in 1246 Henry III granted a charter to the rector by which Wigan was constituted a free borough and the burgesses were permitted to have a guild merchant. Wigan soon grew to be a medieval town of importance. A weekly market and two annual fairs have been held since 1258. In 1314 Edward II granted another charter which still exists. Wigan is the setting for the famous medieval legend of Mab's Cross used by Sir Walter Scott in *The Betrothed.*

During the Great Rebellion the town, from its vicinity to Lathom house and the influence of Lord Derby, adhered staunchly to the king. On April 1, 1643, the parliamentarians captured Wigan. The following month Lord Derby regained it for the royalists, but Col. Edward Ashton soon retook it. In 1651 Lord Derby marched through Preston to Wigan and at Wigan Lane, on Aug. 25, the royalist forces were defeated and Lord Derby was executed soon afterward. A new charter was given by Charles II in 1662 and Wigan is described in it as the "ancient and loyal" borough. During the rebellion of 1745 the Young Pretender occupied quarters in the town. For a short period during the later 18th century the town became a spa through the discovery of chalybeate waters. Its subsequent history has been one of intense industrial and commercial development. Wigan became a county borough in 1888.

In 1295 Wigan returned two members to parliament and again in 1307; the right then remained in abeyance until 1547, but from that time until 1885, except during the Commonwealth, the borough returned two members, and since 188; one member.

Wigan was famous for cannel coal: and outcrops were mined early in the 14th century. Coal mining has been largely carried on since the 17th century. though many mines in the immediate vicinity have been exhausted. Ancient industries were pewter making. pottery manufacture and bell founding. Cheap coal led to the development of large ironworks from the 18th century onward and the manufacture of blankets and other woolen goods was once of some significance. The principal industries today apart from coal mining are cotton spinning and weaving, clothing manufacture, heavy engineering and the manufacture of preserved foods. Other industries are plastics. coachbuildisig and the manufacture of fertilizers. footwear, furniture and telephones and electrical equipment. There are tar, rubber, oil, grease. vinegar and paint works. (H: H. G. A.)

WIGGIN, KATE DOUGLAS (1856–1923), U.S. novelist, was best known as the author of the "Rebecca" books. Daughter of Robert N. Smith, a lawyer, she was born in Philadelphia. Pa., Sept. 28. 1856, whence her family removed to Hollis. Me. She was educated at home and at various seminaries including Abbot academy (Andover, Mass.), and when 17 years of age joined her family in California. Having been a member of Miss Marwedel's pioneer training class, she was called from her teaching in Santa Barbara to establish in San Francisco the first free kindergarten on the west coast (1878), and organized her own California kindergarten training school in 1880. She married. in 1881. Samuel B. Wiggin, who died in 1889. In 1895 she married George C. Riggs, hut continued to write under the name of Wiggin. She died in England. Aug. 24. 1923. Her interest in children's education was shown in numerous books, but her literary reputation rests on her prose fiction: *The Birds' Christmas Carol* (188j), the Penelope series (j vol.): *Rebecca* of *Sunnybrook Farm* (1903); *New Chronicles of Rebecca* (1907); and *The Story* of *Waitstill Baxter* (1913). Several of these were dramatized with the assistance of collaborators. An autobiographical volume is *My Garden* of *Memory* (1923).

A uniform "Quillcote" edition of her books appeared in ten volumes. *See* also Nora Archibald Smith, *Kate Douglas Wiggin as Her Sister Knew Her* (1925); and a short biography with a bibliography by Helen Frances Benner (Orono, Me., 1956).

WIGGLESWORTH, MICHAEL (1631–1705), American clergyman, physician and poet. was born in England (probably in Yorkshire) Oct. 18, 1631. His father, persecuted for his Puritan faith. emigrated with his family to New England in 1638, and settled in New Haven. In 1651 Michael graduated at Harvard, where he was a tutor (and a fellow) in 1652–54 and again in 1697–1705. Having fitted himself for the ministry, he preached at

Charlestown in 1653–54, and in spite of ill health was pastor at Malden, Mass., from 1656 until his death. June 10, 1705. Wigglesworth is best known as the author of *The Day of Doom; or a Poetical Description of the Great and Last Judgment* (1662), an exposition of Calvinistic theology which children were made to learn like a catechism. It went through various editions and was reissued several times in the 18th and 19th centuries. An edition by K. B. Murdock. with drawings adapted from early New England gravestones by Wanda Gág, was published in 1929.

WIGHT, ISLE OF, lies off the south coast of England and is a part of Hampshire. separated from the mainland by the Solent. It is 22½ mi. from east to west and 13½ mi. from north to south with an area of 147.1 sq.mi. and a population (1951) of 95,62j. The climate is mild and healthy.

Newport, at the head of the Medina estuary. is the chief town; Cowes. at the mouth, the principal port and a great centre of sailing and yachting. Holiday resorts are Cowes, Ryde and Seaview, Bembridge. Sandown, Shanklin, Ventnor. Freshwater Bay. Totland Bay and Yarmouth. There are airports at Bembridge and Sandown. Osborne house, near Cowes. a residence of Queen Victoria and the scene of her death, was presented to the nation by King Edward VII in 1902. Farringford at Freshwater. now a hotel. was the home of Alfred Lord Tennyson. The principal communications with the mainland are between Ryde and Portsmouth, Cowes and Southampton. and Yarmouth and Lymington.

Its unique geological structure gives the island many rock formations within a small compass and a consequent variety of scenery and natural history. The central range of downs from Culver cliff in the east to the Needles in the west is the thickest bed of chalk in the British Isles. Off the western promontory rise the Needles. three detached masses of chalk about 100 ft. high. Northward the chalk dips steeply below the Tertiary rocks. with heavy soils which support many trees. The Forestry commission's woodlands in the island extend to over 4,000 ac.. Parkhurst forest covering 1,312 ac. Southward the beds dip more gently and there is a second range of downs in the extreme south which reach 787 ft. on St. Boniface down. The south coast is mostly cliff bound. and between St. Catherine's point and Dunnose extends the Undercliff. a series of terraces formed by the slipping of the chalk and Upper Greensand over the Gault Clay. The upper cliffs shelter this area. Off the coast near Brook is a now petrified submerged forest. Alum was formerly obtained at Alum bay, now visited for its multicoloured sandstone cliffs.

Three rivers, the eastern Tar. Medina and western Yar, flow northward into the Solent. The Medina almost bisects the island; while the western Yar almost insulates the western Wight. Along the south coast the action of small streams on the soft rocks has hollowed out steep and beautiful gullies known as chines, the most famous being at Shanklin and Blackgang.

The Isle of Wight County council was established in 1890. There are two boroughs. Newport (pop.. 1951, 20,430) and Ryde (20,105) and three urban districts. A separate court of quarter sessions was established in 1951. In 1927 the island was transferred from the diocese of Winchester to the newly founded diocese of Portsmouth. The island returns one member to parliament.

History. — There are traces of human occupation at every period from the Paleolithic onward. but the Early Bronze Age (c. 1900–1joo B.C.) seems to have been the period of most intense prehistoric settlement. A hoard of bronze weapons of this period was found on Arreton down in 1735, another at Moon's hill near Totland in 1942 and in 1954 a fine grooved bronze dagger of "Wessex" type was found in the side of a burial mound on Xrreton don-n. The Romans named the island Vectis and there are many relics of their occupation after Vespasian annexed it in A.D. 43, but no trace of a town or a military site. The Jutes probably settled there and in 661 it was annexed by Wulfhere to Wessex and subsequently bestowed on the king of Sussex. In 998 it was the headquarters of the Danes. From the 14th to the 16th century the island was under fear of invasion by the French, who in 1377 burned Yarmouth and so devastated Piewport that it lay uninhabited for two years. In 1404 a French force landed and demanded tribute which was refused and the French returned home. Another raid was attempted in 1545 when a French fleet of 225 ships drew up off Brading harbour and wrought much destruction. As a result forts were constructed at Cowes. Sandown, Freshwater and Yarmouth. Charles I was imprisoned in Carisbrooke castle in 1647–48 as were, in 1650, his two children, the princess Elizabeth and Henry. duke of Gloucester. the former dying there.

The lordship of the island was granted by William the Conqueror to William Fitz-Osbern, but escheated to the crown. It was bestowed by Henry I on Richard de Redvers, whose descendant Isabella de Fortibus sold it to Edward I in 1293.

The island quarries have been worked from remote times, that of Quarr supplying material for Winchester cathedral. Apart from agriculture and catering for visitors the main industries are shipbuilding and aircraft construction at Cowes.

Antiquities include about 1jo mounds, mostly Bronze Age, including three long barrows on several of the chalk downs; the Long Stone at Mottistone, a monolith (presumably Neolithic) 13 ft. high; Roman villas at Brading, Shide and Carisbrooke; an earthwork on Chillerton down called The Five Barrows; Carisbrooke castle. a beautiful ruin. built chiefly in the 12th century; a ruined 14th-century lighthouse on St. Catherine's down; and the remains of the medieval Cistercian abbey at Quarr, near Ryde.

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WIGMAN, MARY (1886–), German dancer who was an outstanding pioneer of the modem expressive dance as developed in central Europe, was born on Nov. 13, 1886 in Hanover. She studied under Émile Jaques-Dalcroze and Rudolf von Laban, the latter of whom is best known for his widely accepted system of dance notation. Wigman gave her first solo concert in Switzerland in 1918 and thenceforth worked independently, formulating her own theories of movement. She often danced without music or with percussion accompaniment. She toured the United States alone in 1930–31 and with her group in 1933. She taught extensively in Germany and Switzerland; her pupils included Harald Kreutzberg and the noted choreographer Hanya Holm. (LN. ME.)

WIGSTON, an urban district in the Harborough parliamentary division of Leicestershire, Eng., 4 mi. S. of Leicester. Pop. (1951) 15,457. Area 5.4 sq.mi. The parish church is dedicated to St. Wulfstan (Wolstan), 11th-century bishop of Worcester, and in Domesday Book the village appears as Wichingestone — the "tun" or settlement of vikings. Since the 17th century Wigston has been known for its hosiery which, in 1956, was made in about 30 factories. Other industries are clothing, boots and shoes and wooden heels, biscuits, drums and other percussion instruments, and salt refining.

WIGTOWNSHIRE (sometimes called WEST GALLOWAY), a southwestern county of Scotland, bounded north by Ayrshire, east by Kirkcudbrightshire and Wigtown bay, south by the Irish sea and west and north by the North channel. Including the island of St. Helena: at the head of Luce bay, its land area is 487.5 sq.mi. Pop. (1951) 31,620. On the eastern boundary the estuary of the Cree expands into Wigtown bay, between which and Luce bay extends the promontory of the Machars or Machers, terminating in Burrow head. By the indentation of Luce bay on the south and Loch Ryan on the north the hammerheaded peninsula of the Rhins (Rinns or Rhinns) is formed, of which the Mull of Galloway, the most southerly point of Scotland, is the southern, and Milleur point the northern extremity. Loch Ryan is a natural harbour of which Stranraer is the port.

A line northeast from the coast about 3 mi. S. of Portpatrick divides the county so that practically all the rocks on the northern side are of Ordovician age, while those on the south are Silurian. This line coincides with the general direction of the strike of the beds throughout the county. Glacial moraines and drumlins are widespread and are well seen between Glenluce and

Newton Stewart and south of Wigtown. On the coasts of Luce bay and Loch Ryan raised beaches are found at levels of 25 ft. and 50 ft. above the sea. Toward the Ayrshire border, hills reach 1,000 ft. in height. The chief rivers are the Cree and the Bladnoch. Most of the numerous lochs are small.

The history of Wigtownshire is hardly distinguishable from that of Galloway (*q.v.*). Evidences of prehistoric occupation are prevalent in the form of hill forts, cairns, standing stones. hut circles and crannogs or lake dwellings. There are so few Roman remains that it has been concluded they effected no permanent settlement there. Ninian, the first Christian missionary to Scotland, is said to have landed at Isle of Whithorn in 396 though some scholars put his foundation as late as 430–440. A monastery was built at Whithorn, and, though the bishopric founded in the 8th century was shortly afterward removed, it was established again in the 12th, when the priory erected by Fergus, "king" of Galloway, became the cathedral church of the see of Galloway; it is now in ruins. Glenluce abbey, a Cistercian house founded in 1190, is also ruined. At Kirkinadrine are three stones with the Christian Chi Rho symbol dating from about the jth–6th century.

Malcolm MacHeth, who had married a sister of Somerled, lord of the Isles, headed about 1150 a Celtic revolt against the intrusion of Anglo-Norman lords! but was routed at Causewayend near the estuary of the Cree. In the disorder of the realm during David II's reign East Galloway had been surrendered to Edward III (1333), but Wigtownshire, which had been constituted a shire in the previous century and afterward called the Shire to distinguish it from the Stewartry of Kirkcudbright, remained Scottish territory. In 1372 the then earl of Wigtown sold his title and estates to the 3rd earl of Douglas, and under that family in 1426, the region came under the general law. Soon after the fall of the Douglases (1455) the Kennedy family obtained a preponderating influence in Wigtownshire. Gilbert, the 4th earl, held the shire for Mary, queen of Scots, when she broke with the Lords of the Congregation, but could do little for her cause.

Among ancient castles are the cliff towers, possibly of Norse origin, of Carghidown and Castle Feather near Burrow head; the ruins of Baldoon (south of Wigtown), and those of Carscreugh, (northeast of Glenluce), both associated with events which suggested to Sir Walter Scott the romance of *The Bride of Lammermoor;* Corsewall near the northern extremity of the Rhins; the Korse stronghold of Cruggleton, south of Garliestown; Dunskey, south of Portpatrick, built in the 16th century, occupying the site of an older fortress; the fragments of Long castle at Dowalton loch, the ancient seat of the MacDonells; Myrton, the seat of the MacCullochs, in Mochrum parish; and the ruined tower of Sorbie, the ancient keep of the Hannays.

The soil is of a light loamy nature, particularly in the Rhins where from 30% to 50% of the arable land is annually under the plow. In the Machars area, where more stony outcrops appear, the percentage under the plow is rather less. Grass is the chief crop. The high land is devoted mainly to the rearing of sheep and store cattle. Over 2,000 ac. of the shore land annually produce the earliest potatoes in Scotland. Farm cheese making, which at one time was the chief dairy product, has almost ceased. Ayrshire cattle are still the favourite dairy breed while Galloways and their crosses are popular as beef breeds. A few pedigree flocks of Border Leicester sheep are kept chiefly to provide rams for crossing purposes. Pigs are increasing in numbers as are hens.

The four small burghs are Newton Stewart (pop., 1951, 1,997), Stranraer (8,618), Whithorn (1,068) and Wigtown (1,376), the last three being royal burghs. In 1951 there were 65 persons speaking Gaelic and English. There is regular communication by mail steamer between Stranraer and Larne in County Antrim, Ire.

See H. Maxwell, *A History of Dumfries and Galloway* (1896); The Land of Britain Survey, *Kirkcudbright and Wigtown* (1941); Royal Commission on Ancient and Historical Monuments . . . Scotland, *Galloway,* vol. 1 (1912); *Transactions and Journal of the Proceedings* of the Dumfriesshire and Galloway Natural History and Antiquarian Society (1863 *et seq.).*

WIGWAM, a term loosely adopted as a general name for the houses of North American Indians. It is, however, strictly applied to a particular dome-shaped or conical hut made of poles lashed together at the tops and covered with bark. The skin tents of many of the Plains Indians are called tepees. "Wigwam" is from the Algonkian.

WIHTRED (d. 725), king of Kent, son of Ecgberht, came to the Kentish throne in 690 after the period of anarchy following the death of Eadric. Bede states that Wihtred and Swefheard were both kings in Kent in 692, and this statement would appear to imply a period of East Saxon influence (*see* KENT [kingdom]). while there is also evidence of an attack by Wessex. Wihtred, however, seems to have become sole king in 694. At his death in 725 he left the kingdom to his sons Aethelberht. Eadberht and Alric. A code of laws issued by him in a council at a place called Berghamstyde (probably 695) is still extant.

WILAMOWITZ-MOELLENDORFF, ULRICH VON (1848–1931), great German classical scholar and teacher, who threw new light on almost every aspect of the ancient world, was born at Markowice, near Poznan, on Dec. 22, 1848. After studying at the universities of Bonn and Berlin and traveling in Italy and Greece he became *Privatdozent* at Berlin in 1874. In 1878 he married the daughter of the famous scholar Theodor Mommsen. He was appointed university professor successively at Greifswald (1876), Gottingen (1883) and Berlin (1897).

He died at Berlin on Sept. 25, 1931.

A man of strong personality and vigorous mind, who aimed at revivifying the past by an imagination controlled by strict scholarship Wilamowitz made fundamental advances in metrics, epigraphy, papyrology, topography and textual criticism. as well as in literary and historical studies on ancient authors. His works include editions of various Greek texts, the most important being that of Euripides' *Heracles,* and books on Greek poetry, the Homeric question, Plato and Greek religion. He was also a brilliant translator of Greek verse.

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WILBERFORCE, SAMUEL (1805–1873), English bishop, third son of William Wilberforce (*q.v.*), was born at Clapham common, London, on Sept. 7, 1805. He graduated from Oriel college, Oxford. in 1826, and was ordained in 1828. In 1830 he became rector of Brightstone, Isle of Wight. Although a high churchman Wilberforce held aloof from the Oxford movement; in 1838 his divergence from the "Tract" writers became so marked that Newman declined further contributions from him to the *British Critic.* In 1839 he published *Eucharistica* (from the old English divines), to which he wrote an introduction. *Agathos and Other Sunday Stories,* and a volume of *University Sermons,* and in the following year *Rocky Island and Other Parables.* In March 1844 he was made dean of Westminster, and in October bishop of Oxford.

In 1847 the bishop signed the remonstrance of the 13 bishops to Lord John Russell against R. D. Hampden's appointment to the bishopric of Hereford. He endeavoured to obtain assurances from Hampden; but, though unsuccessful, withdrew from the suit against him. The establishment of a Roman hierarchy in England in 18jo brought the high church party, in which Wilberforce was prominent, into temporary disrepute.

His attitude toward *Essays and Reviews* (1861), against which he wrote an article in the *Quarterly,* won him the gratitude of the low church party, and latterly he enjoyed the confidence of all except the extreme men of either side. On the publication of J. W. Colenso's *Commentary on the Romans* in 1861. Wilberforce sought a private conference with the author; but after the publication of the first two parts of the *Pentateuch Critically Examined* he drew up the address of the bishops which called on Colenso to resign his bishopric. Though opposed to the disestablishment of the Irish Church, yet, when the constituencies decided for it, he advised that no opposition should be made to it by the house of lords. After 24 years in the diocese of Oxford. he was translated by Gladstone to Winchester. He was killed on July 19, 1873, by a fall from his horse near Dorking, Surrey.

See Life of Samuel Wilberforce, With Selections From His Diary and Correspondence, vol. i, ed. by Canon A. R. Ashwell, and vol. ii and iii,

ed. by his son R. G. Wilberforce (1879–82); R. G. Wilberforce also wrote a one-volume *Life* (1905).

WILBERFORCE, WILLIAM (1759–1833), English politician and philanthropist, is chiefly associated with the abolition of the slave trade. He was born at Hull on Aug. 24, 1759. He was descended from an old Torkshire landed family. but his father, who died when William was nine! was associated with commerce. Wilberforce was educated at Hull grammar school and St. John's college. Cambridge. He was not an outstanding student, but he was a good companion and friend. Soon after leaving the university, and already possessed of a considerable fortune which he inherited from his grandfather and uncle. he became a member of parliament for Hull in 1780. As a friend and colleague of William Pitt. who was his contemporary at Cambridge, he was elected member of parliament for Yorkshire at the election of 1784, and offered Pitt valuable support in the house of commons. He became renowned for his parliamentary diplomacy and his private influence with men in office.

Although never firmly bound by party ties. Wilberforce throughout his life remained loyal to Pitt's principles. Although an early supporter of parliamentary reform and of Roman Catholic emancipation in the 1780s, the experience of the French Revolution made him increasingly conservative. In 1812 he exchanged the representation of the large constituency of Porkshire for that of Bramber, Sussex. After 1815 he supported the corn laws and the repressive policy of the government in domestic affairs. In 1825 he retired from the house of commons, but a few months before his death on July 29, 1833, he declared that he considered the first Reform bill too radical.

Wilberforce's interest in slavery was prompted by religion and humanitarianism, but Pitt encouraged him in the cause as a worthy subject, suited to his character and outlook. Converted to evangelical Christianity in 1784 largely under the influence of Isaac Milner, one of his schoolmasters and later president of Queen's college. Cambridge, he helped to set up in 1784 the Society for the Reformation of Manners. and three years later the Abolition society. The former organization was designed to raise the moral standards of Englishmen, the latter to strike at the slave trade in the West Indies. On account of their ideals and purposes, Wilberforce and his friends were known as "the Saints," or, after his marriage in 1797 and acquisition of a house at Clapham, as "the Clapham sect." Along with Henry Thornton, Thomas Clarkson. Charles Grant, E. J. Eliot, Zachary Macaulay and James Stephen, he pressed for rigorous conduct and zeal for moral welfare. The program of the sect was canvassed in the periodical, the *Christian Observer,* which first appeared in 1801.

Wilberforce was neither an original thinker nor a man of outstanding energy, but he was a greatly respected leader of the antislavery movement and many other causes. While Clarkson conducted the agitation in the country, Wilberforce took every opportunity in the house of commons. where he was an able and influential speaker, to expose the evils and horrors of the trade. For the history of the various motions introduced by Wilberforce *see* SLAVERY. It was not until 1807, the year following Pitt's death, that the first great step toward the abolition of slavery was taken. When the antislavery society was founded in 1823, Wilberforce became a vice-president, but before his aim was accomplished he had retired from public life. The Emancipation act. which was the culmination of his life's work, was not passed until a month after his death. In later years Wilberforce's name was identified with championship of oppressed slaves and although his general views have subsequently been criticized, his reputation is firmly established.

In 1797 Wilberforce published *A Practical View of the Prevailing Religious System of Psofessed Christians in the Higher and Middle Classes of this Countsy Contvasted with Real Christianity,* which within half a year vent through fire editions and was translated into French. Italian. Dutch and German.

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(A. BRI.)

WILBYE, JOHN (1574–1638), English madrigal composer, was born at Diss, Norfolk, in 1574, the date of his baptism being March 9. For many years nothing was known of his life but many facts later came to light. His father was a well-to-do landowner, Matthew Wilbye. Through his early acquaintance with the Cornwallis family at Brome hall John became resident musician at Hengrave hall. the seat of Sir Thomas Kytson. whose wife was Elizabeth Cornwallis. The inventories of Hengrave give the items of furniture in Wilbye's rooms and the Hengrave Letter Book II contains a letter from Rilbye to a friend, which has been reproduced in vol. VI of *The English Madrigal School.* In 1628 Lady Kytson died. and Wilbye retired to Colchester. where he lived in the house of Lady Rivers, a daughter of the Kytsons. Wilbye died there in Sept. 1638. in his 65th year.

Wilbye's madrigals are the most famous of the English school. He had in a supreme degree the quality of style and he obtained wonderful effects of contrast by his skill in grouping the voices. His *First Set of English Madrigals to 3, 4, 5, and 6 Voices* was published in 1598, bearing the date April 12, and was dedicated to Sir Charles Cavendish, son-in-law of Sir Thomas Kytson. It contains 30 numbers, including the famous "Flora Gave Me Fairest Flowers."

The madrigals of the *Second Set,* dedicated to Lady Xrabella Stuart, which appeared in 1609. are even more finished in style. Among them are "Draw on. Sweet Night"; "Stay, Corydon!'; and "Sweet Honey-sucking Bees."

WILD, JONATHAN (*c.* 1682–1725), English criminal, was born about 1682 at Wolverhampton, where his father was a wigmaker. After a term of imprisonment he set up as a receiver of stolen goods. Wild built up an immense business, posing as a recoverer of stolen goods, the thieves receiving a commission on the price paid for recovery. A special act of parliament was passed by which receivers of stolen property were made accessories to the theft, but Wild's professed "lost property office" had little difficulty in evading the new law, and became so prosperous that two branch offices were opened. Wild went on to arrange robberies himself, and he devised and controlled a huge organization, which plundered London and its approaches wholesale. Such thieves as refused to work with him received short shrift. The notorious Jack Sheppard, wearied of Wild's exactions, at last refused to deal with him, whereupon Wild secured his arrest, and himself arrested Sheppard's confederate, "Blueskin." In return for Wild's services in tracking down such thieves as he did not himself control, the authorities for some time tolerated the offenses of his numerous agents. If an arrest were made. Wild had a plentiful supply of false evidence at hand to establish his agents' alibi, and he obtained the conviction, by similar means, of such thieves as refused to recognize his authority. Such stolen property as could not be returned to the owners with profit was taken abroad in a sloop purchased for this work. At last he was arrested, tried at the Old Bailey and, after being acquitted on a charge of stealing lace, found guilty of taking a reward for restoring it to the owner without informing the police. He was hanged at Tyburn on May 24, 1725.

WILD CARROT (*Daucus casota*). a biennial herb of the parsley family (Umbelliferae, *q.v.*), native to Europe, northern Africa and Asia and extensively naturalized in North America as a weed, often exceedingly pernicious in pastures, meadows and fields. It is the parent species of the common root vegetable from which it differs chiefly in the size and quality of the root. The wild carrot springs from a deep, fleshy. conical root, with an erect stem. 1–3 ft. high, bearing much-dissected. hairy leaves and a great many small white flowers crowded in a large globose or flat-topped cluster (compound umbel), often 3–5 in. across, the central flower of each umbel often purple. The ripening seed-vessels, which are small and bristly hairy, often form a concave cluster, suggestive of a bird's nest. Because of this the plant is popularly called crow's-nest or bird's-nest. It is also known as Queen Anne's lace because of the appearance of the flower clusters. Dairy products from cattle grazing on wild carrot are frequently tainted with a "carrot flavour."

WILDE, OSCAR FINGALL O'FLAHERTIE WILLS (1854–1900), English author, son of Sir William Wilde, a famous Irish surgeon. nas born in Dublin on Oct. 16, 1854; his mother, Jane Francisca Elgee, was well known in Dublin as a graceful writer of verse and prose, under the pen-name of "Speranza." Having distinguished himself in classics at Trinity college, Dublin, Oscar Wilde went to Magdalen college, Oxford, in 1874, and won the Newdigate prize in 1878 with his poem "Ravenna," besides taking a first-class in classical Moderations and in Literae Humaniores. At Oxford he adopted what to undergraduates appeared the effeminate pose of casting scorn on manly sports, wearing his hair long, decorating his rooms with peacock's feathers, lilies, sunflowers, blue china and other *objets d'art,* which he declared it his desire to "live up to," affecting a lackadaisical manner, and professing intense emotions on the subject of "art for art's sake"—then a new-fangled doctrine which J. hi. Whistler was bringing into prominence. Wilde made himself the apostle of this new cult. At Oxford his behaviour procured him a ducking in the Cherwell, and a wrecking of his rooms, but the cult spread. Its affectations were burlesqued in Gilbert and Sullivan's travesty *Patience* (1881). As the leading "aesthete." Oscar Wilde became one of the most prominent personalities of the day; his affected paradoxes and his witty sayings were quoted on all sides, and in 1882 he went on a lecturing tour in the United States, where he wrote a drama, *Vera,* which was produced in New York. In 1884 he married Constance Lloyd. He had already published in 1881 a selection of his poems, which, however, only attracted admiration in a limited circle. In 1888 appeared *The Happy Prince and Other Tales,* illustrated by Walter Crane and Jacomb Hood. This charming volume of fairy tales was followed up by *Lord Arthur Savile's Crime, and Other Stories* (1891), and later by a second collection of fairy stories *Tlze House of Pomegranates* (1892), acknowledged by the author to be "intended neither for the British child nor the British public." *The Picture of Dorian Gray* (1891) was the mirror of the new aesthete. In 1891 his tragedy in blank verse. *The Duchess of Padua,* was produced in New Tork. But Wilde's first real success with the larger public as a dramatist was with *Lady Windermere's Fan* (St. James's Theatre, 1892), followed by *A Woman of No Importance* (1893), *An Ideal Husband* (1895) and *The Importance of Being Earnest* (1895). The wit and brilliance of these pieces helped them to keep the stage, and they are still occasionally revived. In 1893 the licenser of plays refused a licence to Wilde's *Salome,* but it was printed in French in 1893, and produced in Paris by Sarah Bernhardt in 1894, and was translated into English in the same year by Lord Alfred Douglas.

His success as a dramatist had by this time gone some way to disabuse hostile critics of the suspicions as regards his personal character which had been excited by the apparent looseness of morals which since his Oxford days it had always pleased him to affect; but to the consternation of his friends, who had ceased to credit the existence of any real moral obliquity, in 1895 came fatal revelations as the result of his bringing a libel action against the marquis of Queensberry; and at the Old Bailey, in May, Wilde was sentenced to two years' imprisonment with hard labour for offences under the Criminal Law Amendment Act. He went bankrupt soon after. It was a melancholy end to a singularly brilliant career. After leaving prison in 1897 he lived mainly on the Continent, at Berneval and later in Paris under the name of "Sebastian Melmoth." He died in Paris on Nov. 30, 1900. In 1898 he published his powerful *Ballad of Reading Gaol.* His *Collected Poems,* containing some beautiful verse, had been issued in 1892. While in prison he wrote an apology for his life which was placed in the hands of his executor and published in 190j.

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WILDER, THORNTON NNEN (1897–), U.S. author, presented in his writings ordinary people who make the human race seem worth preserving. He was born April 17, 1897. in Madison. Wis.; attended schools in California, China and Ohio; received his A.B. from Yale in 1920 and his M A. from Princeton in 192j. He taught at The University of Chicago (1930–37) and at Harvard (1950–51) and served in the U.S. army air force during World War II.

Wilder's novels, mostly historical, include *The Cabala* (1926), *The Woman of Andros* (1930), *Heaven's My Destination* (1934) and *The Ides of March* (1948). In them he explicitly emphasizes the universality of what he portrays. In his novel *The Bridge of San Luis Rey* (Pulitzer prize, 1928) his use of six characters whose various lives end in the same disaster underscores his assertion that life is much the same for everyone.

At times in his plays, *e.g., The Matchmaker* (1956), characters address the audience directly and stress the similarities between the events in the play and the spectators' own experiences. In *Our Town* (Pulitzer prize, 1938) the lack of scenery helps keep the action from seeming limited to one small New Hampshire town; the stage manager's comments on the action also suggest the parallel to any town anywhere. In *The Skin of Our Teeth* (Pulitzer prize. 1943) deliberate anachronisms and the use of the same set of characters in various geological and historical periods tend to show that human experience is much the same whatever the time or place. (Js. T. N.)

WILDERNESS, a large forest in Spotsylvania county, Va., on the south bank of the Rapidan, extending from Mine Run on the west to Chancellorsville on the east. It is famous in military history for the battles of Chancellorsville (1863) and Wilderness (1864) during the American Civil War.

In the following accounts the names of the Confederate generals are italicized.

Chancellorsville.—In May 1863 a three days' battle was fought at Chancellorsville between the Army of the Potomac, under General Hooker, and General *Lee's* Army of Northern Virginia. Hooker had now at his disposal 12,000 cavalry, 400 guns, and 120,000 infantry and artillery, organized in seven corps. *Lee* counted only j5,000 men of all arms effective Hooker detached 10,000 cavalry, under Stoneman, to sweep round *Lee's* left, destroy the railways in *Lee's* rear and cut his line of retreat, and the 1st and 6th corps under Sedgwick (40,000) to cross below Fredericksburg and pin *Lee* in his entrenched position, while with the remainder he himself turned *Lee's* left by a wide maneuvre. Hooker on April 30 fixed his headquarters at Chancellorsville. *Lee,* judging that Sedgwick's advance was only a feint, called up *"Stonewall" Jackson's* four divisions from below the Massaponax. At Chancellorsville. *Anderson's* division was in position, and *McLaws* was sent to support him. while *Jackson* took three divisions to the same point, leaving *Early's* division (10,000) to observe Sedgwick. At 11 A.M on May 1, Hooker began his advance toward Fredericksburg. But when he encountered the columns of the Confederates, also advancing, he fell back to Chancellorsville. There he was almost impregnable tq attack from the east or south. *Lee,* however, discovered a route by which the Federals might be attacked from the north and west. At 4 A.M. on May 2, *Jackson* marched westward, passed round the Federal right flank, then moved to take the Federals in reverse. *Jackson's* attack at 6 P.M. surprised the Federals, who fled in panic at nightfall, but *Jackson* was mortally wounded, and the attack lost impetus. Next day the attack was resumed under *Stuart,* reinforced by *Anderson,* while *McLaws* now threatened the left flank of the Federals and *Fitz Lee's* cavalry brigade operated against their line of retreat. Hooker finally gained an inner line of works covering the ford by which he must retreat. Meanwhile *Early* had checked Sedgwick, who had already abandoned his attack when *Lee,* on receiving word that *Early* was hard pressed, ceased to press Hooker's retreat and moved to

Early's aid. Thus on May 4, Sedgwick was assailed by *Early, McLaws* and *Anderson,* and driven over the Rappahannock to join the remainder of Hooker's beaten army, which had recrossed the Rapidan on the night of May j and marched back to Falmouth. That day *Lee* had once more countermarched to concentrate afresh against Hooker, but his attack, delayed by rain, found that his quarry had slipped away.

Grant's Campaign of the Wilderness and Cold Harbor.—On the evening of May 3, 1864, after dark, the Army of the Potomac, commanded by Meade, left its winter quarters about Culpepër to maneuvre across the Rapidan with a view to fighting a battle at or near New Hope Church and Craig's Church. The army and the 9th corps (Burnside), an independent command, were directed by Lieutenant General Grant, who accompanied Meade's headquarters. The opposing Army of Northern Virginia under *Lee* lay in quarters around Orange Court House *(A. P. Hill's* corps), Verdiersville *(Ewell's* corps) and Gordonsville *(Longstreet's* corps). The respective numbers were: Army of the Potomac, 98,000; 9th corps, 22,000; Army of Northern Virginia, rather less than 70,000.

The crossing of the Rapidan was made at Germanna and Ely's fords, out of reach of *Lee's* interference, and in a few hours the two leading corps had reached their halting places—the jth (Warren), Wilderness Tavern; and the 2nd (Hancock), Chancellorsville. The 6th (Sedgwick) followed the 5th and halted south of Germanna ford. Burnside's corps reached Germanna ford during May 5. On that day the maneuvre toward Craig's Church was resumed at 5 A.M., covered by Wilson's cavalry division, while Gregg's unit moved toward Fredericksburg.

Confederate infantry appeared on the Orange turnpike east of Mine Run, where Warren had posted a division of the 5th corps, and some cavalry at Parker's Store, became engaged a little later with hostile forces on the Orange Plank road. The first idea of the Union headquarters was that *Lee* was falling back to the North Anna. But the appearance of infantry on the Plank road as well as the Pike had shown that *Lee* intended to fight in the Wilderness, and Hancock (2nd corps) was called in from Todd's Tavern. while one division (Getty's) of the 6th was hurried to the intersection of the Brock and Plank roads to hold that point until Hancock's arrival. The division then formed up to await Hancock's arrival up the Brock road, practically unmolested.

Meanwhile Warren had been slowly forming up his attacking line with great difficulty in the woods. Grant appears to have used bitter words to Meade on the subject of Warren's delays, and Meade passed these on to Warren, who in turn forced his subordinates into premature action. The result of the attack by the 5th and later the 6th corps, delivered piecemeal owing to the difficulties of direction and touch in the woods, on *Ewell* was completely unsatisfactory, and for the rest of the battle these corps were used principally as reservoirs to find supports for the offensive wing under Hancock, who arrived on the Plank road at 2 P.M.

Hancock's divisions, as they came up, entrenched themselves along the Brock road. In the afternoon he was ordered to attack whatever force of the enemy was on the Plank road in front of him, but was unwilling to do so until he had his forces well in hand. Finally Getty was ordered to attack "whether Hancock was ready or not." The disjointed attacks of the 2nd corps on *Hill's* entrenchments, while forcing the Confederates to the verge of ruin, were not so successful as the preponderance of force on the Union side ought to have ensured. For four hours the two lines of battle were fighting 50 yd. apart, until at nightfall the contest was given up through mutual exhaustion.

The battle of the 6th was timed to begin at 5 A.M., and Grant's attack was wholly directed on Parker's Store, with the object of crushing *Hill* before *Longstreet* could assist him. Grant ordered Hancock with six of the eleven divisions of Meade's army to attack toward Parker's Store, and sent the 9th corps to strike *Hill's* left. The cavalry was drawn back for the protection of the trains. Wilson's division, in its movement on Shady Grove Church on the jth, had been cut off by the enemy's advance on the Plank road and attacked by some Confederate cavalry. But it extricated itself and joined Gregg. who had been sent to àssist him, at Todd's Tavern. Warren and Sedgwick were to hold *Ewell* occupied on the Pike by vigorous attacks. At 5 o'clock Hancock advanced, drove back and broke up *Hill's* divisions, and on his right Wadsworth attacked their left rear. But after an hour's wood fighting the Union attack came to a standstill, and at this moment, the critical moment for the action of the 9th corps, Burnside was still more than a mile away. Then *Longstreet's* corps attacked Hancock and forced him back several hundreds of yards. But by 7:30 the battle had become stationary. *Longstreet* attacked again and gained more ground. When Grant realized the situation he broke off one of Burnside's divisions from the 9th corps column and sent it to the crossroads as direct reserve to Hancock. At this moment *Longstreet* sent four brigades of infantry by a detour through the woods south of the Plank road to attack Hancock's left and the Union troops were hustled back to the crossroads. But *Longstreet* was wounded by his own men, and the battle came to a standstill (2:30 P.M.).

Burnside's corps, arriving shortly before 10 A.M. near Chewning's House, the position whence it was to have attacked *Hill's* left, was about to attack, in ignorance of Hancock's repulse, when fortunately an order reached it to make its way through the woods toward Hancock's right. This flank march was completed by 2 P.M., and Burnside began an attack upon the left of *Longstreet's* command. But Hancock being in no condition to support the 9th corps, the whole attack was, at 3 P.M., postponed by Grant's order until 6 P.M. About 4:15–4:30 *Lee* delivered a fierce assault upon Hancock's entrenchments along the Brock road. Confederates seized the first line of works, but a counterstroke dislodged them. Burnside put into the fight such of his troops as were ready, and at approximately j:30 the assaulting line receded into the woods. On the extreme right of the Union army a sudden attack was delivered at sunset upon the 6th corps, by *Gordon,* one of *Ewell's* brigadiers. This carried off two generals and several hundred prisoners, and caused a panic.

Grant's next plan was for the army to march to Spotsylvania on the night of the 7th–8th, to assemble on the 8th, and to undertake a fresh maneuvre against *Lee's* right rear on the 9th. *Lee* promptly discovered that a movement was in progress. He mistook its object, however, and assuming that Grant was falling back on Fredericksburg, he prepared to shift his own forces to the south of that place so as to bar the Richmond road. This led to a race for Spotsylvania. On the Union side Warren was to move to the line Spotsylvania Court House–Todd's Tavern, followed by Hancock; Sedgwick was to take a roundabout route and to come in between the 5th and 2nd corps; Burnside to follow Sedgwick. The cavalry was ordered to watch the approaches toward the right of the army. The movement began promptly after nightfall on the 7th. But before long the head of Warren's column, passing in rear of Hancock's line of battle, was blocked by the headquarters escort of Grant and Meade. Next, the head of the jth corps was again checked at Todd's Tavern by two cavalry divisions which had been sent by Sheridan to regain the ground at Todd's Tavern, given up on the 6th, and after fighting the action of Todd's Tavern had received no further orders from him. Meade, greatly irritated, ordered Gregg's division out toward Corbin's bridge and Merritt's to Spotsylvania. On the latter road the Gnion cavalry found themselves opposed by *Fitz Lee's* cavalry. and after some hours, Merritt asked Warren to send forward infantry to drive the enemy, which Warren did. Robinson's division at the head of the corps deployed and swiftly drove in *Fitz Lee.* A little beyond Alsop's, however, Robinson found his path barred by entrenched infantry. This was part of *Anderson's* (formerly *Longstreet's)* corps. Wilson's cavalry division acted in accordance with Sheridan's plan of occupying the bridges in front of the position that the army intended to occupy at Spotsylvania Court House, and seized that place, inflicting a smart blow upon a brigade of *Stuart's* force.

About 9 A.M. on the 8th, Warren, facing east, and opposed by part of *Anderson's* corps, was seeking to fight his way to Spotsylvania Court House by the Brock road. Wilson facing south, was holding the Court House and driving *Fitz Lee's* cavalry partly westward on to the backs of the infantry opposing Warren, partly toward Block House bridge, whence the rest of *Anderson's* infantry was approaching. Sheridan ordered Wilson to evacuate the Court House and to fall back over the Ny. Warren fruitlessly attacked the Confederate infantry at Spindler's, Robinson being severely wounded and his division disorganized. The other divisions came up by degrees, and another attack was made about 11. It was pressed close up to, and in some places over, the Confederate log works. but it ended in failure like the first. A third attempt in the evening dwindled down to a reconnaissance in force. *Anderson* was no longer isolated. *Early's* division observed Hancock's corps at Todd's Tavern, but the rest of *Ewell's* and all *Hill's* corps went to Spotsylvania and prolonged *Anderson's* line northward toward the Ny. On the 9th Sedgwick was killed by a long-range shot from a Confederate rifle. His place was taken by H. G. Wright. On this day also a violent quarrel between Meade and Sheridan led to the departure of the cavalry corps on an independent mission This was the so-called Richmond raid, in which Sheridan defeated *Stuart* at Yellow Tavern (where *Stuart* was killed) and captured the outworks of Richmond, but had then to make his way down the Chickahominy to the nearest supply depots of the Army of the James, leaving the Confederate cavalry free to rejoin *Lee*.

Grant decided to fight again on the 10th. While Hancock opposed *Early,* and Warren and Wright faced *Hill* and *Anderson,* Burnside was ordered by Grant to work his way to the Fredericksburg-Spotsylvania road, thence to attack the enemy's right rear. The first stage of this movement of the 9th corps was to be made on May 9, but not the attack itself, and Burnside was consequently ordered not to go beyond a place called "Gate" on the maps. This, it turned out, was not the farm of a person called Gate, as headquarters supposed. but a mere gate into a field. Consequently it was missed, and the 9th corps went on to Gale's or Gayle's house, where the enemy's skirmishers were driven in. The news of an enemy opposing Burnside at "Gate," which Grant still supposed to be the position of the 9th corps, at once radically altered the plan of battle. *Lee* was presumed to be moving north toward Fredericksburg. The 9th corps was ordered to hold its position and the others were to follow up the enemy as he concentrated upon Burnside. Hancock was sent down to force the fords on the Poe at and below Tinder's Mill, and directed upon Block House bridge, while Warren and Wright were held ready. But a handful of cavalry delayed the effective deployment of the moving wing, and by the time that the 2nd corps was collected opposite Block House bridge it was night. Hancock was ordered to resume his advance at dawn on the 10th.

Meade, however, had little or no cognizance of Grant's orders to the 9th corps, and his orders, conflicting with Grant's, puzzled Hancock and crippled his advance. At 10 A.M. the whole scheme was given up, and the widely deployed Union army closed for a direct attack on the Spotsylvania position. At 4 P.M., before the new concentration was complete, Warren attacked unsupported and was repulsed. In the woods on the left Wright was more successful, and at 6 P.M. a rush of 12 selected regiments under Col. Emory Upton carried the right of *Lee's* log works. But for want of support this attack too was fruitless. Burnside, receiving Grant's new orders to attack from Gayle's toward Spotsylvania, sent for further orders as to the method of attack, and his advance was thus made too late in the day to be of use. *Lee* had again averted disaster, this time by his magnificent handling of his only reserve, *Hill's* (now *Early's)* corps, which he used first against Hancock and then against Burnside.

Three corps were formed in a connected line (from right to left, the 5th, 6th, 9th) during May 11, and that night Hancock's corps moved silently to a position between Wright and Burnside and formed up in the open field at Brown's. Burnside was to attack from Gayle's toward McCool's. Warren and Wright were to have at least one division each clear of their entrenchments and ready to move.

Up to the 11th *Lee's* line had extended from the woods in front of Block House bridge, through Perry's and Spindler's fields to McCool's house, and its right was diffused and formed a loop round McCool's. All these works faced northwest. In addition, Burnside's advance had caused *Early's* corps to entrench Spotsylvania and the church to the south of it, facing east. Between these two sections were woods. The connection made between them gave the loop round McCool's the appearance from which it derives its historic name of The Salient. Upon the northern face of this salient Hancock's attack was delivered.

On the 11th the abandonment of Burnside's threatening advance on his rear and other indications had disquieted *Lee* as to his left or Block House flank, and he had drawn off practically all *Ewell's* artillery from the McCool works to aid in that quarter. But at 4:35. in the mist, Hancock's mass swept over their works at the first rush and swarmed in the interior of the Salient. While *Early,* swiftly drawing back from Block House, checked Burnside's attack from the east, and *Anderson,* attacked again and again by parts of the 5th corps, was fully occupied in preserving his own front. *Lee,* with *Ewell's* corps and the few thousand men whom the other generals could spare, delivered a series of fierce counterstrokes against Hancock. Grant and Meade well knew that *Lee* was struggling to gain time for the construction of a retrenchment. If the counterattacks failed to gain this respite. the Confederates would have to retreat as best they could, pressed in front and flank. *Lee* succeeded so well that after 20 hours' bitter fighting the new line was ready and the Confederates gave up the barren prize to Hancock. By the 20th the Federals were entrenched facing east, between Gayle and Quisenberry's, *Lee* facing west from the new works south of Harrison's through the Court House to Snell's bridge on the Po. While the Union army was resting for the first time since leaving Culpeper, *Ewell's* corps attacked its baggage train near Harris's House, but were driven off.

Hancock was now (20th) ordered to move off under cover of night to Milford; thence he was to march southwest as far as possible along the Richmond and Fredericksburg railroad and to attack whatever force of the enemy he met. It was hoped that this bold stroke by an isolated corps would draw *Lee's* army upon it, and the rest of the Army of the Potomac would, if this hope were realized, drive down upon *Lee's* rear while Hancock held him up in front. Supposing, however, that *Lee* did not take the bait, the maneuvre would resolve itself into a turning movement with the object of compelling *Lee* to come out of his Spotsylvania lines.

Hancock's corps started on the night of the 20th–21st. At Milford, where he forced the passage of the Mattapony, Hancock found himself in the presence of hostile infantry from Richmond and entrenched. The main army began to move off, after giving *Lee* time to turn against Hancock, at 10 A.M. on the 21st, and marched to Catlett's, a place a few miles southwest of Guinea's bridge. But no news came in from Hancock until late in the evening, and the development of the maneuvre was consequently delayed, so that on the night of the 21st–22nd *Lee's* army slipped across Warren's front en route for Hanover junction. The four Union corps, therefore, could only pursue him to the North Anna, at which river they arrived on the morning of the 23rd, Warren on the right. Hancock on the left, Wright and Burnside being well to the rear in second line. The same afternoon Warren seized Jericho ford, brought over the 5th corps to the south side, and repulsed a very sharp counterstroke made by one of *Lee's* corps. Hancock at the same time stormed a Confederate redoubt which covered the Telegraph Road bridge over the river. Wright and Burnside closed up. It seemed as if a battle was at hand, but in the night reports came in that *Lee* had fallen back to the South Anna. Union generals gave orders, about midday on the 24th, for what was practically a general pursuit. This led to the discovery that *Lee's* army had not fallen back but was posted in a semicircle to which the North Anna formed a tangent. On the 27th Sheridan's cavalry and a light division of infantry passed the Pamunkey at Hanover town, and the two divided wings of the Army of the Potomac were withdrawn over the North Anna without mishap. On the 28th the Army of the Potomac had arrived near Hanover town. *Lee* was now approaching from Hanover junction via Ashland. and the Army of the Potomac swung round somewhat to the right so as to face in the presumed direction of the impending attack. The Confederate general, however, planted himself behind the Totopotomoy. Here he was discovered on the 29th, and skirmishing all along the line, varied at times by more severe fighting, occupied that day and the 30th.

The last episode of the campaign centred in Cold Harbor, a village close to the Chickahominy, which Sheridan's cavalry seized on the 31st. Here, a considerable force of Confederate infantry was met. Grant and Meade ordered Sheridan to hold the village at all costs and directed Wright's (6th) corps, from the extreme right wing. and Smith's (18th), from Old Church, to march there with all possible speed. Wright and Smith successfully assaulted the Confederate front opposite Cold Harbor in the evening of June 1, and parts of the 6th corps penetrated the main line. Grant at once prepared to renew the attack with larger forces, ordering Hancock. Wright and Smith to assault on the next morning. But Lee had by now moved more forces down, and his line extended from the Totopotomoy to the Chickahominy. Hancock's corps did not form up until after midday, and meanwhile Smith refused to consider the idea of renewing the attack. Grant again ordered the attack to be made by Wright, Smith and Hancock at j P.M. A last modification was made when, during the afternoon, Lee's far distant left wing attacked Burnside and Warren. This, showing that Lee had still a considerable force to the northward, and being read to mean that the Confederate entrenchments were thinly guarded at all points. led to the order being given to all five Union corps to attack at 4:30 A.M. on June 3. The assault was made at the time arranged and was repulsed at all points with a loss to the assailants of about 8,000 men. Thereafter the two armies lay for 10 days less than 100 yd. apart. (C. F. A.; X.)

WILD FLOWER. Most wild flowers are colourful species growing without the intentional aid of man. Commonly they are native to the region in which they occur, but they may be introduced from other lands. For example, the bright flowers characteristic of the Hawaiian Islands are nearly all native to other parts of the tropics and subtropics. Most of them were taken purposely to the islands for cultivation, but in the warm, moist climate of Hawaii they spread rapidly into the fertile lowlands and displaced the less colourful native species, leaving only the steep mountainsides to the original flora. In the lowlands of the United States and Europe most species are native, but many are migrants from other areas or other continents. Disturbance of the native flora began in prehistoric times whenever escaping fires burned off the native vegetation and made way for aggressive species from the same or other areas. In all probability one of the best-known buttercups of northern Europe, *Ranunculus acris,* became more abundant and widespread as the forests were burned away. In the lowlands of northern Europe, this colourful and highly variable species probably became modified during the Stone Age into some new forms better adapted to habitats created by man than the original types. Two forms occurring in the northern United States and Canada, both introduced into eastern North America at least by the early part of the 19th century, gradually spread across the continent, one becoming common in the state of Washington only within the 20th century. This species is so abundant and colourful that few would question it as a wild flower characteristic of the northern states and Canada.

Distinction of weeds (*q.v.*) from wild flowers is not consistent because it depends upon the purpose of the classification. A weed is a plant out of place, that is, one growing where it is unwanted. Sunflowers are looked upon as weeds when growing in cultivated fields or on grazing land of the Great Plains of North America but as wild flowers in uncultivated valleys. In other parts of the world the same plant is a crop plant cultivated for its seeds; in some places it is a garden flower. Most cultivated flowers have wild varieties.

Colour and Form.—Wild flowers are appreciated first for colour and second for form. The shades of flower pigmentation are seemingly infinite in number. The anthocyanin pigments, for example, range from almost red to almost blue. These are water soluble, and they occur in solution in the cell sap. They are subject to modification in the same way as litmus paper—toward red in an acid medium and toward blue in a basic medium. Most other pigments are not soluble in water, and they are contained in plastids (solid bodies) suspended in the living substance of the cell. The flowers of many species of iris (flag) may be modified in colour by placing them in an acid or a base, just as the juice of a beet may be made to tend toward red or toward blue by addition of drops of one substance or the other.

Although the colours of flowers vary greatly in nature, they may be modified further by selection and hybridization. The roses first cultivated were red, pink or white types readily accessible as native plants easily brought into cultivation. Many new colour combinations, for example the red and yellow of the Talisman roses, were made possible by relatively recent bringing of yellow roses from remote regions. Camellias in cultivation have approximately the same shades as roses before the introduction of yellow, and horticulturists are searching for a yellow-flowered wild species.

Usually the colour of wild flowers is described in terms of the conspicuous petals, but in some plants (*e.g.,* anemones) there are no petals and the sepals are colourful. The sepals, petals, stamens and pistils may be differently coloured. A single organ may vary in colour from base to tip. may be mottled, as in some fritillarias, or spotted, as in tiger lilies.

Variation in form is as much to be appreciated as colour but requires closer study. In larger flowers it may be examined with the naked eye, but many of the most beautiful structural patterns are those seen with a magnifying glass, a hand lens or a dissecting microscope. Examples of plants having minute flowers with beautiful patterns are species of goosefoot and lamb's quarter, small-flowered members of the mustard family, nettles, plantains, carrots, rushes, sedges and grasses.

Study of the form of flowers soon reveals repetition of basic patterns with many modifications of detail. In the mustard family the flower almost invariably consists of four sepals, four petals, six stamens and one pistil. The six stamens are in an outer series of two and an inner series of four. The pistil is composed basically of four fused specialized leaves (though it appears to be of only two). This pattern is repeated with petals of many shapes and sizes and in colours varying from white to yellow, red or purple and many shades or combinations between. The stamens vary through several colours and forms. The pistil may form an elongated pod like that of a mustard or it may have an almost bead-like or disclike form. At maturity the fruit may split open as in the mustards, divide crosswise as in the radishes or remain intact as in the fringepods. Yet through all this variation the basic mustard pattern is maintained. In every other family a special arrangement prevails.

Observation of repeated structural patterns led Linnaeus to describe (Classes Plantarum, 1738) 68 "natural orders" of plants, most of which were the approximate equivalents of plant families described in modem botanical literature. To Linnaeus each pattern indicated a group of related plants. To Charles Darwin (Origin of Species . . . , 1859) this relationship indicated a common ancestry in some pre-existing basic type. Interpretations of the patterns of flower structure and of the structure of other organisms provided some of the strongest evidence underlying the concept of evolution. Thus, true appreciation of wild flowers begins with colour, continues with the study of form and structure and leads ultimately to interpretation of the recurrence of patterns in the flowers of many plants and to appreciation of other natural phenomena.

Hybridization and Interbreeding.—The wild flowers of a given species are not identical. While the variations among cultivated plants are well known, those among wild flowers are known to few people. Appreciation of this aspect of the subject requires careful inspection of both the flowers and the vegetative parts of many individuals of the same species. The range of variation is within certain limits but some individuals have borderline combinations of characteristics and cannot be classified readily in one species or another.

In a given area, where the natural vegetation has been disturbed relatively little, two closely related species may occur near each other or even together. Usually, however, there are either genetic barriers to their interbreeding or environmental factors restricting the species to differing habitats. One species may require more moisture, richer soil and more shade than another. Even though the two species are compatible genetically and produce fertile hybrids, relatively few of the hybrid individuals persist. This is because the hybrid seedlings usually occur in the habitat suitable to the female parent plant, where they are in competition with better adapted nonhybrid seedlings similar to the female parent. The surviving hybrids are likely to occur in an intermediate habitat to which they are better adapted than either species, but where they may be crowded out by some competing plants better suited to this area. If fire, flood, overgrazing or some other factor upsets the natural balance, conditions more favourable to the hybrids may be produced and the conditions best for the competing parent species may be destroyed. Thus some of the hybrids with special character combinations may become more abundant, and they may even be able to replace both parental types.

Either (1) two species occurring at one place together and unable to interbreed effectively or (2) two species occurring in different habitats in one locality and not producing many surviving hybrids there, may shade off gradually into differing forms occurring in other places. In these forms either the hereditary or the ecological barriers may disappear and the species may pass into each other in some areas. Intergradation of species or varieties may occur in all degrees, and for this reason classification is difficult. Thus wild flowers provide the technical material and problems upon which the classifier of plants works, just as their colour and form provide subject matter for the artist.

Besides providing insight into the dynamics of formation of new varieties, species and higher categories (evolution) and into problems of classification (taxonomy). wild flowers present problems in the relationships of living organisms to the environment (ecology); the relationships of living plants to those of the past. and of existing floras to pre-existing floras (paleobotany); and the mechanisms and laws of heredity (genetics).

Geographical Distribution. — There are at least 175,000 species of flowering plants, thousands of which are wild flowers. Relatively few occurring on one continent may be found on another, and the individual parts of the same continent may have almost wholly different floras, for wild flowers and other plants are affected by many factors, especially moisture and temperature.

Moisture variation may be extreme on the opposite sides of the same mountain range. In the state of Washington the average rainfall at Snoqualmie falls (east of Seattle on the western edge of the Cascade mountains) is about 8½ ft. Beyond the mountains 65 mi. eastward in the vicinity of Wenatchee it is 8½ in. Almost no species (except those near streams) are native to both places.

Temperature changes due to altitude or latitude are marked by corresponding variations in flora. Species occurring at the top of Pikes peak (14,110 ft. elevation) in Colorado are wholly different from those on the high plains just east of the Rocky mountains and from those in the foothills at Colorado Springs (5,900 ft. elevation). Over long distances from north to south, even in such level areas as between Saskatchewan and Texas, there is almost a complete change with latitude in wild flowers as well as other plants. Many tropical and subtropical species are limited in northward distribution by the occurrence of any frost.

The distribution of wild flowers and other plants is segregated roughly into those of the tropics and subtropics; the horse latitudes of both hemispheres; the temperate regions of both the northern and southern hemispheres; and the arctic and antarctic and the summits of mountain chains ranging to the southward. These major distributional areas are correlated with the planetary winds. Except in the belt of tropical calms at the equator, the trade winds predominate through the tropics and subtropics. Islands and other land masses tend to be moist on the windward side and very dry on the leeward. This is notable in the islands of the Caribbean and especially in the Hawaiian Islands. On western Maui. Iao canyon, facing toward the northeasterly trade winds, receives hundreds of inches of rainfall each year, while areas near Lahaina on the west side of the same mountain resemble the deserts of Arizona.

At sea. the horse latitudes (at about latitude 30° N. and S.) are areas of calms; on the larger land masses they are regions of deserts. for example. in the northern hemisphere the Sahara the deserts of the middle east and of central Asia, and those of North America from southeastern California to Texas and northern Mexico. In the southern hemisphere deserts occur in the corresponding belt in Chile, South Africa and Australia. At this latitude the air that arises in the warm tropics, dropping its moisture, descends as a warm, dry mass.

North or south of 30° are temperate regions largely within the zone of the prevailing westerly winds. On the western temperate coasts of continents heavy rainfall is common in the winter when the land cools more rapidly than the ocean and moisture tends to condense. The high rainfall at Snoqualmie falls, Washington (see above), is due to this condensation. The rain- and snowfall on the Cascade mountains just eastward is even higher because as the air mass ascends over the mountain range it expands, cools and loses moisture. Descending on the eastern side of the same range, the air mass becomes warmer and tends to absorb moisture. Thus the wild flowers on the windward slopes are those of a dense rain forest while those on the leeward side are characteristic of the sagebrush desert.

Along the summits of high mountains and in the arctic and antarctic low temperature takes precedence over all other factors.

In North America there are nine major floral regions, each with characteristic wild flowers almost wholly different from those of each of the other eight. The regions (more or less from north to south and west to east) are as follows:

Boreal-Alpine Region. — This occurs above timber line in the mountains and beyond it to the northward. This is a region of sod (tundra) with many characteristic colourful species of perennial wild flowers that develop rapidly during the short growing season, mostly in the month of July but sometimes in August. Most species occurring in this region are found around the world north of the timber line. They have been in contact across the northern Bering sea within geologically recent times. Within the last 1,000,000 years four great ice sheets formed in northern regions but not throughout the arctic. Withdrawal of water from the oceans lowered the level of the Bering sea sufficiently to permit migration of plants as well as animals between northern North America and Eurasia.

Northern Forest Region. — This is an area of coniferous forest in northern latitudes just south of the timber line. It covers a large part of Canada and limited portions of the United States, especially in Alaska, the Appalachian system and northern New England. A similar forest belt occurs in areas of northern Europe, including the higher parts of Scotland and Scandinavia. For the most part the species of wild flowers and other plants occurring in the northern forests of the eastern and western hemispheres are different, but the genera tend to be the same. This is interpreted as indicating a longer period of separation for these areas than for the boreal regions to the north.

Rocky Mountain Forest Region. — This is an area of coniferous forests in the Rocky mountain system of North America. In the southern Rockies warm summer rains produce seed germination and an abundance of wild flowers different from those in California.

Pacific Northwestern Region. — This is the great coniferous forest belt of south coastal Alaska, lowland British Columbia and the Pacific northwest. It occurs west of the Cascade mountains and the Sierra Nevada and other higher mountains of California. Superficially this forest area is similar to that of the Rocky mountains, but nearly all the species are different. Particularly this is so in the southern portions of each mountain system. Species of wild flowers and other plants in the Sierra Nevada require low temperatures for germination and are dependent on winter rainfall.

Western Woodland and Brush *Region.*—This includes the sagebrush desert of the Great Basin and the Columbia river basin, parts of south-central British Columbia, the Juniper-Pinyon woodland of the Great Basin region, the oak woodlands and the chaparrals of California and Arizona, and the Pacific grassland in the Sacramento-San Joaquin valley of California. Numerous characteristic wild flowers are abundant in the region and before agricultural disturbance the most colourful wild-flower fields of North America were in the grasslands of the San Joaquin valley. These were far more extensive than the flowers in the deserts and perhaps rivaled only by flower fields in Texas.

Southwestern Desert Region.—This is the creosote-bush desert, occurring approximately from Palm Springs, Calif., to St. George, Utah, southern New Mexico and Texas west of the Pecos river. The western portion of this desert becomes colourful through the growth of innumerable wild flowers of many species whenever there is a winter with unusually heavy rainfall (as, for example, with eight or ten inches as opposed to the usual three to five). As far east as Tucson, Ariz., winter rain is important. Beyond that area both winter and summer rains may occur, but the summer rain is more effective because of its coincidence with the growing season.

Eastern Forest Region.—This is the enormous area of deciduous forest, chiefly of dicotyledonous trees, from the longitude of Nebraska eastward to the Atlantic ocean. The most extensive single floral region in North America, it includes innumerable characteristic wild flowers and other plants. In the lowlands of Britain and the-northern parts of continental Europe, the flora is similar in many ways but most species and many genera are different.

The temperate floristic regions described above differ even more extensively in genera and species from the corresponding temperate regions of Eurasia than does the northern forest region. Probably this is the result of longer geological separation and of consequent independent evolution.

Subtropical Region.—Elements of subtropical forests of the Caribbean islands occur especially in swampy areas on the Gulf coast of southern Texas and in southern Florida. These include characteristic wild flowers of tropical regions of the western hemisphere, among them species of the orchid and the Bromelia families. The genera and species characteristic of this area are usually different from those occurring in the tropics of the old world. About **32** plant families are restricted to the tropical and subtropical regions of the Americas and 65 to similar regions of the eastern hemisphere. This is correlated with even longer geological separation.

Principal Kinds of Wild Flowers.—The more colourful herbaceous species of flowering plants are considered wild flowers. Those native to North America are associated with one or sometimes t o or more of the nine major floral regions, those of Britain with a European belt equivalent to the border zone between the northern forest region and the eastern forest region in North America. Reference to all species according to the regions in which they occur is not practical because many genera are represented in nearly all the regions, though by different species, all known by the same English name. (The principal orders and families including wild flowers are enumerated under ANGIOSPERMS.)

The following are examples of groups of wild flowers represented through all of Korth America and many through much of Europe and northern Asia:

Arrowheads (*Sagittaria*)
Evening primroses (Oenothera)
Flag or iris (Iris)
Flaxes (Linum)
Mint family (including blue-curls) (Trichostema)
- Dragonhead (Dracocephalum)
- False dragonhead (Physostegia)
- Germander (Teucrium)
- Giant hyssop (Agastache)
- Hedge nettle (Stachys)
- Horsemint (Monarda)
- Mint (*Mentha*)
- Mock pennyroyal (Hedeoma)
- Mountain mint (Pycnanthemum)
- Sage (Salvia)
- Savory (*Satureia*)
- Selfheal (Prunella)
- Skullcap (Scutellaria)
- Water horehound (*Lycopus*)

Mustard family (Lesquerella, Draba)
- Bitter cress (Cardamine)
- False flax (*Camelina*)

Mustard family (continued)
- Peppergrass (Lepidium)
- Rock cress (Arabis)
- Toothwort (Dentaria)
- Treacle mustard (Erysimum)
- Winter cress (Barbarea)
- Yellow cress (Roripa)

Rattleweeds (*Astragalus*)
Sandworts (Arenaria)
Stonecrops (Sedum)
Sunflower family (Helianthus)
- Arnica (Arnica)
- Aster (Aster)
- Bur marigold (*Bidens*)
- Coreopsis (*Coreopsis*)
- Everlasting (Antennaria, Gnaphalium, etc.)
- Fleabane (Erigeron)
- Goldenrod (Solidago)
- Groundsel (Senecio)
- Gumweed (Grindelia)
- Ironweed (Veronica)
- Sunflower (North America only) (Helianthus)
- Thistle (Cirsium, etc.)

Veronicas (Veronica)
Water lilies (Nymphaea, Nuphar)

The following are widely distributed, the Korth American and European species being mostly of northern and north temperate species groups:

Adder's-mouths (*Malaxis*)
Avalanche lilies, dogtooth violets, chamise lilies (*Erythronium*)
Avens (*Dryas*)
Baneberries (Actaea)
Beardflowers (Pogonia, *Cleistes, Isotria, Triphora*)
Bellflowers (Campanula)
Blue-eyed grasses (*Sisyrinchium*)
Brook orchids (*Epipactis*)
Buck beans (*Menyanthes*)
Buttercups (*Ranunculus*)
Calypsos (Calypso)
Camasses (*Camassia*)
Campions (*Lychnis*)
Catchflies (*Silene*)
Cinquefoils (Potentilla)
Clovers (*Trifolium*)
Columbines (Aquilegia)
Coralroots (*Corallorhiza*)
Elodeas (Anacharis)
Fairy lanterns (Disporum)
False Solomon's-seals (*Smilacina*)
Figworts (*Scrophularia*)
Fireweeds and willow herbs (*Epilobium*)
Gentians (Gentiana)
Goldthreads (Coptis)
Grasses-of-Parnassus (Parnassia)
Grass pinks (*Colopogon*)
Hound's-tongues (*Cynoglossum*)
Jacob's-ladders (*Polemonium*)
Lady's-slippers (Cypripedium)
Lady's-tresses (*Spiranthes*)
Larkspurs (Delphinium)
Lilies (Lilium)
Louseworts (Pedicularis)
Marsh marigolds (*Caltha*)
Meadow rues (Thalictrum)
Monkshoods (Aconitum)
Onions (*Allium*)
Primroses (Primula)
Puccoons (Lithospermum)
Puttyroots (*Aplectrum*)
Rattlesnake plantains (Goodyera)
Rein orchises (Habenaria)
Saxifrages (Saxifraga)
Shooting stars (Dodecatheon)
Snapdragons (Antirrhinum)
Spring beauties (Claytonia)
Stickseeds (Hackelia)
Strawberries (Fragaria)
Sweet peas (Lathyrus)
Toadflaxes (Linaria)
Twayblades (Listera, *Liparis*)
Twisted-stalks (*Streptopus*)
Valerians (*Valeriana*)
Vetches (*Vicia*)
Violets and pansies (Viola)
Virgin's-bowers (Clematis)
Wake-robins (Trillium)
Waterleaves (Hydrophyllum)
Water plantains (Alisma)
Wild gingers (*Asarum*)
Windflowers (Anemone)

The following are widely distributed, the North American and European species being mostly of groups of species occurring in tropical and warm regions:

Allionias (*Allionia*)
Amsonias (Amsonia)
Burmannias (*Burmannia*)
Butterfly peas (Centrosema)
Cottons (Gossypium)
Dayflowers (Commelina)
Devil's-claws (Proboscidea)
Dutchman's-pipes (Arzstolochia)
Four-o'clocks (Mirabilis)
Golden-eyed grasses (Hypoxis)
Ground cherries (Physalis)
Hibiscuses (Hibiscus)
Indian mallows (Abutilon)
Jimson weeds (Datura)
Jussiaeas (Jussiaea)
Leadworts (Plumbago)
Milk peas (Galactia)
Milkworts (Polygala)
Miterworts (*Cynoctonum*)
Morning-glories (Ipomoea)
Sightshades (Solanum)
Petunias (Petunia)
Rattleboxes (Crotalaria)
Redroots (Lachnanthes)
Ruellias (*Ruellia*)
Sennas (Cassia)
Sidas (Sida)
Sorrels (Oxalis)
Spiderworts (*Tradescantia*)
Spurges (Euphorbia)
Summer poppies (Kallstroemia)
Talinums (*Talinum*)
Tobaccos (*Nicotiana*)
Verbenas (Verbena)
Water primroses (*Ludwigia*)
Wild beans (Strophostyles)
Worm grasses (Spigelia)
Zephyr lilies (*Zephyranthes*)

The C.S. western woodland and brush region, the southwestern desert region and the eastern forest region include numerous groups of wild flowers not falling clearly into the categories above. Examples are as follows:

Western Woodland and Brush Region

Baby blue-eyes (*Nemophila*)
Brodiaeas (Brodiaea)
Canchalaguas (*Centaurium*)
Chinese houses (*Collinsia*)
Clarkias and podetias (Clarkia)
Creamcups (Platystemon)
Downingias (*Downingia*)
Dudleyas (Echeveria, Dudleya)
Fritillaries (*Fritillaria*)
Hollyhocks (Sidalcea)
Indian paintbrushes (*Castilleja*)
Mariposa lilies (Calochortus)
Meadow-foams (Limnanthes)
Monkey flowers (*Mimulus*)
Morning-glories (California) (Convolvulus)
Navarretias (*Navarretia*)
Pentstemons (Pentstemon)
Popcorn flowers (Plagiobothrys)
Red maids (Calandrtnia)
Wind poppies (Papaver)

Western Woodland and Brush Region
and Southwestern Desert Region

California poppies (Eschscholtzia)
Fiddle-necks (Amsinckia)
Gilias (Gilia)
Globe mallows (Sphaeralcea, *Malvastrum*)
Linanthuses (Linanthus)
Lotuses (*Lotus*)
Lupines (*Lupinus*)
Mentzelias (Mentzelia)
Nievetas (Cryptantha)
Phacelias (Phacelia)
Prickly poppies (Argemone)
Sages (*Salvia*)
Wild buckwheats (Eriogonum)

Southwestern Desert Region

Chorizanthe (*Chorizanthe*)
Desert lilies (Hesperocallis)
Eucnides (Eucnide)
Filaree (Erodium)
Mohaveas (Mohavea)
Namas (*Nama*)

Eastern Forest Region

Arrow arums (*Peltandra*)
Bloodroots (*Sanguinaria*)
Bog mosses (*Mayaca*)
Eastern skunk cabbages (*Symplocarpus*)
False indigoes (*Baptisia*)
Floating hearts (*Nymphoides*)
Forget-me-nots (*Myosotis*)
Gerardias (*Gerardia*)
Glade mallows (*Napaea*)
Jack-in-the-pulpits (*Arisaema*)
Lobelias (*Lobelia*)
Loosestrifes (*Lysimachia*)
Meadow beauties (*Rhexia*)
Mud plantains (*Heteranthera*)
Pennyworts (*Obolaria*)
Pickerelweeds (*Pontederia*)
Pipeworts (*Eriocaulon*)
Pitcher plants (*Sarracenia*)
Poppy mallows (*Callirrhoë*)
Sabatias (*Sabatia*)
St -John's-worts (*Hypericum*)
St.-Peter's-worts (*Ascyrum*)
Shoe buttons (*Syngonanthus*)
Solomon's-seals (*Polygonatum*)
Spurred gentians (*Bartonia*)
Sweet flags (*Acorus*)
Tephrosias (*Tephrosia*)
Touch-me-nots (*Impatiens*)
Water willows (*Decodon*)
Wood poppies (*Stylophorum*)
Yellow-eyed grasses (*Xyris*)
Yellowroots (*Xanthorhiza*)

Conservation. — Since the beginning of agriculture and animal husbandry parts of Europe, Asia and Africa have been burned over, cultivated, overgrazed and invaded by aggressive weeds, some of which originated as hybrids selected naturally according to their adaptations to the conditions of disturbed soil. Many weeds were accidentally introduced to new regions and throve when the natural conditions in those areas were disturbed. The bands of sheep brought to California by the mission fathers not only overgrazed the countryside but also brought in their wool the seeds of numerous Mediterranean weeds and weedy grasses. These tended to crowd out native plants especially in the lowlands until a new balance was reached, one in harmony with the newly established conditions based upon agriculture and grazing. Although most of the native Californian species persist, a high percentage of the individual plants now living consists of introduced species. Most of these are not colourful and are not considered wild flowers, although some, like the introduced mustards and radishes, are among the most colourful plants in the state. Nevertheless, the once great flower fields of California have become but a pitiful remnant of even those that remained as late as the 1930s.

What is true in California and, as pointed out above, in Hawaii, is true everywhere. With the coming of man conditions change. As the cities grow the country becomes restricted and invaded by suburbs, and even the more remote wilderness tends to disappear. Some wilderness and some wild flower areas have been preserved in national, state or provincial, and local parks and monuments, particularly in the U.S. and Canada, but in general the once vast areas of flower fields have not been preserved. These tracts of land were most vulnerable to civilization because they were easily plowed up or converted to grazing land. The few remaining are among the areas most needing preservation.

See also FLOWER.

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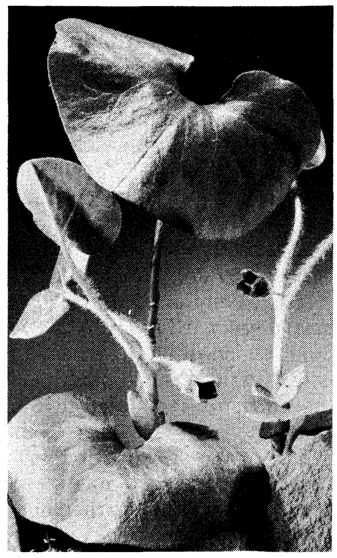
WILDGANS, ANTON (1881–1932), Austrian poet and dramatist, was born in Vienna on April 17, 1881, began and completed a course of legal studies in Vienna university and was artistic manager of the celebrated Burgtheater there 1921–24. In 1909 he attracted notice by a book of verses *Herbstfrühling*, and in a series of lyrical volumes he gave expression to erotic passion, to deep sympathy with nature and with human suffering. Wildgans appears to be connected with the Hofmannsthalists, although maintaining his independence.

His plays *Armut* (1914), *Liebe* (1916) and *Dies Irae* (1918) begin in an atmosphere of realism, culminating in that of symbolism or mysticism. As a counterpart to this *bürgerliche* trilogy another of mythological or religious character was planned, the first part of which, *Kain*, was acted in 1921. An epic poem, written in hexameters, *Kirbisch* (1927), depicts Austrian mentality as influenced by World War I.

WILD GINGER (*Asarum canadense*), called also Canada snakeroot and colicroot, a small North American herb of the birthwort family (Aristolochiaceae), native to rich woods from New Brunswick to Manitoba and southward to North Carolina and Kansas.



POCHE
WILD GINGER (ASARUM CANADENSE)

It is a stemless perennial with a creeping aromatic rootstock having the flavour of ginger. From this usually rise two large kidney-shaped or heart-shaped leaves, 4 in. to 7 in. broad, on nearly erect leafstalks 6 in. to 12 in. long. On a short stalk between the bases of the two leafstalks is borne a single somewhat bell-shaped, brownish-purple flower, about an inch broad, with three small more or less pointed lobes on the rim. About nine other species of wild ginger are found in the United States, and three of them native to the Pacific coast. Among these are the halberd-leaved wild ginger (*A. arifolium*), found from Virginia and Tennessee southward, and the western wild ginger (*A. caudatum*), native to the coast redwood belt of California and northuard to British Columbia. The allied European species (*A. europaeum*) is asarabacca (*q.v.*).

WILDLIFE CONSERVATION. Conservation means not only the preservation and protection of natural resources but also their wise use. The term, popularized in the United States by Gifford Pinchot, pioneer of American forestry. stands for the husbandry and use of natural resources by the present and succeeding generations. Aesthetic, sporting, economic and intellectual exploitation of landscapes, game, minerals, animals, plants, soils and water is thus implied in the concept. The term wildlife conservation has been used to include an ever-widening group of animals—mammals, birds, fish, reptiles, amphibians, arthropods (such as the lobster) ,and mollusks (such as the oyster)—and in this article is taken to include plants as well. Certain aesthetically and economically important groups of animals have tended to dominate the list; but it is expanding as values broaden, interest in science grows, and increasingly subtle but important relationships among animals and plants are reported.

This article deals with the development of the conservation movement, its approaches and methods, and with the conservation of game animals, birds, sea mammals, fresh- and salt-water fish, and plants. Other aspects of the wider subject of conservation are discussed in the articles FORESTS AND FORESTRY; LAND RECLAMATION; NATURAL RESOURCES; SOIL EROSION AND CONSERVATION; and HUNTING. For information on the national parks, one of whose chief purposes is conservation of both plant and animal life *see* NATIONAL PARKS AND NATURE RESERVES.

This discussion is outlined as follows:

Animal-conservation problems vary widely depending on the type of animal (whether, for example, it is exploited primarily for commercial or recreational reasons, whether or not it is free to range over national boundaries) and on the social and economic conditions of various countries. In North America, Africa and Europe, game animals are widely hunted by sportsmen, over both private and public lands; thus an outstanding factor in wildlife conservation in these regions is the licensing and supervision of hunters. Birds and marine mammals and fish present the need for international agreement and legislation—birds because they migrate across international boundaries and are shot by sportsmen, marine mammals and fish because they live in waters that know no national boundaries and are exploited commercially by fishermen from many countries. Small mammals that are trapped for their furs must be protected by domestic laws, but seals are the subject of international agreement. Salt-water fish, exploited mainly for commercial reasons, are protected by international agreement; but the exploiters of fresh-water fish, chiefly anglers who fish for recreation (except in such large inland water areas as the Great Lakes), are licensed and controlled domestically. The sections of this article reflect these varying emphases—Game Management deals largely with the production and harvest of animals that are hunted for recreation; Bird Protection and Conservation of *Sea Mammals* and ***Fish*** emphasize international agreements. (X.)

I. THE CONSERVATION MOVEMENT

1. The Problem.—During the past 2,000 years the world has lost, through extinction, about 106 forms (species or subspecies) of mammals, distributed by regions as follows (according to the American Committee for International Wild Life Protection): Australia 11, Malay archipelago 3, Asia 3, Europe 6; Africa 9, Madagascar 1, North America 27, West Indies 41, South America 1, Falkland Islands 1, Galapagos Islands 2, oceans 1. Approximately two-thirds of these losses have occurred since the mid-19th century, most since the beginning of the 20th. In addition to those mammals already extinct, many others are vanishing or threatened.

The primary factor in the depletion of the world's fauna has been civilized man, operating either directly through excessive commercial hunting or, more disastrously, indirectly through invading or destroying natural habitats, placing firearms in the hands of peoples who previously were without them or introducing to the primitive fauna of certain areas (Australia and various islands) more aggressive exotic (nonnative) mammals. Except in the West Indies, comparatively few species seem to have died out within the past 2,000 years from such natural causes as evolutionary senility, disease or climatic change.

Persons interested in the conservation of wildlife realize that much more is required than the mere protection of individual animals from destruction by shooting and other forms of direct action. Animal protection must begin with the conservation of the habitat—the area where animals feed, rest and breed. This naturally involves the preservation of much besides the animal population itself, including conservation of vegetation cover and soil. The comparatively new science of ecology focuses on the association of living things in natural communities and their mutual interdependence, and on the possibility of preserving the conditions under which the variety and abundance of natural living forms may continue to exist (see ECOLOGY, ANIMAL). But unfortunately in all parts of the world, encroaching upon what remains of our natural heritage, are the immense growth of the world's population and its expanding economic needs, including the consequent extension and intensification of industry and agriculture. This has been accompanied by the introduction of new types of cultivation, by the drainage of marshes, by the general lowering of the water table, by the pollution of rivers and lakes, by the destruction of woodlands and by the indiscriminate use of insecticides and herbicides. In many parts of the world there has also been widespread destruction of forests and other great belts of natural vegetation.

Attitudes toward wild animals liable to be killed for food, oil, skins, feathers or sport are undergoing considerable change in many countries of the world An example of earlier attitudes is well illustrated by Great Britain, which passed through two centuries of so-called game protection, the original purpose of which was to create artificially high populations of grouse, partridge, pheasant, mallard and other sporting species and, at the same time, to reduce the populations of such predators as the stoat, weasel, otter, wild cat and badger, as well as birds of prey including owls. This alteration of the natural equilibrium had many other consequences. particularly in agriculture and forestry. The rabbit and wood pigeon increased rapidly and caused widespread damage. In some places in Great Britain the landscape was changed by the planting of woods and the creation of other new areas, including artificial lakes for wildfowl—all with the purpose of creating larger populations of certain species for sport. Sport was the privilege of the well-to-do. There were strictly kept dates for the shooting of game species, and. most significant, there was very strict etiquette in shooting. Poaching was punished by heavy penalties and was kept under control. As a result, the game species did exceptionally well while the total wildlife resources experienced varied fortunes. The modern view is different: total wildlife conservation is rapidly replacing game protection. (G. TL.)

2. General Origins.—The great conservation movements have all been born of fear, after spectacular catastrophes had taken place or were found to be imminent. Thus in North America it was the complete extinction of the passenger pigeon and the near extinction of big game (especially the bison) in the 19th century that led to the development of a wildlife-conservation movement during the presidency of Theodore Roosevelt. Three decades later the Dust Bowl and its great dust storms provoked the soil-conservation movement that was to grow so rapidly in the U.S.

3. Techniques.—Wildlife-conservation techniques have counterparts in forestry and in soil, water and landscape conservation. They include prohibitions, controls, restoration, subsidy, sanctuary and public ownership.

Prohibition.—Hunting of pheasants and partridges without the landowner's permission was prohibited in the time of Henry VII. Closed hunting seasons on deer appeared as early as 1718 in Massachusetts, and by the time of the American Revolution 12 of the 13 colonies had closed seasons on certain species of game. Limitations on hunting were first applied mainly to protect animals during the breeding season. Bag limits have come to be widely enforced in a number of countries, as have total prohibitions against the hunting of many scarce species. Some prohibitions placed on the hunting and transportation of game in the bag are designed to simplify the work of game wardens. Modern limitations on hunting have successfully adjusted available game supplies to mounting human populations in much of North America and western Europe, but they have been less successful in countries where the rural population is poverty-stricken and poorly fed. Laws against pollution of streams have been slow to appear in heavily industrialized countries and are largely ineffective.

Public Controls.—These may be seen in predator- and rodent-control programs and in the public regulation of hunting (including shooting) and fishing, which has become an accepted tradition in most countries. The exploitation of migratory waterfowl, however, has been successfully regulated only in North America, where international treaties are easier to work out than they are elsewhere. Control of the bird-guano industry in Peru and of the harvest of fur-seal herds on the Pribilof Islands (Alaska) has been extremely successful.

Restoration and *Replacement*.—Artificial methods of offsetting resource depletion appear in the introduction of exotic (that is, nonnative) species, in the establishment of game farms and fish hatcheries, and in programs of habitat restoration. While the introduction of exotic species has in several cases been successful (the ring-necked pheasant in North America), it has been disastrous in others (the house sparrow, starling and carp in America, the European rabbit in Australia and the American gray squirrel in England), and the list of introductions that simply failed is long. Experience proves that harmless behaviour of a species on one continent is no guarantee that it will not become a pest on another. Habitat restoration has frequently proved to be expensive, but its results are dramatic in the restoration of marshes, as many of the national wildlife refuges in the U.S. now testify.

Subsidies.—The oldest types of subsidies are bounties on predators and crop-destroying species, which were offered at least as early as the middle ages in England. Some surviving bounties are deplored by scientists but sponsored by politicians as a form of unofficial rural relief. In the U.S. federal subsidies are intended to encourage municipalities to construct sewage works and farmers to retire land in the soil-bank program.

Sanctuaries and Public Ownership.—Sanctuaries—also called preserves. reserves and refuges—have been prominent in wildlife conservation since the mid-19th century. With the large national parks, they have provided the protection and space critically needed in America and Africa by the larger predators and grassland-dwelling big game and the freedom from human interference needed by nesting birds during the breeding season; in the U.S. they also give migratory waterfowl at least partial relief from hunting pressure. In the United States, public ownership, which usually accompanies the establishment of sanctuaries, facilitates the management of wildlife food and cover resources to an extent seldom possible on privately owned lands. The reverse often applies in Britain and much of Europe.

Public ownership finds its soundest manifestations in the development of sanctuaries and in the preservation of wildlife in national parks, though government ownership of forests in Canada and the U.S. is responsible for the maintenance of big-game populations.

4. Education and Research.—Teaching about wildlife conservation varies greatly in different countries. In the United States it is augmented by the work of private conservation groups and by state conservation departments and the federal government. In Europe and Asia the subject is largely neglected by educators. In Africa, however, growing awareness of the part played by wildlife in soil conservation, land use, economics and amenity is being reflected in education programs. Some universities in emergent territories of the British commonwealth are arranging university faculties for game conservation. Research in wildlife conservation holds much the same promise as it does in other fields of science. Inventories of game populations are so standardized in some parts of the world as to be outside the realm of research, but in many regions inventories of threatened species are still relatively uncommon. Birds native to islands and mammals ranging over wide expanses of grassland appear to be particularly endangered.

5. Wildlife and Modern Society.—The social uses of wildlife include nature study, recreational hunting (including shooting in the British sense) and fishing, photography and simple enjoyment of the outdoors. Sanctuaries are therefore being especially developed for nature lovers, game preserves and national parks for tourists, game-management areas for hunters and nature preserves for the scientific study of biotic communities. These differing cultural approaches separate the wildlife-conservation movement into such components as bird protection (the goal being a complete absence of exploitation), game management and fish management. Conflicting interests in such approaches have in the past divided the wildlife-conservation movement. and it is not clear whether this tendency will disappear or increase.

The economics of wildlife conservation, while seemingly opposed to the ethical and aesthetic aspects, are real In general, the commercial hunting of wild birds and mammals has had disastrous effects: this is the lesson of the passenger pigeon, the Eskimo curlew. the American bison and many other species. Commercial fishing also has its risks, but while the ruined California sardine industry and the depleted North sea fisheries are witness to this, the successful restoration of the Pacific halibut fishery demonstrates that, with proper controls, fish can be harvested on a sustained-yield basis. Vast sums are spent yearly for fishing tackle and hunting equipment, camping gear. boats, motors. dogs, licences and travel connected with these sports, in addition to the uncalculable amounts spent by persons whose sole exploitation of wildlife is aesthetic. The capitalization of the wildlife resource involves a figure of staggering magnitude.

Ethical considerations appear to occupy a central position in wildlife-conservation thinking, but their development has been delayed by the fact that man for so many generations had to fight against nature. Although primitive man had a far more important stake in wildlife than modern man has, it is virtually certain that he had little concept of conserving his game. The disappearance of the moa and the mammoth taught no lessons; the disappearance of the passenger pigeon did. Convinced of the enormous destructive power of man, pioneer conservationists of the early 20th century emphasized the ethical responsibility of their own generation to conserve natural resources for posterity. Modern ecologists perceive that nature is a series of complex biotic communities of which man is an interdependent part; a spokesman for conservationists, Aldo Leopold. has argued that the Golden Rule applies to the lands and to its animals as well as to man. Modern man finds himself responsible for the fate of many products of creation and with a conservation tradition and code of conduct less than a century old to guide him. (J. J. Hi.)

II. INTERNATIONAL CO-OPERATION

As the concept of wildlife preservation gradually spread, particularly in the latter part of the 19th century, the necessity for international co-operation became increasingly apparent. Not only does wildlife know no political boundaries, but efforts to protect an animal in one country are futile if a poacher has merely to slip over the border into another country to evade punishment.

1. Conferences on Africa.—This situation became so apparent in Africa—where many territories ruled by European countries adjoined one another and where game reserves and protection laws were simultaneously springing into being—that in 1900 the plenipotentiaries of the United Kingdom, France, Germany, Italy, Spain, Portugal and the Independent State of the Congo signed a convention "for the preservation of wild animals, birds and fish in Africa."

The 1900 convention was never ratified, but it was the forerunner of the International Conference for the Protection of the Fauna and Flora of Africa, called by the British government and held in London in 1933 under the chairmanship of the earl of Onslow, president of the Society for the Preservation of the Fauna of the Empire. Its final act was to sign a convention, which was duly ratified and which came into force on Jan. 14, 1936. This convention was the foundation upon which the preservation of wildlife in Africa was thereafter built. Moreover, it provided a pattern for protection in Asia and served as a guide wherever laws for nature protection were being formulated. Indeed the convention made special provision for other governments to accede to it, even if they had no territory in Africa.,

Before drawing up its convention the conference arrived at four principles by which wildlife could be preserved from extermination: (1) the creation of protected areas; (2) the regulation of the killing and capturing of animals outside these areas; (3) the regulation of traffic in trophies; *(4)* the prohibition of certain methods of killing and capturing animals. The articles of the convention reflected these principles. Protected areas were divided into three categories—national parks, strict nature reserves and reserves. These were defined so as to indicate the purpose of an area and its degree of permanence.

The convention stressed the importance of making protected areas sufficiently large to allow for seasonal migrations of game. Buffer zones were recommended around national parks and strict nature reserves. In these zones controlled hunting would be allowed but the occupier of the land would have no claim to compensation for damage caused by animals from the protected areas. Consultation among governments was insisted upon when protected areas ran along national boundaries.

Animals in need of protection were divided into two classes: class A for those animals whose need was of special urgency and importance—these might be killed or taken only with special permission of the highest authority in the land; class B for animals requiring a lesser degree of protection, which might be killed or taken only under a special—not an ordinary—game licence. An annex gave the names of African animals placed in these classes and provision was made whereby others might be added in the future. The meaning of the term trophy was defined, and rules were given for the control of trade in trophies. (The most important trophy in Africa is, of course, ivory). The use of motor vehicles or aircraft in hunting animals and also the surrounding of animals by ring fires were prohibited. Recommendations were made for the restriction of various other undesirable methods of hunting.

In a protocol to the 1933 convention provision was made for further conferences, and the first of these was held in London in 1938. Besides being a stocktaking conference, at which action taken and contemplated on the 1933 convention was reported and discussed, this conference recommended that a number of new animals should be added to classes A and B and that there should be exchange of information upon animal diseases. A further conference was also agreed upon, to be held in 1939, with the object of extending to tropical Asia and the western Pacific a regime of protection similar to that established for Africa. World War II prevented the meeting of that conference. (C. L. BE.)

2. Western Hemisphere.—In the Americas protection of nature became a matter of recognized hemisphere policy in 1940 with the signing at Washington, D.C., of the Convention on Nature Protection and Wild Life Preservation in the American Republics. This treaty defined nationa! parks, natural reserves and strict wilderness reserves and set forth criteria for their administration. It reinforced the treaties between the United States and Mexico relating to the protection of migratory birds, and its annex listed species that warranted special protection, including the woodland caribou, sea otter, manatee, trumpeter swan, California condor, whooping crane, Eskimo curlew, Hudsonian godwit, Puerto Rican parrot and ivory-billed woodpecker. Although the convention has not been used to full advantage, it was instrumental in stimulating protective conservation practices in the western hemisphere. An important result was the convening of the Inter-American Conference on the Conservation of Renewable Natural Resources at Denver, Colo., in 1948.

International attention was focused effectively on problems of protecting migratory birds and mammals through the work of such organizations as the International Committee for Bird Preservation, founded in 1922, the American Committee for International Wild Life Protection and other private bodies, and organizations whose activities led to conventions regulating harvesting of whales, oil pollution of the sea, protection of the fur seal and the administration of other oceanic resources *(see* below, *Conservation* of *Sea Mammals and Fish).*

3. IUPN.—A major step to ard co-ordination of the efforts of governments, official agencies and international and local conservation and scientific organizations was achieved at Fontainebleau, France, in 1948, when after preliminary meetings in the two previous years an International Union for the Protection of Nature (IUPN) was founded by representatives of 33 countries, with the encouragement of the United Nations Educational, Scientific and Cultural organization (UNESCO). (F. M. PD.)

4. Africa.—An important step in international co-operation for wildlife protection in Africa was taken by the Belgian government, which summoned the third international conference to Bukavu in the Belgian Congo in Oct. 1953. In amending the 1933 convention the conference added a new class C to protect animals which, though not rare everywhere, were locally in need of special protection. The definition of trophy was extended to cover all parts of the animal. Other measures agreed upon were as follows. There should be stringent control of all arms and ammunition and prohibition of the use of standard military arms, of automatic weapons and of rifles of too small a bore to kill an animal outright. Wounded animals must be followed up; dangerous wounded animals must be reported. The sale, exchange or movement of game meat in quantity should be controlled. The control and conservation of wild animals should be vested in a single, adequately staffed authority in each territory. Naines of persons repeatedly convicted under the game laws should be circulated among territories.

The conference ended with a "fundamental recommendation" which was that another convention should be drawn up to lay down the general policy for nature conservation in Africa and to include the vegetation, soil, water and all other natural resources. It was indeed a long step forward from the few simple schedules of the London conference of 1900.

In 1960 the IUCN *(see* below) launched its African special project in co-operation with UNESCO, FAO and CCTA (Commission for Technical Co-operation in Africa South of the Sahara). The purpose of this project was to inform public opinion in Africa, through African leaders, of the need for nature conservation based on ecological knowledge. and to offer help. Stage I of this project was a preliminary visit by the secretary-general of the IUCN to west, central and east Africa. Stage II was an international conference at Arusha. Tanganyika. J. K. Nyerere, prime minister, gave the conference the "Arusha manifesto," pledging his government to do all in its power to make sure that Africans should continue to enjoy their inheritance of wild animals. Stage III, which started in 1962, was a working team sponsored by IUCN and FAO which would visit African countries to advise on wildlife policies and conservation. (C. L. BE.)

5. **IUCN.**—In 1957 IUPN was renamed the International Union for Conservation of Nature and Natural Resources (IUCN). Through the union and its commissions on ecology, national parks, public information and special committees, scientists and conservationists were aided in securing the effective attention and action of governments to the dangers threatening the natural resources of their countries. **A** survival service was founded to investigate and maintain records of wildlife in danger of extermination and to instigate vigorous protective measures to ensure their survival. In *1954* and 1955 the union sent Lee M. Talbot, an American ecologist, to about 30 countries in Africa, the middle east and Asia to ascertain the status of some of the rarest animals on the earth; as a result of his expedition, improved protection was given many of these species. Other missions were sent to study the lemurs of Madagascar and potential park and reserve areas in Indonesia, Thailand, Burma and Vietnam; special projects to determine ways to safeguard African wildlife and the extraordinary wild populations of the Galapagos Islands were undertaken. The union holds frequent international technical meetings and general assemblies, where authorities from many nations can confer together.

A significant program instigated by a resolution adopted by the union at its general assembly in Greece in 1958 was the adoption by the Economic and Social council of the UN. in 1459. of a proposal to publish a register of the national parks and equivalent reserves of the world. More than 50 nations responded to the secretary-general's invitation, and Part I of the list was issued by the United Nations in 1961; an additional 30 nations were represented in Part II issued by the IUCN in 1962. It will be maintained and expanded on a continuing basis. (F. M. PD.)

6. World Wild Life Fund.—In 1961 the World Wild Life fund was inaugurated. It aimed at raising at least £500,000 ($1,300,000) annually to be spent on conservation in any territory where such measures are needed in the interests of species threatened with extinction. Care was taken to avoid national bias in the organization and in the allocation of the funds. Chief executive positions were held by representatives of the smaller and neutral nations, and the first patron was the prince of the Netherlands; a Belgian was elected president and the headquarters were located in Switzerland. National branches were organized independently in all western countries and in several African territories for the purpose of collecting the money eventually to be spent by the international headquarters. A major field in which the fund could help was that of education and technical research, such as the endowment of departments of conservation at certain universities in emergent countries, particularly in Africa. (W. S.)

7. Special Problem of Africa.—An assessment of wildlife conservation problems all over the world led the IUCN to the conclusion that the accelerated rate of destruction of wild fauna, flora and habitat in Africa—without regard to its value as an economic, scientific and cultural resource—was an urgent international conservation problem and that the disappearance of wildlife would be a biological and cultural catastrophe. Wildlife. at the time of transition from colonial to self-government, was Africa's most neglected but potentially most valuable renewable natural asset.

The problem is twofold: first, conservation of the national parks and faunal reserves; and second, the management of wildlife stocks on lands outside the existing parks and reserves, especially on those lands not suited to agriculture. The great national parks and faunal reserves are important; not only do they have national value to their respective countries but also they are part of the cultural heritage of civilized men everywhere. As living museums of natural history the African national parks, in particular, stood to be the most spectacular areas of their kind—priceless examples without comparison on any other continent.

For a million years certain parts of Africa have been producing wild animals at rates that compare favourably with good present-day domestic livestock production, and this without destruction of the pasturage or soil resources. This phenomenon is worthy of continued study. Research on livestock breeding, meat production and even grassland management is accepted and encouraged; comparable research on wildlife populations and their habitats is urgently needed. The economic use of the ungulate fauna (hooved animals) outside the parks has been little considered in Africa. It has apparently been assumed that modern systems of economic production require the disappearance of wildlife or else disregard its presence. Yet, large-mammal populations, scientifically managed and harvested as a renewable resource. may yield protein foods in areas where livestock production has proved to be difficult or hazardous, and over parts of the African continent these populations offer more efficient and productive results than can be achieved with livestock. The management of wild lands for production of natural crops and the economics of such land use have been demonstrated in several parts of the world less well endowed than Africa, and demonstration projects have been put in motion in parts of Africa.

The ecologist especially questions the advisability of disturbing natural plant and animal communities on lands marginal and submarginal for agriculture. Such areas tend to deteriorate rapidly under the grazing of domestic animals or under cultivation. On these lands, where conventional agriculture is uneconomic or impossible on a long-term basis, there is a need to recognize wildlife as an important nutritional resource.

There are indications that in some areas more protein food could be harvested through scientific management of native animals than by ranching cattle or sheep. In still other areas wildlife can contribute to total meat production, supplementing that produced by livestock. The ungulate fauna of Africa is a valuable economic resource, particularly in areas where human populations are short of meat.

For international co-operation in the protection of birds and flora see below, Bird Protection and Plant Conservation.

(G. TL.)

III. GAME MANAGEMENT

Game is any bird or mammal pursued for sport. Game management is the art of making land produce wild game in sufficient abundance to permit harvest for recreational use. With shotgun, rifle or bow and arrow man accomplishes the harvest, much as did his predecessors—then for survival, now for sport. Species that may be taken are defined by law in all developed countries, and periods of closed season are established to provide protection during the reproductive period. The open season may be limited to a few days or few weeks in any one year. Defining these seasons each year is one of the fupctions of game management.

Hunting regulations are based on the findings of game biologists, who are trained in the earth sciences to understand soil fertility and its influence upon nutritive quality of wild animal foods; in botany and forestry and the means for altering the species composition of farm, forest and marsh; in physiology, ecology and animal behaviour, to detect the subtleties of population changes and their influence upon reproduction; and in statistics and public relations in order to interpret their findings for administrators and the public. Game managers are also concerned with species no longer hunted, such as the whooping crane and Hawaiian goose, and many governmental game departments do intensive work with species not remaining in shootable numbers in their areas.

1. Kinds of Game.—Game species are classified arbitrarily in several ways, such as migratory and resident, or, as below, by their habitats.

Upland or Farm Game.—This includes such animals as squirrels, rabbits, quail, partridges and pheasants (also called small game), species that thrive in association with man, feed on waste grains and weed seeds and have small space requirements and low mobility. Effective management consists of providing the right combination of foods, water and cover, or low, dense shrubbery in which protection can be had from sun, wind, snow or pursuit by predators. Wildlife managers effect increases in these species by diagnosing the requirement that is in short supply locally and supplying it through inducements to farmers, by planting shelter belts of trees and shrubs along highways and field borders. by leaving waste grain from the harvest or by digging farm ponds for water in times of drought.

Forest *Game.*—Deer, bear, turkey and grouse live in forested habitats even when these are interspersed with farms and dwellings. They feed heavily upon mast—acorns, nuts and fruits—and search the forest floor for mushrooms, insects and other small animal life. Forest management practices include selective cutting and thinning to make openings in the leaf canopy, which permits more light to penetrate to the forest floor and induces sprouting of shrubs. Deer seek these growing tips because they are high in nutritive value.

Wilderness Game.—Also known as big game, this group includes species that require much space and are highly mobile (elk, caribou, etc). Although they avoid human settlement they seek agricultural crops when natural foods are in short supply, and game managers may be required to help farmers resist their depredations.

Migratory Game.—This term is used for the waterfowl—ducks, geese and swans—as well as the shore birds, most of which breed far north of their wintering grounds and hence are hunted along their migratory paths. Control of the migratory bird harvest through international agreements—on regulation of open seasons hours during which hunting is permitted and numbers allowable in the hunter's daily bag—is of extreme importance. Agreement among Canada, the United States and Mexico, based on the Migratory Bird Treaty act of 1916, provided this control in North America In Europe each country makes its own regulations with little co-ordination among those sharing the waterfowl of one migratory path (See below, *Bird* Protection.)

2. Game Production.—As Charles Darwin observed, animals tend to multiply in geometric proportion; if there were no natural controls limiting their increase, the world would soon be overrun by quail and rabbits. Game managers attempt to discover the factors that limit the increase of a particular species in a given area, usually by diagnosing deficiencies in foods (diversity, nutritive quality and seasonal abundance), cover for nesting, roosting and escape, and availability of water. Frequently deficiencies are very specific and easily remedied; *e.g.*, brush piles alone usually will lead to a great increase in the number of cottontail rabbits in agricultural areas where food is abundant, and rain water caught and stored in underground tanks will enable thousands of quail to live through months of drought in California and Hawaii. Augmenting the wild game crop by release of pen-reared stock is common practice in Europe but has declined in the United States because such stock by its very success in captivity has been selected for tameness; it neither survives well nor reproduces well in the wild.

The human population explosion has led to great competition for space and also to demands for increased agricultural production. The satisfaction of these needs not only causes a reduction in size of the areas where game is produced but also limits the number of such areas available to hunters. Broadcast chemical sprays for insect control are another serious threat to wildlife, causing mortality both directly and indirectly by decreasing the food supplies. Conversely, introductions of game where no effective predators exist have caused great damage through overpopulation. This is illustrated by the case of the red deer introduced into New Zealand; in mountainous areas that are too difficult to reach for adequate harvest by hunters the deer destroy so much vegetation that erosion and vast land slips result. The European rabbit in Australia provides another familiar example; after 70 years of effort to get it established, it finally overran and denuded the countryside, converting immense areas of pasture land into semi-desert. Kot until the 1950s was it brought under control by means of myxomatosis, an insect-borne virus disease that does not spread to other animals.

3. Game Harvest. — In Canada and many regions of the western United States much public land is open to hunting. Elsewhere in the United States, hunting is by permission of the landowner, and exclusive shooting rights are frequently leased for the year by groups of sportsmen. Many ranchers charge a daily fee for deer or pronghorn hunting on their lands.

In Denmark and Finland farms are leased by organized groups of hunters who actually participate in game management practices. In Great Britain most shooting is let by estate owners to sporting tenants, or done by the owners and their guests, free hunting being available only along the foreshore of the sea, for waterfowl.

In the United States there is a growing trend toward purchase or lease of tracts for management by state and federal game departments. These tracts! known as public shooting grounds, are available to hunters either on a first-come, first-served basis or by reservation. Part of each area is used for shooting and part is held as inviolate sanctuary; a large proportion of the geese of North America now stop at a series of managed areas during their autumn migration, and at one such area in southern Illinois as many as 30,000 Canada geese are shot in one season.

4. Research. — Game-management research is necessitated by the rapidity of environmental change as human populations grow. As the proportion of land covered with concrete — because of urban expansion, construction of airports, highways! etc.—continues to rise, management of the remainder increases in importance. Certain principles, such as the territorial requirements of each species, the carrying capacity of the land, the population turnover and age ratios of different species, emerge as research into the habits and needs of game struggles to keep up with environmental change.

Territorial *Requirements*.—These differ greatly among game species. Adult bears tend to be solitary; peccary bands and quail coveys in winter tolerate members of their own group but repel others; most deer, pheasants. grouse and pronghorn gather in great numbers in winter despite local shortages in food supply, but with the onset of the breeding season their expanded space requirements cause unrest and fighting. Spacing out is maintained in most species by means of scent posts, song and other threats without resort to actual conflict. Thus, many game birds and mammals exert automatic control over their own densities. Species lacking these mechanisms of population control and tolerant of crowding (such as deer) may overpopulate their range and destroy their food supply until starvation occurs. With deer this is especially true since man has extirpated the effective predators from most of their range. Man must now assume responsibility for the predator's function by providing adequate hunting harvest.

Polygamous Species. — Such species as pheasants and deer cannot be overharvested by hunting as long as only males are shot. Despite long open seasons, cock pheasants are never too scarce to fertilize all hens. Deer populations cannot be kept within bounds unless does as well as bucks are shot.

Carrying Capacity. — The capacity of any game range is exceeded when a species becomes so numerous as to destroy or reduce in vigour its food plants. Ranges overbrowsed by deer may require 5 to 15 years to recover; lichen ranges overbrowsed in Alaska required 20 years. Game managers are constantly concerned with refinements in measuring carrying capacity and with clues for early detection of overpopulation.

Population Turnover.—The rate at which a species replaces itself annually is controlled by intensity of harvest and by the natural reproductive rate. The higher the percentage of young, the healthier the population. In short-lived species such as quail and rabbits, 85% live through only one reproductive season. If not shot, they will die of other causes before the year is up; hence liberal hunting is allowable and 50% of the autumn population can be harvested each year without hazard to the breeding stock. In long-lived species with slower rates of population turnover, such as deer, about 25% can be safely harvested each year.

Age Ratios — These provide an indication of population density where numbers cannot be readily counted, as among rabbits, ducks and quail. Birds trapped for banding or game examined in hunters' bags provide information on age ratios that makes it possible to measure the season's reproductive success and rate of population recruitment, and to estimate the allowable harvest. These form the basis for many hunting regulations and give insight into causes of breeding failure.

Stress. — Stress, the term for a group of physiological changes induced by crowding, is a common and subtle force limiting populations. In southern Missouri, when a flood during the breeding season of swamp rabbits caused crowding on the areas remaining above water, two of every three females resorbed their litters and gave birth to no young. When snowshoe hares in Minnesota became crowded at the peak of their cyclic abundance, many fell dead in midwinter, seemingly without cause. Game harvest through hunting prevents crowding and stress.

5. Legislation. — In the United States laws regulating hunting of resident game are established by each state. Wildlife management is accomplished largely by the state conservation departments as a result of the Federal Aid to Wild Life Restoration act of congress. 1937, commonly known as the Pittman-Robertson act, under which an 11% excise tax is levied on sporting arms and ammunition. States must provide matching funds equal to 25%. Similar procedures are followed in countries that have fallen under Soviet influence. In parts of Europe game management and research remain privately exercised functions, either by individuals or voluntary organizations deriving no financial aid from the state.

(W. H. E.)

IV. BIRD PROTECTION

Bird protection has taken shape gradually from a variety of motives. These have included anxiety to keep up or increase numbers of birds valued for food or sport and birds believed to be beneficial to agriculture. Sentiment in favour of songbirds, or of birds generally, and dislike of cruel practices in killing or capturing birds have also become important since the middle of the 19th century. Only in modern times has any general written code emerged. Bird protection is best regarded as that part of nature conservation aiming primarily to protect bird life by specific methods, although secondarily providing background protection for many other animals and plants.

A. Legislation and International Agreements

Among early instances of bird protection were St. Cuthbert's successful efforts, about A.D. 680, to establish a tradition of not disturbing birds, especially eider ducks, on the Farne Islands off Northumberland, and Kublai Khan's closed seasons for birds in the 13th century. In 1534, in England under Henry VIII, an act was passed "to avoide destruction of wilde-fowle" which protected the eggs of herons, spoonbills, cranes, bitterns and bustards, but did not protect the birds themselves even in the breeding season.

1. Continental Europe. — In Germany Lippe-Detmold passed a Bird Protection decree in 1777, Saxe-Coburg in 1809 and Hesse in 1837, the latter forbidding the killing of named species useful to agriculture and the taking of their eggs. In 1837 the Netherlands passed a hunting law giving special protection to lapwings and nightingales and prohibiting egg collecting, except of certain eggs for the table. Most continentai European countries developed voluminous but largely ineffective legislation from then on. In Germany the position was chaotic. In 1890, 55 pages of the laws of Austria dealt specifically with bird protection. Swiss laws were advanced and stringent, including prohibitions of birdcatching and sale of importations, and requirements for children to be taught bird protection in schools. Hungary took a leading part in 19th-century bird-protection development and in 1894 a Hungarian central office for ornithology and a body of field police were created.

2. United States. — In the United States Massachusetts led the way in 1818 with a closed season for American robins. In 1846 Rhode Island prohibited spring shooting of waterfowl. In 1870 California established at Lake Merrit, Oakland, the first state wildlife refuge protecting great numbers of wintering ducks. In 1873' Arkansas prohibited killing wild birds for sale as food, and in 1878 Iowa imposed the first bag limit (25 prairie chickens per day). In 1885 the U.S. department of agriculture established a division of economic ornithology and mammalogy which grew into the later biological survey and then into the U.S. fish and wildlife service. In Oct. 1884 the American Ornithologists' union formed a committee "for the protection of North American birds and their eggs against wanton and indiscriminate destruction." The committee's model law of 1886 for the protection of nongame birds was adopted that year by New York and Pennsylvania, and many other states followed.

In 1900 was passed the Lacey act, the first comprehensive federal law for bird protection, followed quickly by both voluntary and federal wildfowl refuges (Pelican Island, Fla., 1903) and by the incorporation in 1905 of the National Association of Audubon Societies (National Audubon society, 1940). In 1916 the Convention for the Protection of Migratory Birds in the United States and Canada provided a firm foundation for bird protection throughout North America, except for Mexico which adhered by separate treaty in 1937.

3. Great Britain. — In Great Britain modern bird-protection legislation dates from the Act for the Preservation of Sea Birds, 1869. This was secured through a movement promoted by the vicar of Bridlington in Yorkshire and was prompted by slaughter of sea birds on Flamborough cliffs, where one man in one year killed 4,000 kittiwakes. The 1869 act was judged a success in saving breeding colonies from extinction and was followed in 1872 by another protecting some 80 additional species during the breeding season. In 1876 a closed season (Jan. 15 to July 10) was imposed for wildfowl. Subsequent acts extended protection to eggs and gave power to create bird sanctuaries (1896). In 1954 all previous legislation was superseded by the Protection of Birds act, giving complete legal protection throughout Great Britain to all wild birds and their nests and eggs with certain exceptions (principally in respect of birds to be shot or taken as game or as pests). Special penalties were made available for offenses on sanctuaries, (which could also be closed to public access) and in respect of rare species. Licences for scientific purposes and for falconry were authorized, and various cruel or destructive aids to killing or taking were prohibited.

4. British Commonwealth. — The first Canadian wildfowl refuge was established in 1887. Most of the Canadian provinces introduced legislation for the protection of wild birds about 1895–98. following several other British territories led by Queensland and British Guiana (1877), New Zealand (1880), Hong Kong (1885) and India (1887). In Canada bird protection since 1917 has been governed by the Migratory Birds Convention act following the convention with the U.S. It is administered by the Canadian Wildlife service, created in 1947, with the help of provincial authorities. In several commonwealth territories bird protection is merged with that of mammals and reptiles (*e.g.,* in the Fauna Protection act of 1950 in Western Australia).

5. International Measures. — Except in North America, repeated efforts toward international bird protection have been only partially successful. These efforts began in 1868 with an appeal from the General Assembly of German Farmers to the Austrian and Hungarian governments to join in a convention for the protection of birds useful to agriculture and forestry. In 1869 the Italian, French and Swiss governments indicated their support, and in 1875 an Austro-Hungarian agreement with Italy was signed.

Eventually, in 1902, an International Convention for the Protection of Birds Useful to Agriculture was concluded by Austria-Hungary. Germany, France, Spain and several smaller European countries (Great Britain and Italy not taking part). Only France, Hungary, Belgium, Sweden and the Netherlands ratified it. A subsequent convention was provisionally adopted in 1950 at Paris and has been ratified by a few countries. The International Council for Bird Preservation (I.C.B.P. or, in French, C.I.P.O.), organized in London in 1922, has promoted much useful action, including the International Convention for the Prevention of the Pollution of the Sea by Oil. concluded in London in May 1954. The committee also. by arrangement with the International Union for Conservation of Nature and Natural Resources, watches over species of birds listed as in danger of extinction. The International Wildfowl Research bureau at Le Sambac in the Camargue, France. under the auspices of the I.C.B.P., serves as a clearing house for information and advice on wildfowl research and conservation.

6. Modern Trends. — In summary, the following trends in the protection of birds may be observed. (1) to codify the law, making it simpler and more easily understandable; (2) to co-ordinate different objectives, utilitarian. sporting, aesthetic and humanitarian, giving increasing weight to conservation and scientific factors; (3) to promote education, especially in schools, and public information about the law and the broad objects of bird protection; (4) to strengthen enforcement, where necessary by means of specialized officers such as rangers or field police; (5) to make specific and flexible exceptions to meet the needs of scientific research, museums, etc., and generally to prohibit disturbance without any valid purpose; (6) to prevent undue shooting pressure by such means as adjustment of closed seasons and by limits; (7) to prohibit killing or taking by cruel or unduly destructive means, and to suppress illegitimate or commercial exploitation of bird life such as plumage hunting or birdcatching for the cage or collecting eggs or stuffed birds as a hobby or for ornaments; (8) to co-ordinate international action, for example by prohibiting import into advanced countries of birds needing protection in their areas of origin; (9) to rely increasingly on scientific investigation and conservation — for example, by provision of refuges and reserves or sanctuaries and by encouragement or provision of suitable food and shelter.

B. Choice and Management of Refuges

Refuges may be selected for many different purposes. Some offer security from persecution or disturbance to scarce, vulnerable or shy species while breeding, while at halting places during migration or in winter quarters. (Breeding colonies of aquatic birds, or areas where waterfowl flock during the open season are prominent instances.) Other reserves are designed to preserve or recreate habitats threatened by reclamation, such as marshes, fens or tall native forest. In some cases such habitats are artificially provided by tree planting or by excavating pools, for example, in areas where they were previously absent. Some are managed experimentally for scientific research or to devise improved conservation techniques. Others are show places where human visitors can watch this wildlife at close quarters (as at the Hawk Mountain sanctuary in Pennsylvania, where thousands of hawks and eagles can be seen on migration'), or where ornithologists, bird photographers, makers of sound recordings and others can satisfy their requirements. Others are kept as free as possible from all intrusion. The underlying principle is, as far as practicable, to combine the conservation of the birds with the enjoyment of sightseers and with meeting the needs of specialists or photographers, but where bird conservation would suffer from even limited disturbance, the birds' welfare must come first. In some cases. for example in rhe royal parks of London, bird sanctuaries are set aside to provide small areas of quiet cover or quiet water for ordinary birds in heavily populated metropolitan districts.

Modern management aims to measure the pressures bearing most heavily on protected birds and to relieve excessive pressures by suitable adjustments. For example, access may be prohibited or limited to conducted parties at certain times (*e.g.*, in the breeding season), or to certain zones. or to observation posts from which the birds can be seen without being disturbed, as at the Wildfowl trust refuge at the New Grounds, Slimbridge, Eng.

The number of sites classed as bird refuges is often large—Switzerland alone has more than 100—but generalizations on the distribution and value of bird refuges in the various countries would be seriously misleading. The great majority are, however, in North America and in northwest Europe. While many are maintained by bird protection societies, others are operated by central and local governments and a wide variety of other agencies.

1. Predators and Pests.—Several early bird sanctuaries allowed pests to multiply. but it has become generally recognized that where this would happen control, especially of crows. rats and foxes, is essential. The need, however, usually arises only where the fauna has already suffered from unwise human interference. The ideal of nonintervention is successfully practised in many refuges, where this is not the case, in the United States and elsewhere. In principle, modern bird protection policies call for protection of all species at all times except insofar as control or "cropping" of certain populations by explicit means and at certain seasons is shown to be justified. The labeling of any species permanently as "harmful" or "beneficial" is not scientifically favoured.

2. Feeding.—Excessive pressure on food is sometimes relieved, especially in the United States, by artificial feeding, by aerial or other planting of suitable mild foods (*e.g.*, wild rice), or by crops (*e.g.*, cereals) deliberately left in the fields to be eaten by waterfowl. Jack Miner's pioneer waterfowl refuge at Kingsville, Ont. (1907), showed how much could be achieved in this way. The C.S. fish and wildlife service and other C.S. organizations developed by experiment various successful means of artificially expanding or supplementing the food resources which determine the carrying capacity of refuges in terms of bird populations. Bird tables and feeding devices are widely used in Europe and North America for similar purposes. In order to ensure that the Hawaiian goose is kept in existence, parts of the stock are being reared in captivity. about one-half of the world population in the early 1960s being so maintained by the Wildfowl trust at Slimbridge and elsewhere in England by arrangement with the Hawaiian authorities.

3. Provision of Breeding Sites.—Shortage of breeding sites is a limiting factor for many species and progress is being made by research and experiments in increasing the numbers and enlarging the range of certain species. In North America the wood duck has taken readily to artificial nest boxes on posts in standing water, where the ducks and eggs are relatively immune to predation by raccoons and other mammals. Experiments with hole-nesting birds have been carried out in Germany, the C.S.S.R.. England and elsewhere on titmice, pied flycatchers and other species. with, in several cases, striking success. At Patuxent Research refuge, Md., the U.S. fish and wildlife service has induced wintering Canada geese to stay to breed far south of the normal breeding range by providing suitable artificial islets and by meeting other habitat requirements. Nesting boxes are among the most generally effective and attractive devices for practical bird protection, but faults in design. siting or construction often cause failures.

4. Other Practical Assistance.—Among other practical methods of bird protection mention must be made of provision of perches on lighthouses and floodlighting of the structure to prevent heavy casualties in poor visibility. First-aid measures are applied where aquatic birds are exposed to oil pollution or at times when onset of cold weather leads to heavy mortality of insectivorous or other delicate species in winter quarters or on passage. Aircraft. including helicopters, are used in such situations for dropping food supplies or even for ferrying numbed and exhausted birds to warmer climates; *e.g.*, swallows have been so carried across the Alps. Icebreaking on frozen waters is also undertaken.

5. Education and Information.— Apart from such practical measures to assist particular bird populations, much can be done rnore generally to educate and inform people of all ages of the importance of bird protection and the means of encouraging bird life or of avoiding actions injurious to it. For example, the Massachusetts Audubon society (founded 1896) conducts special courses in conservation and natural science. reaching regularly about 15,000 boys and girls in the state grade schools, and operates five natural history day camps and one resident camp for boys and girls. The National Audubon society of the U.S. provides extensive and excellent services and literature for schools. giving practical programs and instructions. Bird day is observed in schools in many states. In Hungary a Bird and Tree day was established in 1906, but in most European countries teaching in schools is not general. There are, however, active conservation societies at work, such as the Royal Society for the Protection of Birds in Great Britain (founded 1889). In Great Britain and certain other countries. television and broadcasting services concern themselves with bird-protection matters on a large scale and at a high standard, and nature films also help in educating and informing the public.

6. Control of Undesirable Human Interference.— Success in bird protection calls for effective control of undesirable human interference. For this purpose it is necessary to know what is undesirable, and accordingly to have adequate provision for scientific research and for consultation regarding its practical application among the interests concerned. Experience shows that unless these two needs are satisfactorily met legislatures cannot agree to adopt. nor can governments enforce, reasonable measures of bird protection. In Great Britain they are in principle covered by statutory wild birds advisory committees to advise the secretaries of state (for Scotland, and for England and Wales respectively) and by the official nature conservancy and other agencies, which are represented on these committees and are responsible for providing them with a scientific basis for recommendations, and for advising on repercussions on agriculture, fisheries, sport and so forth. The U.S. fish and wildlife service and the Canadian wildlife service fill similar roles in the United States and Canada. An important problem is to ensure that sectional interests do not pursue conflicting private control policies of their own—for example, regarding predators—often in defiance of the law. The problem, however, is not only one of law enforcement. Both in the United States, at the Aransas refuge for whooping cranes, and in Europe. at the Knechtsand molting area for shelducks, problems arose over threatened destruction of important and vulnerable bird populations by air force bombing ranges. In these instances satisfactory settlements were negotiated, but there is constant danger of major engineering and development projects nullifying bird-protection policies. Protection against cruelty or persecution is part of a wider problem on which public opinion in many countries is still backward. and it is often difficult to enforce the ban on illegal methods of killing or taking in remote places, and especially on private land. (E. M. N.)

V. CONSERVATION OF SEA MAMMALS AND FISH

The seas, apart from narrow coastal zones, are international. and the principle of the freedom of the high seas is well established; hence conservation measures affecting high-seas fisheries are usually subject to international agreement. In general. conservation problems increase in relation to the number of governments involved and are least when the interests of only a single country are at stake, as in many coastal and inland fisheries. The basic principles of conservation are similar in both coastal and pelagic fisheries, and this article therefore deals largely with the more important international conservation measures and organizations.

1. Whales. — Whales are particularly vulnerable to commercial exploitation because of their slow reproductive rates. Historically they have been progressively depleted. species by species, in region after region, and effective conservation measures have proved difficult to apply. When it became apparent that the antarctic stocks of baleen whales were being depleted, restrictions were introduced and a number of international agreements were concluded. The 1931 convention was followed by the agreements of 1937 and 1938, while in 1929 the Bureau of International Whaling Statistics had been established.

After World War II the machinery for regulation was greatly improved by the signing in 1946 of an International Convention for the Regulation of Whaling by 15 contracting governments. The convention set up the International Whaling commission (I.W.C.), which has scientific and technical committees to discuss and report on relevant biological research and advise on conservation measures and procedures. Research is undertaken by some of the member governments. The I.W.C. is empo ered to fix an over-all limit to the antarctic pelagic catch of baleen whales, which in 1959–60 comprised 80% of the total world catch of baleen whales. Competition resulting from increased catching capacity has brought the industry to the limit of economic operations. As a result of associated developments Norway and the Netherlands withdrew from the convention in 1959. Norway rejoined in 1960 but withdrew again late in 1961.

Other important conservation measures applied to whaling have been complete protection of some species, restriction of whaling seasons, minimum length regulations, protection of calves and suckling females, sanctuary areas and provision for utilization of the carcasses and for inspection. In spite of these measures whale stocks have been seriously depleted, but the depletion would certainly have been much more rapid and catastrophic without the restraint imposed by the International Whaling commission.

This convention also regulates pelagic whaling in areas other than the antarctic and shore whaling operations. Chile and Peru, which have whaling industries, are not signatories but, with Ecuador, are member governments of the Permanent Commission for the Exploitation and Conservation of the Maritime Resources of the South Pacific (C.P.E.C.R.M.P.S.), which is concerned with whale conservation among other things.

2. Seals. — Seals breed on land and in this respect are more vulnerable to hunters than whales, but their more rapid reproduction means a quicker build-up of depleted stocks. The history of the northern fur seal, hunted for its fur, provides a classic example of sound conservation practice. The rise of indiscriminate pelagic fur sealing by U.S., Canadian and Japanese nationals in the 1880s caused serious depletion of the fur-seal herds in the North Pacific, but it was not until 1911, after prolonged negotiations, that a convention signed by Great Britain. the United States, Russia and Japan prohibited pelagic sealing and opened the way to rational management. The United States, Japan and Russia each undertook to manage its respective herds and to divide the proceeds of the sale of skins among all four governments. Management on the Pribilof Islands has included the protection of females and the restriction of killing to surplus three- and four-year-old males. The annual kill is determined by population studies, and there is no commercial competition since killing is in the hands of a single contractor. In 1941 Japan withdrew from the convention, claiming that the objectives had been achieved and that the seal herds had become so large that they were damaging Japanese coastal fisheries. In 1952 an interim agreement on co-operative research was negotiated and in 1957 a new Convention on the Conservation of the North Pacific Fur Seals was signed, setting up a commission that co-ordinates research on the seal populations and their effect on other marine resnurces.

The southern fur seals are also recovering under complete or partial protection from the effects of indiscriminate sealing in the 18th and 19th centuries, and there are small industries in South Africa and South America. Conservation of the elephant seal is also of long standing. Exploitation of the herd at South Georgia has been regulated since 1910, and it supports a thriving industry, taking an annual quota of adult. males.

In the north there was for many years a joint Norwegian-Russian sealing commission with consultative status. In 1958 Norway and the U.S.S.R. signed an agreement on measures for conservation of seal stocks in the northeast Atlantic. This covers harp and hooded seals and walrus and may be extended to bearded and ringed seals and polar bears. It includes provision for fixing open seasons and prohibiting certain methods of catching, and a commission was established to recommend measures relating to co-ordination of research and regulation of sealing. In the northwest Atlantic where Canada and Norway exploit the stocks the only control is an informal agreement relating to the starting dates for taking young seals. (See also SEAL FISHERIES.)

3. Other Sea **Mammals.**—In addition to whales and seals, both of which are exploited commercially on a large scale, there are the sea otter of the North Pacific, still increasing in numbers after complete protection since 1911; the polar bear, now partially or completely protected in most parts of its range; and the manatee and dugong. which also receive some protection in most areas they inhabit. The International Union for the Conservation of Nature and Natural Resources watches the status of these and other animals.

4. Salt-Water Fish. — For biological reasons fish stocks are less easily depleted than mammal populations, hence conservation measures rarely include the prohibition of fishing. More usual measures include fixed annual catch quotas, closed seasons. sanctuary areas (frequented by immatures), mesh size regulations (to allow escape of small fish), minimum sizes of fish to be landed, and prohibition of gear considered destructive.

The aim of conservation of exploited stocks. which are usually the only ones needing conservation, is to attain the maximum sustainable yield and at the same time to keep the catch per unit effort (*e.g.*, the catch per hour's tra ling) as high as possible so as to minimize the cost of fishing. It has been shown for a number of fish stocks that by introducing regulatory measures such as the selection of a suitable mesh size; and reducing the over-all fishing effort, it is possible to increase the annual yield. These measures depend on intensive and continuing research on the various stocks of fish, for the solutions to conservation problems vary according to the type of fishery and the resource exploited.

Atlantic Ocean. — It was formerly thought that fish resources were inexhaustible) but with the improvements in fishing techniques and enlargement of markets it became apparent toward the end of the 19th century that certain fish stocks were declining and that conservation measures should be introduced. Following conferences in 1899 and 1901, the International Council for the Exploration of the Sea (I.C.E.S.) was founded in 1902. This organization, an intergovernmental body with the function of co-ordinating and advising on research in the northeast Atlantic, has committees on special topics and on different areas; and the results of investigations are discussed at its meetings. Statistics and scientific results are published.

In the 1930s an intensification of fishing and decreased catches lent urgency to the efforts to reach agreement on conservation measures, and conventions were signed in 1929. 1932 and 1937. The last, the most important and comprehensive, was sigried by ten countries but for various reasons was not ratified by all the signatory governments. An International Fisheries convention, negotiated and signed by 12 countries in 1946, became effective in 1954. It was concerned with mesh sizes and minimum sizes at which a number of species of fish may be legally landed. A permanent commission (P.C.I.F.C.) was set up to advise on extending or altering the provisions of the convention after consultation with I.C.E.S. In 1959 a new agreement, the North-East Atlantic

Fisheries convention. signed by 14 governments, replaced the 1946 convention. It covers a larger area. including the Barents sea, and is more far-reaching in its provisions. The resultant North-East Atlantic International Fisheries commission. which planned to establish three regional committees. may consider any conservation measures for any species of fish, and provision is made for international inspection.

The long-established and productive Rank fisheries of the northwest Atlantic are fished by many European and North American countries. When it was recognized that conservation might be necessary the International Korthwest Atlantic Fisheries convention was signed in 1949 and the 11 member countries set up a commission (I.C.N.A.F.) with a small scientific staff. Subareas roughly corresponding to separate fish stocks mere defined, and panels were formed to co-ordinate research and recommend conservation measures for each area. Research is carried out by member governments and the commission has a co-ordinating role, but can undertake research if necessary.

These two North Atlantic organizations are concerned mainly with groundfish such as cod, haddock, redfish and plaice.

Mediterranean Sea.—A Commission for the Scientific Exploration of the Mediterranean Sea (C.I.E.S.M.M.), set up in 1919, is not directly concerned with fishery problems. The General Fisheries Council for the Mediterranean (GFCM), sponsored by the Food and Agriculture organization of the United Nations (FAO), has 11 member countries and dates from 1949; it functions as an advisory body on research and development.

Pacific Ocean.—In the Pacific ocean there are two international fisheries commissions which, like I.C.E.S., were set up before World War II, and a number of organizations of postwar origin.

The International Pacific Halibut commission (I.P.H.C.), formerly the International Fisheries commission (I.F.C.), and the International Pacific Salmon Fisheries commission (I.P.S.F.C.) were established in 1923 and 1937 respectively. Unlike I.C.E.S. or I.C.N.A.F., they themselves conduct research and regulate the fisheries by fixing quotas and other restrictions. The I.P.H.C. provides a unique and successful example of international regulation and management of a fishery and has set a pattern for several later commissions. It has the advantage, however, that only two countries, Canada and the United States, are involved. Under its supervision the halibut fishery of the northeast Pacific, which had been disastrously depleted by unrestricted fishing, has been successfully restored; by 1954 the annual production was over 50% higher than before regulation by the commission, with only half the previous fishing effort. The management policy adopted in 1932 was preceded by thorough scientific investigation, and included catch quotas, a closed season and protection of nursery grounds. The authority of the commission was broadened by later conventions in 1937 and 1953, and the conservation measures are revised from year to year in the light of improved knowledge of the stocks.

The I.P.S.F.C.. also the result of a bilateral convention and similar to the I.P.H.C., has been markedly successful in restoring stocks of sockeye salmon.

The International Convention for the High Seas Fisheries of the North Pacific Ocean, signed by Canada. Japan and the United States. set up an International North Pacific Fisheries commission (I.K.P.F.C.) similar in scope to I.C.N.A.F. in the northwest Atlantic. This convention employs the principle of abstention. which provides that if it can be shown that a stock of fish is being fully utilized by one or more contracting parties and is under scientific management. then parties that have not historically fished these stocks agree not to engage in fishing them. For the salmon fisheries a provisional boundary was fixed to define salmon stocks of Asian and North American origin. The convention has enforcement provisions which may be reviewed from time to time. Research is to be undertaken by contracting governments, but the commission has a small scientific staff to plan and co-ordinate research.

A convention between Costa Rica and the United States, later joined by Panama, set up in 1950 the Inter-American Tropical Tuna commission (I.-A.T.T.C.) which investigates the biology of tunnies and bait fish. This has its own scientific staff to conduct research. and recommends measures to maintain the stocks at a level that would permit maximum utilization. The 16-nation Indo-Pacific Fisheries council (IPFC), sponsored by FAO and set up in 1948, co-ordinates and reports on research on fisheries and related subjects carried out by member governments (like I.C.E.S. in the North Atlantic). A South Pacific organization with wide terms of reference similar to the FAO councils (GFCM and IPFC) but with regulatory powers, is C.P.E.C.R.M.P.S., referred to above in connection with whale conservation.

For a more detailed discussion of the techniques of fish conservation and fisheries management, see FISHERIES: Scientific Research a d *Fisheries Conservation.* (R. M. Ls.)

5. Fresh-Water Fish.—Fishing (*q.v.*) is one of the most popular outdoor sports. and both recreational and commercial fresh-water fishing are of great economic importance. Since, however, only a small percentage of fresh-water fish have either sport or commercial value, management efforts are mainly limited to these few.

The increasing use of water for individual consumption, industry, irrigation and navigation has created serious problems in fish conservation. Industrial wastes, municipal sewage and silt from eroded farm lands have poisoned many kinds of fish or eliminated them by destroying their food supplies and spawning grounds. Dams have blocked runs of migratory fishes. Increased private ownership of lands and waters has interfered with public use of natural resources. To meet these problems, better methods of waste disposal are being developed, and laws have been enacted to prevent pollution. Where practical, fishways are built so that migrating fish can pass safely around dams. More lands are being purchased by public agencies to provide access to public' waters. Sometimes! where the conservation of fish is incompatible with other uses of the water, the fish are sacrificed. These losses can be offset by creation of new fishing ponds, hydroelectric impoundments or water supply reservoirs. Even in waters where there is no conflict in use, overfishing, slow growth of fish, competition from undesirable species or scarcity of some life requirement such as spawning grounds may be problems.

Number and size of fish harvested, fishing seasons and gear are often restricted by law to preserve sufficient spawning stock or protect fish until they reach a sporting or marketable size. Prolific fishes (such as bass and panfish) need little protection, and liberalization of restrictions on these species has greatly increased fishing opportunity. Where undesirable species are abundant, poisons can be used to kill all the fish in a lake, after which one or a few desirable species are reintroduced. Poisons can also be used to thin out overabundant populations where growth is slow, and chemicals have been developed that kill only a certain type of fish, such as the destructive sea lamprey. Fish are raised in hatcheries for restocking waters after deliberate poisoning, pollution or natural catastrophes. Sometimes only an introductory stocking is necessary. after which the fish perpetuate themselves. Where fish cannot reproduce successfully the waters can be regularly restocked. New fish-management techniques are being evolved continually through scientific research.

(J. T. McF.)

VI. PLANT CONSERVATION

Plant conservation has to do with the preservation of species or communities of plants that are of interest for their beauty, rarity or inherent scientific value. It is distinguished from forest conservation. which is concerned with the proper methods for utilization of forest trees as sources of commercial wood products, but it may include the preservation of individual tree species of particular interest (see FORESTS AND FORESTRY). The goals of the plant-conservation movement (illustrated by the three methods of approach described below) are: to stop, through legislation and education, the needless destruction of interesting or beautiful wild plants over large regions; to ensure the preservation of such plants and the communities in which they occur through the creation of sanctuaries, nature reserves or scientific-study areas; and finally to prevent the complete extermination of as many rare species as possible through cultivation and permanent maintenance in special botanical gardens.

1. Protective Laws.—Several different methods of plant preservation are in general use. One of these is the enactment of protective laws prohibiting the picking, mutilation, destruction or sale of certain enumerated species. usually those in danger of extermination in the region covered by the laws. Many countries provide such protection for cherished wild flowers. and many tropical countries have similar laws regarding the collection and exportation of orchids and other plants of horticultural value. Usually such laws can be effective only for plants growing on government-owned lands, since private ownership of land generally entails the right to dispose of the plants as the owner desires. The method is most valuable in local or national parks, where protection of all plants is comparatively easily enforced.

2. Sanctuaries.— A second approach to plant conservation is based upon the protection of particular tracts of land or pieces of landscape rather than individual species of plants. These tracts are variously called wild-flower sanctuaries, nature reserves, scientific areas, natural areas, etc. Establishment of such reserves is based on recognition that the destruction of the habitat is a far more serious menace to the survival of interesting wild flowers than is any amount of flower picking or other direct utilization of the plants. A further benefit derived from area preservation results from the fact that plants grow in mixed populations, or plant communities, and that protection of a given area thus preserves all plant species in the local community rather than just one or two species. *(See* also PLANTS AND PLANT SCIENCE *Plant Ecology.)* It cannot. however. be too strongly emphasized that effective preservation involves adequate control measures. These may be of communities. as when a particular phase of the natural succession, such as scrub. must be stabilized. or of particular species which become aggressively abundant or need to be artificially encouraged. The acquisition of the requisite techniques to achieve these aims is one of the prime necessities for success. Nothing is further from the truth than the widespread belief that noninterference will achieve preservation.

Many organizations have been concerned with the preservation of wild flowers and with the creation of sanctuaries or other reserved areas. The first such group, the Association pour la Protection des Plantes, was formed at Geneva, Switz.. in 1883 under the leadership of H. Corevon and other prominent botanists. It was devoted largely to the prevention of mass destruction of alpine plants by collectors and dealers in plants for rock gardens. Similar associations with comparable aims were formed in Italy in 1899 and in Germany in 1900.

The Wild Flower Preservation Society of America, organized in 1902 in New York under the sponsorship of the New York Botanical Garden, spent much effort in its early years on educational aids to improve wild-flower appreciation by means of bulletins, posters and motion pictures. After 1930 the society began to urge the creation of wild-flower sanctuaries as the best method for plant conservation and, through the co-operation of local garden clubs, was successful in stimulating a number of them in eastern North America. In the United Kingdom a Society for the Promotion of Nature Reserves was founded by Charles Rothschild with headquarters at the British Museum (Natural History) in London in 1912 and early began the acquisition of nature sanctuaries for the preservation of both fauna and flora. Wild-flower preservation societies were formed about the same time in Australia and South Africa.

In the United States there exist a number of plant-conservation organizations with special objectives. The Save-the-Redwoods league, for example, was formed in California in 1918 to promote the purchase of outstanding groves of sequoia trees and to protect them from destruction by lumbering. Several groups—including the Natural Areas committee of the American Society of Foresters, the Grassland Research foundation and the Nature Conservancy—are organized to urge the preservation of examples of complete plant communities. The members of these groups believe that future research of basic interest in fields dealing with land management, such as forestry, range management and applied ecology, will be dependent on a widespread and complete system of natural area reserves. The first official U.S. governmental organization for the same purpose was created in Wisconsin in 1951 when the legislature of that state formed the Wisconsin State Board for the Preservation of Scientific Areas.

Similar organizations devoted to the preservation of plant communities for scientific-study purposes exist in many other countries. Notable examples are the Nature Conservancy in Great Britain, the All-Russian Society of Nature Protection in the U.S.S.R. and government-sponsored agencies in the Netherlands and other European countries. All of these are affiliated with the International Union for the Conservation of Nature and Natural Resources, with headquarters in Morges, Switz.

3. Botanical Gardens.—The third approach to plant conservation is concerned with the conservation of plant species as living repositories of definite genetic constitution. As such, it seeks to prevent the extinction of rare plant species because of the actual and potential value of the germ plasm they contain. This is most readily accomplished by growing the species in special botanical collections under suitable environmental conditions. Several of the very first efforts at plant conservation employed this method. Anton Kerner established a garden in the Austrian Tirol in 1875 for the cultivation of alpine plants in danger of extermination. Similar gardens were started in Switzerland in 1883 and in Germany in 1900. Other Alpine gardens are maintained by educational institutions of the region, such as that of Grenoble university near Lautaret. France.

A number of botanical gardens and arboreta have expanded this approach by restoring or establishing entire communities so that the rare plants may exist under as nearly natural conditions as possible. The earliest efforts along these lines were conducted by the botanic garden at Bremen, Ger., and by the University of Wisconsin arboretum at Madison, Wis. See also BOTANICAL GARDENS; ARBORETUM. (J. T. Cu.)

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WILDMAN, SIR JOHN (1623–1693), English agitator, outlasted political vicissitudes under three kings and two protectors. He was of obscure ancestry and was educated at Cambridge. He first came into prominence in Oct. 1647, when he helped to write

The Case of the Army and the first *Agreement of the People,* expressing the political program of the democratic republican, or Leveller, section of the army, which opposed all compromise with Charles I. (*See* LEVELLERS.) In the debates which took place during 1647 in the general council of the army he defended this program against Henry Ireton and Oliver Cromwell (*q.v.*). Afterward he violently attacked these two in *Putney Projects* and with John Lilburne (*q.v.*) agitated for the abolition of the monarchy and the house of lords. He was thereupon imprisoned (Jan.–Aug. 1648). After his release he helped to draw up the second *Agreement of the People.* He acquiesced in the establishment of the Commonwealth and his name appeared in Aug. 1649 as a major in Sir John Reynolds' regiment: but he devoted most of his time to building up a considerable fortune by land speculation, both on his oun behalf and as agent for others who made use of his wide knowledge of the law. In 1654 he was returned to the first Protectorate parliament. but his election was disallowed. Thereupon he began to conspire with malcontent army officers for a rising against Cromwell and was again imprisoned (Feb 16j5). He was released in July possibly after undertaking to spy upon the royalists. uith uhom he was now in touch. But he occupied himself chiefly in trying to organize a Leveller and royalist rising with Spanish aid and to get Cromwell assassinated. He now came under the influence of the political philosopher James Harrington (*q.v.*) and, after the fall of Richard Cromwell, co-operated with the leaders of the Rump Parliament in the hope of eventually establishing a modified form of democratic republic on the model of Harrington's *Oceana* After the restoration he obtained great influence in the post office, but was again imprisoned (Nov. 1661) for six years on suspicion of using it as a centrè for republican plotting. He owed his release to the duke of Buckingham, with whom he had intrigued before the Restoration. In 1670 he went abroad but was home again by 1675. acting as the duke's solicitor and one of the trustees of his estate. He supported the duke in opposition to the Danby ministry and sided with the earl of Shaftesbury during the "popish plot" agitation. but voted against the Exclusion bill since he preferred a strict limitation of the royal power as being more akin to a republic. He was again imprisoned in 1683 on suspicion of complicity in the Rye House plot. He took no active part in Monmouth's rebellion (1685), but afterward fled to Holland. In 1688 he wrote the influential pamphlet *A Memorial of Protestants* and. returning to England with William of Orange, became a member of the 1689 Convention Parliament. He was appointed postmaster general in Xpril 1689 but fell once more under suspicion and was dismissed in Feb. 1691. Nevertheless he was knighted in 1692. He died on June 4, 1693, leaving an only son, John. who died childless in 1710.

See M. Ashley, *John Wildman, Plotter and Postmaster: a Study of the English Republican Movement in the seventeenth century* (London, New Haven, Conn., 1947). (R B. WM.)

WILD RICE or INDIAN RICE: *see* RICE, WILD.

WILFRID (c. 634–709), English archbishop, born in Northumbria. He attracted the notice of the queen, Eanfled, who placed him in care of an old noble. Cudda, then a monk at Lindisfarne. Later on Eanfled enabled him to visit Rome in the company of Benedict Biscop. On leaving Rome he spent three years with Annemund. archbishop of Lyons. After the murder of his patron he returned to England, where he received a monastery at Ripon, and then took priest's orders.

He was probably already regarded as the leading exponent of the Roman discipline in England when his speech at the council of Whitby determined the overthrow of the Celtic party (664). About a year later he was consecrated to the see of York, not, however, in England, where perhaps he could not find the fitting number of orthodox prelates, but at Compiègne. On his return journey he narrowly escaped the pagan wreckers of Sussex, and reached England to find Ceadda (St. Chad) installed in his see.

The rest of his life is largely a record of wandering and misfortune. For three years (665–668) he ruled his monastery at Ripon in peace, though acting as bishop in Mercia and Kent during vacancies in sees there. On Archbishop Theodore's arrival (668) he was restored to his see, and spent in it nine years of ceaseless activity, especially in building churches, only to be driven out through the anger of King Ecgfrith's queen (677).

After Ecgfrith's death (May 20, 68j) Wilfrid was restored to York (much circumscribed), and Ripon (686–687). He was once more driven out in 691–692, and spent seven years in Mercia. A great council of the English Church held in Northumbria excommunicated him in 702. He again appealed to Rome in person, and obtained another decision in his favour (703–704). He died at Oundle in Northamptonshire as he was going on a visit to Ceolred, king of Mercia (709). He was buried at Ripon.

Wilfrid's is a memorable name in English history, not only because of the large part he played in supplanting the Celtic discipline and in establishing a precedent of appeal to papal authority, but also by reason of his services to architecture and learning. At York he renewed Paulinus's old church, roofing it with lead and furnishing it with glass windows; at Ripon he built an entirely new basilica with columns and porches; at Hexham in honour of St. Andrew he reared a still nobler church, over which Eddius grows eloquent. In the early days of his bishopric he used to travel about his diocese attended by a little troop of skilled masons. He seems to have also reformed the method of conducting the divine services by the aid of his skilled chanters, Aedde and Aeona, and to have established or renewed the rule of St. Benedict in the monasteries. On each visit to Rome it was his delight to collect relics for his native land; and to his favourite basilica at Ripon he gave a bookcase wrought in gold and precious stones, besides a splendid copy of the Gospels.

Wilfrid's life was written shortly after his death by Eddius at the request of Acca, his successor at Hexham, and Tatbert, abbot of Ripon—both intimate friends of the great bishop. Other lives were written by Frithegode in the 10th, by Folcard in the 11th, and by Eadmer early in the 12th century. *See* also Bede's *Hist. Eccl.* v. 19, iii. 25, iv. 13, etc. All the lives are printed in J. Raine's *Historians of the Church of York,* vol. i, "Rolls" series.

WILHELMINA [WILHELMINA HELESA PAULINE MARIA OF ORANGE-NASSAU] (1880–), queen of the Netherlands, was born at The Hague on Aug. 31, 1880 Her father, William III (Willem Paul Alexander Frederik Lodewijk), had by his first wife, Sophia Frederika Mathilde of Württemberg, two sons, both of whom predeceased him. Having been left a widower on June 3, 1877, he married on Jan. 7, 1879, Adelheid Emma Wilhelmina Theresia (1858–1934), second daughter of Prince George Victor of Waldeck-Pyrmont, and Wilhelmina was the only issue of that union. She succeeded to the throne on her father's death, which took place on Nov. 23, 1890, but until her 18th year, when she was "inaugurated" at Amsterdam on Sept. 6, 1898, the business of the state was carried on under the regency of the queen mother. On Feb. 7, 1901, Queen Wilhelmina married Henry Wladimir Albert Ernst, duke of Mecklenburg-Schwerin (1876–1934). The queen's only child, Princess Juliana (b. April 30, 1909), was married on Jan. 7, 1937, to Prince Bernhard zu Lippe-Biesterfeld (1911–) and gave birth to the princess Beatrix (Jan. 31, 1938) and three other daughters. Wilhelmina abdicated Sept. 4, 1948, after a 50-year reign and was succeeded by Juliana.

WILHELMSEN, (MORTEN) WILHELM (1839–1910), the founder of a large Norwegian shipping company, was born in Tonsberg on Dec. 7. 1839. After serving in various shipping offices outside Norway he returned to Tonsberg in 1861 and joined the ship broking firm of I. W. Balchen as a partner, soon becoming the sole proprietor. He specialized in the Baltic timber trades and soon became a shareholder of various shipowning enterprises. In 1887 he gave up the ship broking business and went into partnership as a shipowner with his son Halfdan Wilhelmsen. Much of the credit for the size and prosperity of the Norwegian shipping industry must go to Wilhelmsen. who early realized the benefits of technical developments in ship propulsion. He died at Tonsberg on Nov. 16, 1910. (P. DF.)

WILHELMSHAVEN, a town in Lower Saxony and chief German naval station on the North sea; as such it played an important part in World War I, and in World War II it was very frequently and heavily bombed by British and United States planes. It is situated on the northwest shore of the Jade Busen. Pop. (1959 est.) 99,766. The ground where it stands (19 sq.mi.)

was purchased by Prussia from the grand-duke of Oldenburg in 1853, when the Prussian navy was being formed, but was returned to Oldenburg by Hitler after 1933.

The construction of the harbour and town began in 1855, and the former was opened in 1869. The harbour consists of three large basins and seven smaller ones as well as a basin for shipbuilding.

There are six dry docks. The harbour has three entries and locks are 260 metres long and 40 metres wide, with a depth of from $6\frac{1}{2}$ to 10 metres at the quays. The establishment is defended by strong fortifications. The commercial harbour lies at the east end of the Ems-Jade canal.

WILKES, CHARLES (1798–1877), American naval officer and explorer, born in New York city April 3, 1798. He entered the U.S. Navy as a midshipman in 1818 and became a lieutenant in 1826. In 1830 he was placed in charge of the division of instruments and charts, and in 1838 was appointed to command an exploring and surveying expedition to the South Seas, authorized as the first of its kind by Congress in 1836. The expedition, including naturalists, botanists, mineralogists, taxidermists, a philologist, etc., left Hampton Roads Aug. 1838, stopped at various ports in South America and visited the Paumotu group of the Low Archipelago, the Samoan islands, and New South Wales. From Sydney, Wilkes sailed into the Antarctic ocean and along the Antarctic barrier from 150° to 97° E., reporting land at a number of points in the region which has subsequently been known as Wilkes Land. He visited the Fiji group and the Hawaiian islands in 1840, and in 1841 explored the west coast of the United States. The findings were timely in view of the dispute with Great Britain over the Oregon territory. He visited San Francisco bay, and the Sacramento river, and crossing the Pacific he called at the Philippine islands, Sulu archipelago, Borneo, Singapore, Polynesia and the Cape of Good Hope, reaching New York in June 1842, having sailed around the world. He served on the Coast Survey 1842–43 and in the latter year was advanced to the rank of commander. In 1844–61 he was chiefly engaged in preparing the report of the expedition. Twenty-eight volumes were planned but only 19 were published. Of these Wilkes wrote the *Narrative* (6 vols., 1844); and the volumes *Hydrography* (1851) and *Meteorology* (1851). At the outbreak of the Civil War Wilkes was assigned to the command of the "San Jacinto" to search for the Confederate commerce destroyer "Sumter." On Nov. 8, 1861, he stopped the British mail packet "Trent," and took off the Confederate commissioners to Europe, James M. Mason and John Slidell. Though he was officially thanked by Congress, his action was later disavowed by President Lincolr. Wilkes was commissioned commodore in 1862, and placed in command of a squadron sent to the West Indies to protect the U.S. commerce in that region. On July 25, 1866, he was promoted to the rank of rear-admiral on the retired list. He died at Washington Feb. 8, 1877.

In addition to many shorter articles, reports, etc., he published *Western America, including California and Oregon* (1849); *Voyage Around the World* (1849); and *Theory of the Winds* (1856). "The Diary of Wilkes in the Northwest" (E. S. Meany, ed.) appeared in the *Washington Historical Quarterly,* vol. 16–17 (1925–26).

WILKES, JOHN (1727–1797), English agitator and reformer, was born in St. John's Square, Clerkenwell. His father, Israel Wilkes, a successful malt distiller, came from a yeoman family of Leighton Buzzard. John was the second son; his elder brother, Israel, emigrated to America and became the grandfather of (Admiral) Charles Wilkes (*q.v.*).

John Wilkes was schooled at Hertford and afterwards privately by the Rev. F. Leeson, a dissenting minister of Aylesbury, under whose charge he went to Leyden university in 1744. Here he learnt little—"Jack has great variety of talk, Jack is a scholar, Jack has the manners of a gentleman," said Dr. Johnson. He became close friends with Andrew Baxter and D' Holbach (*qq.v.*).

On his return to England, he married Miss Mary Mead, an Aylesbury heiress. "In my nonage," he says, "to please an indulgent father, I married a woman half as old again as myself; of a large fortune—my own being that of a gentleman. It was a sacrifice to Plutus, not to Venus. I stumbled at the threshold of the temple of Hymen:

"The god of love was not a bidden guest,
Nor present at his own mysterious feast."

Their marriage, uneventful for a time, and even successful while they lived at Aylesbury (they had one child, Mary), was broken up soon after Wilkes entered into politics, and they separated by mutual consent. Mrs. Wilkes had hardly any affection for either her husband or daughter, and she was scandalized by Wilkes' loose life and companions. He had been introduced by Thomas Potter, a finished profligate, to the society of Sir Francis Dashwood, chief of the "Medmenham Monks," of whom he became a member. This was a secret fraternity, which met occasionally in the summer in the ruins of St. Mary's abbey at Medmenham, for obscene orgies, in which it parodied Roman Catholic ritual. Dashwood, Lord Sandwich, Paul Whitehead, Potter, Wilkes and perhaps Charles Churchill the poet were among the ringleaders; the "order," whose reputation for indecency probably exceeded even the reality, was broken up by a practical joke of Wilkes', who unexpectedly released from a box a baboon disguised as a devil during a prayer addressed to Satan by Lord Orford, who nearly went out of his mind in the belief that his supplication was answered.

Partly under the encouragement of these friends, Wilkes had entered politics as a follower of Richard, Lord Temple (*q.v.*). He unsuccessfully fought Berwick in 1754, having bribed a captain to land a shipload of opposition voters from London in Norway instead of Berwick, but in 1757 by a complicated arrangement with Potter and Pitt, which was made to cost him the absurd sum of £7,000, he was elected M.P. for Aylesbury. In 1762, with the aid of Churchill and the countenance of Temple, he began to publish the *North Briton.* The wit and virulence of its attacks on Lord Bute, the Tory favourite of the King, silenced the *Auditor* and *Briton,* the ministerial papers, and were chiefly responsible for the wave of indignation which carried Bute from office on Mar. 8, 1763. Wilkes then held his hand, but when-Pitt and Temple read an advance copy of the King's speech sent to them by George Grenville, the new Premier, they decided that Grenville's ministry was no more than a camouflage of the same autocratic power, and encouraged Wilkes to publish (April 23) the famous "No. 45" of the *North Briton,* which was a devastating attack on the statements in the King's speech, which he described as false. Though he had carefully prefaced his attack by the remark "the King's speech has always been considered by the legislature and by the public at large as the speech of the Minister," George III. chose to consider Wilkes' article as a personal insult, and instigated immediate proceedings. A "general warrant" (one that did not name the persons to be arrested) was issued over the signatures of Lords Halifax and Egremont, secretaries of State, and 48 persons were seized by the authorities before Wilkes was arrested (April 30). He was thrown into the Tower and for a short while kept in the closest confinement. To the public delight, however, Lord Chief Justice Pratt on May 6 released Wilkes on the ground that his arrest was a breach of privilege. Actions against Under-Secretary Woods (who was fined £1,000), against Halifax (who by repeated evasions adjourned the case till 1769 when he was fined £4,000), and against minor agents, established the illegality of general warrants.

A second attack was now more carefully prepared by Wilkes' one-time friend Sandwich, now a member of the Government. By bribery and theft P. Carteret Webb, an under-secretary, secured from Wilkes' private press the proofsheets of an obscene parody written by himself and Potter years before on Pope's *Essay on Man,* called the *Essay on Woman.* Wilkes had commenced, but never completed printing twelve copies of this, probably for the Medmenham monks. This disgusting work, together with notes purporting to be by the Bishop of Gloucester, was read aloud with relish on Nov. 15 by Sandwich to the Lords, who voted it a libel and a breach of privilege. The Commons at the same time declared "No. 45" a seditious libel. To face the forthcoming trial before Lord Mansfield after these pronouncements would have been extremely hazardous. Wilkes, who had been gravely wounded in a duel with Samuel Martin, M.P., one of the vehicles of government bribery, withdrew to Paris, and sent to the Speaker (Jan. 11, 1764), when a motion for his expulsion was brought forward, a certificate of his ill-health. The Speaker declared that this certificate was not sufficiently authenticated, and though triple authentication was forthwith provided, Wilkes was expelled (Jan. 19). In these circumstances, Wilkes, who believed that life sentence would be pronounced against him, decided not to stand his trial and was consequently outlawed (Nov. 1). He spent the next four years on the Continent, chiefly in "amorous delights." The fall of Grenville in 1765 and the accession of the Whigs to power under Rockingham and then Grafton led him to believe that a pardon would be granted to him and his services rewarded by some honourable place. He only slowly realized that none of the Whigs were prepared to risk the King's displeasure for his sake and that the various offers privately made to him were only intended to keep him amused. When he discovered the truth he was extremely bitter against Chatham and Grafton, those chiefly responsible, and pilloried them in a Letter to the *Duke* of *Grafton,* one of his ablest performances.

In 1768 he decided to risk all by a bold stroke, crossed to London, and announced his candidature, first for London (where he was not elected) and then for Middlesex, where he was chosen M.P. by a heavy majority (Mar. 28). He then surrendered to his outlawry and was sentenced to the comparatively light penalty of £500 fine and a year's imprisonment, each, for the Essay *on* Woman and "No. 45." His popularity was immense, and crowds regularly assembled outside the prison gates (St. George's Fields). On May 10 a riotous crowd was dispersed with bloodshed and loss of life by Scottish soldiery, who were congratulated by the Government. Wilkes published the government instructions which had led to this, with some bitter comments, in the St. James' Chronicle; he also presented to the Commons a petition raising the whole question of the illegality of the proceedings against him. (Subsequent investigations show that in the case of the Essay these included actual forgery.) He had ignored private promises that he would be left undisturbed if he remained quiet; he reaped the reward of his temerity (Feb. 4, 1769) by being expelled again from the House of Commons, this time with hardly a shred of excuse. He now, by his resentment of a patronizing defence by George Grenville, lost his last wealthy patron (Temple) and was nearly £20,000 in debt. But the arbitrary proceedings of the ministry (instigated by the King) brought him power and, through the subscriptions of wealthy admirers to a "Society of the Supporters of the Bill of Rights," even solvency. He was immediately (Feb. 16) re-elected by the Middlesex electors and once more expelled. Again he was elected (Mar. 16) and again expelled. The Court then secured a bravo named Colonel H. L. Luttrell to stand against Wilkes at the next election (April 13); the figures were Wilkes 1,143, Luttrell 296; but the enraged Commons declared that Luttrell ought to have been elected and actually seated him for Middlesex.

These audacious proceedings had stirred up tremendous excitement in which for the first time for years the artisans and lower middle class felt acutely their disfranchisement. "One of your supporters has turned his coat," Wilkes was told. "Impossible, not one has a coat to turn," he answered. They avenged themselves by rioting and strikes, by scrawling "45" on every door and forcing the court followers to cheer for "Wilkes and Liberty." More effectively, Serjeant Glynn, his colleague for Middlesex, and after his release Wilkes himself, organized, by the medium of public meetings, support from the electors as far distant as Truro, for a "Wilkite" programme which till about 1780 was the standard of a political party. Its chief points were the radical reform of Parliament (to include enfranchisement of the "lower orders" and the suppression of rotten boroughs) and the protection of individual liberty against Ministerial or Parliamentary attack. Wilkes also entered into relations, not fully explored yet, with the American malcontents and seems to have acted as an inspirer of their subsequent action and as English representative of the Boston "Sons of Liberty." His greatest successes, however, were won in the City of London where he triumphantly fought his way through to the Lord Mayoralty in 1774. As Sheriff and Alderman he had welded the powerful City interests with a single block of opposition to the Court and Ministry, achieving his most remarkable victory in the Wheble case, when the City's judicial powers mere successfully used to prevent the arrest of printers who reported the House of Commons debates. After the election of 1774, when the Court no longer found it wise to prevent him taking his seat in Parliament, he had a "tail" of about a dozen M.P.'s. He presented (1776) a bill for the radical reform of Parliament. During the American Revolution Wilkes championed the colonial cause. He delivered, in the House of Commons, ten set speeches in which he advocated the immediate cessation of hostilities with America. Lord Shelburne, in concert with John Horne (see TOOKE, JOHN HORNE) was able to shake his influence for a short while in the City, but Wilkes more than recovered his position, and in 1779 he was elected Chamberlain of the City, a lucrative office which he filled with absolute scrupulousness till his death. But the violence of his popularity was necessarily waning when in 1780 the Gordon riots broke out (see GORDON, LORD GEORGE). Wilkes, despite his turbulence, had never encouraged mob violence, and religious persecution he had always fought. Though all the "lower orders" and even such old allies as Alderman Frederick Bull were deeply implicated in the burning and looting, Wilkes hesitated only a day or two before he practically took matters out of the hands of the complaisant city authorities, secured a draft of troops, and took a prominent part in crushing the disturbance. His own supporters he had to jail—in one case committing his printer Moore for an attack on the house of the judge, Mansfield, who had condemned him.

From this moment, honourable though his motives were, his political career was made impossible. He could no longer drive the rich London merchants and the lower orders in harness together. He had broken violently with the latter and with his own principles (for six years before he had replied to Horne, not necessarily insincerely, that he really believed the voice of the people, when he could ascertain it, to be "the voice of God") and the former had therefore less need for his services. Moreover, they and all well-to-do reformers were attracted by the more respectable reform movement started in the previous year by the Yorkshire M P.'s. This, based on Rockingham's "Oeconomical reform," substituted triennial for annual Parliaments and the addition of 100 M.P.'s to London and the counties for universal suffrage and redistribution of seats; it was rapidly adopted by a dozen or more counties at general meetings of electors.

Wilkes' energies declined as did his popularity. After he had secured (May 3, 1782) the expunging from the Commons of all record of his expulsions he took little part in politics. In 1790 he did not seek re-election, but retired into private life, dying in 1797. Characteristically enough, he was found to be insolvent, but quite unaware of the fact. An obelisk in Ludgate Circus commemorates him.

Wilkes was above the middle height, exceedingly ugly, with a startling squint that is given all its value in Hogarth's celebrated cartoon, but with a charm of manner and wit which few could resist. Some of his jests have passed into history—as for example his rejoinder to an elector who answered his canvass by saying he would sooner vote for the Devil than Wilkes: "And if your friend is not standing?" To an offer of snuff he answered, "No thank you, I have no small vices." To Sandwich, who told him he would either die on the gallows or of venereal disease, "That depends, my lord, on whether I embrace your principles or your mistress." His character, largely through his own fault, has been subject to exaggerated attacks which may be generally traced to Lord Brougham (see BROUGHAM AND VAUX, LORD) or to Horace Walpole, whom he was unwise enough to offend. His conversation was indecent, he was entirely incapable of continence in regard to women, though temperate in other ways, and like almost every other public man of his century, he was extravagant. His cynical tongue ruined his reputation with the Victorians: he never did a good thing without giving a bad reason. But dishonesty, cruelty, cowardice or hypocrisy were unknown to him; public money passed untouched through his hands when he was "in want of a guinea"; his political principles were honestly and to all appearances firmly held up till the deadlock of the Gordon riots, described above. He secured the great reforms of the abolition of general warrants, the freeing of the press and freedom of choice for the electors; his nonsuccess in securing parliamentary reform or justice for America can hardly be counted against him.

See H. Bleackley, *John Wilkes,* with bibliography (1917); R. W. Postgate, *That Devil Wilkes* (1929). (R. W. P.)

WILKES-BARRE, a city of northeastern Pennsylvania, U.S., and seat of Luzerne county, lies in the Wyoming valley on the north branch of the Susquehanna river, 94 mi. N.N.W. of Philadelphia and 111 mi. N.W. of New York city. On the western fringe of the Pocono mountains, Wilkes-Barre has been noted as a centre of the anthracite industry in the northern field.

Permanent settlement by colonists from Connecticut, under grants issued by the Susquehanna company, dates from 1769. Maj. John Durkee led the early group and named the town in honour of John Wilkes and Isaac Barré, defenders of the American colonies in the British parliament. The frontier community survived two major threats to its existence: (1) a series of wars (known as the Pennamite-Yankee wars) fought over conflicting land claims between Pennsylvania and Connecticut settlers from 1769 to 1784 *(see* WYOMING VALLEY); and (2) during the American Revolution, Tory and Iroquois Indian attacks which culminated in the battle and massacre of Wyoming, July 3, 1778. The subsequent expedition of 1779, led by Gen. John Sullivan (*q.v.*) against the Iroquois, was formed at Wilkes-Barre.

The major force in the history of Wilkes-Barre was the development of the coal industry. It brought adequate transportation; it created the need for auxiliary and complementary industries; and it attracted workers from England, Wales, Ireland, Russia, Poland, Lithuania, Italy and other European countries. Upon the decline in the use of anthracite as a domestic fuel, the city faced unemployment problems; greater diversification of industry was achieved, however, with the development of garment, shoe, textile, tobacco, pencil, wire-goods, electronic and power-equipment manufacturing.

Wilkes-Barre is the trade, transportation and financial centre of the Wyoming valley and the central city of the standard metropolitan statistical area of Luzerne county (pop. 1960, 346,972), which includes Hazleton (*q.v.*). In the decade 1940–50, the population of Wilkes-Barre decreased almost 10,000—from 86,236 to 76,826—and over 13,000 or 17.3% in the following ten years (pop., 1960, 63,551). (For comparative population figures, *see* table in PENNSYLVANIA: Population.)

A symphony orchestra, art and historical societies, ballet guild and numerous choral groups provide cultural resources. King's college (Roman Catholic), a liberal arts school enrolling over 1,000 men in the 1960s, was chartered in 1946. Wilkes college (private control) was chartered as a four-year coeducational school in 1947; it also enrolled over 1,000 students. Recreational facilities near the city include several state parks, Harvey's lake and resorts in the Pocono mountains.

See O. J. Harvey, *A History of Wilkes-Barre and Wyoming Valley* (1909). (R. D. WI.)

WILKIE, SIR DAVID (1785–1841), Scottish genre and portrait painter, was born in Cults, Fife, on Nov. 18, 1785. In 1805 he entered the Royal Academy schools, exhibiting at the Royal Academy from 1806. His first exhibit was "Village Politicians," a genre picture in the Dutch manner, recalling Adriaen van Ostade and David Teniers, a style which he practised with great success for about 20 years. Wilkie was elected associate of the Royal Academy in 1809 and royal academician in 1811; he succeeded Sir Thomas Lawrence as painter to the king in 1830 and was knighted in 1836. In 1814 he visited Paris with his friend B. R. Haydon (*q.v.*), and in 1816 he went to the Netherlands. For reasons of health he spent the years 1825–28 in Italy, Germany, Switzerland and Spain, and his experience of Italian and Spanish art caused him to adopt a broader and richer style. He also painted Spanish subjects and some portraits. Returning from a journey to the near east, he died at sea, off Gibraltar, on June 1, 1841.

Examples of his earlier and later styles include "The Blind Fiddler" (1806), "Village Festival" (1811), "The Parish Beadle" (1823), "John Knox Preaching" (1832), "The First Earring" (1835) and "Peep-0'-Day Boy's Cabin" (1836); "Pitlessie Fair" (his first important picture, 1804), "The Bride's Toilet" (1838) and "The Irish Whiskey-still" (1840), are all in the National Gallery of Scotland, Edinburgh. The royal collection includes "Blind Man's Buff" (1812), "The Penny Wedding" (1818) and several portraits. The Wellington museum, London, has "Chelsea Pensioners Reading the Waterloo Gazette" (1822), and other pictures are in the Wallace collection, London, and in New York (Metropolitan Museum of Art), Munich and at the town hall, Cupar, Fife. *See* A. Cunningham's *Life* (1843). (P. J. MY.)

WILKINS, SIR GEORGE HUBERT (1888–1958), British explorer who greatly increased the use of the airplane in polar research, was born at Mount Bryan East, South Australia, on Oct. 31, 1888. Having studied at the Adelaide School of Mines, he learned flying in 1910–12 and was official photographer to the Turkish army during the Balkan War of 1912. From 1913 to 1916 he was photographer with the Canadian arctic expedition of Vilhjalmur Stefansson. Wilkins joined the Australian flying corps in 1917 and was seconded to the military history department in France as official photographer, winning the military cross and bar. From 1920 to 1921 he was second in command of a British expedition to Graham Land (Palmer peninsula) in the antarctic, and from 1921 to 1922 was naturalist on the last antarctic expedition of Sir Ernest Shackleton. He led a British museum biological expedition to tropical Australia in 1923–25.

In 1926 he began a series of trial flights to explore by air the unknown area of the arctic north of Point Barrow, Alaska, with C. B. Eielson as copilot. On April 16, 1928, Wilkins and Eielson flew from Point Barrow to Spitsbergen in 20½ hours, a distance of 2,100 mi. over unknown seas. For this feat Wilkins was knighted. In Dec. 1928 he and Eielson flew from Deception island, 600 mi. south across Graham Land, discovering several new islands. In 1931 Wilkins captained the "Nautilus" submarine and navigated it under the Arctic ocean to latitude 82°, 15′ N. From 1933 to 1939 he was manager of the Ellsworth antarctic expeditions and from 1942 to 1952 was consultant to the U.S. army military planning division. He was geographer to the research and development command of the department of defense from 1953. Wilkins died at Framingham, Mass., on Dec. 1, 1958. (H. G. KG.)

WILKINS, MARY ELEANOR: *see* FREEMAN, MARY ELEANOR WILKINS.

WILKINSBURG, a borough of Allegheny county in southwestern Pennsylvania, U.S., is contiguous to Pittsburgh (*q.v.*) to the east and is a part of that standard metropolitan statistical area. Settled about 1798 and early known as McNairsville (after its founder, Col. Dunning McNair) and then as Rippeyville, Wilkinsburg was renamed in 1840 in honour of William Wilkins, a prominent Pennsylvania politician of the time. It was incorporated as a borough in 1887. It is primarily residential; its employment has been basically in the services, although some small manufacturing businesses have been established there. For comparative population figures *see* table in PENNSYLVANIA: Population. (P. R. J.)

WILKINSON, JAMES (1757–1825), U.S. soldier and adventurer, was born in Calvert county, Md., in 1757. He served in the American Revolution and, in 1784, settled near Louisville, Ky.. where he became a merchant, farmer and man of influence. He took an active part in the movement for separate statehood for Kentucky, and in 1787 took an oath of allegiance to Spain and began to intrigue with his fellow Kentuckians to detach the western settlements from the union and bring them under the influence of the Louisiana authorities. For services he received until 1800 a substantial pension from the Spanish authorities, being officially known as "Number Thirteen." At the same time he worked actively against the Spanish authorities, especially through Philip Nolan. Wilkinson's ventures were not so lucrative as he hoped for, and in Oct. 1791 he was given a lieutenant colonel's commission in the regular army, possibly to keep him out of mischief. In 1803 Wilkinson was one of the commissioners to receive Louisiana from France, and in 1805 became governor of that portion of the purchase above the 33rd parallel, with headquarters at St. Louis. In his double capacity as governor of the territory and commanding officer of the army, he attempted to conquer the Mexican provinces of Spain. For this purpose in 1805 he entered into an agreement with Aaron Burr, and in 1806 sent Z. M. Pike to explore the most favourable route for the conquest of the southwest. Before his agent returned, however, he had betrayed his colleague's plans to Jefferson, formed the Neutral Ground agreement with the Spanish commander of the Texas frontier, placed New Orleans under martial law and apprehended Burr and some of his alleged accomplices. In the ensuing trial the prisoners were released for lack of evidence and Wilkinson emerged with a damaged reputation. He was then subjected to courts-martial and congressional investigations, but succeeded in hiding his duplicity. In 1812 he resumed his command at New Orleans and in 1813 was promoted to major general and took possession of Mobile. Later in that year, by making a miserable fiasco of the campaign against Montreal, he finally brought his military career to a dishonourable end. He died at Mexico City on Dec. 28, 1825. (I. J. C.; X.)

WILKINSON, JOHN (1728–1808), "the great Staffordshire ironmaster," was born at Clifton, Cumberland, where his father was overlooker in an iron furnace. A box iron, patented by his father but said to have been invented by the son, which helped laundresses to gratify the frilled taste of the dandies of the day, was the beginning of their fortunes. This they made at Blackbarrow, near Furness. When he was about 20, John moved to Stafiordshire and built, at Bilston, the first iurnace there. After many experiments he succeeded in utilizing coal instead of wood charcoal in the puddling and smelting of iron. The father, who then had works at Bersham, near Chester, was again joined by his son, who constructed a new boring machine, of an accuracy theretofore unequaled. James Watt found that the work of this machine exactly filled his requirements ior his "fire engine" for cylinders bored with greater precision. Wilkinson then started the manufacture of wrought iron on a large scale at Broseley and used the first steam engine made by Boulton and Watt to blow the bellows there. Great care was taken in its manufacture, and Watt himself set it up early in 1776. In 1786 he was making 32-pounders, howitzers, swivels, mortars and shells for the government. The difficulty of getting barges to carry his war material down the Severn led him, in 1787. to construct the first iron barge. Wilkinson taught the French the art of boring cannon from the solid and cast all the tubes, cylinders and ironwork required for the Paris waterworks. He also erected the first steam engine in France. Wilkinson also designed and cast the first iron bridge, which connected Broseley and Madeley, across the Severn. He died on July 14, 1808.

WILL or TESTAMENT is the legal transaction by which an owner of property disposes of his assets in the event of his death. The terms are also applied to the instrument in writing in which the testator's dispositions are expressed. While in modern usage the two terms "will" and "testament!' are interchangeable, down to the 19th century in Anglo-American lam will referred to the disposition of real. and testament to that of personal property.

In the strict terminology of the older Anglo-American law. a disposition of real property is called devise and its beneficiary devisee. By a bequest or legacy, on the other hand, a disposition of personal property is made in favour of a legatee.

In modern society, the freedom to dispose of property by will is regarded as an essential element of individual freedom in general. The power of an owner of property by his own free will to determine who is to have it upon his death is thought to stimulate economic activity; it is also regarded as important that a property owner can modify the rigid rules of descent and distribution of the intestacy laws so as to adapt them to the particular situation of his family by preferring, for instance, a crippled child over one of proven capacity to take care of himself; the freedom to disinherit a child may be used to induce filial obedience, but freedom of testation also implies the freedom of making provision for charity. The possibility of abuse for ends of spite, arbitrariness or whimsy is the price society has to pay for such power.

History.––In a primitive or archaic society in which property is owned by the kinship or neighbourhood group rather than by individuals, freedom of testation cannot, of course, exist. Transition from group to individual ownership has rarely if ever occurred in one single step. In many primitive societies, utensils of individual use (*e.g.,* weapons, pieces of adornment, horses or even slaves) were destroyed upon the death of the owner or buried with him. As to land. even when its use was regarded as rightfully belonging to an individual, free alienation by sale or gift, and even more so by will, would for long periods be hedged in by superior rights of the kinship group, the village or the feudal lord. Transition to free alienation has been frequently achieved by means of subterfuge, such as the adoption of the "purchaser" or "devisee" as a son; or, once free alienation had become possible inter *vivos* (between living persons) but not yet upon death. by fictitious sale or gift to a middleman who would promise to let the grantor keep the property as long as he should live and upon his death to deal with it as directed by the grantor. Such use of adoption occurred in ancient Babylonia. China, Japan, India and other societies of an archaic-patriarchalic order. In ancient Greece, effects similar to those of a will would be achieved by gift to take effect upon the death of the donor or, where the only child of the family was a daughter, by giving her in marriage together with the estate. Transfer by use of a middleman became possible among the Germanic peoples who succeeded the Roman empire both on the European continent and in England.

In ancient Rome the institution of the will appeared at an early stage of cultural development, but there, too, it seems to have been preceded by a stage in which its effects could be achieved only by indirection. The so-called will made in assembly (*testamentum comitiis* calatis) seems in truth to have been the approval by the assembly of the adoption of a son by the childless chief of an aristocratic house so that the house and the worship of its gods would be perpetuated.

By the 5th century B.C., it seems to have become possible for the head of a Roman family during his lifetime to achieve the purposes of a testamentary transaction by fictitious sale to a middleman, *familiae emptor* ("buyer of the family property"). In the period of the early principate (1st century A.D.), the testament was fully recognized in its proper sense. In the mature form in which it is dealt with in the Corpus *Juris* (6th century A.D.), it became in the late Middle Ages the model for continental Europe.

Among the Germanic peoples by whom the Roman empire had been overrun, *e.g.* the Anglo-Saxons, land was subject to ties of the kinship group and, later, of feudalism. so that there was no place for disposition by will. Chattels were more freely alienable, however. In establishing freedom of testation, a prominent role was played by the Church. which desired thereby to obtain funds for its activities. which extended far beyond those directly concerned with divine worship and included the bulk of medieval education. charity and cultivation of the arts.

In England. the Church succeeded shortly after the Norman Conquest in establishing the jurisdiction of its courts for matters concerning succession upon death to personal property. Through the Church. the will of the Roman pattern became firmly institutionalized. but a testator still had to leave a "reasonable part of the estate" (ordinarily at least one-third), to his wife and children.

Once the alienation of real property again had become possible by gift or sale. there grew up all over Europe that same practice of indirectly achieving the effects of a will by fictitious sale to a middleman (German: *Salman,* "sale man"; English: feoffee to uses) which in analogous circumstances had grown up at other times and places. On the continent. the will as such became again available when Roman law was rediscovered and "received." which occurred from the 12th century first in Italy and then north of the Alps. In France and Germany, the will of the Roman pattern was fully recognized in the late 1jth century. Just about that time, however, the enfeoffment to uses, which had been popular in England, was abolished there by Henry VIII's Statute of Uses in 1535. The king wished to restore to the crown its prospects of escheat (*q.v.*) and of certain feudal duties which could be evaded by the alienation to uses. Public indignation was so strong, however, that five years later the king found it advisable, by the enactment of the Statute of Wills, to open the way for true testamentary disposition of land. Restrictions limiting devises of those lands of which ownership was connected with the duty of rendering military service were abolished shortly after the Restoration by the Military Tenures act. 1662. In Scotland, testamentary disposition of land remained precarious until the enactment of the Land Titles Consolidation act, 1868. and its amendment in 1871.

Limits of Freedom of Testation.— Freedom of testation never has been absolutely unlimited. Nowhere is a testamentary provision valid where its enforcement would be shocking to public morals. Where a testamentary gift is conditioned upon an act of the beneficiary ahich in good morals should not be so conditioned, the gift is either invalid or valid unconditionally as. for instance, a gift conditioned upon the beneficiary's changing his religion. Generally, property given by testament cannot be tied up by the testator for an indefinite future. While a testator may leave property to a person for life and upon the first taker's death to some other person, under the rule against perpetuities as developed in England and commonly applied in the United States, the last "remainder" must "vest" not later than, roughly speaking, one generation after the testator's death. In the civil law countries of the German system, the freedom to provide for substitutions is limited in a similar way, and in those of the French system even more strictly.

Provisions Against *Disinheritance.*—A testator's freedom to disinherit his surviving spouse. children or other heirs has been more extensive in ancient Roman and modern Anglo-American law than in the modern civil law countries, but it never has been without any limits at all. In republican Rome a testator had the power to disinherit his wife and'children, but if he wished to do this, he had to say so expressly in the will. In the period of the principate (27 B.C.–A.D. 284), it became particularly necessary to state the reasons, because a will disinheriting a close member of the family without reasonable and honest cause mas in danger of being declared invalid. In the late Roman empire the descendants and later on, the parents, too, were given the right to a compulsory share in the estate (pars legitima, legitim), of which none of them could be deprived except upon serious cause stated in the will. When after the fall of the Roman empire testamentary disposition came to be recognized again in the later Middle Ages, custom generally required that some minimum share, frequently one-third, be left to the surviving spouse or the descendants or both. Upon the revival of Roman law on the European continent and in Scotland, these customs were in various ways combined with the rules of the Corpus *Juris*.

In the modern civil law, two systems are used to provide protection against disinheritance. (1) Under the French system, a testator who is survived by descendants, parents or (in some countries) brothers. sisters or even other close relatives cannot dispose at all of the "reserved portion" of his estate, the size of which depends upon the number and degree of nearness of relationship .of the surviving "forced heirs." Under the civil code of Louisiana, for instance. donations inter vivos or ntortis causa ("by cause of death") cannot exceed two-thirds of the property of the disposer, if he leaves at his decease a legitimate child; one-half: if he leaves two children; and one-third, if he leaves three or a greater number. The indisposable share is two-thirds of the property, if the disposer, having no children, leave a father, mother or both. (2) Under the system of the German civil code, the surviving spouse, a descendant or, if there are no descendants, a parent can claim to be paid in money one-half the value of the share which would have been his in the case of intestate succession.

In England, those customs which required a minimum share in the personal property to be left to the surviving spouse and descendants disappeared in the 17th and 18th centuries. The interests of dower and curtesy which guaranteed life estates to the surviving spouse in the real estate of the predeceasing, were abolished by the Dower act, 1834. At the turn of the 20th century, freedom of testation was complete in England as well as in the dominions and colonies, but not in Scotland, where the legitim (children's share) can still be claimed by the children, and the terce (widow's share) and the *jus relictae* or *relicti* (*q.v.; i.e.* right of the relict) by the surviving spouse. In 19th-century England itself, freedom of testation, while unlimited by law, was kept within narrow limits, however, by the custom prevailing among the families of wealth, to prevent the splitting up or alienation of the family wealth by means of a so-called strict settlement. In each generation, the head of the family would so settle the estate upon his eldest son that it would descend to him undivided, but subject to a generous life estate for the widow and provisions for the daughters, younger sons and other needy relatives. In the different social climate of New Zealand, a new device for protecting needy family members against disinheritance was invented with the enactment in 1900 of a statute which empowers the court to order adequate provision for the maintenance out of the estate of any testator who had not made such provisions for his or her spouse or a needy child. Family provision acts nf this kind have since been enacted in Australia, Canada and even in England itself.

Under the English act, 1938, as amended by the Intestates' Estates act. 1952, the court may, contrary not only to the testator's will but also to the general rules of intestacy, order that in case of need. provision be made out of the income and under certain circumstances even out of the capital, for the benefit of the surviving spouse, an unmarried daughter. a minor son or any child, male or female, who is incapable of maintaining himself or herself because of physical or mental inability.

In the United States: the surviving spouse is protected against complete disinheritance in every state. As to lands, dower (which no longer exists in England) has in one form or another been preserved in the majority of the states. Under this system, each spouse has an "estate" in the lands of the other, which. as to a portion thereof, continues beyond the death of the predeceasing spouse until the death of the surviving spouse. and of which he cannot be deprived without his consent by will or by sale, gift, mortgage or any other kind of transaction. Under the system of the indefeasible share, the surviving spouse cannot be completely disinherited, but he is not protected against the other spouse's giving away or using up his property before he dies. In most states the two systems are combined, but New York and other states in the eastern part of the country as well as a few others, followed the example of England and abolished dower and curtesy, because their existence in a state renders it necessary in every case of intended purchase of land to investigate whether the title might not be encumbered with dower and curtesy rights which are not readily discoverable from the abstract or the title deeds.

In those jurisdictions which adopted the so-called community property system (Louisiana, Texas, New Mexico! Arizona. California, Washington, Idaho, Nevada and Puerto Rico) an indefeasible share in the family wealth is secured to the surviving spouse by his or her being entitled to one-half of the community property, which generally consists of the property which was acquired during the marriage by the gainful activities of either spouse. Varying systems of community property also exist in numerous European and Latin-American countries. In the countries of the French system, community property law applies unless it has been expressly contracted out by the parties to the marriage. Under the German system, the assets of husband and wife remain separate, but upon the termination of the marriage the acquests are distributed among them. Protection of the surviving spouse can, furthermore, be achieved through homestead laws and those laws which guarantee to the widow or, frequently now, to the surviving spouse, an award of income payable out of the estate for a few months immediately following the death of the other spouse. Both types of laws are common in the United States.

The only jurisdictions in the United States which protect descendants against disinheritance by giving them indefeasible shares are Louisiana and Puerto Rico, whose legal systems are not derived from the common law. In the other states, the descendants are protected either not at all or only indirectly and incompletely by (1) so-called pretermitted heir statutes which! like early Roman law, require the testator to state the disinheritance of a descendant expressly in the will; (2) after-born heir statutes, under which a child born after the making of the will is to receive his intestate share unless a contrary provision is stated in the will; (3) "charity begins at home" statutes, under which no more than a certain fraction (*e.g.*, one-half) of the estate may be given to charity by a testator who is survived by certain close relatives; (4) "hell fire" statutes, which declare ineffective a testamentary provision for charitable purposes made by the testator upon his deathbed, in his last illness or within a certain fixed period immediately preceding his death.

In the U.S.S.R., the family is protected by the limited scope to which freedom of testation exists. With the exception of savings accounts, which may be disposed of freely, testamentary power is limited to modifying the shares to which family members are entitled under the rules of intestacy.

Formalities **of** Wills.—In order to secure proof, impress the testator with the importance of the transaction and to prevent fraud and forgery, a will must regularly be declared in an instrument in writing. However, a nuncupative (orally declared will) is exceptionally admitted in some countries in such emergency situations as those of the soldier on active war duty. the sailor on board ship. or a person finding himself in immediate danger of death.

In their rules establishing the requirements of the execution of a regular testamentary instrument, the legal systems of the modern world usually follow one or more of three forms: (1) the witnessed will as developed in England, especially through the Statute of Frauds, 1677; (2) the unwitnessed holographic will as developed in French customary law; (3) the notarial will as developed in the late Roman empire. Under the system of the witnessed will, which prevails throughout the United States, and in all common law parts of the British Commonwealth. the instrument, which may be typed or written by anyone, must be subscribed by the testator and his signature must be attested to by two or, especially in the New England states, three witnesses, who must also sign their names to the instrument. Under the system of the holographic will, which is available not only in most civil law countries but also in numerous states of the south and the west in the United States, the entire instrument must be exclusively in the testator's own handwriting and must also be signed by him; witnesses are not required. The notarial will. which is available in most civil law countries, is executed so that the testator either dictates his provisions to the notary or hands him an instrument declaring that it contains his mill. The entire transaction is recorded by the notary in a public instrument so that its proof upon the testator's death is greatly facilitated. In civil law countries, a notary is, of course, not a layman but a highly respected member of the legal profession who is experienced in matters of drafting wills, estate planning the conveyancing.

Drafting. — The proper drafting of a will can be difficult. In the United States the law is complicated not only by its diversity from state to state but also by the fact that (unless different provisions have been stated in the will expressly) rules. which are in many respects obsolete, apply to such questions as: (1) how to apportion the burden of death taxes among the beneficiaries; (2) in which order creditors ought to be paid; (3) assets to be used for the payment of debts; (4) legacies to be abated in the case of insufficiency of the estate to pay them all in full; and (j) what to do when a beneficiary has predeceased the testator. Unless the testator has given special powers to his executor, it will be necessary for the latter in his administration to observe cumbersome and expensive formalities. In the United States a will thus tends to be lengthy and complicated, and it appears unwise ever to draft one without expert legal advice. Also, in order to keep up not only with the changing circumstances of the testator's family circle and of his property but also to keep abreast of the frequent changes in the tax laws and thus to avoid unnecessary taxes, it is advisable ior a testator to have his will regularly checked by a lawyer.

Invalidity. — A testamentary disposition is not valid if at the time of its execution the testator was mentally incompetent or if he acted under "undue influence"; *i.e.,* coercion, or under fraud. It is difficult, however, to break a will upon any such ground. In the case of an attack upon the ground of incompetency, the courts, especially those of the Anglo-American system, demand strict proof that the testator, when he made the provision, was mentally unable to know what he owned or who were his relatives, and that he was also unable to form a reasonable plan for the disposition of his property. The mere fact that the testator laboured under some insane delusion will not affect the validity of his will unless it is proved that it actually constituted the motive for the disposition made by him. Coaxing and persuasion are generally not held to constitute undue influence unless there were actual threats. A testator may be led. but he may not be pushed. Undue influence may be held to exist, however, where a testamentary disposition was brought about by a person upon whom the testator was dependent or whom he was likely to obey blindly.

The statutory formalities prescribed for the execution of a will must be observed meticulously. An unwitnessed holographic will may fail because the instrument contained a printed letterhead or some other words, figures or signs in print, rubber stamp or another person's handwriting. A witnessed will may fail because a witness signed outside of the testator's line of sight, or because the witnesses were not told that the instrument was the testator's will or because a blank space was left between the end of the text and the signature of the testator. The witnesses must be absolutely disinterested; *i.e.,* persons who derive no direct or indirect benefit from any of the provisions of the instrument. A witness may be held to be benefited indirectly if her husband is appointed in the will as executor and thus given the opportunity to earn the fees of that office. Ordinarily, attestation of a will by such a disqualified witness will not result. however, in the invalidity of the entire instrument, but only of the provision from which the witness would have benefited.

Revocation. — Since a will is ambulatory (of no effect until the testator's death), it can be revoked or changed by him at any time. Revocation is effected either by the testator's physically destroying the instrument. or by executing a new testamentary instrument the provisions of which are incompatible with those of the earlier one, or in which it is simply declared that the will is revoked. In many states of the United States a will is also revoked automatically if the testator marries after its execution. Attempts by contractual promise to limit one's freedom of changing or revoking his will are without any effect in those legal systems which follow the pattern of the French civil code. But under the system of the German civil code, a disposition *causa mortis* is irrevocable if it is expressed in an hereditary pact (Erbvertrag) made with a beneficiary or even a third person. In Anglo-American law the will remains revocable even if the testator has promised that he will not revoke it; but if he does, his estate will be treated as if the testator had lived up to his promise. In practical effect, a testator may thus bind himself not to revoke the will by which he has made a disposition in favour of the person who has promised to take care of him in old age, or in which a husband and his wife have mutually promised each other that upon the death of the one dying first. his property is to be enjoyed by the survivor, and upon the latter's death is to belong to the children, or certain relatives or charities.

Probate and Administration. — In common law countries, it is usual for the testator in his will not only to direct who is to have his property and under what terms. but also to appoint an executor by whom the estate is to be settled. If no executor has been appointed in the will, or if the person so appointed does not qualify or is unwilling to act, an administrator with the will annexed (administrator cum *testamento* annexo or administrator *c.t.a.*) will be appointed by the court. If the executor cannot complete the administration, the court will appoint another (administrator de bonis *non* or *administrator d.b.n.*), as his successor.

In the countries of Anglo-American law, a will cannot be used for any legal purpose until it has been admitted to probate by the proper court, which means that its genuineness and validity has been judicially ascertained. In numerous states in the United States, a will contest may be raised within a certain period even after the instrument has been admitted to probate. If the testator has failed to express himself with full clarity, it may become necessary to have the will "construed" judicially.

In most civil law countries. a mill is effective upon the testator's death without formal admission to probate. The heir or executor is rarely able, however, to collect the testator's bank account. sell his land or in other nays make practical use of his rights until he can identify himself as heir or executor by a certificate of heirship or some similar paper issued to him by a court, notary or other public agency.

Will Substitutes. — In order to avoid costs and pitfalls really or supposedly connected with will making, there have evolved several kinds of transactions which are meant, in a less expensive and less awesome may, to take care of the transfer of property from one generation to the next. Among these will substitutes, life insurance plays the most important role. Also of considerable significance are: (1) the revocable inter *vivos* trust; (2) the nomination of a third party beneficiary in a government savings bond; (3) the creation of a joint tenancy with the incident of survivorship in a piece of land, a bank account or some other asset; and (4) the so-called tentative or Totten trust, which is the designation by the depositor in a bank of a person who is to be entitled to withdraw whatever may be left in the account at the time of the depositor's death. This "poor man's will" is popular in the state of New York, but its legal effectiveness has not been firmly determined in all other states. The frequent resort in the United States to such will substitutes perhaps indicates the desirability of a thorough-going revision of the overcomplicated U.S. law of wills. Reliable statistics as to the proportion of property owners dying testate and intestate respectively, would be desirable, but these were almost completely lacking in the 1950s. While the majority of adult persons seemed to die intestate, it was also probable that of the considerably smaller group of those leaving net estates of some size. nills were made by a majority, which nas greater in the United States than in other countries in which the intestacy laws were more in accord with the intentions of the average citizen.

See also INHERITANCE.

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WILLARD, EMMA (HART) (1787–1870), U.S. educator whose efforts in behalf of women's education had great influence, was born at Berlin, Conn., Feb. 23. 1787. and began teaching at age 16. In 1807 she became principal of a girls' academy at Middlebury, Vt., and there, in 1809, she married John Willard. Her son. John Hart Willard, was born in 1810. In 1814 Mrs. Willard opened a boarding school of her own. Her *Plan for Improving Female Education* (1819), first addressed to the New York state legislature, was an appeal for state aid in founding schools for girls and for educational advantages for women equal to those for men. It was rejected by the legislature but found favour with Gov. DeWitt Clinton, who invited her to move her school to Waterford, N.Y. Two years later (1821) it was moved to Troy as the Troy Female seminary. In 1845–47 Mrs. Willard traveled 8,000 mi. throughout the south and west, counseling in educational matters. In 1854, with Henry Barnard, she represented the United States at the World's Educational convention in London. She wrote several textbooks, which passed through many editions and were widely used, and also a volume of poems. of which the best known is "Rocked in the Cradle of the Deep." Her second marriage, to Christopher Yates, which took place in 1838 after the death of her first husband in 1825, ended in divorce. Her death occurred at Troy. N.Y., on April 15, 1870.

See A. Lutz, *Emma Willard: Daughter of Democracy* (Boston, 1929).

WILLARD, FRANCES ELIZABETH CAROLINE (1839–1898), U.S. educator, reformer and temperance advocate, was born at Churchville, Monroe county, N.Y., Sept. 28, 1839. She became a teacher upon graduation from the North-Western Female college at Evanston, Ill., in 1859. In 1871 she accepted the presidency of the newly organized Evanston College for Ladies. When it merged with Northwestern university in 1873, she was appointed dean of women. She resigned this post in 1874 to become corresponding secretary of the National Woman's Christian Temperance union. In 1879 she was elected president and held that office until her death. In 1883 she organized the World's Woman's Christian Temperance union and was its first president. The organizations in which she was active were committed to temperance reform, woman suffrage and improved industrial codes for women. In recognition of her work, she was chosen president of the National Council of Women in 1888.

Her work ior reform led her into politics. She joined the national Prohibition party and in the 1880s exerted influence in its executive council. She was an excellent speaker, a successful lobbyist and an expert in public opinion and pressure politics. She participated in the Industrial conference, forerunner of the Populist party, held in St. Louis, Mo., in Feb. 1892. She died in New York city on Feb. 1S, 1898. (M. E. DN.; X.)

With Mary A. Livermore she edited *A Woman of the Century* (Buffalo. 1893), which includes a sketch of her life; and she published *Nineteen Beautiful Years* (1864), a life of her sister; *How to Win: a Book for Girls* (1886); *Glimpses of Fifty Years* (1889); and, in collaboration with others, *Occupations for Women* (1897).

See A. A. Gordon, *Thr Beautiful Life of Frances E. Wzllard* (Chicago, 1898), with an introduction by Lady Henry Somerset; W. M. Thayer, *Women Who Win* (1896).

WILLCOCKS, SIR WILLIAM (1852–1932), British engineer. was born in India and educated at Roorkee college. India. From 1872 to 1897 he was engaged successively in the Indian and Egyptian public works departments. He designed and carried through the Aswan dam in 1898. His most important undertaking, however. was the irrigation of 3,500,000 ac. in Mesopotamia, begun in 1911.

His works include: *Egyptian Irrigation* (1889); *The Irrigation of Mesopotamia* (1905); *From the Garden of Eden to the Crossing of Jordan* (1918).

WILLEMITE, a mineral consisting of zinc orthosilicate. Found near Liège, it was named after William I of the Netherlands. It occurs at Sterling Hill and Franklin in New Jersey, where it is associated with other zinc ores (franklinite and zincite) in crystalline limestone. and at a few other places. After more than 100 years of production the Franklin mine was closed in 1954 because of exhaustion of ore reserves. A variety of willemite containing much manganese replacing zinc is called troostite. Under ultraviolet radiation willemite fluoresces with a brilliant green colour, a characteristic used in separating it from other minerals and that led to its use in the manufacture of early television tubes. Its formula is Zn_2SiO_4. It crystallizes in the rhombohedra1 system. Crystals have the form of hexagonal prisms terminated by rhombohedral planes; there are distinct cleavages parallel to the prism faces and to the base. Granular and cleavage masses are of commoner occurrence. It varies considerably in colour, being colourless. white, greenish-yellow, apple-green, flesh-red. etc. The hardness is $5\frac{1}{2}$ and the specific gravity ranges from 3.9 to 4.2. (CL. F.)

WILLESDEN, a municipal (1933) and parliamentary borough (returning two members) of Middlesex, Eng.. 6 mi. N.W. of Charing Cross, London. Pop. (1961) 170,835. Area 7.2 sq.mi. It extends southwestward from Watling street (Edgware road) to Acton, and northwestward from Hammersmith and Paddington to Wembley and Edgware. Although ten manors in Neasden-cum-Willesden were granted to the canons of St. Paul's in 940 and St. Mary's parish church has Norman features, the town is almost entirely of modern growth. In the 15th century the church was a place of pilgrimage for people seeking cures at the shrine of Our Lady of Willesden, but by the middle of the following century the shrine had been suppressed. In 1835–39 the Brent reservoir (known as the Welsh Harp) was built, on the northern boundary. to feed the Grand Junction canal; there is an annual regatta held on it. The population of A'illesden in 1875 was only 15,500; by 1895 it had become a residential suburb with a population of 58,000; World War I brought munitions factories; and the opening of the North Circular road in 1924 increased the industries, especially on the trading estates of Park Royal and North Cricklewood, and at Kilburn and Church End. Motor accessories, water heaters, paper and shoe cream are made; food and beverages are processed.

WILLET, a conspicuous North American wading bird (*Catoptrophorus semipalmatus*), about 15 in. long, and to be recognized by its black primaries with a broad white band and white upper tail coverts. The willet breeds as far north as New Jersey and Manitoba, wintering from southern United States south. The western willet (*C. s. inornatus*) is paler and slightly larger.

WILLETTE, ADOLPHE LÉON (1857–1926), French caricaturist and illustrator, was an effective moral and political satirist. He was born at Châlons-sur-Marne, April 30, 1857. He contributed freely to *Le Courrier français* and *Le Chat noir*. His drawings were often *risqué* and sometimes horrific. He exploited the cardinal sins and the struggle between virtue and vice; his frail but lovable character "Mimi Pinson" became immensely popular. In *Pauvre Pierrot* and other similar publications he made use of the pathetic and ironical element of the *comédie italienne* with the figure of Death in the background. In this method of counterpointing levity with an astringent wryness he came close to Félicien Rops (*q.v.*), though lacking the latter's powers of draftsmanship. He died at Paris, Feb. 4, 1926.

See E. Bayard, *La Caricature et les caricaturistes*, pp. 239–259 (Paris, 1900); A. Willette, *Oeuvres Choisies* (Paris, 1901).

WILLIAM (c. 1130–*c.* 1190), archhishop of Tyre and chronicler, belonged to a noble French family and was probably born in Palestine about 1130. This, however. is only an inference; unfortunately the chapter (xix, 12) which relates to his early life has been excised or omitted from every extant manuscript- of his *Historia.* William was still pursuing his studies in Europe when Amalric I became king of Jerusalem in 1162, but he returned to Palestine toward the close of 1166, or early in 1167, and was appointed archdeacon of Tyre at the request of Amalric in Aug. 1167. In 1168 he was sent on an embassy, the forerunner of several others, to the emperor Manuel I at Constantinople, and in 1169, at the time of the disastrous campaign against Damietta, he was obliged to take refuge in Rome from the "unmerited anger" of his archbishop. But he was soon in Palestine again, and about 1170 he was appointed tutor to Amalric's son, Baldwin, afterward King Baldwin IV. Toward the end of 1174, soon after Baldwin's accession to the throne, he was made chancellor of the kingdom of Jerusalem, an office which he held until 1183, and less than a year later (May 1175) he was consecrated archbishop of Tyre. He was bne of those who went to negotiate with Philip I, count of Flanders, in 1177, and in 1179 he was one of the bishops who represented the Latin Church of the East at the Lateran council in Rome. On his return to Palestine he stayed seven months at Constantinople with Manuel. This is William's last appearance in history, but he mas writing his history in 1181, and this breaks off abruptly at the end of 1183 or early in 1184. He died probably between 1187 and 1190.

William of Tyre is among the greatest of medieval historians. His *Historia rerum in partibus transmarinis gestarum*, or *Historia Hierosolymitana* or *Belli sacri historia*, covers the period between 1095 and 1184, and is the main authority for the history of the Latin kingdom of Jerusalem between 1127, where Fulcher of Chartres leaves off, and 1183 or 1184, where Ernoul takes up the narrative. It was translated into French in the 13th century, or possibly before the end of the 12th, and this translation. known as the *Chronique d'outremer,* or *Livre d'Eracles* or *Livre du conquest,* is quoted by Jean de Joinville, and increased **by** various continuations! in the standard account of the exploits of the French warriors in the east. William's work consists of 22 books and a fragment of another book; it extends from the preaching of the first crusade by Peter the Hermit and Pope Urban II to the end of 1183 or the beginning of 1184.

As *Belli sacri historia* the *Historia rerum* was first published in 1549 at Basel. Later editions are in J. P. Migne's *Patrologia Lafina,* vol. cci, and in the "Recueil des historiens des croisades," *Hist. occid.* i (Paris, 1844). An English translation was made for the Early English Text Society by M. Pi. Colvin (London, 1893).

WILLIAM I (1027 or 1028–1087), king of England, surnamed the Conqueror, was born in 1027 or 1028. He was the bastard son of Robert the Devil, duke of Normandy, by Arletta, the daughter of a tanner at Falaise. In 1034 Robert resolved on a pilgrimage to Jerusalem. Having no legitimate son he induced the Norman barons to acknowledge William as his successor. They kept their engagement when Robert died on his journey (1035), though the young duke elect was a mere boy. But the next 12 years was a period of the wildest anarchy. Three. of William's guardians were murdered; and for some time he mas kept in strict concealment **by** his relatives, who feared that he might experience the same fate. Trained in a hard school, he showed a precocious aptitude for mar and government. He was only 20 years old when he stamped out, with the help of his overlord, Henry I of France, a serious rising in the districts of the Bessin and Cotentin, the object of which was to put in his place his kinsman, Guy of Brionne. Accompanied by King Henry, he met and overthrew the rebels at Val-des-Dunes near Caen (1047). It mas by no means his last encounter with Norman traitors, hut for the moment the victory gave him an assured position. Next pear he joined Henry in attacking their common enemy, Geoffrey Martel, count of Anjou. Geoffrey occupied the border fortress of Alençon with the good will of the inhabitants. But the duke recovered the place after a severe siege, and inflicted a terrible vengeance on the defenders, who had taunted him with his base birth; he also captured the castle of Domfront from the Angevins (1049).

In 1051 the duke visited England. and probably received from his kinsman, Edward the Confessor, a promise of the English succession. Two years later he strengthened the claims mhich he had thus established by marrying Matilda, a daughter of Baldwin V of Flanders, who traced her descent in the female line from Alfred the Great. This union took place in defiance of a prohibition mhich had been promulgated, in 1049, by the papal council of Reims. Pope Nicholas II at length granted the needful dispensation (1059). By way of penance William and his wife founded the abbeys of St. Stephen and the Holy Trinity at Caen. The political difficulties caused by the marriage were more serious. Alarmed at the close connection of Piormandy with Flanders, Henry I joined forces with Geoffrey Martel in order to crush the duke, and Normandy was twice invaded by the allies. In each case William decided the campaign by a signal victory. The invasion of 1054 was checked by the battle of Mortemer; in 1058 the French rear guard was cut to pieces at Varaville on the Dive, in the act of crossing the stream. Between these two mars William aggrandized his power at the expense of Anjou by annexing Mayenne. Soon after the campaign of Varaville both Henry I and Geoffrey Martel died. He at once recovered Maine from the Angevins, nominally in the interest of Count Herbert II, on whose death (1062) Maine was formally annexed to Normandy.

Conquest of England.— About 1064 the accidentai visit of Harold II (*q.v.*) to the Norman court added another link to William's connection. It seems clear that the earl made a promise to support the claims of William upon the English succession. This promise he was invited to fulfill in 1066, after the Confessor's death and his own coronation. William had some difficulty in securing the help of his barons for his proposed invasion of England; it was necessary to convince them individually by threats and persuasions. Otherwise conditions mere favourable. William secured the benevolent neutrality of the emperor Henry IV; and the expedition had the solemn approval of Pope Alexander II. With Tostig, the banished brother of Harold, William formed a useful alliance; the duke and his Kormans were enabled, by Tostig's invasion of northern England, to land unmolested at Pevensey on Sept. 28. 1066. On Oct. 14 a crushing defeat was inflicted on Harold at the battle of Senlac or Hastings; and on Christmas day William was crowned at Westminster.

Five years more were to elapse before he became master of the west and north. Early in 1067 he made a progress through parts of the south, receiving submissions, disposing of the lands of those who had fought against him and ordering castles to be built; he then crossed the channel to celebrate his triumph in Normandy. Disturbances at once occurred in Northumbria, on the Welsh marches and in Kent; and he was compelled to return in December. The year 1068 was spent in military expeditions against Exeter and York, in both of which the adherents of Harold had found a welcome. In 1069 Robert of Comines, a Norman to whom William had given the earldom of Northumberland, was murdered by the English at Durham; the north declared for Edgar Atheling, the last male representative of the West Saxon dynasty; and Sweyn Estrithson of Denmark sent a fleet to aid the rebels. Joining forces, the Danes and English captured York, although it was defended by two Norman castles. Marching rapidly on York. William drove the Danes to their ships, and the city was then reduced by a blockade. The king ravaged the country as far north as Durham with such completeness that traces of devastation were still to be seen 60 years later. But the English leaders were treated with politic clemency. and the Danish leader, Jarl Osbiorn, was bribed to withdraw his fleet. Early in 1070 the reduction of the north was completed by a march over the moors to Chester, which was now placed under an earl of William's choice. From this point we hear no more of general rebellions against the foreign rule.

Administration.— Of the measures which William took to consolidate his authority we have many details; but the chronological order of his proceedings is obscure. The redistribution of land appears to have proceeded *pari passu* with the reduction of the country; and at every stage of the conquest each important follower received a new reward Thus were formed the vast but straggling fiefs which are lecorded in Domesday. The great earldoms of the West Saxon period mere allowed to lapse; the new earls, for the most part closely connected with William by the ties of blood or friendship, were lords of single shires; and only on the marches of the kingdom was the whole of the royal jurisdiction delegated to such feudatbries. William's writs show that he kept intact the old system of governing through the sheriffs and the courts of shire and hundred. Those whom he enfeoffed with land held it according to the lam of Norman feudalism, and were thus brought into close personal relations with the king. But he forced the most powerful of them to acknowledge the jurisdiction of the ancient local courts; and the old fyrd-system was maintained in order that the crown might not be wholly dependent on feudal levies. Though his forest laws and his heavy taxation caused bitter complaints, William won the respect of his English subjects. They appear to have accepted him as the lawful heir of the Confessor; and they regarded him as their natural protector against feudal oppression. This is to be explained by his regard for legal forms, by his confirmation of the "laws of Edward" and by the support which he received from the church. Domesday Book shows that in his confiscations he can have paid little attention to abstract justice. Almost every English landholder of importance was dispossessed, though only those who had actually borne arms against William should have been so treated. As far as possible Englishmen mere excluded from all responsible positions both in church and state. After 1071 our accounts of William's doings become jejune and disconnected. Much of his attention must have been engrossed by the work of administration, carried on without the help of those elaborate institutions, judicial and financial, which were perfected by Henry I and Henry II. William had few ministers of note. William Fitz Osbern, earl of Hereford, who had been his right-hand man in Normandy, fell in the civil wars of Flanders (1071). Odo, bishop of Bayeux, William's half-brother, lost favour and was finally thrown into prison on a charge of disloyalty (1082). Another half-brother, Robert of Mortain, earl of Cornwall, showed little capacity. Of the king's sons Robert, though titular count of Maine, was kept in leading strings; and even William Rufus, who was in constant attendance on his father, never held a public office. The Conqueror reposed much confidence in two prelates, Lanfranc of Canterbury and Geoffrey of Coutances. They took an active part in the civil no less than the ecclesiastical government. But the king himself worked hard in hearing lawsuits, in holding councils and ceremonious courts, and finally in conducting military operations.

In 1072 he undertook a campaign against Malcolm, king of Scots, who had married Margaret, the sister of Edgar Atheling. and was Inclined to promote English rebellions. When William reached the Forth his adversary submitted, did homage as a vassal and consented to expel Edgar Atheling, who mas subsequently endowed with an English estate and admitted to William's favour. From Scotland the king turned to Maine, which had profited by the troubles of 1069 to expel the Norman garrisons. William had no difficulty in reducing the country, even though Le Mans mas assisted by Fulk of Anjou (1073). A conspiracy of the earls of Hereford and Norfolk, in which the Englishman Waltheof, earl of Northampton, was to some extent implicated, was defeated by Lanfranc in the king's absence; but William returned to settle the difficult question of their punishment, and to stamp out the last sparks of disaffection. The execution of Waltheof, though strictly in accordance with the English law of treason, he only sanctioned after long hesitation, and this severity to a man who was generally thought innocent is one of the dark stains on his career. In 1076 he invaded Brittany to get possession of the fugitive earl of Norfolk; hut Philip of France came to the aid of the Bretons, and William gave way beiore his suzerain. The next few years were troubled by a quarrel between the king and his eldest son, Robert (*q.v.*). In the years 1083–85 there was a second rising in Maine. In 1085 news arrived that Cnut the Saint, king of Denmark, was preparing to assert the claims of his house in England. The project fell through, but gave occasion for the famous moot at Salisbury in which William took an oath of direct allegiance from "all the land-sitting men that were in England" (1086).

While the danger was still impending he took in hand (1085) the compilation of Domesday Book (*q.v.*). In 1087 he invaded the French Vexin to retaliate on the garrison of Mantes for raids committed on his territory. He sacked and burned the town. But as he rode out to view the ruins his horse plunged on the burning cinders and inflicted on him an internal injury. He was carried in great suffering to Rouen and there died on Sept. 9, 1087. He was buried in St. Stephen's at Caen. A plain slab still marks the place of his tomb, before the high altar; but his bones were scattered by the Huguenots in 1562.

Character. — In a profligate age William was distinguished by the purity of his married life, by temperate habits and by a sincere piety. His most severe measures mere taken in cold blood, as part of his general policy; but his natural disposition mas averse to unnecessary bloodshed or cruelty. His one act of wanton devastation, the clearing of the New Forest, has been grossly exaggerated. He was avaricious, but his church policy (*see* article ENGLISH HISTORY) shows a disinterestedness as rare as it was honourable. In personal appearance he was tall and corpulent, of a dignified presence and extremely powerful physique, with a bald forehead, close-cropped hair and short moustaches.

By Matilda (d. 1083) William had four sons, Robert, duke of Normandy, Richard (killed while hunting), the iuture kings William II and Henry I and five or six daughters including Adela, who married Stephen, count of Blois.

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(H. W. C. D.)

WILLIAM 11 (*c.* 1056–1100), king of England, surnamed Rufus, was the third son of William I by his queen Matilda of Flanders. He seems to have been his father's favourite son. and constantly appears in the Conqueror's company, although like his brothers he was carefully excluded from any share in the government. A squabble with Rufus was the immediate cause of Robert's first rupture with the Conqueror; in the ensuing civil war we find Rufus bearing arms on the royal side (1077–80). On his deathbed the Conqueror was inclined to disinherit his eldest son in favour of Rufus. who by the early death of Prince Richard was now left second in the order of succession. But Normandy was bequeathed to Robert, while Rufus was designated as king of England. Rufus was crowned at Westminster on Sept. 26, 1087, 15 days after the death of his father.

Domestic Administration. — In his domestic administration we can trace a certain continuity of purpose, and in his dealings with the Welsh and Scots he proceeded, though intermittently, along the broad lines of policy which his father had marked out. Beyond the channel he busied himself with schemes, first for the reunion of England and Normandy, then for the aggrandizement of Normandy at the expense of France. But the violence, the irregularity, the shamelessness of his private life are faithfully reflected in his public career. Even in cases where his general purpose could be justified. his methods of execution were crudely conceived, brutal and shortsighted. Rufus was not without valour or glimmerings of chivalry. but perfidious to his equals, oppressive to his subjects, contemptuous of religion, with no sense of his responsibilities and determined to exact the last farthing of his rights. The baronage took up arms for Robert in the name of the hereditary principle, but with the secret design of substituting a weak and indolent for a ruthless and energetic sovereign. Local risings in Norfolk. Somerset and the Welsh marches were easily repressed. The castles of Kent and Sussex offered a more formidable resistance, since their lords were in direct communication with Robert of Normandy, and were led by the able Odo of Bayeux (*q.v.*), the king's uncle, who had been released from prison at the opening of the reign. Rufus secured the help of the native English, by promises (never fulfilled), of good laws, the abolition of unjust taxes and redress for those who had suffered by the afforestments of the former king. Aided by large contingents of the national militia he subdued the rebels. Odo of Bayeux left England under a safe-conduct to sow fresh seeds of discord in Normandy. But Rufus resolved to take vengeance on his brother, and in 1089 he invaded eastern Normandy. In 1091 a treaty was hastily patched up. Rufus retained the eastern marches of the duchy, and also received certain seaports. In return he undertook to aid Robert in reducing the rebellious county of Maine. and in recovering the Cotentin from their younger brother, Henry Beauclerk, to whom it had been pledged by the impecunious duke. The last part of the agreement was duly executed. Rufus then recrossed the channel to chastise the Scots, who in his absence had raided the north country. Malcolm III of Scotland prudently purchased his withdrawal by doing homage (Aug. 1091) on the same terms which William I had imposed in 1072. Next year Rufus broke the treaty by seizing the stronghold of Carlisle and the other lands held or claimed by Malcolm in Cumberland and Westmorland. Malcolm in vain demanded satisfaction; while attempting reprisals on Northumberland he was slain in an obscure skirmish (1093). Rufus immediately put forward a candidate for the vacant throne; and this policy, though at first unsuccessful, finally resulted in the accession of Edgar (1097), a son of Malcolm, who had acknowledged the English overlordship. Carlisle remained an English possession; in the next reign Cumberland and Westmorland appear as shires in the accounts of the exchequer.

Norman Policy. — Rufus resumed his designs on Normandy at the first opportunity. Robert reproached his brother with nonfulfillment of the terms arranged in 1091; and Rufus seized the excuse for a second invasion of the duchy (1094). But Robert resolved to go upon a crusade and, to obtain the necessary funds, gave Normandy in pledge to his brother (1096). The interests of Normandy at once became the first consideration of Rufus' policy. In 1098–99 he recovered Maine, and commenced operations for the recovery of the Vexin. Early in 1100 he accepted a proposal, made by William IX of Aquitaine, that he should take over that duchy on terms similar to those arranged in the case of Normandy. Contemporaries were startled at the rapid progress of the king's ambitions, and saw the direct interposition of heaven in the fate which cut them short. On Aug. 2, 1100, Rufus fell, in the New Forest, the victim of an arrow from an unknown hand. The common story names Walter Tirel, who was certainly close at hand and fled the country without venturing to abide the issue of a trial. But a certain Ralph of Aix was also accused; and Tirel, from a safe distance. solemnly protested his innocence.

It remains to notice the main features of the domestic administration which made the names of William and his minister, Ralph Flambard, infamous. We are told that the "moots" all over England were "driven" in the interests of the king; which perhaps means that aids were extorted from the shire courts. We also learn that the forest laws were rigorously administered;

that the king revived, for certain offenses, the death penalty which his father had abolished; that all men were vexed by unjust gelds and the feudal classes by unscrupulous misinterpretations of the customs relating to the incidents of wardship, marriage and relief. On one occasion the militia were summoned in considerable numbers for a Norman expedition, which was no part of their duty; but when they arrived at the seacoast they were bidden to hand over their journey money and go home. The incident is not uninstructive as a sidelight on the king's finance. As to the oppression of the church we are more fully informed; after allowing for exaggeration there still remains evidence enough to prove that the ecclesiastical policy of Rufus was unscrupulously venal.

In appearance William II was unattractive: bullnecked, with sloping shoulders. extremely corpulent and awkward in his gait. His long locks and clean-shaven face marked his predilection for the newfangled fashions which contemporary ecclesiastics were never weary of denouncing. His features were strongly marked and coarse, his eyes gray and deeply set; he owed his nickname to the fiery hue of his complexion. He stuttered violently and in moments of passion was almost inarticulate. His familiar conversation was witty and blasphemous. He was surrounded by a circle of vicious parasites, and no semblance of decorum was maintained in his household. His character was assailed by the darkest rumours which he never attempted to confute. He died unmarried and without issue.

The main authorities for the reign are the *Peterborough Chronicle,* ed. by C. Plummer, 2 vol. (Oxford, 1892–99) ; Eadmer, *Vita Anselmi* and *Historia Novorum,* ed. by *M*. Rule, "Rolls Series" (1884); William of Malmesbury, *De gestis regum,* ed. by *W*. Stubbs, "Rolls Series," 2 vol. (1887–89) ; Orderic Vitalis, *Historia ecclesiastica,* ed. *by A*. le Prévost, 5 vol. (Paris, 1838–55). Of modern works the most exhaustive is by E. A. Freeman, *Reign of William Rufus,* 2 vol. (Oxford, 1882). *See* also J. *H*. Round, *Feudal England* (1895).

WILLIAM III (1650–1702), prince of Orange, who was also (1689–1702) William III. king of England, and William II. king of Scotland, was born at The Hague on Nov. 4, **1650.** eight days after the death of his father. As he was the only child of William II he was prince of Orange from his birth; but his position was nevertheless far from enviable, for his hereditary principality, on the Rhône a few miles north of Avignon, was small and in constant peril of absorption by France, while the authority which his ancestors had long enjoyed as leading officials in the United Provinces of the Ketherlands seemed in danger of being lost forever. Shortly before his death William II had made an unsuccessful attempt to increase that authority by a military coup *d'état,* with the result that the republican oligarchy which was especially strong in the powerful province of Holland and the great city of Amsterdam had become bitterly hostile to the house of Orange, and was prepared to exclude it altogether from office.

In **1654.** under the direction of the famous grand pensionary of Holland, John de Witt (*q.v.*), an act was adopted which debarred William and his descendants forever from the stadtholdership or chief magistracy of Holland and from the position of captain general or commander in chief of the armed forces of the United Provinces.

For ten years William III was brought up under the direction of his mother, Mary, the eldest daughter of Charles I. king of England; but on Dec. 24, **1660,** Mary died of smallpox while on a visit to her newly restored brother, Charles II, and William came under the care of his paternal grandmother, Amalia, countess of Solms-Braunsfeld, and his uncle by marriage, Frederick William the Great Elector of Brandenburg. Over all these mutually jealous individuals an increasingly watchful eye was kept by the government of the United Provinces, ever distrustful of the autocratic tendencies of the house of Orange and fearful of its popularity with the multitude. William's boyhood and early manhood, in consequence, were spent in an atmosphere of jealousy, suspicion and intrigue, which early taught him how to conceal his purposes, repress his feelings and present to the world that cold, impassive exterior which later was to make such an unfavourable impression in England. His more formal education was obtained at the University of Leyden, which he entered at the age of nine, and left with some knowledge of mathematics, geography and history, and an unusually wide acquaintance with the languages of contemporary Europe.

Nevertheless as he grew older his position steadily improved. In May **1660** the restoration of his uncle Charles II to the English throne gave indirect encouragement to his many partisans among the nobility, clergy and commons, and enabled them to secure the repeal of the Act of Exclusion. During the war of 1664–67 between England and the United Provinces there was an increased demand that he should be entrusted with part of the authority of his ancestors, and in **1668** a compromise was reached by which he was to be accepted as captain general on attaining the age of 22, but while holding that post was to be debarred from the office of stadtholder. De Witt, indeed, was maintaining his position with difficulty, for the burgher oligarchy which he controlled was only a small, though powerful, minority and was distracted by serious dissensions within its own ranks.

The crisis which eventually brought William to the front arose in the spring of **1672.** England and France. united in the secret treaty of Dover, made a sudden and unprovoked attack on the Dutch republic with the object of seizing its territory and dividing it between them. At sea the Dutch put up a skillful and heroic defense, which was successful in preventing any English invasion; but on land their armed forces, which had been suspected of favouring the house of Orange and had therefore been neglected, proved both inadequate and halfhearted and gave way at every point. A large part of the United Provinces was rapidly overrun by the French, riots broke out, and on July **8. 1672,** the burgher oligarchy was forced to accept William's appointment as stadtholder and captain general for life. By ruthless determination he infused new vigour into the defense; but although the cutting of the dikes and the flooding of the surrounding country saved Amsterdam, no immediate improvement in the situation was visible, and on Aug. 20 the mob at The Hague, filled with unreasoning fury at what they interpreted as treachery on the part of their former governors, fell upon John de Witt and his brother and brutally murdered them. William was in no sense responsible for this crime, but it is typical of his whole character that he neither took precautions to prevent it nor endeavoured to punish the perpetrators.

As a military commander William never rose above the second rank, and he became renowned for his skill in making the best of defeats rather than for any capacity for winning victories. Entrusted with the direction of armies while scarcely of age, he had to learn from his own mistakes, and while he soon mastered the art of planning on a large scale he remained inadequately equipped with that knowledge of detail which early experience in subordinate posts would have given him. His strategy to begin with was of necessity defensive, but in Aug. **1674** he risked his first major engagement at Seneffe, and was defeated. Three years later he was again defeated at St. Omer, and on Aug. **14, 1678,** he suffered a third defeat near Mons.

William excelled in diplomacy and in the formation of great international combinations. As early as Oct. **1672** he had induced the emperor Leopold and the Great Elector to come to his assistance, and so had eased the pressure on the Dutch. In Aug. 1673 he enlisted the support of Spain, and a few months later that of Denmark. In Feb. **1674.** partly by concessions and partly by intrigues with the English opponents of Charles II, he procured the withdrawal of England from its alliance with France. Left thus almost alone to face the chief powers of western Europe Louis XIV had to abandon his conquests in the United Provinces, and William's services were recognized by the Dutch, making the stadtholdership hereditary in his family. Nevertheless the French remained successful in the field, and William could see no prospect of decisive victory except through engaging England on his side. This he tried to accomplish by his marriage on Kov. 4, **1677,** to Mary, eldest daughter of James! duke of York. the brother of Charles II; but the English king could not be prevailed upon to do more than make a pretense of hostility to France, and as war weariness increased on both sides no course remained open but to acquiesce in the indecisive settlement at Nijmegen in Aug. **1678.**

William then endeavoured to form a new coalition against Louis XIV, who continued even in time of nominal peace to absorb, bit by bit, territory to which he declared himself entitled. From this attempt emerged in 1686 the league of Augsburg, which would have had a fair prospect of checking Louis but for the uncertain attitude of England, now under James II, who showed signs of throwing in his lot with France. William therefore devoted renewed attention to the affairs of England, to the throne of which his wife was heiress presumptive, and on receiving an invitation from the opponents of James's Catholic and autocratic policy undertook to bring an army to their assistance. Landing at Torbay on Nov. 5, 1688, he advanced upon London, being joined by numbers of James's discontented subjects and even of his armed forces. James in foolish panic fled to France, and a specially summoned convention parliament, on the ground that by doing so he had "abdicated the government," and on the wholly unwarranted assumption that his recently born son was supposititious, conferred the crown jointly on William and Mary, with the exercise of the royal authority in the former. On Feb. 13, 1689, they were proclaimed, and on April 11, they were crowned.

William's recognition as king was followed by the dispatch of an English force to assist his allies on the continent, where war had already broken out.. But in order that English intervention against Louis might be genuinely effective it was necessary that he should establish himself securely in the outlying kingdoms of the British Isles. In Scotland there was little difficulty; William and Mary were accepted as sovereigns on April 11, 1689, and after the defeat of William's forces at Killiecrankie on July 27 his fortunes were restored by the success of William Cleland at Dunkeld on Aug. 21. In Catholic Ireland, on the other hand, opposition was very bitter and was encouraged by the arrival of James II, with French money, munitions and men, at Kinsale on March 12. The relief of Londonderry on July 30, however, brought hope to the Protestants in Ireland, and on July 1, 1690, William restored their ascendancy by his own victory at the Boyne, a victory of European significance, as it enabled him in the following spring, after nearly three years' absence, to turn his personal attention to the main struggle in Flanders.

In that area and at sea his fortunes pursued much the same course as in his previous contest with France. On June 30, 1690, the English and Dutch fleets were defeated off Beachy head, and England was momentarily thrown open to invasion. In April 1691 William in person failed to prevent the fall of the important fortress of Mons. In June 1692 he lost the yet more important fortress of Namur, and on Aug. 3 was defeated at Steinkirk. In July 1693 he was again defeated at Neerwinden. It is true that the position at sea was restored in May 1692 by the English and Dutch victory at La Hogue (*q.v.*); but it was not until 1695 that the fortune of war on land turned with William's recovery of Namur. and by that time both sides were thoroughly weary of the struggle. In 1697 an indecisive peace treaty was concluded at Ryswick, by which, however, Louis XIV formally recognized William's title to the English throne.

In domestic affairs William's reign was one of the most important in the history of England. It witnessed the passing of the Bill of Rights and the Act of Settlement; the acceptance of the idea that parliament should meet regularly once a year, and should exercise some control not merely over legislation and finance but also over administration and the army; the establishment of the freedom of the press and the recognition of the principle of religious toleration; the foundation of the Bank of England and of the national debt. But these achievements were William's only in a very negative sense. Of some he approved; to others he was indifferent or even hostile; but in all he acquiesced with a view to securing the support of a united England in the continental struggle.

No sooner had the treaty of Ryswick been signed, however, than the divergent outlook of king and people, the one intent only on foreign and the other on domestic affairs, became a cause of serious trouble. With the vast possessions of the dying Charles II of Spain about to be disputed by the powers of Europe, William recognized that the contest with France had only died down, and that a supreme crisis was approaching. The people of England, on the other hand, accepted the treaty as a permanent settlement. William insisted on the need for maintaining a large standing army, and parliament refused the legislation and supplies necessary for it. William then endeavoured to avert the crisis by two successive treaties with France for the peaceful partition of the Spanish empire, and parliament condemned not merely the treaties but also the fact that they had been concluded without its knowledge.

In Nov. 1700 Charles II died, leaving his inheritance by will to Philip of Anjou, grandson of the French king. Even then English public opinion was but faintly stirred. But Louis XIV's conduct in treating the Spanish dominions as if they were now his own, and still more his reckless breach of faith in acknowledging the son of James II as king of England, led to an immediate revulsion of feeling which swept England into an alliance with the coalition already built up by William on the continent. For some time William had been associating John Churchill, earl of Marlborough, whom he had previously distrusted, more and more with his work, and Marlborough, a greater soldier than he and as great a diplomatist, now stood ready to take over from him. On March 8, 1702, William, whose health had never been robust and who had for several months been visibly declining, died of pleurisy, fortunate in this, that he had practically ensured the success of his life's work though he did not live to complete it.

BIBLIOGRAPHY.—The story of William's life between 1672 and 1702 is scarcely distinguishable from the history of Europe, and all the major authorities for the period throw light upon it. William's own correspondence has been largely preserved and has been made available mainly in Dutch official publications, of which the most important are *Archives ou Correspondance inédite de la Maison d'Orange-Nassau,* ser. 2, 1584–1688, ed. G. Groen van Prinsterer, 5 vol. (Utrecht, 1857–62); ser. 3, 1689–1702, ed. F. J. L. Kramer, 3 vol. (Leyden, 1907–09); and *Correspondentie van Willem III en van Hans Willem Bentinck,* ed. N. Japikse, 5 vol. (The Hague, 1927–37). Of considerable importance also is *Letters of William III and Louis XIV and of their Ministers,* ed. Paul Grimblot, 2 vol. (London, 1848). There is no adequate biography of William in English, but useful sketches are available by H. D. Traill (London, 1888), G. J. Renier (London, 1932; New York, 1933) and David Ogg (London, New York, 1956), and an account of the early part of his career in Marjorie Bowen, [pseud.], *William, Prince of Orange, 1650–1673* (London, New York, 1928). The best biography in Dutch is N. Japikse, *Prins Willem III. de Stadhouder-Konine.* 2 vol. (Amsterdam, 1930–33). (A. Bc.)

WILLIAM **IV.** (1765–1837), king of England, third son of George III., was born at Buckingham Palace on Aug. 21, 1765. In 1779 he was sent to sea and became a midshipman under Admiral Digby. Next year he sailed under Rodney and took part in the action off Cape St. Vincent (Jan. 16, 1780). During the rest of the war the young prince sa plenty of service, for which he had a strong liking, and so laid the foundation of his popularity. On the conclusion of the war he travelled in Germany, visiting Hanover and Berlin, where he was entertained by Frederick the Great. In 1785 he passed for lieutenant; next year he was made captain and stationed in the West Indies.

In 1789 he mas made duke of Clarence. When war was declared against the French republic in 1793, he could obtain no command. He amused or revenged himself by joining the prince of Wales and the duke of York in their opposition to the king. He took his seat in the House of Lords, where he defended the extravagances of the prince of Wales, spoke on the Divorce Bill, and vehemently opposed the emancipation of slaves. Meanwhile he formed a connection with Mrs. Jordan, the actress, with whom he lived on terms of mutual affection and fidelity for nearly twenty years. The death of Princess Charlotte in 1817 compelled him to break with Mrs. Jordan, and to marry (1818) Adelaide of Saxe-Meiningen, who obtained great influence over her husband. On the death of the duke of York in 1827 the duke of Clarence became heir to the throne, and in the same year he was appointed lord high admiral. He endeavoured to assume independent control of naval affairs. although his patent precluded him from acting without the advice of two members of his council. This involved him in a quarrel with Sir George Cockburn, in which he had to give way. As he still continued to act in defiance of rules, the king was at length obliged to call upon him to resign.

On June 26, 1830, the death of George IV. placed him on the throne. During the first two years of his reign England underwent an agitation more violent than any from which it had suffered since 1688. William IV. was well-meaning and conscientious; but his timidity and irresolution drove ministers to despair, while his anxiety to avoid extremes and his want of insight into affairs prolonged a dangerous crisis and brought the country to the verge of revolution. The July revolution in France gave a great impulse to the reform movement in England. Within a fortnight of the opening of parliament the Tory ministry were beaten on a motion for the reform of the civil list, and resigned. Lord Grey undertook to form a ministry, with the avowed intention of bringing in a large measure of reform. This was not in itself displeasing to the king, who had liberal tendencies, and a few years before had supported Catholic emancipation. But when the government were beaten in committee, and offered to resign, the king declined to accept their resignation, but at the same time was unwilling to dissolve. He was only forced to it (April 1831) by the action of the opposition. After a protracted political crisis (*see* GREY, CHARLES GREY, 2nd earl) the king was compelled to consent to create a sufficient number of new peers to carry the Second Reform bill, and the threat was successful in bringing about the passing of the act in 1832.

During the rest of his reign William IV. had not much opportunity of active political interference, but on one other occasion he made an unjustifiable use of his prerogative. This was in Nov. 1834 when he suddenly dismissed the Melbourne ministry on a mere pretext, but in reality because he disapproved of their Irish Church policy, and summoned Sir Robert Peel. The formation of the Peel ministry was immediately followed by a dissolution, and, beaten on Lord John Russell's motion respecting the Irish Church (3rd of April, 1835), Peel resigned and Melbourne again came into power. Under him the Whigs retained the lead during the remainder of the reign. This *coup d'ktat* of Nov. 1834 was the last occasion on which an English sovereign attempted to impose an unpopular ministry on the majority in parliament.

In May 1837 the king began to show signs of debility, and died from an affection of the heart on June 20, leaving behind him the memory of a genial, frank, warm-hearted man, but a blundering, though well-intentioned prince. He was succeeded by his niece Queen Victoria.

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WILLIAM I. (1797–1888), king of Prussia and German emperor, second son of Frederick William III. of Prussia and Louise, a princess of Mecklenburg-Strelitz, was born at Berlin on March 22, 1797, and received the names of Wilhelm Friedrich Ludwig. After the battle of Jena he spent three years at Konigsberg and Memel. On Jan. 1, 1807 he received an officer's patent, and on Oct. 30, 1813 was appointed a captain. William accompanied his father in the campaign of 1814, and early in 1815, received the iron cross for personal bravery shown at Bar-sur-Aube. He took part in the entry into Paris on March 31, 1814, and afterwards visited London, He joined the Prussian army in the final campaign of the Napoleonic wars, and again entered Paris. He was made a colonel and member of the permanent military commission at 20, a major-general at 21, and commander of a division in 1820. During the following nine years he mastered the Prussian military system and studied closely those of the other European States. In 1825 he was promoted lieutenant-general, and commander of the corps of guards. On June 11, 1829 he married Augusta (d. Jan. 1, 1890), daughter of Charles Frederick, grand duke of Saxe-Weimar, a lady of liberal tendencies and Catholic sympathies, whose considerable influence at court was generally exerted against that of Bismarck. By this lady William had two children: the crown prince Frederick William (b. 1831) who succeeded him as Frederick III. (*q.v.*) and the Princess Louise (b. 1838) who in 1850 married the grand duke of Baden.

On the death of his father in 1840—the new king, Frederick William IV., being childless—Prince William, as heir presumptive to the throne, received the title of prince of Prussia. He was also made lieutenant-governor of Pomerania and appointed a general of infantry. In politics he was decidedly conservative. On the outbreak of the revolution of 1848 he saw that some concessions were necessary, but urged that order should first be restored. Generally held responsible for the bloodshed in Berlin on March 18 (and hence nicknamed the "Cartridge Prince," although actually no longer in command of the guards), William was so hated for his supposed reactionary views that the king entreated him to leave the country for some time. He went to London, where he formed intimate personal relations with the leading English statesmen. Returning to Berlin, on June 8 he took his seat in the Prussian national assembly, and spoke expressing belief in constitutional principles. In 1849 he conducted the army which crushed the revolutionary movement in Baden. At the beginning of the campaign an unsuccessful attempt was made on his life. In Oct. 1849 he was appointed military governor of the Rhineland and Westphalia. In 1854 he was promoted field-marshal and made governor of the fortress of Mainz. On Oct. 7, 1858 he became regent for his brother, succeeding him on Jan. 2, 1861.

Political events of William's regency and reign are told elsewhere. (See GERMANY: The Growth *of Prussia.*) William was not a ruler of the intellectual type of Frederick the Great; but he believed in the "God of battles" and in his divine right as the viceregent of God so conceived. He believed also in the ultimate union of Germany and in the destiny of Prussia as its instrument; and held that whoever aspired to rule Germany must seize it for himself. But an attitude so alien to the Liberal temper of contemporary Germany was tempered by shrewd common sense, and wisdom in his choice of advisers. Thus as regent he called the Liberals into office on Bismarck's advice, though later he did not hesitate to override the Constitution when parliament refused supplies for the new armaments. From Sept. 1862, when Bismarck took office as minister president, William's personality tends to be obscured by that of his masterful servant. Yet he was no cipher. His prejudices, indeed, were apt to run athwart the minister's plans; as in the Schleswig-Holstein question, when the king's conscience regarding the claims of the Augustenburg prince threatened to wreck Bismarck's combinations. But, as Bismarck put it, the annexation of the duchies gave him "a taste for conquest," and in the campaign of 1866 the difficulty was to restrain the king, who wished to enter Vienna in triumph.

In 1870–71 again it was Bismarck and not the king that gave the determining impulse. King William's attitude was strictly correct; and the excitement which it aroused in France was due to Bismarck's editing of the Ems telegram. On the French declaration of war all Germany rallied round the king of Prussia, and when, on July 31, he quitted Berlin to join his army, he knew that he had the support of a united nation. It was during the siege of Paris, at his headquarters in Versailles, that he was proclaimed German emperor (Jan. 18, 1871). On March 21, he opened the first imperial parliament of Germany; on June 16, he entered Berlin at the head of his troops.

After that period the emperor left the destinies of Germany almost entirely in the hands of Bismarck. In his personal history the most notable events were two attempts upon his life in 1878, on the second of which he was seriously wounded. Until within a few days of his death the emperor's health was remarkably robust; he died at Berlin, March 9, 1888.

William I.'s military writings were published in 2 vols. at Berlin in 1897. Of his letters and speeches several collections have appeared: *Politische Korrespondenz Kaiser Wilhelms I.* (1890); *Kaiser Wilhelms des Grossen Briefe, Reden und Schriften* (2 vols., 1905), and his correspondence with Bismarck (ed. Penzler, Leipzig, 1900). A large number of biographies have appeared in German, of which may be mentioned L. Schneider's *Aus dem Leben Kaiser Wilhelms* (3 vols., 1888; Fr. trans., 1888); Oncken, *Das Zeitalter Kaiser Wilhelms* (2 vols., 1890–92); F. Delbrück, *Die Jugend des Königs Friedrich Wilhelm IV. von Preussen und des Kaisers u. Königs Wilhelm I., Tagebuckblatter* (1907); *E.* Marcks, *Kaiser Wilhelm I.* (Leipzig, 1897; 5th ed. 1905). In English have appeared *William of Germany*, by Archibald Forbes (1888), a translation of Edouard Simon's *The Emperor William and his Reign* (2 vols., 1886). *See* also GERMANY.

WILLIAM II. (1859–1941), German emperor, was born on Jan. 27, 1859, eldest son of Prince Frederick William of Prussia and Princess Victoria of England. Even as a young prince he had to feel the conflict of opinions then swaying Germany. His mother always remained at heart a foreigner there; deeply convinced of the excellence of English institutions, she regarded her new home as a backward country; in particular, she always looked on her father-in-law's minister, Bismarck, as a personal antagonist—a view which he returned with interest. Clever, but imperious and essentially cold, Princess Victoria was never able to win the heart of her son. The Crown Prince Frederick William had grown up in an age when the ideas of liberalism had become general among the educated classes of Germany, and was himself deeply influenced by them. He was often accused of lacking initiative, and despite occasional revolts, of being too much influenced by his wife's stronger will. As a soldier he did his duty in the great wars of 1866 and 1870, and, with the assistance of expert advisers, won great successes on the battle-field; but he was never primarily a soldier. His diaries show a wide range of interests, but little serious occupation with any one definite subject. His whole nature and views seemed un-Prussian to the old Emperor William I. and his circle. He was kept wholly outside official business, and thus up to the 60th year of his life he was obliged to stand beside the throne in the part of a critic without influence.

Education and Character.—His eldest son grew up in a different spiritual atmosphere. The great victories over Austria and France, the foundation of a new German empire and the winning of the German Crown by the Hohenzollerns were the dominating impressions of his boyhood years. He shared the enthusiasm felt by his generation for Bismarck and for the glorious German army. Thus from an early age he was really at variance with the spirit reigning in his parents' house. His father and mother wished to train him in other ways by giving him a middle-class education, quite contrary to the traditions of the Hohenzollern dynasty. They sent him to the gymnasium in Kassel. But although nominally a student like all the rest, yet for teachers and comrades alike he still remained always the prince and future emperor. None the less, these school years had an important effect on his intellectual development; all the solid knowledge he ever had was acquired in this period. He always retained a great devotion and respect for Professor Hinzpeter, the head of the Kassel gymnasium. In Jan. 1877 the young prince passed his final examination in Kassel. He was then sent for six months to serve in the first regiment of Guards, and afterwards to the University of Bonn, where he studied constitutional law and political economy. He passed two years at Bonn, but here again failed to come into really close contact either with his teachers or with the students.

After the autumn of 1879 military training definitely took the first place; the prince spent the next years chiefly in Potsdam, and although he was introduced by the chief president of the Province of Brandenburg into the secrets of civil administration, this was only a secondary occupation. His years with the corps in Potsdam again brought him into touch almost exclusively with the views predominant among Prussian nobles and corps of officers. The veneratior paid him here suited his wilful and imperious nature better than the spirit of the middle class school or of his parents' house. Sustained work was never demanded of him, and consequently he never learnt to perform it. In Feb. 1881 he married Princess Augusta Victoria of Schleswig Holstein-Augustenburg. daughter of the Prince Frederick who in 1864 had crossed Bismarck's plans by aspiring to the throne of Schleswig-Holstein. The prince had been for long a personal friend of the Crown Prince Frederick William. The old emperor and Bismarck approved of this marriage, as tending to bring about a reconciliation with those elements in Schleswig-Holstein which still maintained the rights of the Augustenburgs. The young princess had been brought up very simply and piously; she had no great intellectual powers. Six sons and a daughter were born of the marriage Prince William had come little before the eyes of the public, when his father's sudden death on June 15, 1888, brought him to the throne.

The new emperor was certainly a man of intellectual gifts above the average. He had a quick apprehension which enabled him to form in a short time a general view of matters which interested him, but which also seduced him into satisfying himself with these quick, superficial impressions and thinking it unnecessary to penetrate more deeply into the heart of a problem. He also possessed an extraordinarily happy turn of speech, equally effective in intimate conversation and in dealing with large audiences. His oratorical gifts, often, indeed, led him, particularly when he was speaking in public, into saying more than he really meant. He often found himself carried away, by his own inner excitement and by the admiring astonishment of his listeners, into ill-considered remarks afterwards turned against him on the battle-ground of politics. He was most profoundly persuaded of the importance of his imperial office, and of his duty to maintain his authority as monarch. Never doubting that the monarchy was a divine institution, he believed firmly that God, who had set him in this place, would also show him the right way in the exercise of his sovereign duties.

In a letter to Bismarck written two years before his death, William's father had complained of his eldest son's immaturity and inexperience, which was coupled with an inclination to over-estimate his own powers. This was, indeed, a just criticism of very important traits in William's character. He was unready and unripe in mind when he ascended the throne at the age of twenty-nine. He never attained that spiritual maturity which comes only through heartfelt co-operation in great tasks and earnest consideration of the problems of the world and of life. His personality lacked the solid background of a definite philosophy of life; thus he always remained dependent on the impressions of his immediate surroundings and on the influences of those persons who knew how to win his ear and flatter his vanity. Nor had he any definite religious convictions which might have given him this inner firmness; for although he believed in the basic dogmas of Christianity, yet he was as strongly affected by the confusing influence of the modern technical and intellectual culture and really never knew at heart how far he could give way to it without violating the traditional religious beliefs so essential for his monarchic sentiments.

He has often been compared with Frederick William IV., and there were certainly many points of resemblance between him and his great-uncle; but the deep difference between them lay in the fact that Frederick William's whole nature was rooted in a definite philosophy of the world which always turned the scale at the critical moments of his life, despite all wavering in points of detail, while this firm basis was lacking in William II. Consequently he was never free from a feeling of inner uncertainty, which he tried to hide from the outward world under a pompous manner and by big words. As soon as he showed himself in public he put on the mask of the emperor. When he laid it aside there remained a man of fine talents, but of moderate education and weak character, vain and wilful through excess of self-consciousness, who felt himself most at home in amusements of a very common sort, and liked to surround himself with subservient people who suffered his not always tactful jokes with becoming respect. A great and increasing part of his time was taken up with journeys, with official appearances, with parades and shows, while real work receded more and more into the background.

When he became emperor he knew very little of the details of foreign policy. He had only a few definite principles, to which he always remained true. First among these came the maintenance of his own monarchic status at home and of Germany's international position. This in his opinion required not only a strong army, which Germany already possessed, but also a strong fleet, which he set about forming. The big increase of military forces was intended not only to enable Germany to defend herself against possible attack, but also to increase her prestige and to ensure her her share in the partition of the world's territories which was proceeding rapidly. He believed that the likelihood of ever having to make serious use of these armaments would decrease in inverse proportion to the strength of them. He never had any warlike intentions or ambitions; he certainly always felt at heart that he was lacking in the military gifts requisite for command in a great modern war. On the other hand, he felt that his duty to himself as monarch forbade him to leave the control to others.

William's Relations with his Ministers.—When the new emperor mounted the throne, Bismarck was still in charge. While still a prince, William had often assured him of his admiration, although there had, indeed, already been several small disagreements, the story of which Bismarck has told in the third volume of his *Gedanken und Erinnerungen.* But it was in any case hardly likely that a young man of so lively a temperament and so keen an ambition to bring affairs under his personal control could agree for long with a minister who had conducted the Government according to his own principles for a generation, and who was not inclined to subordinate himself to the wishes of a young and inexperienced monarch. Bismarck felt from the first that in the personality of the emperor were inherent grave dangers for Germany's peaceful development and for the settlement of her international relations, and thought himself bound to confine the emperor's influence on policy within the narrowest limits possible. In these circumstances a collision was inevitable, and the occasion which finally led to the split was of comparatively minor importance. The repeated great strikes in the Rhenish Westphalian coal fields had inclined the emperor to listen to the counsels of his former teacher, Hinzpeter, who urged that his duty was to meet the wishes of the workmen half way and to remove their discontent by a wide measure of social reiorm. He demanded suddenly an announcement of such measures on the occasion of his coming birthday.

The friction began when Bismarck, in view of the great importance of such a proclamation, demanded close scrutiny and preparation in detail. It was increased by differences of opinion with regard to the prolongation of the state of emergency against the Social Democrats, and led to personal conflicts of increasing violence. Bismarck had undoubtedly determined to remain in office even against the emperor's will, and attempted to persuade the other ministers to declare themselves one with him. At last, on the strength of a cabinet order of 1850, he forbade the individual ministers to report to the emperor except in his presence; the emperor saw in this an attempt to eliminate his influence and demanded that this cabinet order be revoked. Bismarck refused to give the order, and the emperor then sent word that he expected the chancellor to tender his resignation. This Bismarck did on March 18, 1890, and it was immediately accepted by the emperor.

After Bismarck's dismissal the emperor announced that the course of the ship of State was to remain the same, even though the steersman had been changed. He proposed to take over command of the ship himself, and called to the leading posts men wholly unacquainted with the duties which they were to assume, in order to secure himself from supervision by experts. General von Caprivi became imperial chancellor and Freiherr von Marschall, a former lawyer, secretary of State for foreign affairs. Such men were meant only to be channels for executing William's will. Indeed, the emperor believed up to the end of his reign that he himself was the real guiding force of all German policy. If, however, we consider more closely the system of government which developed after Bismarck's dismissal, we find that the emperor's influence was not nearly so great as most of his contemporaries assumed. The right which he enjoyed of nominating at his personal discretion the imperial chancellor, the secretaries of State and the Prussian ministers naturally gave him great influence.

Yet the emperor could not lay down a consistent line of policy, if only for the reason that he himself possessed no solid views, based on definite convictions, in the main questions, and that he had neither the will nor the perseverance to help with hard, sustained work on the big issues. This was apparent even in foreign affairs, which attracted his chief interest. The emperor read a great part of the despatches from the ministers abroad and added notes to them, mostly expressing his views at the moment, but seldom containing real political directions. Reports were rendered to him verbally or in writing on important questions and his decisions were put away in the files. He also often had political conversations with the representatives of foreign powers and made a rule of reporting all these in detail to the Foreign Office. When he was travelling, which was often the case, he was accompanied by a member of the diplomatic service who saw to communications between him and the Foreign Office.

Very often, and particularly in important questions, he let himself be persuaded by his ministers into decisions altogether contrary to his own views. For example, immediately after Bismarck's dismissal, he allowed Caprivi and Holstein tc dissuade him from renewing the re-insurance treaty with Russia, although he personally wished, and had, indeed, already consented to renew it. Later he always disapproved at heart of Holstein's and Biilow's policy in Morocco, but allowed himself time and again to be persuaded into approving of the measures proposed by his advisers. On the whole, William II. did not so much exercise a real, lasting control, as produce confusion by sudden and impulsive interierence.

In foreign policy, after Bismarck's dismissal, as the new chancellor and the new secretary of State had absolutely no experience in this field, the actual control fell into the hands of Baron von Holstein, chief of the political department in the Foreign Office, a mistrustful and misanthropic eccentric who shrank from any sort of public appearance, never reported to the emperor or appeared in parliament, but provided the ministers with his information from the seclusion of his office. He always regarded the emperor's personality and inclination to personal interference with the greatest mistrust. When the chancellor and secretary of State, out of loyalty to their sovereign—a feeling very little developed in Holstein—put up too weak an opposition to the emperor, he tried by every kind of intrigue to egg them on or else to turn them out, and had them attacked in the press with which he was connected. Consequently during the decade after Bismarck's dismissal there was a continual feeling of crisis which might at any moment have led to grave conflicts.

The events of William II.'s reign will be found elsewhere. (*See* GERMANY.) Here we can only attempt to indicate the emperor's personal share in the most important decisions of this time, beginning with foreign policy.

Foreign Policy.—Although the non-renewal of the re-insurance treaty was contrary to the emperor's wish, the *rapprochement* with England which began with the conclusion of the Heligoland treaty, undoubtedly accorded at the time with his personal wishes. He was anxious to create a counterpoise to the pressure of the incipient Franco-Russian *rapprochement* by strengthening relations between the Triple Alliance and England. But he very soon experienced bitter disappointments; the interests of Germany and England clashed violently in Africa, and England, after the outbreak of the Chinese-Japanese War (1894) followed the opposite policy to Germany in the Far East. Germany's intervention in this struggle against Japan and on the side of France and Russia was essentially the work of Baron von Holstein. The emperor had at first shown great personal sympathies for the military efficiency of Japan, but skilful working on his Christian sentiments and his fear of the "yellow peril," persuaded him to fall in with Holstein's advice; especially as this coincided with his personal ambition to seize the occasion to secure for Germany a naval base in the Far East. He then promised the tsar of Russia support if the latter's Far Eastern policy led him into difficulties, the tsar, in return, consenting on Russia's behalf to Germany's occupying a Chinese port.

After these events had brought about a coldness between Germany and England, the emperor devoted his chief attention to strengthening the German war fleet, in which he had always felt a strong personal interest. He used every opportunity, public and private, to advocate this move, because he was convinced that Germany would only be able to follow a policy independent from England if she was covered against attack from the sea by a strong navy of her own. Throughout his entire reign, the expansion of German sea power remained one of the unaltered principles of his policy; from 1897 on he found in Admiral von Tirpitz, the secretary of State for naval affairs, an enthusiastic assistant in these plans, who was capable of giving them practical form and of defending them against statesmen and parliament.

If the emperor's naval policy already showed a deep mistrust of England, this was intensified by British policy towards the Boers. When Jameson made his raid into the Transvaal in 1896, the emperor seriously thought of breaking off diplomatic relations with the British Government if it countenanced Jameson's conduct. He even planned a military intervention in favour of the Boers; his advisers only restrained him from doing so, with difficulty, by proposing instead the despatch of the notorious telegram to President Kruger. The growing tension of relations with England made the emperor increasingly ready to adopt the idea, originally put forward by Holstein and afterwards also repeatedly advocated by Biilow, of seeking *rapprochement* with France via St. Petersburg (Leningrad) in order to create a counterpoise to the threatening increase of British power through an alliance of all the great European continental States, the so-called Continental Alliance. It may, however, be doubted whether all these efforts were not only meant to serve to bring England to change her policy and enter into closer relations with Germany. For the emperor always retained a lively sympathy for England, which was expressed in particularly vivid fashion in the reports which he sent to the German Foreign Office on his frequent'visits to that country. On the other hand, he also felt himself attracted to Russia by old family traditions and by the consciousness of common monarchic interests, and probably never really made up his own mind which of these two countries would prove the more valuable ally for Germany. Holstein and Biilow, who thought Germany would do best to bind herself to neither of these two Powers, but to sell her support to the one or the other, as the case arose, for concrete concessions, took advantage of the emperor's uncertainty to restrain him from entering into any binding engagements on one side or the other. Biilow flattered his vanity by representing to him that he would then become the arbiter of the world. Nevertheless, when England began in the spring of 1898, at Chamberlain's instigation, to sound Germany regarding a German-English alliance, William II. showed a real inclination to accept this offer, and all his advisers' cunning and precautions were needed to keep him in the path which they considered desirable.

After the failure of these negotiations, when England first drew closer to France and Russia and the path was cleared for the Entente, Berlin began to grow apprehensive. Holstein and Biilow thought it their duty to show the world, in the Morocco question, that France and England were not to be allowed to dictate the partition of the world's remaining colonial territories without reference to Germany, especially as Russia was at the time completely immobilized by her severe struggle with Japan. The emperor, whose personal view it was that German interests in Morocco were not large enough to justify such an attitude, and who only a short while previously had told the king of Spain that Germany demanded nothing for herself in Morocco, was utterly opposed to such interference. Biilow needed all his art of persuasion to persuade him to land in Tangier on his Mediterranean voyage in March 1905. Up to the last moment he hesitated whether to do this. Here he certainly showed more political wisdom than his advisers, but once again he was too weak to carry his point against them. The result of Germany's action here was not only to make her relations with France more strained, but also to confirm the Franco-British entente. It is well-known that the agreements between these two Powers for military and naval co-operation in case of war were a result of the Morocco crisis.

Another reason why the emperor viewed the increasing tension of Franco-German relations with alarm was because, after the failure of the negotiations for an alliance with England, he had resumed with new zest the idea of a Continental Alliance. Biilow prevented him from intervening during the delicate negotiations with Paris on the preparations for the Algeciras conference, but only by concealing from him altogether the offer made by Rouvier, the French minister-president, for a general understanding with Germany. He consented, however, that the emperor should take advantage of his meeting with the tsar in Finland to conclude with him a treaty, to which France should afterwards be asked to adhere. The emperor in fact succeeded at the meeting in Bjorko (July 23, 190j) in persuading the tsar Nicholas to sign an offensive and defensive alliance. He believed that he had won a great success, and wrote to Biilow that the meeting had been a turning point in the history of the world. This, however, soon proved to be a complete error; when the tsar returned to St. Petersburg his ministers persuaded him to demand a revision of the treaty, as in its existing form it was irreconcilable with the provisions of the Franco-Russian treaty. As the alterations proposed by Russia would have deprived the treaty of its whole value for Germany, it was thought best to drop the whole affair and the Björkö treaty was buried for good and all.

Germany's situation now grew increasingly dangerous; Russia's adhesion to the Franco-British entente (1907) was followed by growing tension between Germany and England, due principally to the fears aroused in England by the German naval programme. Various early attempts by England to reach an understanding with Germany on the naval armaments of the two Powers broke down because the emperor, in agreement with Admiral von Tirpitz, maintained that any engagement of this sort was dishonourable to Germany. On this point Biilow disagreed with the emperor. He would willingly have negotiated with England on a limitation of armaments; but when King Edward visited Friedrichshof in Aug. 1908, the emperor told the British official, Hardinge, most abruptly, that he would not agree to any negotiations of the sort, and Bulow thought it better not to press his own view any further at present, hoping to be able to convert the emperor gradually. In the autumn of 1907 the emperor visited England, and made remarks which, in his opinion, were calculated to remove the apprehension aroused in England by the German naval programme. Soon after, these remarks were published as an interview with the *Daily Telegraph*, but produced exactly the opposite effect to that which had been intended. They were looked on in England as an attempt by a foreign monarch to interfere in England's private affairs. In Germany also the publication evoked lively disapproval and led to a question in the Reichstag and to an excited debate on the emperor's personal conduct of affairs. The emperor was obliged to make a declaration (Oct. 31, 1908), that he would in the future undertake no political step of importance without the chancellor's advice.

The first conflict between the Triple Alliance and the Entente arose over Austria's annexation of Bosnia in the autumn of 1908, in consequence of the Young Turk revolution. Serbia protested against the annexation, and as Russia supported her, a severe crisis broke out. Here again the emperor and Bulow differed. The emperor was shocked by Austria's action, which she had taken without previously informing Germany. He accused Vienna of duplicity and said that he personally felt himself most deeply wounded in his sentiments as an ally. Biilow, however, fearing that Germany would lose her last reliable ally, thought it right to support Austria at all costs.

Soon afterwards, Bulow, having been defeated in the Reichstag on the question of financial reform, again offered his resignation, which was this time immediately accepted by the emperor. The chancellor had long enjoyed his particular favour; but their relations had become increasingly unhappy for some time past. This was due partly to differences on points of policy, but even more to the emperor's feeling that Biilow had deceived him and left him in the lurch over the *Daily Telegraph* affair. Bethmann-Hollweg was now appointed imperial chancellor; but the emperor never really trusted him. Bethmann-Hollweg's earlier career had been passed in the internal administrative service and he himself realized his own lack of experience in foreign affairs; he therefore insisted on the appointment of Kiderlen-Wachter, formerly minister in Bucharest, as secretary of State. Kiderlen-Wachter enjoyed a reputation for unusual skill and energy, but more than ten years previously he had incurred the emperor's personal dislike in a private matter. He was primarily responsible for the new collision with France which arose in 1911 when the French began to bring Morocco under their rule altogether. Here again the emperor was against letting a fresh quarrel between Germany and France arise over Morocco. At his instigation, a treaty with France had been concluded in Feb. 1909, while Biilow was still in office, allowing France an exceptional position in Morocco. Kiderlen, however, believed that France would be prepared to cede the French Congo wholly or in part to Germany in return for a free hand in Morocco; he succeeded in making the emperor believe that this could be reached at the cost of a little pressure. Here again William yielded against his own better judgment to pressure from his advisers and agreed to the despatch of the "Panther," a small ship of war, to the Moroccan coast. Kiderlen did, indeed, obtain some of his demands, but the resentment in France now grew increasingly serious, and Germany's relations with England, who felt herself particularly pledged to support France over Morocco, deteriorated correspondingly.

Nevertheless one more opportunity for a German-English *rapprochement* seemed to offer itself, when the peace of Europe was dangerously threatened by the outbreak of the Balkan Wars. Relations seemed to have become really happy when Lord Haldane, the British War Minister, visited Berlin in Feb. 1912 on an official mission, and held personal conversations with the emperor, Tirpitz and Bethmann-Hollweg. The emperor in his sanguine fashion believed that his interview with Haldane had resulted in a complete understanding, but failed to see that the limitation of Germany's naval armament was still the British *sine* qua *non;* whereas he himself and Tirpitz were just engaged in drafting a new bill for increasing the rate of naval construction. This attempted *rapprochement* thus led to renewed coolness.

When the murder of the heir to the Austrian throne precipitated a crisis which led to the World War, the emperor was determined from the start to help Austria to get satisfaction from Serbia. Real difficulties could only arise if Russia took Serbia's part. The emperor, however, reckoned firmly on the community of monarchical interests, which he believed would prevent the tsar from coming forward as protector to the murderers of a prince. He failed to see that the final decision in Russia did not really lie with the weak tsar at all. The emperor himself did not at first imagine that any danger of war could arise. He started off on his Baltic cruise, without making any preparations; the alleged "Crown council" in Potsdam never took place. He did not return till after the Austrian Note to Belgrade had already been delivered; and he personally thought the Serbian answer quite fitting to form a basis for future negotiations. He disapproved when, despite this answer, Austria mobilized and declared war on Serbia, and he undoubtedly approved of Bethmann-Hollweg's eleventh-hour attempt to persuade the Austrians to hold their hand and to negotiate directly with Russia. He also sent a number of personal telegrams to the tsar Nicholas to try to restrain him from the mobilization which finally led to the outbreak of the war, and to offer him his mediation. All these endeavours to maintain peace proved, however, unsuccessful. The idea that the emperor wished for a war in order to found a German world empire, or to make any conquests at all, though widely current during the war, is, in the opinion of the writer, incorrect.

Interference in Internal Policy.—The emperor's interventions in German internal policy were also irregular. The first occasion was when he called on Bismarck to proclaim a far-reaching social and political reform. Only a small fraction of this was carried out during the first years of his reign. As these measures had not the desired effect of winning the mass of the workers from Social Democracy, a feeling of disappointment overcame the emperor. He always looked upon Social Democracy, which was republican on principle, as the irreconcilable enemy of the whole existing order, and particularly of the monarchy, and held it to be his duty to fight against it with all the means in his power. The murder of the French president, Carnot, seemed to him to be a sign of the increasing effect of international social propaganda, and after the autumn of 1894 he pleaded repeatedly in his speeches that the revolutionary movement must be fought, and called on his ministers to bring in fresh emergency legislation penalizing all attempts to overthrow the social order and any agitation in favour of class hatred with penal servitude. It was the differences which this bill evoked among the emperor's advisers that led to the dismissal of Caprivi in Oct. 1894 and the appointment of Prince Hohenlohe as imperial chancellor. Hohenlohe brought in a bill, which was rejected by the Reichstag in May 1895. The emperor, however, returned again and again to the idea but was never able to carry it through.

Another matter which caused him anxiety was the increasing influence of the Centre Party in the Reichstag and in the Prussian diet. Himself a Protestant, he resented the growing power of the Catholic elements. He intervened personally when the Centre allied itself with the Conservatives and attempted to pass a primary education act for Prussia, which would have increased the influence of the Church in the schools to an extraordinary degree. Being hostile both to Social Democracy and to the Centre party, the emperor naturally looked with sympathy on the idea of for ing a working majority in parliament by a coalition between the Conservative and Liberal parties. Prince Biilow, who had become Imperial Chancellor in 1899, attempted to put this idea into practice, his own feelings agreeing here with the emperor's. The elections of Jan. 1907, which brought the so-called "Bloc Parties" a considerable majority, seemed to the emperor to be a personal victory for himself. Bulow's inability to form a permanent coalition between the Bloc Parties, and to carry through the urgent financial reform by their help, seemed to the emperor a proof that the chancellor was incapable of carrying through his principles in domestic policy and strengthened him in his decision to accept his resignation.

The emperor did not openly rebel against the constitutional form of government which he found on his accession, since he saw the impossibility of altering it, but at heart he always disliked it, and his dislike increased in proportion to the numerical growth of Social Democracy and of the Centre in the parliaments. He looked on parliament as a necessary evil, and always considered the monarch to be the true vessel of sovereign power, appointed thereto by God. The opposition raised by the Reichstag to the emergency legislation which he desired, and the difficulties which had to be overcome over every increase of the army or the fleet led him on many occasions into bitter remarks about the people's representative. The emperor never had any new and constructive ideas on matters of domestic policy.

The World War.--On the outbreak of the World War, the emperor himself felt his own inability to take over the supreme command of the military operations. During the first years of the war an appearance was kept up of referring the last decisions to the imperial headquarters; but William was increasingly reduced to the position of a mere onlooker. The choice of leaders lay, indeed, in his hand, and here he did not always show the best judgment. He only agreed with reluctance, and under the pressure of emergency, to make Hindenburg commander-in-chief and to leave the real decisions to him and Ludendorff. The inaction of the German fleet during the first years of the war is also to be attributed to the emperor's personal wish, and involved him in a sharp difference with Admiral von Tirpitz.

After Aug. 1918 it became ever clearer that the existing situation was growing untenable; and now the emperor proved himself once again incapable of a firm decision. He was driven forward step by step by events and by individual advisers who managed to win his ear. A Crown Council under his presidency resolved to initiate peace negotiations; yet he allowed so much time to be wasted before this decision was executed, that in the meantime the military situation took a turn fatal for Germany. At the same time the signs of discontent in the population and in parliament increased, and he let himself be persuaded to appoint Prince Max of Baden imperial chancellor in Oct. 1918, although the prince was looked on as an advocate of the parliamentary methods which the emperor hated in his heart. After this, when President Wilson in his proclamations showed clearly that he considered the person of the emperor to be a real obstacle to the conclusion of peace, Prince Max, in agreement with the majority of the Reichstag, called upon the emperor to abdicate, a step which was not at first thought to involve the removal of the Hohenzollern dynasty. The outbreak of the revolution at the beginning of Nov. 1918 and its rapid growth made an immediate decision urgently necessary. As the emperor hesitated, Prince Max acted on his own authority, and on Nov. 9, proclaimed that the emperor would renounce the throne and the crown prince the succession, and that a regency was to be formed. The victorious Socialist party, however, was no longer satisfied with these concessions but proclaimed a republic.

The emperor, who was at that time on the western front, was now confronted with a very difficult decision. He might have ventured an attempt to overthrow the revolution by force by detaching a portion of the army on the western front, whose loyalty to the sovereign was not yet shaken. It was, however, doubtful whether the remainder of this army would be able, meanwhile, to defend Germany's western frontiers against the increasingly violent attacks of the enemy. Or again. he might have placed himself at the head of his army and sought death on the field of battle. Both these mere courses which only a strong and confident personality could have taken. William II. preferred to abandon the army, steal quietly away from the territory of his former empire, and escape to Holland on Nov. 10. His action dealt a fatal blow to the monarchist cause in Germany. The minor princes now saw no issue but to capitulate and to abdicate before the revolution.

On arrival in neutral Holland, William was interned. The castle of Doorn was given him as a residence and he lived henceforth in complete retirement from the world. During the peace negotiations the idea arose from time to time among Germany's enemies of demanding his extradition and punishing him for initiating the war, of which he was unjustly accused. Finally, however, this idea was abandoned. The most important change in William's circumstances during these last years was his second marriage, after the death of the Empress Augusta Victoria, with the widowed Princess Hermine of Schonaich-Carolath. He died at Doorn June 4, 1941 and was buried there. A military funeral was ordered by Adolf Hitler. (E. BRA.)

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See *Kaiserreden; Reden und Erlässe, Briefe und Telegramme Kaiser Wilhelms II.* (ed A. O. Klaussmann, 1902) Eng. trans., selection, *The German Emperor's Speeches* (ed L. Elkind, 1904); *Briefe Wilhelm II. an den Zaren 1894–1914* (ed. W. Goetz. 1920; Eng trans. I. D. Levine, 1921); F. Rachfahl, *Kaiser und Reich, 1888–1913* (1913); W. von Massow, *Die deutsche innere Politik unter Kaiser Wilhelm II.* (1913); J. L. de Lanessan, *L'empire germanique sous la direction de Bismarck et de Guillaume II.* (1915); H. Oncken, *Die Friedenspolitik Kaiser Wilhelms II.* (1918); W. Rathenau, *Der Kaiser* (1919); *Die Grosse Politik der Europäischen Kabinette, 1871–1914* (German Foreign Office, 1922, etc.); E. Ludaig, *Wilhelm II.* (1926; Eng. trans. 1926); *Letters of the Empress Frederick* (ed. F. Ponsonby, 1928).

WILLIAM I. (1772–1844), king of the Netherlands, born at The Hague on Aug. 24, 1772, was the son of William V., prince of Orange and hereditary stadtholder of the United Netherlands by Sophia Wilhelmina, princess of Prussia. In 1791 he married Frederica Wilhelmina, daughter of Frederick William II., king of Prussia. thus cementing very closely the relations between the houses of Orange-Nassau and Hohenzollern. After the outbreak of war with the French republic in 1793, he distinguished himself in the struggle against the revolutionary army under Dumouriez by the capture of Landrecies and the relief of Charleroi. By the victories of Pichegru the stadtholder and all his family were, however, compelled to leave Holland and seek refuge in England, where the palace of Hampton Court was set apart for their use. He afterwards made Berlin his residence. and took an active part in the unfortunate campaign under the duke of York for the reconquest of the Netherlands. After the peace of Amiens he had an interview with Napoleon at Paris, and received some territory adjoining the hereditary domains of the house of Nassau in Westphalia as a compensation for the abandonment of the stadtholderate and the domains of his house William refused, however. in 1806, in which year by the death of his father he became prince of Orange, to separate his interests from those of his Prussian relatives, and fought bravely at Jena. He was therefore despoiled by Napoleon of all his possessions. In 1809 he accepted a command in the Austrian army under the archduke Charles and was wounded at the battle of Wagram. When Holland rose in revolt against French domination in 1813, after eighteen years of exile he landed at Scheveningen (on Nov. 19) and was on Dec. 3. proclaimed prince sovereign of the Netherlands. His assumption in 1814 of the title of king of the Netherlands was recognized by the Powers, and by the Treaty of Paris his sovereignty was extended over the southern as well as the northern Netherlands, Belgium being added to Holland "as an increase of territory." After the battle of Waterloo, in which Dutch and Belgian troops fought side by side under his command, the congress of Vienna further aggrandized him by making him sovereign of the territory of Luxembourg with the title of grand duke.

William failed to realise that religious, racial and other differences made the union of the Netherlands and Belgium difficult. He drew up a constitution, which was accepted unanimously by the Dutch, but was rejected by the Belgians, because it contained provisions for liberty of worship. The king, however, by a subterfuge declared that the fundamental law had been approved. The new constitution, therefore, started badly, and it was soon evident that William intended to make his will prevail, and to carry out his projects for what he conceived the social, industrial and educational welfare of the kingdom regardless of the opposition of Belgian public opinion. For the discontent which culminated in the revolt of 1830 *see* BELGIUM: *History*. The Dutch were almost without striking a blow expelled from the country, the strongly fortified seaport of Antwerp alone remaining in their hands. Had the king consented at once to the administrative autonomy of Belgium, and appointed the prince of Orange governor of the southern Netherlands, the revolt might perhaps have been appeased. William, however, was too proud and too obstinate to lend himself to such a course. He appealed to the Powers, who had, in 1815, created and guaranteed the independence of the kingdom of the Netherlands. By the treaty of the eighteen articles, however, concluded at London on June 29, 1831, the kingdom of Belgium was recognized, and Leopold of Saxe-Coburg was elected king. William refused his assent, and in August suddenly invaded Belgium. The Belgian forces were dispersed, and the Dutch would have entered Brussels in triumph but for the intervention of the French. Still, however, William declined to recognize the new throne, and he had behind him the unanimous support of Dutch public opinion. For nine years he maintained this attitude, and resolutely refused to append his signature to the treaty of 1831. His subjects at length grew weary of the heavy expense of maintaining a large military force on the Belgian frontier and in 1839 the king gave way. He did so, however, on favourable terms and was able to insist on the Belgians yielding up their possession of portions of Limburg and Luxembourg which they had occupied since 1830.

A cry now arose in Holland for a revision of the fundamental law and for more liberal institutions; ministerial responsibility was introduced, and the royal control over finance diminished. William, however, disliked these changes, and finding further that his proposed marriage with the countess d'Oultremont, a Belgian and a Roman Catholic, was very unpopular, he suddenly abdicated on Oct. 7, 1840. After his abdication he married the countess and spent the rest of his life in quiet retirement upon his private estate in Silesia. He died in 1844.

See L. Jottsand, *Guillaume d'Orange avant son avénement au trône des Pays-Bas*; E. C. de Gerlache, *Histoire du royaume des Pays-Bas depuis 1814 jusqu'en 1830* (3 vols., Brussels, 1842); W. H. de Beaufort, *De eerste regeeringsjaren van Koning Willem I.* (Amsterdam, 1886); H. C. Colenbrander, *De Belgische Omwenteling* (The Hague, 1905); T. Juste, *Le Soulèvement de la Hollande en 1813 et la fondation du royaume des Pays-Bas* (Brussels, 1870); P. Blok, *Geschiedenis der Nederlandsche Volk*, vols. vii. and viii. (Leiden, 1907–08); H. T. Colenbrander, *Gedenksbukken d. algem. gesch. v. Netherland, d8–10, Regeering v. William I.* (1915–20).

WILLIAM II. (1792–1849), king of the Netherlands, son of William I., was born at The Hague on Dec. 6, 1792. When he was three years old his family was driven out of Holland by the French republican armies, and lived in exile until 1813. He was educated at the military school at Berlin and afterwards at the University of Oxford. He entered the English army, and in 1811, as *aide-de-camp* to the duke of Wellington, took part in several campaigns of the Peninsular War. In 1815 he commanded the Dutch and Belgian contingents, and won high commendations for his courage and conduct at the battles of Quatre Bras and Waterloo, at the latter of which he was wounded. The prince of Orange married in 1816 the grand duchess Anna Pavlovna, sister of the tsar Alexander I. In 1830, on the outbreak of the Belgian revolution, he went to Brussels, and tried to bring about a peaceable settlement on the basis of the administrative autonomy of the southern provinces under the house of Orange. His father had given him powers to treat, but afterwards threw him over and rejected the terms of accommodation that he had proposed. He withdrew on this to England and resided there for several months. In April 1831 William took the command of a Dutch army for the invasion of Belgium, and in a ten-days' campaign defeated and dispersed the Belgian forces under Leopold I. after a sharp fight near Louvain. His victorious advance was stayed by the intervention of the French. In 1840, on the abdication of his father, he ascended the throne as William II. The peace of 1839 had settled all differences between Holland and Belgium, and the new king found himself confronted with the task of the reorganization of the finances, and the necessity of meeting the popular demand for a revision of the fundamental law, and the establishment of the electoral franchise on a wider basis. He acted with good sense and moderation, and, although by no means a believer in democratic ideas, he saw the necessity of satisfying public opinion and frankly gave his support to larger measures of reform. The fundamental law was altered in 1848 and the Dutch monarchy, from being autocratic, became henceforth constitutional. The king's attitude secured for him the good will and affection of a people, loyal by tradition to the house of Orange, and the revolutionary disturbances of 1848 found no echo in Holland. William died suddenly on March 17, 1849.

See J. J. Abbink, *Leven van Koning Willem II.* (Amsterdam, 1849); J. Bosscha, *Het Leven van Willem den Tweede, Koning der Nederlanden, 1793–1849* (Amsterdam, 1852); P. Blok, *Geschiedenis der Nederlandsche Volk* (Leyden, 1908).

WILLIAM III. (1817–1890), king of the Netherlands, son of William II., was born at Brussels on Feb. 19, 1817. He married in 1839 Sophia, daughter of William I., king of Wiirttemberg. The marriage was an unhappy one, and ended in complete estrangement. William had no sympathy with political liberalism, but throughout his long reign of forty-two years, with a constant interchange of ministries and many ministerial crises, he never had a serious conflict with the states-general. He was economical, and gave up a third of his civil list in order to help forward the task of establishing an equilibrium in the annual budget, and he used his large private fortune to forward schemes of social and industrial progress.

William's two sons by his marriage with Sophia of Württemberg, William (1841–1879) and Alexander (1843–1884), died unmarried. By his second marriage in 1879, with the princess Emma of Waldeck-Pyrmont, he had a daughter, Wilhelmina (*q.v.*), who succeeded him. William died at the Loo, on Nov. 23, 1890.

See J. A. Bruijne, *Geschiedenis van Nederland in onzen tijd.* (5 vols., Schiedam, 1889–1906); P. Blok, *Geschiedenis der Nederlandsche Volk* (Leiden, 1908), vol. viii.; and G. L. Keppers, *De regeering van Koning Willem III.* (Groningen, 1887).

WILLIAM (1227–1256), king of the Romans and count of Holland, was the son of Count Floris IV. and his wife Matilda, daughter of Henry, duke of Brabant. He was about six years of age at his father's death, but his long minority, under the guardianship of his two paternal uncles, was peaceful. In 1247 William allowed Pope Innocent IV. to proclaim him king of the Romans in opposition to the excommunicated Frederick II., and having taken Aix-la-Chapelle, was crowned there on All Saints' Day, 1248. He thus became the recognized head of the Guelph party, but even after Frederick's death he had gained few adherents, when he was killed on Jan. 28, 1256. He was more successful in asserting the rights of John of Avennes, who had married his sister Aleidis, to the county of Hainaut against John's mother, Margaret, whom he defeated decisively at West Kappel in 1253.

See A. Ulrich, *Geschichte des römischen Königs, Wilhelm von Holland* (Hanover, 1882).

WILLIAM (1143–1214), king of Scotland, surnamed "the Lion," was the second son of Henry, earl of Huntingdon (d. 1152), a son of King David I., and became king of Scotland on the death of his brother, Malcolm IV., in Dec. 1165, being crowned at Scone during the same month. After his accession to the throne William spent some time at the court of the English king, Henry II.; then, quarrelling with Henry, he arranged in 1168 the first definite treaty of alliance between France and Scotland, and with Louis VII. of France assisted Henry's sons in their revolt against their father in 1173. In return for this aid the younger Henry granted to William the earldom of Northumberland, a possession which the latter had vainly sought from the English king, and which was possibly the cause of their first estrangement. However, when ravaging the country near Alnwick, William was taken prisoner in July 1174, and after a short captivity at Richmond was carried to Normandy, where he purchased his release by assenting in Dec. 1174 to the Treaty of Falaise. By this arrangement the king and his nobles, clerical and lay, undertook to do homage to Henry and his son; this and other provisions placing both the church and state of Scotland thoroughly under the suzerainty of England. William's next quarrel was with Pope Alexander III., and arose out of a double choice for the vacant bishopric of St. Andrews. But in 1188 William secured a papal bull which declared that the Church of Scotland was directly subject only to the see of Rome, thus rejecting the claims to supremacy put forward by the English archbishop. This step was followed by the temporal independence of Scotland, which was one result of the continual poverty of Richard I. In Dec. 1189, by the Treaty of Canterbury, Richard gave up all claim to suzerainty over Scotland in return for 10,000 marks, the Treaty of Falaise being thus definitely annulled.

In 1186 at Woodstock William married Ermengarde de Beaumont, a cousin of Henry II., and peace with England being assured three years later, he turned his arms with success against the turbulent chiefs in the north and west. Soon after John's accession in 1199 the Scottish king asked for the earldom of Northumberland, which John, like his predecessors, refused; but the threatened war did not take place, and in 1200 William did homage to the English king at Lincoln with the ambiguous phrase "saving his own rights." War again became imminent in 1209; but a peace was made at Norham, and about three years later another amicable arrangement was reached. William died at Stirling on Dec. 4, 1214, and was buried at Arbroath. He left one son, his successor Alexander II., and two daughters, Margaret and Isabella, who were sent to England after the treaty of 1209, and who both married English nobles, Margaret becoming the wife of Hubert de Burgh. He also left some illegitimate children.

See E. W. Robertson, *Scotland under her Early Kings* (Edinburgh, 1862); Lord Hailes, *Annals of Scotland* (Edinburgh, 1819); A. Lang, *History of Scotland*, vol. i. (1900); also SCOTLAND: *History*.

WILLIAM I. (d. 1166), king of Sicily, son of King Roger II. by Elvira of Castile, succeeded in 1154. His title "the Bad" probably expresses the bias of the historian Falcandus and the baronial class against the king and the official class by whom he was guided. William was far inferior in character and energy to his father, however, and the real power in the kingdom was at first exercised by Maio of Bari, whose title *ammiratus ammiratorum* was the highest in the realm. Maio continued Roger's policy of excluding the nobles from the administration, and sought also to curtail the liberties of the towns. The barons were encouraged to revolt by Pope Adrian IV., whose recognition William had not yet sought, by the emperor Manuel and the emperor Frederick II. At the end of 1155 Greek troops recovered Bari and began to besiege Brindisi.

William, however, destroyed the Greek fleet and army at Brindisi (May 28, 1156) and recovered Bari Adrian came to terms at Benevento (June 18, 1156), abandoned the rebels and confirmed William as king, and in 1158 peace was made with the Greeks. These diplomatic successes were probably due to Maio; on the other hand, the African dominions were lost to the Almohads (1156–1160). The policy of the minister led to a general conspiracy, and in November 1160 he was murdered in Palermo by Matthew Bonello, leader of the Sicilian nobles. For a while the king was in the hands of the conspirators, but the people and the army rallied round him; he recovered power, crushed the Sicilian rebels, and in a short campaign reduced the rest of the Regno. Thus freed from feudal revolts, William confided the government to men trained in Maio's school, such as the grand notary, Matthew d'Agello. He was the champion of the true pope against the emperor, and Alexander III. was installed in the Lateran in November 1165 by a guard of Normans. William died on May 7, 1166.

WILLIAM II. (d. 1189), king of Sicily, was only thirteen years old at the death of his father William I. when he was placed under the regency of his mother, Marguerite of Navarre. Until 1171 the government was controlled first by the chancellor Stephen of Perche (1166–1168), and then by Walter Ophamil, archbishop of Palermo, and Matthew d'Ajello, the vice-chancellor. William's character is indistinct; yet his reign is marked by an ambitious foreign policy and a vigorous diplomacy. Champion of the papacy and in secret league with the Lombard cities he defied the common enemy, Frederick II. In 1174 and 1175 he made treaties with Genoa and Venice and in February 1177 he married Joan, daughter of Henry II. of England. To secure peace with the emperor he sanctioned the marriage of his aunt Constance, daughter of Roger II., with Frederick's son Henry, afterwards the emperor Henry VI., causing a general oath to be taken to her as his successor in case of his death without heirs. This step, fatal to the Norman kingdom, was possibly taken that William might devote himself to foreign conquests. He now attacked Egypt, but Saladin's arrival before Alexandria, forced the Sicilians to re-embark in disorder. On the death of Manuel Comnenus (1180), William took up the old design and feud against Constantinople. Durazzo was captured (June 11, 1185), Thessalonica surrendered in August, and the troops then marched upon the capital; but were overthrown on the banks of the Strymon (Sept. 7, 1185). Thessalonica was abandoned and in 1189 William made peace with Isaac, abandoning all the conquests. He now planned to induce the crusading armies of the West to pass through his territories, and seemed about to play a leading part in the third Crusade. His admiral Margarito kept the eastern Mediterranean open for the Franks, and forced Saladin to retire from before Tripoli in the spring of 1188. In November 1189 William died, childless.

WILLIAM I. [FRIEDRICH KARL] (1781–1864), king of Wiirttemberg, son of Frederick, afterwards King Frederick I. of Wiirttemberg, was born at Luben, Silesia, on Sept. 27, 1781. In early years he took no part in public life owing to a quarrel with his father whose deference to Napoleon displeased him; but in 1814–15 commanded an army corps in the Wars of Liberation with distinction. On his accession in 1816 he realized the expectations formed of him as a liberal-minded ruler by promulgating a constitution (1819), under which serf dom and obsolete class privileges were swept away, and by issuing ordinances which greatly assisted the financial and industrial development and the educational progress of his country. In 1848 he issued further liberal decrees; but his relations with the legislature having become hopelessly strained over questions of Germanic policy, William repudiated the enactments of 1848–49 and summoned a packed parliament (1851), which re-enforced the code of 1819.

William encountered similar difficulties as a champion of Germanic union and of the rights of the Middle Germanic States against encroachments by Austria and Prussia. In 1820–23 he protested against Metternich's treatment of the minor German States and in 1848–49 opposed the proposals for a Germanic union made by the Frankfort Diet, for fear of granting Prussia excessive preponderance. Thus he gradually became the ally of Austria against Prussia. Nevertheless his devotion to the cause of Germanic union is proved by the eagerness with which he helped the formation of the Zollverein (1828–1830), and in spite of his conflicts with his chambers he achieved unusual popularity with his subjects.

William died on June 25, 1864.

See Nick, *Wilhelm I., Konig von Württemberg, und seine Regierung* (Stuttgart, 1864).

WILLIAM (FRIEDRICH-WILHELM-VICTOR-AUGUST-ERNST VON HOHENZOLLERN) (1882–1951), crown prince of Germany, eldest child of William II of Germany, was born in the Marble palace, Potsdam. on May 6, 1882 He received a commission in the 1st Foot Guards in 1900. On June 6. 1905, he married Cecilia, daughter of the grand duke Frederick-Francis III of Mecklenburg-Schwerin. There were five children, four sons and one daughter, of the marriage. His interventions in public affairs gave some trouble in the years preceding World War I; *e.g.,* in 1913, during the Saverne incident.

On the outbreak of World War I the crown prince was appointed to the command of the 5th army in the west. He received the command of an army group in 1915 and was nominally in charge of the German operations against Verdun. His flight to the Netherlands followed that of the kaiser in Nov. 1918, and he went to Wieringen. an island in the Zuider Zee. He formally renounced. on Dec. 1, 1918, his rights of succession to the crowns of Prussia and the German empire His wife and children, however, continued to reside at Potsdam.

His sudden return to his Silesian estate at Oels in Nov. 1923 caused considerable anxiety among the Allied powers. which was allayed, however, by assurances that he would take no part in politics. Yet he encouraged Berlin to vote for Hitler in 1932 and joined the Nazi motorized corps the following year. In 1944 he moved from Oels to the Cecilienhof in Potsdam; but with the end of World War II he fled to Lindau in Bavaria and was eventually captured by French troops. He died at Hechingen in Württemberg on July 20. 1951.

His *Erinnerungen* were published at Stuttgart in 1922.

WILLIAM (1533–1584), surnamed the Silent, count of Nassau and prince of Orange, was born at the castle of Dillenburg in Nassau on April 25, 1533, eldest of the five sons of William count of Nassau and Juliana of Stolberg (see NASSAU). The boy's father had decided leanings towards Lutheranism, his mother was a convinced adherent of the new faith. So it was not without hesitation that the emperor sanctioned an arrangement by which the great heritage of the Nassau family in his Netherlands dominions and the princedom of Orange would fall to their son, and when he did sanction it, it was on condition that the old count should surrender all claims to the guardianship and that the boy should be educated in the Netherlands, with a household of Netherlanders, and as a Catholic. To this arrangement the father consented.

William of Orange thus grew up, at Brussels and at Breda, a great Netherlands nobleman, marked out for a career in the service of the ruler. In 1551 he married Anna van Buren, an heiress of the Egmont family, adding estates in Holland to his already extensive possessions. Charles V. distinguished him with his favour. Philip II., too, began by creating Orange a member of the Brussels Council of State, and before he left the Netherlands for Spain, 1559, he made him his governor (Stadtholder) in the provinces of Holland, Zeeland and Utrecht.

If William of Orange's career was soon so startlingly to deviate from the lines of tradition laid down for him by his predecessors, it was due in the first place to the different relationships in which, in his time, the monarchy had come to stand with respect to the Netherlands. The creation of a united Netherlands state had been the historical task of the Burgundian dynasty. By successive marriages of Mary, daughter of Charles the Bold, with Maximilian of Habsburg, and of their son, Philip the Fair, with Johanna of Spain, that state had become connected with an empire with which it had few interests in common. Under Charles V. already this had created many difficulties, while his son Philip II. looked upon the Netherlands merely as an outpost of the Spanish imperialist policy.

The high nobility of the Netherlands were quick to resent the anti-national tendencies of Philip's government at Brussels. After the king's departure it was carried on by his half-sister, Margaret of Parma, as his regent, but the real force behind her was the bishop of Arras, later archbishop of Mechlin and cardinal, the Franc-Comtois Granvelle, who was made president of the Council of State. Between that zealous and docile minister and the proud, unruly nobles a bitter struggle was soon in progress, in which Orange, with the counts of Egmont and Horn and others, played a conspicuous part. When Orange and Egmont stayed away from the Council of State as a protest against Granvelle's presence there the public realized that grave issues had been raised. In 1564 Philip gave way and ordered Granvelle to depart, whereupon the Regent tried to govern with the noblemen of the Council of

State. It was a victory for the national cause, but at the same time it was a victory for class interests.

One question, which aggravated the difficulties between the ruler and the Netherlands people considerably, had suddenly become of paramount importance when the dismissal of the cardinal seemed to indicate a slackening of purpose on the part of the distant king. All through Charles V.'s reign Lutheranism had been severely kept under. To the Lutheran heresy Calvinism, spreading northward from France, was now added. Public opinion in the Netherlands was generally averse from the savage methods of suppression imposed on the government by Philip. William of Orange never was a very devout Catholic. He had maintained close relations with his Lutheran kinsmen in Germany. His brother Louis, particularly, who spent much of his time at Orange's court at Brussels or Breda, had great influence over him. In 1561, Anna van Buren having died in 1558, the prince had contracted a matrimonial alliance with German Protestantism in the person of Anna of Saxony, daughter of the late Elector Maurice, the betrayer and victor of Charles V. In order to gain the present elector's consent, as well as to quiet the objections and suspicions of Philip II.'s Government, Orange had secretly given to both sides flatly contradictory assurances. The episode shows his character on its least attractive side. But at any rate his position helped him to realize how impossible it was, in the Netherlands, surrounded by countries where Protestantism had in some form or other achieved some sort of recognition, and always open to influences from outside, to enforce a rigid Catholic supremacy. He said so boldly in the Council of State, but it was in vain that he and his friends urged the king to concede some degree of toleration. When Philip, after long delay, by the famous letters from Legovia, ordered more relentless persecution than ever, Orange, realizing the impotence of the Council of State, countenanced the action of his brother Louis, and Hendrik van Brederode, who organized the lower nobility to petition the governess for liberty of conscience. The question was thus brought before the public and excitement raised to fever pitch.

Most of the petitioners were undoubtedly good Catholics, but suddenly there now occurred the outbreak by extreme Calvinists, known as the Breaking of the Images, which brought about a violent reaction. While the nobles lately in opposition ranged themselves behind Margaret of Parma to restore order, Philip prepared to send to the Netherlands an army under the duke of Alva to chastise them and to introduce absolutism. In the interval before the arrival of the terrible duke there was much talk of organizing resistance. The prince of Orange was in doubt as to the régime to be expected, yet he shrank from co-operating with the only party ready to throw themselves into the fight, the Calvinists. As viscount of Antwerp he prevented the Antwerp Calvinists from going to the assistance of a little army of their co-religionists that was cut to pieces by Margaret of Parma's troops under the walls of the town (March 1567).

The first period of Orange's career ended in failure. After the encouragement he had given to the national opposition movement his conduct at the moment of crisis is disconcerting. To understand it one has to remember that the Calvinists still were a tiny minority, suspected and hated as a menace to society no less than to the Church. A movement in which they took the lead had, at that moment, little chance of becoming truly national, and William of Orange, who was not yet personally in sympathy with Calvinism, was then and always concerned before everything else with preserving national unity.

From Germany, where he had retired, the prince kept in touch with adherents in the Netherlands, and with money collected from them and raised in his Nassau lands, he brought together an army with which he attempted to deliver the Netherlands from Alva's tyranny (1568). The attempt failed miserably. The Netherlands, cowed, did not rise, and the army had, for lack of money, soon to be disbanded. Help, as Orange realized, could only come from outside, and nothing was to be expected from German Lutheranism. He now entered into close relations with the French Huguenot leaders, for some years taking part in their campaigns against the French Government. At La Rochelle Louis of Nassau organized the forces of the Sea Beggars, whose booty went to swell the prince's war chest. New hope was born when after the peace of St. Germain (Aug. 1570) they seemed to win influence at the court of France. Louis of Nassau and Coligny inspired Charles IX. with plans of war and conquest against Spain, and it was in the expectation of French help that Orange in 1572 repeated the attempt of 1568 and invaded the Netherlands with an army collected in Germany. The St. Bartholomew's massacre, which overthrew Huguenot influence at court dashed his hopes. Again he had to disband his army and to leave Alva in possession.

But this time there had been a response to his invasion. Not the central province of Brabant, kept quiet by the presence of Alva's army, but a number of towns in the outlying northern provinces had risen against the Spaniards. The surprise capture of the Brill by a fleet of Sea Beggars had started the movement. Now that his great plans in conjunction with France had come to nothing, the prince decided to join the Holland and Zeeland rebels, who had proclaimed him as their Stadtholder again. It seemed a forlorn hope. Compared with Flanders and Brabant, Holland and Zeeland at that time seemed poor and distant regions.

The decision was one of the great moments of his career. For four heroic years he shared the anxieties and distress of the two maritime provinces, stubbornly holding out against the Spanish army sent to subdue them. The States assemblies of Holland and Zeeland, which were almost entirely composed of burghers and of Calvinists, placed complete confidence in the great nobleman who had lost his fortune and his position for the national cause. In 1573 the prince himself joined the Reformed Church. Meanwhile he led the desperate resistance against the Spaniards. The relief of Leyden in 1574 was to a large extent due to his untiring efforts. Yet in 1576, with the Spaniards at Haarlem and Amsterdam as well as at Middelburg and Zieriksee, the two provinces were near succumbing, when the situation underwent a dramatic change.

The Spanish governor, who had succeeded Alva in 1574, Requesens, unexpectedly died. The Spanish soldiery, long unpaid, mutinied. They evacuated their hard-won posts in Holland and Zeeland and came south to live on the riches of Brabant. The Spanish Government in the Netherlands practically broke down. The States of Brabant summoned a meeting of the States-General to Brussels, and negotiations between this nominally loyal body and the two rebel provinces were started at Ghent for the purpose of combining against the Spanish soldiers. The conclusion of the Pacification of Ghent (Nov. 8, 1576) seemed to restore the unity of the Netherlands, threatened since the separate rebellion of Holland and Zeeland.

But an ominous rift threatened that unity. The Pacification, while suspending the edicts against heresy, had safeguarded the supremacy of Catholicism in all the provinces save Holland and Zeeland. Calvinist refugees were now flocking back to the towns of Flanders and Brabant, and they were not content with toleration, they wanted the same position of supremacy which their co-religionists in the two rebel provinces, in the stress of revolution and under the immediate menace of foreign attack, had managed to secure. This irritated the nohility, who in the south had greater power and were everywhere slow to embrace Calvinism, while the French-speaking provinces, like Hainaut, or Lille, Orchies and Douai, were now almost solidly Catholic. Orange was fully alive to the danger of these elements gravitating back to the king.

But in many respects his position was a thoroughly false one. Circumstances had ever since 1567 conspired to drive him into closer association with Calvinism. The Calvinists who had obtained control in the provinces of Holland and Zeeland did not dream of sacrificing any of their local supremacy to the national compromises elaborated at Brussels. Yet those two provinces continued to afford to the prince his firmest *point d'appui* in the shifting conditions of Netherlands polities. Early in 1579, the Walloon provinces, incensed at the aggressiveness of the Flemish Calvinists, had deserted the national cause and at Arras had made their peace with the king's new governor, the duke of Parma, who could now from that foothold in the south set about re-conquering the rest of the Netherlands. Did not the event, which was followed by the loss of the north-eastern province of Groningen, go to prave that the Calvinists were the only party who could be counted on to hold out against all the blandishments of Parma? When Orange tried once more to enlist the help of France, and the Catholic duke of Anjou was clothed with the sovereignty of the Netherlands from which in 1581 the States-General solemnly deposed Philip II., the prince's particular connection with the two maritime provinces was expressly safeguarded. And however earnestly he deplored and tried to restrain the intolerant fanaticism of the Calvinists in Flanders and Brabant, all the time he saw himself forced underhand to work with them, thereby adding to the grievances of the Catholics, although at the same time Calvinist ministers denounced him as a godless timeserver.

The last years of William the Silent's life were a tragic struggle against overpowering circumstances. The unity of the Netherlands was broken beyond repair, and the area supporting the national cause kept crumbling away, The States-General had to leave Brussels in 1578, they stayed at Antwerp for a short while, then moved behind the waters to Middelburg, and finally to Delft, where William the Silent resided from 1583 onwards. His main efforts throughout those years were directed towards preserving the southern provinces, until then the principal provinces of the Netherlands, and of which Brabant had such close associations with him personally, and towards obtaining foreign help. The conclusion of the Union of Utrecht in 1579 met with his disapproval, as it seemed to be, on the part of the more easily defensible regions north of the rivers, an abandonment of the wider union of the Pacification. He had soon, nevertheless, to fall back upon it, and then did his best to make it comprehensive, nor were his efforts without success, for in the course of that year and the next all the towns of Flanders and several of those of Brabant entered it.

In 1581 Philip II. had promulgated a ban against William of Orange, by which a high reward was promised to anyone who would deliver the world of this traitor. A year later a serious attempt was made on his life, but it was only in 1584 that the ban achieved its purpose. On July 9, Balthazar Gérard, a Burgundian, shot the prince at Delft. William was 51 years of age.

Some years after the prince's death, owing to the assistance given by England and to Philip's injudicious interference in the French civil war, the turn came in the tide of Netherlands affairs, and although of the country south of the rivers little was recovered, at least the country north of them was secured and blossomed out into the republic of the Seven United Provinces. Of that state William the Silent is truly called the father. Yet it should not be forgotten that this was not the object which he had in view and that the split of the Netherlands means that his life's work was not accomplished. Apart from his success and failure in Netherlands politics, William the Silent will always be hocoured as a man who nobly struggled and suffered for the cause of liberty of conscience. His personality, genial and humane, was fully worthy of the great part he played. There is something exceptionally attractive in his evolution from a frivolous courtier into the frugal and hard-working leader of a seemingly hopeless revolt, harassed but patient, courageous in the face of accumulating disaster, while the steadfastness with which at a time of furious religious fanaticism he preached moderation and forbearance has a heroic quality that is not disposed of by observing that his outlook was secular. His correspondence proves that in his later years religion was a real thing to him, and his attachment to the Reformed Church was sincere.

See Groen van Prinsterer, *Archives ou correspondance inédite de la Maison d'Orange-Nassau;* Gachard, *Correspondance de Guillaume le Taciturne; Apologie du Prince d'Orange;* Motley, *Rise of the Dutch Republic;* Putnam, *William the Silent;* Fruin, *Het Voorspel van den tachtigjarigen oorlog,* and other essays; Rachfahl, *Wilhelm van Oranien* (3 vols. to 1572, no more appeared); P. J. Blok, *Willem de Eerste* (2 vols., Amsterdam, 1919–20). (P. GE.)

WILLIAM II. (1626–1650), prince of Orange, born at The Hague on May 27, 1626, was the son of Frederick Henry, prince of Orange, and his wife Amalia von Solms, and grandson of William the Silent. By the act of survivance passed in 1631 the offices and dignities held by Frederick Henry were made hereditary in his family. On May 12, 1641 William married, in the royal chapel at Whitehall, Mary, princess royal of England, eldest daughter of King Charles I. At the time of the wedding the bridegroom was not yet fifteen years old, the bride was five years younger. William from his early youth accompanied his father in his campaigns, and already in 1643 highly distinguished himself in a brilliant cavalry fight at Burgerhout (Sept. 5). On the death of Frederick Henry William succeeded him. At the moment of his accession to power the negotiations for a separate treaty of peace with Spain were almost concluded, and peace was actually signed at Munster on Jan. 30, 1648. By this treaty Spain recognized the independence of the United Netherlands and made large concessions to the Dutch. William did his utmost to prevent the ratification, but failed. He opened secret negotiations with France in the hope of securing the armed assistance for a war of aggrandisement against the Spanish Netherlands and of a restoration of his brother-in-law, Charles II., to the throne of England. The states of Holland, on the other hand, were determined to thwart any attempts for a renewal of war, and insisted, in defiance of the authority of the captain-general supported by the states-general, in virtue of their claim to be a sovereign province, in disbanding a large part of the regiments in their pay.

A prolonged controversy arose, which ended in the states-general in June 1650 commissioning the prince of Orange to visit the towns of Holland and secure a recognition of their authority. The mission was unsuccessful. Amsterdam refused any hearing at all. William resolved therefore to use force and crush resistance. On July 30 six leading members of the states of Holland were seized and imprisoned in the castle of Loevestein. On the same day an attempt was made to occupy Amsterdam with troops. The citizens were, however, warned in time, and the gates closed. William's triumph was nevertheless complete. The states of Holland submitted. The prince entered into fresh negotiations with the French government, and a draft treaty was drawn up. But William died of small-pox on Nov. 6, 1650. A week after his death his widow gave birth to a son, who was one day to become William III., king of England.

WILLIAM IV., landgrave of Hesse (1532–1592), was the son and successor of the landgrave Philip the Magnanimous. He took a leading part in safeguarding the results of the Reformation, endeavouring to unite all sections of Protestantism against the Catholic reaction. As ruler he displayed common-sense and tolerance; patronized art and science; placed the finances of his country on a sound basis and secured it against subdivision by a law of primogeniture. He was chiefly famous, however, as a pioneer in astronomical research.

See R. Wolf, "Astronomische Mittheilungen," No. 45 (*Vierteljahrsschrift der naturforschenden Gesellschaft in Zürich,* 1878).

WILLIAM [Frederick Henry], Prince of Wied (1876–), born at Neuwied on March 26, 1876, was 3rd son of William Prince of Wied and Mary Princess of Holland, grand-nephew of the emperor William I. and nephew of Queen Elizabeth of Rumania. An able soldier, he became a captain of the general staff in 1911, and in 1913 commanded a squadron of the 3rd Uhlans of the Guards. He married in 1906 Sophie, Princess of Schoenburg-Waldenburg, and had two children, Princess Marie Eleonor (1909) and Prince Charles Victor (1913). In Feb. 1914, inspired by idealism rather than ambition, he accepted the Albanian throne against the Kaiser's advice, and landed on March 7. Italy, France, Russia, Greece, Montenegro, Serbia, Turkey and Essad Pasha intrigued against him. Essad possessed troops, and the Mbreti (King), who had none, felt obliged to conciliate him with the Ministries of War and Interior. While the Greeks ravaged southern Albania an insurrection confined the Mbreti to Durazzo Essad was exiled in May; but foreign agents, protected by the Capitulations, paralysed the royalists. In Aug. 1914 Austria abandoned him because he determined to preserve neutrality. Besieged, and without resources, he reluctantly left Albania on Sept. 3. He did not abdicate. Early in 1915 the insurgents, finding they had been victims of intrigue, asked him to return, but this Austria prevented. He was attached as an Albanian and foreigner to a German divisional staff in Poland during the World War. On the accession of Ahmed Zogu in 1928 Prince William declared that he would not return unless unanimously invited. (J. Sw.)

WILLIAM OF MALMESBURY (c. 1090–c. 1143), the foremost historian of his time, was born about 1090 in the southwest of England. He was educated at Malmesbury abbey and became a monk there, assisting Godfrey, abbot from 1081 to 1105, in collecting a library for the use of the community. His education included some logic and physics, but his principal studies were moral philosophy and history. He made a collection of the histories of foreign countries, and decided to write a popular account of English history, modeled on Bede's great work. He produced the first edition of his *Gesta regum Anglorum* in c. 1125: the first edition of the *Gesta pontificum Anglorum* followed shortly afterward. Two later editions of the *Gesta regum* (1135–40) were dedicated to Robert, earl of Gloucester: another patron was Henry, bishop of Winchester. William was a candidate for the abbacy of Malmesbury in 1140, but cheerfully yielded to his friend John. In 1141 he attended the council of Winchester, at which the clergy declared for the empress Matilda. At about this date he undertook to write the *Historia novella,* giving an account of events after 1126. This work breaks off abruptly at the end of 1142; presumably William died before he could finish it.

William's contempt for the annalistic form adopted by other chroniclers makes him at times careless in his chronology and arbitrary in his method of arranging his material, but he has preserved much valuable information, as for the reign of King Athelstan, and is an authority for the period after 1066. His pages contain many entertaining and telling anecdotes, many shrewd judgments on persons and events, and his style is vivid and powerful.

The standard edition of the *Gesta regum* and the *Historia novella* is that by W. Stubbs, "Rolls Series," 1 vol. in 2 (1887–89); the second part contains a valuable introduction on William's sources and value as a chronicler. There is also an edition of the *Historia novella* by *K. R.* Potter (1955). The *Gesta pontificum* was ed. for the "Rolls Series" by N. E. S. A. Hamilton (1870) from a manuscript which he was the first to identify as the archetype. Another work *De antiquitate Glastoniensis ecclesia* (A.D. 63–1126) is printed in vol. 1 of T. Hearne's *Adam of Domerham* (1727) and discussed by J. Armitage Robinson in *Somerset Historical Essays* (1921). His *Vita Wulfstani,* an amplified translation of an Anglo-Saxon biography, was ed. by R. R. Darlington, Royal Historical society, "Camden Series" XL (1928). Stubbs, in his *Memorials of St. Dunstan,* "Rolls Series" (1874) prints a *Vita S. Dunstani* written about 1126. (H. W. C. D.; R. H. C. D.)

WILLIAM OF NEWBURGH (d. c. 1198), or, as he is sometimes styled, Guilielmus Parvus, English ecclesiastic and chronicler, was a canon of the Augustinian priory of Newburgh in the North Riding of Yorkshire. He was born about 1136, and lived at Newburgh from his boyhood. Shortly before 1196 he began his *Historia rerum Anglicarum.* This work, divided into five books, covers the period 1066–1198. A great part of it is derived from known sources, especially from Henry of Huntingdon, Jordan Fantosme, the *Itinerarium regis Ricardi,* or its French original, and a lost account, by Anselm the chaplain, of the captivity of Richard I. The value of Newburgh's work lies in his estimates of men and situations. His political insight and his impartiality entitle him to a high place among the historians of the 12th century. (H. W. C. D.)

WILLIAM OF WYKEHAM (1323?–1404), English lord chancellor and bishop of Winchester. William Wykeham was born at Wickham, Hants, in 1323 or 1324. He was educated at Winchester, probably at the grammar school there, and became undernotary to the constable of Winchester castle, probably Robert of Popham, who was appointed in 1340. He was transferred to the king's court in 1343. In 1350 he appears to have been keeper of the manor of Rochford, Hants. His name appears in various other transactions in the county during the next few years; in 1356 he is first recorded as being directly employed by the king as clerk of the works to the manors of Henley and Easthampstead. In October he was appointed to the same office at Windsor, which he held until 1361.

Wykeham was already receiving wages as king's clerk in 1357, and he was richly rewarded for his various services by a series of benefices. He received the rectory of Pulham, Norfolk, in 1357, a canonry and prebend at Lichfield in 1359, though he did not obtain actual possession in either case without a struggle. In 1359 also, after the French raid on Winchelsea, he was placed in charge of the repair of the castles on the Kent coast and of many manors.

Meanwhile he had been appointed a clerk of the exchequer (Oct. 1361) and keeper of the forests south of the Trent. In 1364 he became privy seal. On Oct. 13, 1366, Wykeham was named bishop of Winchester. He was consecrated in Oct. 1367, and enthroned in 1368. Meanwhile he had been made (Sept. 17, 1367), chancellor of the kingdom. Parliament was inclined to lay the blame of the disasters of the French war on the clerical advisers of the Crown, and in 1372 Wykeham resigned the chancellorship.

Wykeham must have amassed a large fortune by his various employments and benefices; his application of that fortune has made him revered by successive generations of "Wykehamists." He began buying lands for the endowment of his great foundations of Winchester college, Winchester, and of New college, Oxford, in 1367. In 1373 he entered into an agreement with the master, Richard of Herton, "Grammaticus," for ten years faithfully to teach and instruct the poor scholars whom the bishop maintained at his own cost, in the art of grammar, and to provide an usher to help him. He was diverted from his foundations by public affairs, being named by the Commons one of the eight peers to discuss with them the state of the realm.

Lord Latimer and Alice Perrers, the king's mistress, were impeached (1376), and Wykeham took a leading part against Latimer. At the dissolution of parliament a council of nine, of whom Wykeham was one, was appointed to assist the king. But on June 8, the Black Prince died. Alice Perrers returned. John of Gaunt called a council (Oct. 16) to impeach Wykeham on articles which alleged misapplication of the revenues, oppressive fines on the leaders of the free companies, taking bribes for the release of the royal French prisoners, especially of the duke of Bourbon, who helped to make him bishop, failing to send relief to Ponthieu and making illegal profits by buying up Crown debts cheap. He was condemned on one only, that of halving a fine of £80 paid by Sir John Grey of Rotherfield for licence to alienate lands, and tampering with the rolls of chancery to conceal the transaction. Wykeham's answer was that he had reduced the fine because it was too large, and that he had received nothing for doing so. Skipworth, a judge of the common pleas, cited a statute under which for any erasure in the rolls to the deceit of the king 100 marks fine was imposed for every penny, and so Wykeham owed 960,000 marks. Wykeham was convicted, his revenues were seized and bestowed (1377) on the young prince Richard.

On June 21, 1377, Edward III. died. Wykeham received full pardon, and at once took an active part in the financial affairs of the new king, giving security for his debts and himself lending 500 marks, afterwards secured on the customs (Pat. 4 Rich. II. pt. i. m. 4). He then set to work to buy endowments for Winchester and New colleges. On Nov. 26 he issued his charter of foundation of "Seynt Marie College of Wynchestre in Oxenford" for a warden and 70 scholars to study theology, canon and civil law and arts, who were temporarily housed in various old halls. On March 5, 1380, the first stone was laid of the present buildings, which were entered on by the college on April 14, 1386. The foundation of Winchester was begun with a bull of Pope Urban VI. on June 1, 1378, enabling Wykeham to found "a certain college he proposed to establish for 70 poor scholars, clerks, who should live college-wise and study in grammaticals near the city of Winchester," and appropriate to it Downton rectory, one of the richest livings belonging to his bishopric. The bull says that the bishop "had, as he asserts, for several years administered the necessaries of life to scholars studying grammar in the same city." On Oct. 20, 1382, "Seinte Marie College of Wynchestre by Wynchestre" was founded for a warden and "70 pore and needy scholars studying and becoming proficient in grammaticals or the art and science of grammar." The first stone of the buildings was laid on March 26, 1388, and they were entered by the scholars on March 28, 1394, not, as supposed at the quincentenary celebration in 1893, in 1393. While the new buildings were being erected, the college remained in the parish of "St. John the Baptist on the Hill" of St. Giles, supplying scholars to New college then as since. The foundation was on the model of Merton and Queen's colleges at Oxford, to which grammar schools were attached by their founders, while fellows of Merton were the first wardens of both of Wykeham's colleges. The severance of the school which was to feed the college exclusively, placing it not at Oxford, but at Winchester, and constituting it a separate college, was a new departure of great importance in the history of English education. Ten fellows and 16 choristers were added in 1394 to the 70 scholars, the choristers attending the school like the scholars, and being generally, during the first three centuries of the foundation, promoted to be scholars. The original statutes have not come down to us. Those which governed the colleges until 1857 were made in 1400. They state that the colleges were provided to repair the ravages caused by the Black Death in the ranks of the clergy, and for the benefit of those whose parents could not without help maintain them at the universities.

The time which elapsed between the foundation and completion of the colleges may be attributed to Wykeham's preoccupation with politics in the disturbed state of affairs, due to the papal schism begun in 1379, in which England adhered to Urban VI. and France to Clement VII., to the rising of the Commons in 1381, and the wars with France, Scotland and Spain during John of Gaunt's ascendancy. Then followed the constitutional revolution of the lords appellant'in 1388. When Richard II. took power on himself on May 3, 1389. he at once made Wykeham chancellor, with Brantingham of Exeter again as treasurer.

On Sept. 27, 1391, Wykeham finally resigned the chancellorship. For three years after there are no minutes of the council. On Nov. 24. 1394, Wykeham lent the king the sum of £1,000, which same sum or another £1,000 he promised on Peb. 21. 1395, to repay by midsummer. and did so. Wykeham was clearly against the assumption by Richard of absolute power. He excused himself from convocation in 1397. and from the subservient parliament at Shrewsbury in 1398. Possibly he took part in the revolution of Henry IV. He appeared in the privy council four times at the beginning of Henry's reign. There are records of loans by him to Henry IV. in the first years of his reign. Meanwhile, on Sept. 29. 1394, he had begun the recasting of the nave of the cathedral with William Wynford, the architect of the college, as chief mason. and Simon Membury, an old Wykehamist, as clerk of the works. He died on Sept. 27, 1404, aged 80.

See Thomas Martin, *Wilhelmi Wicami* (1597); *R.* Lowth, *Life of Wykeham* (1736); Mackenzie E. C. Walcott, *William of Wykeham and his Colleges* (1852); T. F. Kirby, *Annals of Winchester College* (1892); G. H. Moberly, *Life of Wykeham* (1887); A. F. Leach, *History of Winchester College* (1899); and the *Calendars of Patent and Close Rolls, Edward III. and Richard II.*

WILLIAMS, JOHN (1582–1650), English archbishop and lord keeper, son of Edmund Williams of Conway, was born in March 1582 and educated at St. John's College, Cambridge. He received rapid promotion in the Church, and, on the fall of Bacon (1621), was appointed lord keeper, and was at the same time made bishop of Lincoln, retaining also the deanery of Westminster. Williams took the popular side in condemning arbitrary imprisonment by the sovereign. A case was preferred against him in the Star Chamber of revealing state secrets, to which was added in 1635 a charge of subornation of perjury, of which he had undoubtedly been guilty and for which he was condemned in 1637 to pay a fine of £10,000, to be deprived of the temporalities of all his benefices, and to be imprisoned during the king's pleasure. He was sent to the Tower. In 1639 he was again condemned by the Star Chamber for libelling Laud, a further heavy fine being imposed for this offence. In 1641 he recovered his liberty on the demand of the House of Lords, who maintained that as a peer he was entitled to be summoned to parliament. In December 1641 the king, anxious to conciliate public opinion, appointed Williams archbishop of York. In the same month he was one of the twelve bishops impeached by the Commons for high treason and committed to the Tower. Released on an undertaking not to go to Yorkshire, a promise which he did not observe, the archbishop was enthroned in York Minster in June 1642. On the outbreak of the Civil War, after visiting Conway in the Royalist interest, he joined the king at Oxford; he then returned to Wales, and finding that Sir John Owen, acting on Charles's orders, had seized certain property in Conway Castle that had been deposited with the archbishop for safe-keeping, he went over to the Parliamentary side and assisted in the recapture of Conway Castle in November 1646. Williams, who was a generous benefactor of St. John's College, Cambridge, died on March 25, 1650.

WILLIAMS, JOHN (1796–1839), English Nonconformist missionary, was born at Tottenham near London on June 29, 1796. He was sent by the London Missionary Society in 1816 to Eimeo, in the Society Islands, where he rapidly acquired a knowledge of the native language. After staying there for a short time, he finally settled at Raiatea, which became his permanent headquarters. His success was remarkable. The people rapidly became Christianized and adopted many of the habits of civilization. Williams travelled unceasingly among the various island groups, planting stations and settling native missionaries whom he himself had trained. From the Society Islands he visited the Hervey group, where he discovered, and stayed for a considerable time on, the island of Rarotonga. Besides establishing Christianity and civilization among the people, he also, at their own request, helped them to draw up a code of laws for civil administration upon the basis of the new religion. While at Rarotonga he, with the help of the natives, built himself a 60-ft. ship, "The Messenger of Peace," within about four months; with this he returned to Raiatea, and made voyages among other island groups, including Samoa and the neighbouring islands. Williams returned to England in 1834 (having previously visited New South Wales in 1821); and during his four years' stay at home he had the New Testament, which he had translated into Rarotongan, printed. Returning in 1838 to the Pacific, he visited the stations already established by him, as well as several fresh groups. He went as far west as the h'ew Hebrides, and, while visiting Eromanga, one of the group, was murdered by cannibal natives Nov. 20, 1839.

His *Narrative of Missionary Enterprises in the South Sea Islands* was published in 1837, and formed an important contribution to our knowledge of the islands with which the author was acquainted. See *Memoir of John Williams,* by Ehenezer Prout (London, 1843); C. S. Horne, *The Story of the L.M.S.* (1908), pp. 41–54.

WILLIAMS, ROGER (1603?–1683), founder of the colony of Rhode Island and pioneer of religious liberty, was the son of a London merchant tailor. As a boy he attracted the attention of Sir Edward Coke, who employed him as a shorthand clerk in official proceedings and saw him through his schooling at Charterhouse (1621–24). He then attended Pembroke hall, Cambridge, as a pensioner, graduating in 1627.

Cambridge during Williams' residence was a centre of Puritan activity, and the young scholar joined the ranks of those who accepted the theology of John Calvin and promoted political measures which would bring an end to episcopacy in the Church of England. In 1628 he became chaplain to the household of Sir William Masham at Otes, Essex. where he was surrounded by such politically active Puritans as Oliver Cromwell, John Winthrop, John Cotton and Thomas Hooker (*qq.v.*) During his chaplaincy Williams became a complete nonconformist and, upon the organization of the Massachusetts Bay colony, left his post to pursue his religious ideals in h'ew England.

When he arrived in Boston early in 1631, however, he showed himself to be more reformed than those who had preceded him, for he rejected an invitation to become temporary pastor at Boston on the grounds that he "durst not officiate to an unseparated people." He insisted upon the open repudiation of the Church of England instead of holding the prevailing rationale that although the Bay churches did not conform with the "corrupt" practices of the national church, they were, nevertheless, a part of it. Williams accepted appointment as teacher of the church at Salem, but there, too, he was uneasy at what he believed to be halfway measures, and in 1632 went to Plymouth colony where the congregation was avowedly separatist.

In 1633, however, Williams was back in Salem, having come to open disagreement with Plymouth on his insistence that the king's patent was invalid and that only direct purchase from the Indians gave a just title to the land. Although the Salem church invited him to become pastor in 1634, the civil authorities of Massachusetts Bay were opposed to his residence, for in addition to his notions about land rights. other of his views were unpopular: he claimed that magistrates had no right to interfere in matters of religion, and that they could not administer oaths to the unregenerate because this constituted an act of religious communion with them. For these views he was banished from Massachusetts Bay, and in Jan. 1636. set out on foot for Narragansett bay.

In the spring of 1636, Roger Williams stepped from his canoe onto the western bank of the Seekonk river. and there on land which he had purchased from the Indians founded the town of Providence and the colony of Rhode Island. As news spread of his radical tenet that "none bee accounted a Delinquent for *Doctrine,*" Providence grew, filling with those whose religious beliefs could find no public expression in the English-speaking world. notably Anabaptists and Quakers. Williams himself had a brief period as an Anabaptist, but thereafter (1639) declared himself a Seeker, recognizing no church as the true one and ministering to no set congregation. Although he staunchly defended the right of all to worship as they pleased he himself cleaved steadfastly to the theology of John Calvin and opposed Quaker doctrines even while offering the Quakers residence during the years of their persecution elsewhere.

Because the identity of Rhode Island was constantly threatened by internal differences and the distrust and ambition of its neighbours. Williams went to England in 1643 to secure a charter for the colony from the parliament (granted on March 14. 1644), and again in 1651–54 to have the charter confirmed. During these visits. he successfully drew upon the acquaintances he had made while serving in the Masham household; on his second visit he became the friend of John Milton. He was the first president of Rhode Island under its charter and until his death always held some public office. In spite of his differences with the theocratic neighbouring colonies. he was of constant service to all as a peacemaker with the Narragansett Indians whose language he knew and whose trust he had earned. When King Philip's War came; however, the aged Williams served as captain of the handful who remained to defend Providence against the Indians. From 1636 tc his death sometime between Jan. 27 and March 15. he supported himself by farming and trading; since he financed his trips to England from his own income he was often in reduced circumstances.

Williams' advocacy of the separation of church and state and the toleration of all religions did not stem from "modern" notions that there are many roads to heaven. but rather from a conviction that so strait was the path that no community could possibly be made up entirely of true believers, and therefore, the best policy was not to mix church and state. His passionate defense of liberty of conscience found physical form in the institutions of Rhode Island, which showed the way to the other states, and lasting expression in his greatest book. *The Bloudy Tenent of Persecution* (1644).

See also RHODE ISLAND: *History.*

Williams was a vigorous controversialist, and published. chiefly during his two visits to England, *A Key Into the Language of America,* written at sea on his first voyage to England (1643); it was reprinted in vol. i of the *Collections of the Rhode Island Historical Society* (1827), and in series i, vol. iii of the *Massachusetts Historical Society Collections; Mr. Cotton's Letter Lately Printed, Examined and Answered* (1644); *The Bloudy Tenent of Persecution for the Cause of Conscience* (1644); *Christenings Make Not Christians* (1645); *Queries of Highest Consideration* (1644); *The Bloudy Tenent Yet More Bloudy* (1652); *Experiments of Spiritual Life und Health and Their Preservatives* (1652); *The Hireling Ministry None of Christ's* (1652); *George Fox Digg'd Out of His Burrows* (1676); and *Something in Answer to a Letter . . . of John Leverat Governor of Boston . . .* (1678).

His writings were republished in the *Publications of the Narragnnsrtt Club* (1866–74). *Letters and Papers of Roger Williams, 1629–82* (limited to 18 copies, photostatic reproductions, 1924) contained manuscripts discovered later.

BIBLIOGRAPHY.—The best recent biographies are those by S. H. Brockunier (1940) and O. E. Winslow (1957). . Recommended also are biographies by J. D. Knowles (1834), W. Gammell (1846), R. Elton (1857), O. Straus (1894), E. J. Carpenter (1909), M. E. Hall (1917), E. Easton (1930), J. E. Ernst (1937) and C. S. Longacre (1940). Outstanding studies of special aspects of Williams' career are M. C. Tyler, *History of American Literature 1607–1765* (1878) ; C. M. Andrews, *The Colonial Period of American History,* II (1936); H. M. Dexter, *As to Roger Williams and His "Banishment" From the Massachusetts Plantation* (1876). (L. Z.)

WILLIAMS, TENNESSEE (THOMAS LANIEX) (1914–), U.S. author who achieved his principal success as a dramatist, was born March 26, 1914, in Columbus, Miss. During his boyhood, his family moved to St. Louis; he later attended the University of Missouri and Washington university in St. Louis and received a B.A. degree from the University of Iowa in 1938. Williams began writing in childhood and tried fiction, poetry and drama; his first public recognition came in 1945 with the successful Broadway production of *The Glass Menagerie.* He won the New York Drama Critics' Circle award three times—for *The Glass Menagerie, A Streetcar Named Desire* (1947), and *Cat on a Hot Tin Roof* (1955)—and the Pulitzer prize for the latter two.

His characters, always theatrically exciting, range from the pretentiously genteel to the crude and ruthless, from poor to rich, but their varied surfaces cover thinly what Williams finds common beneath all mankind's pretenses—the violent beast driving man to destroy his fellow man and himself. Williams' characters are all psychologically sick, entrapped in a world indifferent to them and uncomprehended by them. For such characters, no hope can be offered, for they can only react, not act. What Williams with his poetic language does afford them—and the rest of mankind—is not anger, but compassion for man's desperate plight.

See Nadine Dony, "Tennessee Williams: 4 Selected Bibliography," *Modern Drama,* I, pp. 181–191 (Dec. 1958). (Js. T. N.)

WILLIAMS, WILLIAM CARLOS (1883–), one of the most original poetic voices of the United States in the 20th century, was born on Sept. 17, 1883, in Rutherford, N.J.

After he won his M.D. from the Cniversity of Pennsylvania in 1906. and after internship in New York and graduate study in pediatrics in Leipzig, he returned in 1910 to a lifetime of poetry and medical practice in Rutherford.

Williams' largely imitative *Poems* (1909) was followed by experimental volumes; gradually he developed an individualistic method and style in collections culminating with *Sour Grapes* (1921) and *Spring and All* (1922). His frequently anthologized poems "Light-Hearted William," "By the Road to the Contagious Hospital" and "The Red Wheelbarrow" characteristically proffer a fresh, direct impression of the sensuous world. The first book of Williams' most ambitious poem, *Paterson,* appeared in 1946, and subsequent parts in 1948, 1949 and 1951. The epic scope became clear: Williams was dramatizing Paterson, N.J., to evoke a complex vision of America and modern man. Although Williams' work defies neat classification, his poetry seems closer to the free, loose affirmations of Walt Whitman than to the rigidly controlled negations of T. S. Eliot. Williams was also a prolific writer of prose. Three novels form a trilogy dealing with a single family—*White Mule* (1937), *In the Money* (1940) and *The Build-up* (1952). His short stories, brief but deep glimpses into strange facets of human behaviour, were collected in 1950 as *Make Light of It.* Other works include his *Autobiography* (1951), *Selected Essays* (1954) and *Selected Letters* (1957).

For a critical evaluation *see* Vivienne Koch, *William Carlos Williams (1950).* (J. E. MR.)

WILLIAMSBURG, a city of southeastern Virginia, U.S., on the peninsula between the James and York rivers, 50 mi. S.E. of Richmond; the capital of Virginia. 1699–1780, and seat of James City county. It is the site of the Coiiege of William and Mary, Eastern State hospital and Colonial R'illiamsburg.

In 1698 fire destroyed the statehouse at Jamestown, Virginia's first capital. The following year the general assembly enacted legislation to move the seat of government to Middle Plantation, first settled in 1633, the scene in 1676 of episodes in Eacon's rebellion, and the site chosen in 1693 for the newly chartered College of William and Mary. The act set aside 220 ac. at Middle Plantation for a town, to be named Williamsburg in honour of William III. and directed the construction of a capitol to house the general assembly and the general court.

In the 18th century, Williamsburg's resident population never exceeded 2,000, but, as the political and cultural centre of Great Britain's largest and wealthiest continental colony, the little city was as important as any in British North America. Twice a year, in April and October, the general court met. Visitors flocked to the capital, swelling its population to over 5,000 during these "public times," to transact business and attend balls, fairs and races. To a lesser degree, other public events were the occasions for similar scenes.

A number of important episodes leading to the American Revolution took place in Williamsburg. In 1765 Patrick Henry (*q.v.*) presented his strongly worded resolutions against the Stamp act to the house of burgesses and defended them in a famous, fiery speech. Nine years later the burgesses, in extralegal session at the Raleigh tavern, were among the leaders in proposing the first Continental Congress. And it was in Williamsburg, in May of 1776, that the Virginia convention instructed its delegates to the Continental Congress to move for independence.

In 1780 the capital was moved to Richmond. Overnight, Williamsburg became a small tountry town; little remained but the college and the public hospital. In the post-Revolutionary War years the college suffered losses of revenue but by 1836 it had recovered. Twice closed by the Civil War and its aftermath, in 1906 William and Mary became a state institution and in 1918 was made coeducational. The modern college has over 20 departments, and branches at Richmond and Norfolk. The public hospital, now Eastern State hospital, was the country's first hospital devoted exclusively to the care of the mentally ill. Opened in 1773, it has served the state continuously ever since.

During the Civil War, Union forces advancing on Richmond clashed with the Confederate rear guard just east of Williamsburg. After a day of heavy fighting (May 5, 1862), the Confederates withdrew, and Williarnsburg remained in Union hands for the remainder of the war.

Modern Williamsburg is famous as the site of Colonial Williamsburg, a restoration of the colonial capital of Virginia. William A. R. Goodwin, rector of Bruton Parish church, conceived the idea of preserving and restoring the colonial buildings that survived. In 1926 he interested John D. Rockefeller, Jr., in the project and Rockefeller agreed to provide the funds, which ultimately totaled more than $62,000,000.

An area of 130 ac., comprising the important part of the colonial city, was restored to its former appearance, and more than 3.000 additional acres were acquired to protect the restored area. In the course of the work, 700 modern structures were torn down or removed; 83 existing, original buildings were restored; and 413 buildings were reconstructed on their original foundations. The exhibition buildings, which include the capitol and the governor's palace, are furnished as they were in the 18th century, and the entire area has been landscaped to recover its colonial appearance. From its inception, the restoration has been based upon intensive and continuous architectural, archaeological and historical research. To give visitors a brief experience in 18th-century Iife, Colonial Williamsburg carries out a vigorous interpretive program. An information centre, located just outside the restoration. introduces visitors to the history and importance of Williamsburg; within the restored area costumed hostesses, craftsmen, militiamen and attendants give the city a flavour of living history.

For comparative population figures *see* table in VIRGINIA: *Population.*

BIBLIOGRAPHY.—Rutherfoord Goodwin, *A Brief and True Report Concerning Williamsburg in Virginia* (1941); Marcus Whiffen, *The Public Buildings of Williumsburg* (1958); *Colonial Williamsburg Official Guide Book* (1957); *The Eighteenth-Century Houses of Williamsburg* (1960). (M. BR.)

WILLIAMSON, WILLIAM CRAWFORD (1816–1895), English naturalist, one of the founders of modern paleobotany, was born at Scarborough, Yorkshire, on Nov. 24, 1816. He early acquired a knowledge of geology and natural history. Successively an apprentice apothecary, medical student, museum curator and physician, he was appointed professor of natural history at Owens college, Manchester, in 1851, where he taught until 1892. Williamson died at Clapham Common, London, on June 23, 1895.

Among Williamson's earlier works are accounts of *Volvox* (1851–52) and Foraminifera (1858). He had meanwhile begun the serious study of fossil plants; his paleobotanical researches culminated in the 19 memoirs under the title *On the Organisation of the Fossil Plants of the Coal Measures* (1872–94) that established Williamson as a leader in the field. These studies continued in three memoirs (1895–96) written with D. H. Scott (*q.v.*). Notable also are Williamson's papers on *Sphenophyllum, Lepidodendron* and *"Stigmaria,"* and his work on isolated seeds. He rightly maintained that certain fossils containing secondary wood—then considered a phanerogamic characteristic—were in reality cryptogams.

Williamson's *Reminiscences of a Yorkshire Naturalist* (1896) contains an approximate list of his more than 150 publications. (J. W. TT.)

WILLIAMSPORT, a city in north-central Pennsylvania, U.S., and seat of Lycoming county, is on the north bank of the west branch of the Susquehanna river, 85 mi. N. of Harrisburg.

Founded in 1795 near the site of a Revolutionary War Indian massacre, Williamsport became the seat for the new Lycoming county, the largest county (1,215 sq mi.) in Pennsylvania. Chartered as a borough in 1806, it became a city in 1866. In the 1860s the U.S lumber industry was centred there as logs were floated down the upper tributaries of the Susquehanna. In 1871 a "sawdust war" developed during a wage strike by lumber workers. As the forests disappeared, and new forests were opened in the west, the lumber industry dwindled. With more diversified industry in the second half of the 20th century, the city's major industries concerned metal products, including aircraft engines, boilers, wire rope. fire hydrants and valves. Textile mills made broad silks, braids, clothing, hosiery and shirts. Hardwood flooring, furniture and leather products continued in importance.

A Methodist academy founded in 1812 later became Williamsport-Dickinson junior college and in 1948 Lycoming college. Williamsport Technical institute is a trade school. Four city parks have an area of about 250 ac. Williamsport is the home of Little league baseball and the annual world series are held in the city. The weekly newspaper *Grit* is distributed nationally. For comparative population figures, *see* table in PENNSYLVANIA: *Population.* (W. A. C.)

WILLIAMSTOWN (VICTORIA) : *see* under MELBOURNE.

WILLIBRORD (WILBRORD), **SAINT** (d. 738), English missionary, "the apostle of the Frisians," was born about 657. His father, Wilgils, an Angle or, as Alcuin styles him, a Saxon, of Northumbria, withdrew from the world and constructed for himself a little oratory dedicated to St. Andrew. The king and nobles of the district endowed him with estates till he was at last able to build a church, over which Alcuin afterward ruled. Willibrord, almost as soon as he was weaned, was sent to be brought up at Ripon, where he must doubtless have come under the influence of Wilfrid. About the age of 20 the desire of increasing his stock of knowledge (*c.* 679) drew him to Ireland, which had so long been the headquarters of learning in western Europe. Here he stayed for 12 years, enjoying the society of Ecgberht and Wihtberht. Ecgberht commissioned him as a missionary to the North German tribes.

In his 33rd year (*c.* 690) he started with 12 companions for the mouth of the Rhine. These districts were then occupied by the Frisians under their king, Rathbod, who gave allegiance to Pippin of Herstal. Pippin befriended Willibrord and sent him to Rome, where he aas consecrated archbishop (with the name Clemens) by Pope Sergius on St. Cecilia's day 696. Bede says that when he returned to Frisia his see was fixed in Ultrajectum (Utrecht). He spent several years in founding churches and evangelizing, till his success tempted him to pass into other districts From Denmark he carried away 30 boys to he brought up among the Franks. When Pippin died, Willibrord iound a supporter in his son Charles Martel. He was assisted for three years in his missionary work by St. Boniface (719–722).

He was still living when Bede wrote in 731. A passage in one of Boniiace's letters to Stephen III speaks of his preaching to the Frisians for 50 years, apparently reckoning from the time of his consecration. This would fix the date oi his death in 738; and, as Alcuin reports he was 81 years old when he died, it may be inferred that he was born in

657. The day of his death was Nov. 6.

WILLIS, ROBERT (1800–1875), British professor distinguished for his teaching and research in applied mechanics and for his contributions to architectural archaeology, was born in London, Feb. 27, 1800. Educated at Caius college, Cambridge, he was elected a fellow in 1826 and ordained the following year. He worked for some time on the phenomena of sound, being elected to the Royal society in 1830, and in 1837 he became Jacksonian professor of experimental philosophy, confining his attention particularly to applied mechanics and mechanisms. An original member of the British Association for the Advancement of Science. he was president in 1862 and contributed important papers on gear teeth (1837) and on the effect of moving loads on bridges (1849), the result of his researches for the royal commission on the application of iron to railway structures.

Willis was also an antiquary and a student of architecture and wrote many papers on the history and construction of English cathedrals. However, his most lasting memorial is the professorship of mechanism and applied mechanics and the university department of engineering, which were established at Cambridge on his death there, Feb. 28, 1875. (J. F. Br.)

WILLIS, THOMAS (1621–1675), English anatomist and physician, was born on Jan. 27, 1621, the son of a well-educated landowner who lived near Oxford. He attended Christ Church college, Oxford, graduating in 1639. Despite his military service on the royalist side during the Civil War, he was able to continue his studies and established a scientific reputation through his publication entitled *Of Fermentation, of Feavers, and of Urines.* He became Sedleian professor of natural philosophy at Oxford in 1660. While holding this position, Willis published his most important work, *Cerebri anatome nervorumque descriptio et usus* (1664), in which he described what is still known in the anatomy of the brain as the circle of Willis.

In 1667 he moved to London to practise medicine. Although he carried on the largest fashionable practice of his time, he continued to study and to write extensively. He was the author of the first important treatise on diabetes to be translated from Latin into English; this appeared in a chapter of *Pharmaceutice Rationalis—Shewing the Signs, Causes and Cures of Most Distempers.* He described the typical symptoms of diabetes, including the thirst, increased urination and sweetness of the urine, "as if there had been Sugar or Honey in it." Willis' career was terminated prematurely by his death from pleurisy and pneumonia on Nov. 11, 1675.

See Frank N. Allan, "The Writings of Thomas Willis, M.D.: Diabetes Three Hundred Years Ago," *Diabetes,* 2:74–73 (Jan.–Feb. 1953).
(F. N. A.)

WILLISTON, SAMUEL WENDELL (1852–1918), paleontologist and entomologist who became the leading U.S. authority of his time on fossil reptiles and amphibians, was born in Boston. Mass., on July 10, 1852, but was reared in Manhattan, Kan.. where he graduated from Kansas State Agricultural college (later Kansas State College of Agriculture and Applied Science) in 1872. Having successfully participated in a fossil-collecting trip on behalf of O. C. Marsh of Yale university, he was invited in 1876 to go to New Haven as an assistant to Marsh. He served in this capacity for much of the time for the next nine years, meanwhile earning both the M D. and Ph.D. at Yale. Dissatisfied, Williston finally broke with Marsh in 1855. After some years spent in teaching and the practice of medicine in New Haven, he went in 1890 to the University of Kansas, where, during the next 12 years. he was professor of geology and of anatomy and later dean of the school of medicine. In 1902 he was called to The University of Chicago as professor of vertebrate paleontology. Forbidden under Marsh to publish on fossils, Williston early took up the study of entomology and became an authority on the Diptera. His main interest. however, continued to be fossil vertebrates. At Kansas, his researches lay mainly in the abundant marine reptiles of the chalk deposits of that state. At Chicago his interests turned to the Permian red beds of Texas and New Mexico, from which, with the assistance of the veteran collector Paul C. Miller, he described a great series of early tetrapods. His most important work was the posthumous *Osteology of the Reptiles* (1925), setting forth his mature conclusions on reptilian classification and phylogeny. Williston died at Chicago, Aug. 18, 1918.
(A. S. Rr.)

WILLKIE, WENDELL LEWIS (1892–1944), U.S. businessman and presidential candidate, was born Feb. 18, 1892, in Elwood. Ind. His father mas a lawyer and judge. and his mother was Indiana's first woman attorney. Willkie attended Culver Military academy and Indiana university (B.A., 1913; LL.B., 1916). and practised law with his father before entering the U.S. army in World War I. In Jan. 1918 he married Edith Wilk of Rushville, Ind. After the war, Willkie spent a year with the Firestone Tire and Rubber company before joining the law firm of Mather and Newbitt in Akron, O. In 1929 he moved to New York to handle legal work for Commonwealth and Southern corporation, a utilities holding company. Four years later, he became president of Commonwealth and Southern.

After 1933 Willkie engaged in a public feud with the federal government over competition from the Tennessee Valley authority (TVA), climaxed in July 1939 by the sale of Commonwealth and Southern's Tennessee holdings to TVA for $78,600,000. Although he had been a Democrat. Willkie's effective criticism of the New Deal and his widely circulated article in *Fortune* (April 1940) entitled "We, the People" made him a dark horse candidate for the Republican party. Despite a late start limited organization and opposition of the Republican party leadership. Willkie performed a miracle of modern politics. To chants of "We Want Willkie!" from the galleries in Philadelphia, he was nominated on the sixth ballot. Willkie carried only 10 states and was defeated by an electoral vote of 449 to 82; but he polled 22,305.198 to Roosevelt's 27,244,160, more popular votes than any previous Republican candidate.

Long before the attack on Pearl Harbor, Willkie advocated giving aid to the Allies. He went to England in 1941 and to the middle east, the Soviet Union and China in 1942. In the latter year he was named chairman of the board of Twentieth Century-Fox Film corporation His book *One World* (1943) was largely an outgrowth of his travels and was a strong plea for postwar international co-operation.

Support of Roosevelt's war policies brought considerable opposition to Willkie's renomination in 1944; and, after his defeat in the Wisconsin primary, he withdrew from the race. He died in New York city on Oct. 8, 1944. (*G.* Wo.)

WILLOW ***(Salix),*** a genus of plants constituting, with the poplar (*Populus*), the family Salicaceae. Willows are trees or shrubs, varying in height from a few inches, like the small British *S. herbacea* and arctic species generally, to 120 ft.. and occurring most abundantly in cold or temperate climates in both hemispheres, and generally in moist situations. Their leaves are deciduous. alternate, simple and generally much longer than broad, whence the term willow-leaved has become proverbial. At their base they are provided with stipules, which are also modified to form the scales investing the winter buds.

The floners are borne in catkins. which are on one tree male (staminate) only. on another female (pistillate). Each staminate flower is borne in the axil of a small scale or bract, and consists usually of two but sometimes of more stamens In addition there are one or two small glandular organs. the nectaries. The pistillate flowers are equally simple and also arise in the axil of a bract; they show a very short stalk, surmounted by two carpels adherent one to the other for their nhole length, except that the upper ends of the styles are separated into two stigmas; nectaries are present in these flowers also. When ripe the two carpels separate in the form of two valves and liberate a large number of seeds, each provided at the base with a tuft of silky hairs. The flowers appear generally before the leaves and are thus rendered more conspicuous, while transport of pollen by the wind is facilitated. Fertilization is effected by insects. especially by bees; but some pollen must also be transported by the wind to the pistillate flowers, especially in arctic species which, in spite of the poverty of insect life. set abundant fruit. The tuft of hairs at the base facilitates rapid dispersion of the seed.

Although the limitations of the genus are well marked, and its recognition in consequence easy, it is otherwise with regard to the species. The greatest difference of opinion exists among botanists as to their number and the bounds to be assigned to each; and the extensive cross-fertilization that takes place between the species, resulting in numerous hybrid forms, intensifies the difficulty.

Species and Distribution.— N. J. Andersson, a Swede, who spent nearly 25 years in their investigation, published a monograph on the genus. He admitted about 100 species. C. S. Sargent (*Silva of North America*) suggested 160 to 170 as the number of distinguishable species. In North America upward of 70 native species occur, together with numerous varieties and natural hybrid forms. Some botanists have enumerated 80 species from Great Britain, while others count only 12 or 15. Buchanan White, who made a special study of the British willows, grouped them under 17 species with numerous varieties and hybrids.

Of the North American species about 25 attain the stature of trees. The black willow *(S. nigra)*, the largest and most conspicuous willow of eastern North America, reaches a height of 120 ft., with a trunk 3 ft. in diameter. Other well-known willow trees found east of the Rocky mountains are the peach-leaved willow *(S. amygdaloides)*, sometimes 70 ft. high; the pussy willow *(S. discolor)*, 10 ft. to 25 ft. high; the shining willow *(S. lucida)*, occasionally 20 ft. high; the beaked willow (*S. bebbiana*), rarely 25 ft. high; and the sandbar willow *(S. interior)*. Some of the foregoing range northward and westward to British Columbia, Alaska and the Arctic circle. Interesting shrubby species found chiefly east of the Rocky mountains are the autumn willow *(S. serissima)*, with fruit maturing in the autumn; the broad-leaved willow *(S. glaucophylla)*, found on sand dunes; the furry willow *(S. adenophylla)*, of lake and river shores; the silky willow *(S. sericea)*, with silky leaves; the hoary willow *(S. candida)*, with sagelike foliage; and the prairie willow *(S. humilis)* and the dwarf pussy willow *(S. tristis)*, both low slender shrubs.

ROCHE

BLACK WILLOW (SALIX NIGRA) CATKINS

Among noteworthy willows found in the Pacific states and northward are the western black willow *(S. lasiandra)*, sometimes 45 ft. high; the red willow *(S. laevigata)*, 20 ft. to 50 ft. high; the California white willow or arroyo willow *(S. lasiolepis)*, 8 ft. to 20 ft. high; and the Sitka or velvet willow *(S. sitchensis)*, sometimes 30 ft. high, which grows from California to Alaska.

Several old world willows, widely planted for ornament and other purposes in eastern North America, have become extensively naturalized, especially the white willow *(S. alba)*, the yellow willow *(S. vitellina)*, the weeping willow *(S. babylonica)*, the brittle or crack willow *(S. fragilis)* and the purple willow *(S. purpurea)*. The basket willow (*S. viminalis*), the bay willow *(S. pentandra)* and the goat willow or sallow *(S. caprea)* have become sparingly naturalized.

Economic Value.—As timber trees many of the species are valuable for their rapidity of growth and for the production of light durable wood, serviceable for many purposes. Among the best trees of this kind are *S. fragilis*, the crack willow, and *S. alba*, the white or Huntingdon willow. These trees are usually found growing by riverbanks or in other moist situations, and are generally pollarded for the purpose of securing a crop of straight poles. The wood of *S. alba* var. *calva* is used for cricket bats; there is a great difference in the value for this purpose of timber from different soils; and wood of the pistillate tree is said to be preferable to that of the staminate. *S. caprea*, a hedgerow tree, generally grows in drier situations. It is a useful timber tree, and its wood, like that of *S. alba*, is prized in the manufacture of charcoal. Its catkins are collected in celebration of Palm Sunday, the bright-coloured flowers being available in early spring. Certain types of willow are largely used for basketmaking and wickerwork. The species employed for this purpose are known under the collective name of osiers. *(See* OSIER.) *S. acuminata* and other species do well by the seaside, and are serviceable as windscreens, nurse trees and hedges. *S. daphnoides*, *S. repens* and other dwarf kinds are useful for binding heathy or sandy soil. In addition to their use for timber or basketmaking, willows contain a large quantity of tannin in their bark. A medicinal glucoside named salicin *(q.v.)* is also extracted from the bark. The wood, especially of *S. alba*, is used for paper pulp. As ornamental trees some willows also take a high rank. The white willow is a great favourite, while the drooping habit of the weeping willow renders it very attractive. Though named *S. babylonica*, it is really a native of China, from which it has been widely spread by man; the willow of the Euphrates (Ps. cxxxvii) is in all probability *Populus euphratica*. *S. repens* var. *rosmarinifolia* is remarkable for its very narrow leaves—purplish above, silvery beneath.

WILLOW HERB, the popular name for species of *Epilobium*, a genus (of the evening primrose family, Onagraceae) of often tall herbaceous plants. The genus embraces upwards of 200 species. The slender stems bear narrow leaves and pink or purple flowers, which in the great willow herb *(E. angustifolium)* are one inch in diameter and form showy spikes; this is one of the fireweeds found throughout the north temperate zone, especially after forest fires. The hairy willow herb, E. *hirsutum*, found by sides of ditches and rivers, is popularly known in the United States as apple pie, and in England as codlins and cream. In North America willow herbs are common; E. *angustifolium* is native across the continent, and E. *hirsutum* is extensively naturalized in the eastern states and Canada. The spread of both species is facilitated by copious, tufted seeds. (N. TR.)

WILLSTÄTTER, RICHARD (1872–1942), German organic chemist whose studies of the structure of chlorophyll *(q.v.)*, demonstrating the central magnesium atom, the pyrrole rings and the presence of phytol won him the Nobel prize in 1915, was born at Karlsruhe, Aug. 13, 1872. These and similar researches on the pigments of the blood formed the basis for the later work of Hans Fischer who was named Nobel laureate in 1930 for his complete synthesis of hemin.

Willstatter studied at Munich under Adolf von Baeyer, *(q.v.)*, obtaining his doctorate in 1894. In 1905 he became professor at Zurich. He was director of the Kaiser Wilhelm institute in Berlin (1912–16) and then succeeded his old teacher Baeyer at the University of Munich. He resigned because of anti-Jewish pressure in 1925, but continued his work privately, first in Munich, and later in Switzerland.

Willstatter began his career with an investigation of plant alkaloids, determining (1898) the structures of tropine, atropine and cocaine, and synthesizing several alkaloids including tropine. There followed a penetrating study of the quinones, culminating in the determination of the structure of aniline black. Next came the work on blood pigments and chlorophyll, leading to further investigations which revealed the structures of many of the pigments of flowers and fruits.

In his later years, Willstatter took up the study of enzymes and of catalytic hydrogenation, particularly in the presence of oxygen. His work on the degradation of cellulose was used as the basis for the process for obtaining glucose from wood. He also investigated the phenomenon of fermentation, and was a pioneer in the use of hydrogels for absorption.

It was characteristic of Willstatter that he attempted only difficult problems, remarking that the greatest joy in research came from overcoming obstacles. He also stated that the highest goal of science is the improvement of the lot of humanity, and he was particularly proud of his syntheses of hypnotics and narcotics, which included cocaine and Avertin.

He died in forced exile at Locarno, Switz., on Aug. 3, 1942. His autobiography, *Aus meinem Leben*, was published in 1949.

For additional biographical details *see* R. Adams, *J. Amer. Chem. Soc.*, 65:127 (1943); F. Haber *et al., Naturwissenschaften*, 20:601 (1932).

WILLUGHBY, FRANCIS (1635–1672), English naturalist, ornithologist and ichthyologist, born at Middleton, Warwickshire, was the pupil, friend and patron, as well as the active and original co-worker, of John Ray (*q.v.*), and hence to be reckoned as one of the most important precursors of Linnaeus. His connection with Ray dated from his studies at Trinity college, Cambridge (1653–59), and he made an extensive continental tour with Ray in 1663–64. The specimens, figures and notes they accumulated were in great part elaborated into Willughby's *Ornithologia*, posthumously published in 1676 and translated by Ray as *The Ornithology of Francis Willughby* (1678); the same friend published his *Historia Piscium* (1686). In Ray's preface to the *Ornithology* he gives Willughby much of the credit usually assigned to himself, both as critic and systematist. Willughby was an original fellow 'of the Royal society, organized in 1663. He died at Middleton hall on July 3, 1672.

WILEYS, JOHN NORTH (1873–1935), early U.S. automobile manufacturer, was born in Canandaigua, N.Y., on Oct. 25, 1873. In 1898 he organized the Elmira Arms Co. and then turned to the production of bicycles. Willys also acted as dealer for the Overland automobile, and he bought the company when it was in financial difficulties during the panic of 1907, changing its name to Willys-Overland. In 1909 he purchased the plant of the Pope-Toledo company and expanded the Willys-Overland operation. By 1916 only the Ford outsold the Willys-Overland. Willys was appointed Cnited States ambassador to Poland in 1930. He resigned in 1932 and resumed control of the Willys-Overland company, which was in financial trouble. The firm went into receivership in 1933. Willys died on Aug. 26, 1935. (M. J. Bi.)

WIEMETTE, a residential village of Cook county, in northeastern Illinois, U.S., is 14 mi. N. of downtown Chicago and borders Lake Michigan on the east and Evanston on the south. Public beach, park and other recreational facilities are among the best on the North Shore, a residential area comprising suburbs north of Chicago. There is a U.S. coast guard station at the lake harbour, which provides mooring for pleasure craft.

The name is derived from Antoine Ouilmette, a French fur trader who lived there. The village was founded in 1869 and incorporated in 1872; it established council-manager government in 1930. A tourist attraction is the Baha'i temple, a house of worship of the Baha'i faith (*q.v.*). For comparative population figures see table in ILLINOIS: *Population.* (H. H. Gr.)

WILMINGTON, a city in Delaware, U.S., and seat of New Castle county, is at the confluence of the Christina river and the Delaware; the city extends along both banks of the Christina and of Brandywine creek, which joins the Christina just above its mouth. Pop. (1960) city 95,827; standard metropolitan statistical area (New Castle county in Delaware and Salem county in New Jersey) 366,157. The oldest permanent settlement in the Delaware River valley, Wilmington was founded in 1638 by Swedish settlers under the leadership of Peter. Minuit (see DELAWARE: *History*). Then called Ft. Christina, it was captured by the Dutch under Peter Stuyvesant in 1655 after a short siege by land and water. In turn the Dutch, who had named the town Altena, were conquered by the English in 1664.

For its first 100 years the settlement was a small agricultural hamlet. In the 1730s enterprising Quakers moved there from Pennsylvania and developed it into a prosperous port and market town. They secured a borough charter from Thomas Penn, the proprietor, who named the town for his friend Spencer Compton, earl of Wilmington (1673–1743), who had no other connection with it.

By the time of the American Revolution: Wilmington, though still small, was the largest town in Delaware. Its growth was due to facilities for transportation afforded by the Christina and to the fertility of neighbouring farmlands. Farmers in Lancaster county, Pennsylvania, brought their goods to Wilmington to be sent on by water to Philadelphia, farther to the east and north. Mills on neighbouring streams processed wheat and corn for market. The Brandywine, just north of Wilmington, was a miller's paradise, remarkable for its steady flow and numerous millsites. Sawmills, grist mills, textile mills and paper mills were built on its banks and by the 1790s its flour mills were the largest in the United States. In 1802 a French immigrant, Eleuthère Irénée du Pont de Nemours, established a powder mill, the beginning of the most famous business in Delaware.

In the 1830s Wilmington began to develop rapidly as a manufacturing centre. It received a city charter in 1832, and in 1837 the Philadelphia, Wilmington and Baltimore railroad (now part of the Pennsylvania system) was completed, giving Wilmington easy rail connection with all the principal cities of the east coast. The characteristic of its manufacturing in the next century was variety, with iron-hulled ships, leather. textiles, iron and steel goods, and vulcanized fibre among the chief products.

In the 20th century, three Wilmington powder companies, the Hercules Powder company, the Atlas Powder company and especially E. I. du Pont de Nemours and company, expanded into the chemical industry and the city became the centre of their administration and experimentation, but of only a small part of their manufacturing. Therefore in Wilmington's fourth century, beginning in the 1930s, it continued to be a manufacturing city and port but was also a white-collar centre and the home of many business executives, scientists and technologists, particularly those connected with the chemical industry. In the same period, its growth overleaped the city boundaries, and housing, industrial establishments and shopping centres began moving into the neighbouring countryside. The population of Wilmington is changing very little within the city boundaries, but the remainder of New Castle county experienced its most rapid growth in history after World War I In 1920 Wilmington included over half the population of the entire state; 40 years later there were more people in the suburbs than in the city.

Transportation facilities include the Wilmington Marine terminal on the Christina, which serves ocean-going ships; the New Castle county airport; and railroad passenger and freight service. Recreational facilities include the Playhouse theatre in the Du Pont building, and public parks, the largest of which are those on both shores of the Brandywine. Historic sites and museums include Fort Christina State park, Old Swedes church. Historical Society of Delaware (Old Town hall), the Hagley museum (of industrial history) on the Brandywine and the Henry Francis du Pont Winterthur museum. For comparative population figures *see* table in DELAWARE: *Population.*

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WILMINGTON, the chief seaport of North Carolina. U.S., a port of entry and seat of New Hanover county, is in the southeastern part of the state on Cape Fear river. 30 mi. above its entrance and 115 mi. S.E. of Raleigh. Connected with the ocean by a 34-ft. river channel, its spacious fresh-water harbour has public and private shipping accommodations. An important distribution point for its major imports, petroleum and its derivatives, it also imports fertilizer materials and numerous other products. The principal exports are wood pulp, pulpwood and scrap metal. Wilmington is the trading centre of a thriving truck-, tobacco- and flower-growing area; its industry includes textiles. wearing apparel, wood and wood products, commercial boilers and fertilizer. It is also the centre of a resort and sports fishing area.

In the early 1730s adjacent settlements known as New Liverpool and New Carthage were laid out; the whole soon became known as New Town (Newton) to distinguish it from the older town of Brunsmick, formerly located downstream. In 1730 it was incorporated as a town and renamed in honour of the English political leader Spencer Compton, earl of Wilmington. Wilmington was the centre of violent resistance to the Stamp act in 1765–66. and nearby, in Feb. 1776. a British effort to conquer the colonies by division was frustrated at the battle of Moore's Creek Bridge. In the spring of 1781 it was occupied for several weeks by Cornwallis. A centre of Civil War blockade running and the last Confederate port to close, it was open until Jan. 15, 1865, when Ft. Fisher (22 mi. S.) fell before a land and sea attack. It was incorporated as a city in 1866 and adopted a council-manager government in 1941. For comparative population figures *see* table in NORTH CAROLINA: *Population.* (E. L. LE.)

WILMOT, DAVID (1814–1868), U.S. political leader, born at Bethany, Pa., Jan. 20, 1814. He was admitted to the bar in 1834 and practised law in Towanda. He entered politics as a Democrat, served in the national house of representatives (1845–51), and, although he favoured the Walker tariff, the Mexican War and other party measures, he opposed the extension of slavery. On Aug. 8, 1846, on behalf of advocates of the restriction of slavery he offered an amendment to a bill appropriating $2,000,000 to settle the U.S. boundary with Mexico by purchase of land if necessary, to the effect that "neither slavery nor involuntary servitude shall ever exist in any part of the said territory" acquired from Mexico. The bill including the Wilmot proviso, as the amendment was called, passed the house, but was defeated by the senate's adjournment. Although the Wilmot proviso failed again in 1847, it was revived in the house again and again in the two years following. Out of the efforts of the Democrats and Whigs to subordinate this issue grew the Republican party that definitely accepted the principle of the proviso. Wilmot supported Martin Van Buren in 1848 and entered the Republican party at the time of its formation. Wilmot was president judge of the 13th judicial district of Pennsylvania in 1853–61, U.S. senator in 1861–63 and judge of the U.S. court of claims in 1863–68. He died at Towanda, Pa., March 16, 1868.

WILSON, ALEXANDER (1766–1813), Scottish-American ornithologist and poet, author of *American Ornithology,* a pioneer work on North American birds, was born in Paisley, Renfrewshire, Scot., on July 6, 1766. At 13 he was apprenticed to a weaver, but in 1789 he rebelled and became a peddler; traveling throughout eastern Scotland, he composed numerous dialect poems treating his lot or depicting with broad humour the life and poverty of the common folk. The most famous of these productions, *Watty and Meg,* published as a penny chapbook, is said to have sold to the number of 100,000 copies within a few weeks and to have been praised by Robert Burns. In the labour troubles which arose at this time Wilson's sympathies were naturally with the oppressed weavers. He published a number of lampoons in verse, for which he was convicted of libel and compelled to burn his satires at the town cross; later, unable to pay a fine, he was imprisoned. Beset by these events Wilson, with his nephew William Duncan, emigrated as a deck passenger in 1794 to America, landing with only a gun and the clothes on his back. His years of poverty and hardship were not over, but a turning point came when, in 1802, as a village schoolmaster near Philadelphia, he met William Bartram, the naturalist, who encouraged him in his drawing and collecting "of all the birds in this part of North America." In 1807 he obtained the assistant editorship of the American edition of Abraham Rees's *Cyclopaedia,* and thus acquired more means and leisure for his great work, *American Ornithology,* the first volume of which appeared in 1808. By 1813 seven volumes had appeared. Wilson died at Philadelphia on Aug. 23, 1813.

Wilson's poems and literary prose were edited with a memoir by A. B. Grosart in 1876, a statue being erected to him in Paisley the same year. The eighth and ninth volumes of the *American Ornithology* were edited after his death by his friend George Ord, who published an early *Sketch of the Life of Alexander Wilson,* and the work was continued by Lucien Bonaparte. The complete *Ornithology* has been republished several times.

WILSON, CHARLES THOMSON REES (1869–1959), Scottish physicist who made the paths of electrically charged particles visible by means of the so-called "Wilson cloud chamber," for which work he was awarded the Nobel prize for physics in 1927, jointly with A. H. Compton (*q.v.*). He was born on Feb. 14, 1869, at Glencorse, near Edinburgh, Scot., and was educated at Owens college, Manchester, and Sidney Sussex college, Cambridge. He was Clerk Maxwell student in the Cavendish laboratory, Cambridge, and in 1900 he was appointed lecturer in physics and elected a fellow of the Royal society. From 1925 to 1934 he was Jacksonian professor of natural philosophy at Cambridge. He studied the formation of clouds and mists as well as atmospheric electricity for many years and between 1895 and 1911 he applied his knowledge of the condensation of water vapour in his work on the Wilson cloud chamber. These researches on the paths of electrically charged particles were based on the observation that the sudden expansion of moist air above certain limits led to the condensation of droplets of water even in the absence of dust particles. Wilson concluded that in dust-free air the nuclei effecting condensation were electrically charged particles or ions, and demonstrated the correctness of this inference by experiments with a variety of ionizing rays. He then realized that it should be possible to photograph the track of an ionizing particle passing through moisture saturated air, suddenly and adequately expanded, because minute water droplets would condense on the ions produced by the particle along its path through the moisture saturated air. The first test was made with X rays and it revealed the track of the electrons ejected by the rays. Similarly, the tracks of alpha particles were photographed; and this ingenious method proved of the greatest advantage in the study of the subatomic particles, as, for instance, in the determination of the fundamental electronic charge, *e*, and in the study of cosmic rays, while it led also to the discovery of the positron *(see* CLOUD CHAMBERS). He died Nov. 15, 1959, near Edinburgh. (D. McK.)

WILSON, EDMUND BEECHER (1856–1939), U.S. biologist. an outstanding investigator of the structure and physiology of cells. as well as the early stages of development in animals, was born at Geneva. Ill.. on Oct. 19. 1856. He received a Ph.B. degree from the Sheffield scientific school, Yale university, in 1878, and his Ph.D. at Johns Hopkins university, Baltimore, Md., in 1881. This was followed by an extended period of study in Europe, chiefly at the universities of Cambridge and Leipzig, as well as the zoological station at Naples. It was during this period that he formed close friendships with such men as Anton Dohrn and T. Boveri, who like himself were to wield an immense influence in the growth of biology.

Starting in 1883, Wilson held positions successively at Williams college. Williamstown, Mass., Massachusetts Institute of Technology, Cambridge, and Bryn Mawr college. Bryn Mawr, Pa. In 1891 he joined the department of zoology at Columbia university, where, after serving as adjunct professor and professor, he became Da Costa professor and chairman of the department At Columbia he attained international fame and many honours for his researches He died on March 3, 1939.

Wilson's studies were first concerned with the early stages in the embryology of animals, special emphasis being laid on tracing the formation of the different types of tissues from certain, individual cells. This work on "cell lineage" led him to problems presented in the internal organization of the cell. and this was signalized in 1896 by the publication of his *The Cell in Development and Inheritance,* a book which was to have a profound effect on the trend of biological thought. On the rediscovery of G. J. Mendel's earlier findings in 1900, Wilson at once recognized their far-reaching significance, and this recognition was to have much influence in preparing the way for the great genetical discoveries made in his department at Columbia by T. H. Morgan and his associates. In 1905 Wilson published his first paper on the relation of chromosomes to the determination of sex; this. as well as a series of brilliant studies on the same subject that were published during the following eight years, represents the crowning achievement of his research activities. Much of his later endeavour was directed to the preparation of the famous third edition (1925) of *The Cell,* a comprehensive treatise on the great developments that had occurred in the field to which he had contributed so much.

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(F. SR.)

WILSON, GEORGE GRAFTON (1863–1951), U.S. international lawyer, known particularly for his contribution to the laws of naval warfare and the rules for insurgents, mas born March 29, 1863, at Plainfield, Conn. Educated at Brown university where he received his Ph.D. degree (1889) and where he was professor of political science (1894–1910), he was professor of international law at Harvard university (1910–36) and at the U.S. Naval War college (1900–37). Wilson was a U.S. delegate to the London Naval conference, 1909; counselor, American legation, The Hague, 1914; editor in chief, *American Journal of International Law*, 1924–43; and also noted as author of *International Law Situations* (36 vol., 1902–37) prepared for the Naval War college. In those volumes and in *International Law* (with George F. Tucker, 1901; 10th ed., 1937) Wilson stressed the importance of the laws of war and of sovereign consent as basic for international law's binding character. He died April 30, 1951, at Cambridge. Mass. (P. S. W.)

WILSON, HAROLD ALBERT (1874–), Anglo-American physicist. best known for his experiments bearing on the theories of Maxwell. Lorentz and Einstein. was born in York, England, Dec. 1. 1874. Educated at the universities of Leeds (1893–97), Cambridge (1897–99 and 1900–05) and Berlin (1899–1900), he held professorships at King's college, University of London (1905–09); McGill university, at Montreal (1909–12); University of Glasgow, Scot. (1924–25), and in 1912 he became professor of physics at the opening of the Rice institute in Houston) Tex., where he remained until his retirement in 1947. He became a naturalized American citizen in Nov. 1931.

Wilson was at the Cavendish laboratory in Cambridge during the years 1897–1905 at the time when J. J. Thomson's work on electrons and positive rays had made it a centre for the study of the newly emerging field of the electrical nature of matter. The impetus created by his study at Cambridge continued unabated through the rest of his active life. and led to a steady stream of research results. Wilson published papers on electrical effects in gases and flames, on the emission of electrons by hot bodies: on the electronic charge and on the electromotive force in insulators moving in a magnetic field.

Wilson was elected a fellow of the Royal society (1906) and of the American Philosophical society (1914). He wrote four books: *The Electrical Properties of Flames and Incandescent Solids* (1912). *Experimental Physics* (1915), *Modern Physics* (1928) and *The Mystcries of the Atom* (1934). (W. V. H.)

WILSON, HENRY (1812–1875), U.S. vice-president, 1873–75. was born at Farmington, N.H., on Feb. 16. 1512. His original name, Jeremiah Jones Colbath, was changed by legislative act to Henry Wilson when he was 21. He was an indentured farm labourer as a youth, then learned shoemaking at Natick, Mass., and became a small-scale ,shoe manufacturer. Largely self-educated, he attracted attention as a stump speaker and was elected to the Massachusetts house of representatives in 1840 as a Whig. He served in the Xlassachusetts house and senate for several terms. Disappointed at the Whig party's stand on slavery. he helped form the Free-Soil party in 1848, and presided over its national convention in 1852. He joined the Know-Nothing party in 1854. an act that caused him some embarrassment later, but which secured him election to the U.S. senate in Jan. 1855.

Wilson served in the senate until 1873. His pronounced anti-slavery views soon converted him into an uncoinpromising Republican. He became chairman of the committee on military affairs and was responsible for much wartime legislation. He opposed President Johnson and supported extreme reconstruction measures. After being defeated for vice-president at the Republican convention of 1868 he was nominated in 1872 and elected for Grant's second term. He died in office from a paralytic stroke, Nov. 22, 1875.

Wilson was a shrewd political organizer and was always a defender of the underdog. He wrote three volumes on the accomplishments of the American Civil War and reconstruction congresses. but is best known for his *History of tlze Rise and Fall of the Slave Power in America* (3 vol., 1872–77).

See Elias Nason and Thomas Russell, *Life and Public Services* of *Henry Wilson* (1876). (E. H Ro)

WILSON, SIR HENRY HUGHES (1864–1922). British soldier, who did great constructive work for the British army and was, as much as any man in Great Britain, the builder, though not the architect, of the entente with France. was born at Edgeworthstown, County Longford, Ire., on March 5. 1864, and educated at Marlborough and Sandhurst. His earliest experience of active service mas in Burma between 1886 and 1888. He served in the South African War and before that war ended in 1902 was brought back to the war office. where in the newly formed staff-duties directorate It was his task to study and to apply the lessons which were learned in South Africa—of which the chief perhaps was the necessity of organizing the British army and establishing a general staff for the study and application of the principles of war. In the work of reform Henry Wilson played a great. if still subordinate, part and in 1906 he was appointed as commandant of the Staff college at Camberley. An inspiring teacher. he gathered around him a group of young officers upon whom he impressed his own views and his own system. He became impressed with an almost overpowering sense of the imminence of war between France and Germany. The entente was already in existence. and if it were to mean anything. must carry with it grave military responsibilities. Wilson, therefore, established close relations with the French Staff college, and particularly a close personal friendship with its commandant, Ferdinand Foch. Cnder his influence Wilson became convinced of the danger which was threatening Europe and made himself acquainted with the Franco-German frontier.

In 1910 he left the Staff college to succeed Sir W. Robertson as director of military operations. Wilson concentrated the labours of his directorate upon what he believed to be the vital field of operations. He was one of Lord Roberts' most ardent supporters in his campaign for national training. Thus, while British statesmen were striving for peace, Wilson, acting under the chief of the imperial general stafi. was step by step perfecting the nation's preparations for war. Hence, in Aug. 1914 the British war office was in a position to bring off a strategical surprise. Mobilization was rapid and the British expeditionary force was landed in France without the loss of a man or a horse. complete in every detail. In France Wilson was deputy chief of the general staff. It was therefore natural that he should be appointed principal liaison officer with the French field headquarters.

Although deeply interested in the life and welfare of the private soldier, he never really made his mark as a commancler. Early in 1917 he left the field armies and accompanied Lord Milner's mission to Russia. In Nov. 1917 he went to Versailles as British military representative on the newly established Supreme War council. Three months later he became chief of the imperial general staff. He supported Lloyd George in his efforts to secure unity of command on the western front and strongly pressed for the appointment of Foch as the commander in chief of the Allied forces in France.

Wilson belonged to what became known as the eastern school of thought rather than to the western, and when the German advance was checked he worked hard to re-establish that eastern front which was shaken by the Russian Revolution, When the Armistice was declared on Nov. 11. 1918, he had attained the rank of general, and in the final honours for the war he was promoted field marshal and was given a baronetcy and a grant of £10,000. As chief. of the general staff he was military adviser of the government during the prolonged negotiations at Versailles, and subsequently at numerous conferences.

Political Career.—Immediately after World War I the troubles in Ireland came to a head. His position as chief of the imperial general staff, under a government with whose policy in Ireland he could not agree, became extremely difficult. Cordial relations became strained and old friendships were broken. When. in Feh. 1922, his tenure at the war office came to an end, he entered parliament as member for North Down and placed his military experience at the disposal of the government of Xorthern Ireland. In the house of commons he quickly established himself as the most outspoken critic of those colleagues with whom in his military capacity he had worked so long. and in so doing he drew upon himself the hatred of his fellow countrymen in the 26 Irish counties.

He was shot on his doorstep in Eaton place, London, June 22, 1922, by two Sinn Feiners. (N. MA.)

WILSON, HENRY MAITLAND WILSON, 1ST BARON (1881–), British field marshal, a leading figure of World War II, was born in London on Sept. 5, 1881, and educated at Eton. After service in the South African War and World War I, he was sent in 1939 to command British troops in Egypt. With Generals Wavell and O'Connor he was largely responsible for the rout of the Italian army in the western desert in the winter of 1940–41. Thereafter he held a succession of high commands in the middle east, including those of the expedition to Greece in March 1941 and of the mixed force of British commonwealth and Free French troops which wrested Syria from the control of the Vichy government in the summer of that year. In 1944 he became supreme Allied commander in the Mediterranean. Wilson maintained excellent relations between the British and U.S. forces, being, in Gen. Dwight D. Eisenhower's words, "affectionately known as 'Jumbo' throughout the Allied forces," and he was a natural choice to succeed Sir John Dill as head of the British joint staff mission at Washington (1945–47). In this capacity he attended the Yalta and Potsdam conferences. He was created a baron in 1946. Lord Wilson's book, *Eight Years Overseas, 1939–1947,* was published in 1950. (J. R. M. B.)

WILSON, JAMES (1742–1798), U.S. constitutional lawyer, political theorist, politician and jurist. He was born on Sept. 14, 1742, on his father's farm in the little village of Carskerdy in the shire of Fife, Scot. Wilson attended nearby St. Andrews university, which was alive with the spirit of the Scottish Renaissance. Forced to cut short his formal education when his father died, he tried tutoring and bookkeeping before abandoning Scotland for America in 1765. He arrived in Philadelphia during the exciting Stamp act days and began anew by teaching Greek and rhetoric in the College of Philadelphia. He soon turned with relief to law, his true métier, and for a year studied under John Dickinson, leader of the Pennsylvania bar and famous spokesman for colonial liberties. He left Philadelphia for Reading in 1767 to start his law practice, but in 1770 moved to Carlisle where he married Rachel Bird in 1771. By 1774 his training and his talents, both of which were of a high order, had carried him to the top of his profession in the colony. The publication in that year of his treatise (written in 1768), *Considerations on the Nature and Extent of the Legislative Authority of the British Parliament,* in which he set out a scheme of empire to give the British colonies the equivalent of dominion status, spread his fame beyond the bounds of Pennsylvania. In the power and acuteness of his intelligence he was the peer of John Adams and Thomas Jefferson, both of whom chose this time to publish schemes similar to Wilson's and thus anticipating the British Commonwealth of the future.

Wilson took his place in the forefront of the revolutionary movement in Pennsylvania at the outset when he became in 1774 a member of the committee of correspondence in Cumberland county and one of the county's delegates to the first continental congress at Philadelphia. His varied activities during the ensuing decade represented a valuable contribution to the revolutionary cause and made him a leader of the emerging nation. More important, they prepared Wilson himself for the great work of his career at the federal Constitutional Convention in 1787. He was a dominant figure in the second continental congress from May 1775, to Sept. 1777, and signed the Declaration of Independence. He opposed the radical champions of the strange Pennsylvania state constitution of 1776. As a Philadelphia lawyer he adopted conservative views that led to an unsuccessful attack on his home by a Philadelphia mob in 1779. In that year he was appointed advocate general for France and represented that country in cases arising out of its alliance with the American colonies. He also became a champion of the Bank of North America and an associate of Robert Morris in his struggle for currency reform after 1781. He served as an agent representing Pennsylvania in its dispute with Connecticut over the Wyoming valley in 1782. As a member of congress in 1783 and 1785–86 he pressed for an amendment to the Articles of Confederation to permit congress to levy a general tax. In all of these experiences he was led to think deeply again and again about the whole problem of government.

Before coming to the Constitutional Convention at Philadelphia in 1787. Wilson had penetrated to the heart of the great question that had perplexed Britain and the American colonies for a generation: how to establish viable central authority so necessary if the union were to endure and at the same time preserve the local rights that Americans insisted upon. During the convention he worked effectively to produce the answer found in the federal constitution. *(See* CONSTITUTION AND CONSTITUTIONAL LAW: *United States.)* Wilson followed up his work in the federal convention by leading the fight for ratification in Pennsylvania. In 1790 he engineered the drafting of a new constitution for the state and delivered a series of lectures which are landmarks in the evolution of American jurisprudence. An associate justice of the first U.S. supreme court, he participated in all of its important decisions after 1790 including his notable decision in *Chisholm* v. *Georgia.*

In the winter of 1796–97 long-impending financial ruin brought on by his reckless land speculations shattered his health and ended his career. He died a broken man, at Edenton, N.C., Aug. 21, 1798.

See the standard biography and guide to pertinent sources, Charles Page Smith, *James Wilson: Founding Father, 1742–1798* (1956). (W. W. A.)

WILSON, JOHN (1595–1674), English composer of songs from Shakespeare plays who may have been the Jacke Wilson mentioned in the stage direction of the first folio edition of Shakespeare (1623). Wilson became one of the King's musicians in 1635, went to Oxford with the court in the Civil War and after the surrender retired to the country for some years. He was professor of music at Oxford from 1656 to 1661. He published "Psalterium Carolinum" in 1657 and "Cheerfull Ayres" in 1660. He went back to his post as one of the King's musicians at the Restoration and died in London on Feb. 22, 1674.

WILSON, JOHN (CHRISTOPHER NORTH) (1785–1854), Scottish writer, principal contributor to *Blackwood's Magazine* in its early days, where his work appeared under the pseudonym Christopher North, was born at Paisley on May 18, 1785, the son of a wealthy manufacturer. He mas educated at Glasgow and Oxford universities, entering Magdalen college as a gentleman commoner in 1803. After receiving his B.A. in 1807 he lived at Elleray, his estate on Windermere. Noted for athletic prowess, he also cultivated literature, was friendly with Wordsworth and published in 1812 a volume of poems, *The Isle of Palms.* He married in 1811 and began to read for the Scottish bar in 1813, moving to Edinburgh with his family after losing his fortune in 1815. In 1817 he began to write for the newly founded *Blackwood's Magazine,* helping to ensure its success after a doubtful start, and, as its chief contributor, influenced its development, though never officially editor. The famous series of symposia, *Noctes Ambrosianae,* begun in 1822. was after 1825 mainly Wilson's work.

In 1820, largely through political influence, he became professor of moral philosophy at Edinburgh university. He continued, however, a voluminous contributor to *Blackwood's,* especially of sketches and miscellaneous and critical essays. He also wrote fiction of a sentimental and moral cast. Not an original thinker, Wilson relied much, both as teacher and essayist, on the ideas of his friend Alexander Blair (professor of rhetoric and belles-lettres at the new London university from 1831–34), clothing them with his own imaginative and often rhapsodic eloquence. His critical views were lively and sometimes penetrating, though erratic and often inconsistent.

He died at Edinburgh, April 3, 1854, after three years' retirement on a civil list pension.

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WILSON, RICHARD (1714–1782), one of the earliest major British painters of landscapes, was born at Penegoes, Montgomeryshire, on Aug. 1, 1714, the son of a clergyman. Sent to

London in 1729, he studied portraiture under Thomas Wright and worked on his own from about 1735, being among those who presented works to the Foundling hospital in 1746. These and his "View of Dover" (National Museum of Wales, Cardiff). probably dating from 1747, show a growing interest in landscape which soon after his arrival in Italy late in 1750 became almost exclusive. Staying at first in Venice he studied the works of Titian, meeting the painter F. Zuccarelli and the British collector-consul Joseph Smith. Early in 1752 he went to Rome with William Lock of Norbury, one of the influential art circle which Wilson joined there and which included the painters C. J. Vernet and A R. Mengs. He remained until 1757, working much for aristocratic English tourists and producing not only large landscapes in the manner of the Poussins, Salvator Rosa and Claude, but numerous drauings of Roman sites and buildings which he used in composing Italianate landscapes after his return home. The finest of these is a set made for Lord Dartmouth and dated 1754. An oil painting of 1753, "Rome From the Villa Madama," still, like the drawings in the Dartmouth collection, shows how Wilson tempered his delicate observation of light and distance with the classical discipline of the 17th century. Returning to London probably in 1757, he became influential as a teacher, and after 1760 as an exhibitor with the Society of Artists and the Royal Academy of which in 1768 he was a founder-member and from 1776 librarian, a post he took to relieve his poverty.

Though continuing to produce Italian landscapes such as the "Lake Nemi" (Ford collection, London), dated 1768, Wilson now turned to his own country, especially to Wales and the then park-like environs of London. The order and clarity, rather than the classical apparatus, of Italy survive, but U'ilson's exact and tranquil recording of clear or suffused air, of distance and varied lights, predominates. Works of this class were vital in their influence on J. M. W. Turner, John Constable and John Crome, and later ones such as "Minchinden House" (Lord Leigh) tend to abandon formal composition, using tonal methods of recording space. Many works ascribed to him, especially late ones, are partly the work of his many pupils. He died near Llanberis, Caernarvonshire, on May 12, 1782. *See* also PAINTING: *Great Britain.*

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(*D.* **C.** T. **T.**)

WILSON, ROBERT (d. 1600), English actor and playwright, was a comedian in the earl of Leicester's company in 1572, 1574 and 1581, and from 1583 until about 1588 in the Queen's. He then probably gave up acting for writing. He wrote several morality plays. The *Three Ladies of London* (1584), *Three Lords of London* (1590) and *The Cobbler's Prophecy* (1594) are generally ascribed to him. *Three Ladies of London* contains the episode of the attempt of the Jew to recover his debt, afterward adapted by Shakespeare in *The Merchant of Venice.* ROBERT WILSON (1579–1610), supposed to be his son, was one of Philip Henslowe's dramatic hack writers.

WILSON, (THOMAS) WOODROW (1856–1924), 28th president of the United States, was born in Staunton, Va., Dec. 28. 1856. He had two older sisters, Marion and Anne, and a younger brother, Joseph. The Scottish strain predominated in his ancestry. His paternal grandfather migrated to the United States from Ulster in 1807. His maternal grandfather, Thomas Woodrow, brought up in the little town of Paisley, near Glasgow, and a graduate of Glasgow university, gave distinguished service as pastor at Carlisle. Eng., before moving to the United States in 1835. The stern Presbyterianism of Woodrow's father, Joseph Ruggles Wilson, a minister of indomitable character and theological distinction, left an indelible impression upon the character of the future president.

Wilson's early years were spent in Georgia and South Carolina. where he was deeply affected by the ravages of the Civil War and the sufferingof the south during the Reconstruction period. After a brief experience at Davidson college in North Carolina he entered Princeton university in 1875 and graduated four years later. His scholastic record placed him high in his class but not at the top. He took a prominent part in debating and literary activities and also participated in the administration of student athletics. His most notable achievement as an undergraduate was the publication in the *International Review* during his senior year of an article which analyzed critically and skilfully the committee system of the U.S. congress. In the essay may be discovered the basis of his more mature political principles. After graduating from Princeton he studied law at the University of Virginia but poor health cut short his residence. Following an unsuccessful attempt at legal practice in Atlanta, Ga., he decided to pursue advanced studies in government and history at Johns Hopkins university, Baltimore, Md. There, in 1886, he received the Ph D. degree.

Wilson's doctoral dissertation, published in 1885 under the title of *Congressional Government,* developed his attack upon the controls exercised by congressional committees in the legislative process. Clear and felicitous in expression, its scholarly quality received general recognition. In that same year he married Ellen Louise Axson of Savannah, Ga., and began his teaching career at Bryn Mawr college as associate professor of history and political economy.

In 1888 he became professor of the same subject at Connecticut Wesleyan university, and two years later joined the Princeton faculty as professor of jurisprudence and political economy. He served in this capacity until 1902 when he was chosen president of the university. His academic lectures, like his public addresses and published writings. were characterized by clarity of presentation and brilliance of phrasing. His tastes led him to elucidation and generalization rather than profound scholarship; after the publication of his thesis his most successful literary efforts were in essay form.

As president of Princeton, Wilson devoted himself to basic reform of the educational framework of the institution and to attempts at reshaping the intellectual life of the undergraduates. In 1905 he inaugurated the preceptorial system, designed to stimulate intimate and lively intellectual contacts between teachers and students. His attempt to democratize the social customs of the undergraduates aroused heated controversy among alumni, faculty and trustees. He was not without enthusiastic supporters but he met determined opposition in influential circles. Wilson was not adept in diplomatic handling of those who opposed him. Further difficulties developed from personal disagreement with the dean of the graduate school. It is noteworthy that both Harvard and Yale later adopted in essence the plans he proposed for undergraduate life in quadrangles and the principles of his preceptorial plan have been generally approved by U.S. colleges.

As professor and as president at Princeton, Wilson achieved a national reputation by his addresses and articles on political questions of the day. Discussion of his availability as a candidate for the governorship of New Jersey in the election of 1910 was widespread. In September of that year he was offered the Democratic nomination. The offer came at a moment when prospects for the success of his policies at Princeton seemed most discouraging and he readily accepted. After resigning the presidency of the university, he conducted a dynamic and fearless campaign. He won the support of progressive elements throughout the state and in November was elected by a plurality of 49,000 votes.

As governor of New Jersey, Wilson at once made it plain that he intended to fulfill his liberal pledges regardless of protests from the machine politicians who had fostered his nomination. Under the pressure of his active personal leadership the legislature successfully carried through a series of reform measures. Of these the most significant were: a Direct Primaries act which, supplemented by an effective Corrupt Practices act, did much to purify the political atmosphere of New Jersey; an Employers' Liability act; the creation of a public utilities commission; and reforms which made possible the commission form of municipal government. His leadership was threatened by the election of 1911 when the Republicans won a majority in both houses of the legislature. Although he was no longer in a position to dictate, Wilson was able to provide the impetus necessary for enactment of a series of bills. known as the Seven Sisters, that were directed toward the protection of the public from exploitation by trusts. It constituted a triumph on the eve of the approaching campaign for the presidential nomination.

Wilson's rapid and resounding success in New Jersey brought him clearly into the arena of national politics. He was not slow to develop an active campaign. But when the Democratic national convention in June 1912 met at Baltimore to select a candidate for president, Wilson's chances were not highly favoured as compared with those of the leading candidate, Champ Clark. The contest was prolonged, but on the 14th ballot William Jennings Bryan threw his support to Wilson and the tide began to run strongly in his direction. On the 46th ballot he received the necessary two-thirds vote and was nominated, July 2, 1912.

In the presidential campaign that followed, the clarity and positive quality of Wilson's domestic program soon won for him the leadership of the Democratic party and of the entire progressive movement throughout the nation. He called for expanded exercise of federal authority not so much for the regulation of industrial enterprise as for its emancipation from the control of privileged groups. He rejected Roosevelt's New Nationalism, which implied active government intervention on behalf of social justice and the economic welfare of the underprivileged. The purpose of his program, the New Freedom as he called it, was to restore unfettered opportunity for individual action. By its emphasis upon the idea of liberation the New Freedom appeared as a revival of traditional Democratic principles; but it redefined those principles to meet 20th-century social and economic conditions.

In the November election Wilson received 435 electoral votes as against 88 for Roosevelt and 8 for Taft. His popular vote was 1,000,000 less than that of his two chief opponents combined, and in only 14 states (all of them in the south) did he receive a clear majority. But the election, because of the division of Republican votes, put both houses of congress under Democratic control and in the nation at large Wilson could reasonably expect support from the Progressives for his legislative program of reform.

Once in the White House the president proceeded with amazing vigour to initiate and carry through the major items of legislation he had advocated in his campaign. In this process he rapidly established his personal ascendancy. He delivered his first message to congress in person, renewing the custom that had lapsed since the administration of John Adams. In this session and later he intervened constantly to influence individual senators and representatives on behalf of the program in which he was especially interested.

The record of legislative accomplishment in the first two years of Wilson's presidency is impressive. He dealt with crucial and contentious issues and he achieved extraordinary success. His first major victory was passage of the Underwood Tariff act (signed Oct. 3, 1913) over the bitter opposition of varied industrial interests. To counterbalance the downward revision of tariff rates, the act levied a federal income tax, under authority of the recently approved 16th amendment. The new tariff act was followed by a broad measure of currency reform, the Federal Reserve act, signed Dec. 23, 1913. Designed to supplant so-called dictatorship of private banking institutions by a public board (the Federal Reserve board) which mould control the expansion and contraction of the currency, it was destined to become the pediment of the national financial structure. (See FEDERAL RESERVE SYSTEM, THE.) The establishment of the Federal Trade commission (*q.v.*) in 1914 provided for the use of federal powers to assure competitive conditions in trade. In the same year the Clayton Anti-Trust act met the demands of labour by prohibiting injunctions in labour disputes unless necessary to prevent irreparable damage and by proclaiming that strikes and boycotts were not violations of federal law. (See LABOUR LAW: United States.) The achievement of such far-flung legislation in these four fields went far toward creating a new social and economic atmosphere.

Wilson's foreign policy, in contrast to his domestic policy, was by no means clear cut. It was characterized, at least in principle, by a refusal to exert the material power of the United States against weaker nations and by a studied respect for the rights and interests of small nations. Steps were taken, for example, to prepare the Filipinos for self-government. The so-called "dollar diplomacy" of the preceding administration was repudiated and U.S. bankers were effectively discouraged from participating in the international Chinese loans. At the urgent request of the president. congress repealed the la that exempted U.S. coastwise shipping from Panama canal tolls, thereby greatly relieving tension with the British. But conditions in the Caribbean continued to be disturbed and the controlling vigilance of the United States was necessarily tightened. By a treaty signed Sept. 16. 1915, a virtual protectorate over Haiti was assumed by the United States. In Santo Domingo precautionary visits of United States cruisers were followed in the summer of 1915 by the landing of U.S. marines and in November of that year by the proclamation of a military government under U.S. auspices.

In revolutionary Mexico, President Wilson was confronted with a dangerously chaotic situation. Following his failure to secure the elimination of Gen. Victoriano Huerta from the dictatorship which he had assumed, Wilson resigned himself to what he called a policy of "watchful waiting." He stoutly opposed formal intervention as urged upon him by U.S. and European business interests. But in April 1914, following affronts to U.S. sailors for which no apology was forthcoming. and also to prevent the landing of munitions from a German ship, a U.S. naval force seized the terminal facilities of Veracruz. The danger of war with Mexico became obvious.

The proffered mediation of Argentina. Brazil and Chile was gladly accepted by Wilson but the resulting protocol of Niagara Falls (June 24, 1914) provided no practical basis for peace and order. The overthrow of Huerta brought no settlement of the civil war, which continued to threaten U.S. business interests. Wilson's recognition of the government of Venustiano Carranza, in Oct. 1915, did not end complications. The raids of the guerrilla leader Pancho Villa into U.S. territory in March 1916 led Wilson to authorize a punitive expedition under Gen. John J. Pershing. To the end of his administration, Wilson was plagued by Mexican anarchy. (See also MEXICO: Independent Mexico.)

After July 1914 U.S. foreign affairs were naturally dominated by the European war and by the efforts of President Wilson to protect the rights of the United States as a neutral. His formal proclamation of neutrality (Aug. 4, 1914) was emphasized by a more personal appeal of Aug. 18, in which he adjured the American people to remain impartial in thought as well as in behaviour. Meanwhile his offer of mediation evoked no favourable response from the belligerents, and his attempts to initiate secret peace negotiations failed. Almost immediately Wilson and his secretary of state, William Jennings Bryan, discovered the difficulties involved in protecting the neutral position of the United States from infringement by one side or the other. The British sought to establish a virtual blockade of German ports through the utilization of their maritime control: they extended the doctrine of continuous voyage, enlarged contraband schedules, brought neutral ships into British ports and detained neutral cargoes. American opinion was inflamed by such disregard of traditional maritime rules in time of war and active controversy developed.

The dispute was thrown into the background almost immediately by a more critical altercation with Germany. On Feb. 4, 1915, the Berlin government declared the waters around the British Isles a war zone, threatened to sink all belligerent ships met within that zone and gave warning that neutral ships might also be sunk. To this Wilson replied with a vigorous note on Feb. 10 admonishing the German government that it would be held to "strict accountability" for the lawless acts of submarine commanders. Destruction of an American vessel or of American lives, the president stated, would be regarded as an "indefensible violation of neutral rights." But the Germans nevertheless maintained their position. On May 7 the British liner "Lusitania" was sunk by a German submarine without warning; more than 1,000 persons were drowned, among them 128 Americans. From this moment the issue was clarified in Wilson's mind, never to be altered. The Germans must not use the submarine against merchant ships except according to recognized rules that called for warning and provision for the safety of passengers and crews.

Wilson was determined to avoid war and displayed long-suffering patience in the negotiations of the ensuing weeks. "There is such a thing as a nation being too proud to fight," he declared in a public address shortly after the sinking of the "Lusitania." He spoke in no mood of cowardice and his will to compel Germany to abide by the established rules of cruiser warfare was unshakable. His protest to Germany was, in fact, so strongly worded that Secretary of State Bryan resigned rather than sign it. Following the sinking of the "Arabic" in Aug. 1915, the German government promised that liners would not be attacked without warning. In the spring of 1916 when a rupture with Germany again became imminent because of the torpedoing of the channel steamer "Sussex," Wilson protested in terms that amounted to an ultimatum and finally drew from Berlin a more comprehensive pledge to abandon the ruthless submarine campaign altogether. For the next seven months relations with Germany were less disturbed.

This diplomatic victory not only postponed American intervention in the war, but proved of political value to Wilson in the presidential campaign of 1916 in which he was the Democratic candidate. It gave strength to the argument that he had vindicated the rights of the United States successfully and at the same time had "kept us out of war." The slogan made a strong popular appeal, especially west of the Mississippi. The Republicans, who nominated Charles Evans Hughes, denounced the president as hesitating and cowardly, both in his dealing with Germany and in his handling of the Mexican problem. They criticized his legislative reforms as demagogic and cited the Adamson act, which Wilson had urged upon congress to avert a railroad strike, as an untimely surrender to labour. On the eastern seaboard and in most of the industrial centres of the middle west, the reunited Republican party could count on success, but in the farming districts west of the Mississippi and on the Pacific coast, Wilson showed great strength; he drew largely from the Progressives, who refused to follow Theodore Roosevelt back into the Republican fold. The result of the election held on Nov. 8 was so close that for 12 hours a Republican victory was generally conceded. Only as returns from the west came in was it determined that Wilson had been re-elected by 277 electoral votes to 254 for Hughes and with a popular plurality of 9,129,606 to 8,538,221.

Wilson's victory was generally ascribed to the support of the pacifists; he lost no time in preparing to justify their confidence by a determined move for peace. Earlier in the year he had authorized Col. Edward M. House to suggest to the British foreign secretary, Sir Edward Grey, that the president "on hearing from France and Britain that the moment was opportune" was ready to propose a conference to end the war. "Should the Allies accept this proposal and should Germany refuse it, the United States would probably enter the war against Germany." A memorandum embodying such an agreement was drafted by House and Grey, Feb. 22, 1916. It received the rather guarded approval of Wilson, but Great Britain and France made no move to take advantage of this plan to restore peace. In Germany, the chancellor was himself determined to avoid war with the United States. But by early summer he became convinced that unless conversations pointing toward an immediate peace were opened, the German military and naval leaders would force resumption of the unrestricted submarine campaign An invitation to Wilson to take the initiative in the starting of negotiations was drafted in September by the kaiser himself. It was secretly passed on to the president through Colonel House.

Wilson delayed any move until the result of the election was certain and for a month thereafter. Wearied of waiting for him, the Germans themselves, on Dec. 12, issued a statement of their willingness to enter peace negotiations. Six days later, Wilson published his own note asking the belligerents to state the terms they would accept. The replies to the president's appeal were not encouraging, but they gave him the opportunity to expound his own conception of what would serve as the basis of an enduring peace. This he did in an address to the U.S. senate, Jan. 22, 1917. Better than any of his war speeches, because it was composed while the United States was still neutral, it set forth Wilson's basic principles. Peace must be organized by the major force of mankind under the protection of a League of Nations (*q.v.*). No nation should extend its policy over another; no one power should dominate the land or the sea. There must be a limitation of armaments. As a guarantee of future peace and justice, the ending of the existing war must not result in the violation of the rights of one side or the other. It must be "a peace without victory."

Wilson's drive for peace negotiations was frustrated almost immediately by the German decision to renew the unrestricted submarine campaign, a decision that had been taken at the Council of Pless on Jan. 9, 1917. The German ambassador in Washington, D.C., Count von Bernstorff, gave clear warning to his government that such a step would bring the United States into the war. But Berlin had lost hope of Wilson's creating an opportunity for them to enter peace negotiations on favourable conditions. German military and naval leaders assured the chancellor that if they could operate without hampering restrictions the submarines would rapidly achieve victory and Germany could shortly dictate terms of peace. Von Bernstorff was informed of the decision on Jan. 19. On Jan. 31, according to his orders, he delivered the fateful German note.

As he had foreseen, the German ambassador was immediately given his papers, but President Wilson refused to believe that the diplomatic rupture meant war—"only actual overt acts" would persuade him that the Germans were determined to carry their threats into effect, He was willing to negotiate everything except the sinking without warning of passenger and merchant ships. But the Germans showed no sign of weakening. "If Wilson wants war," wrote the kaiser. "let him make it and let him then have it." Opinion in the United States was exasperated, not only by the formal declaration of the renewal of the submarine warfare, but especially by the virtual blockade of cargoes in U.S. ports held there by fear of submarine attacks; it was infuriated by the publication of the Zimmermann telegram which suggested a German-Mexican-Japanese alliance and a Mexican reconquest of Texas, New Mexico and Arizona; it was deeply shocked by the sinking of the "Laconia" with the loss of American lives. On April 2, unable longer to resist the pressure of events and public opinion, the president appeared before congress to ask a declaration that a state of war with Germany existed. The resolution passed the senate on April 4 and the house of representatives on April 6, in each case by an overwhelming majority.

The United States was ill prepared for war, a condition for which Wilson carried a heavy share of responsibility. But once in the war he displayed outstanding qualities of leadership. Through his speeches he created a national consciousness of common effort; he made the people feel that the conflict was a people's war, one in which every citizen should be glad to make his individual sacrifice. He guaranteed full authority and steady support to the men selected for the vital military and administrative positions. The president's leadership brought the nation to accept emergency measures that were distasteful but essential to victory. These measures included a selective draft of manpower, supervision and control exercised by the War Industries board and the Food and Fuel administration, and national administration of railways. Wilson's leadership further ensured a ready response to appeals for a popular financing of the war effort through the Liberty Loans. To the secretary of war, Newton D. Baker, he gave the authority that enabled him to proceed methodically and with ultimate success to the organization of a national service of supply that met the needs of an overseas force which finally numbered more than 2,000.000 men. In France. Gen. John J. Pershing was granted a free hand in the development of this force into a unified army. In no war previously waged by the United States was the opportunity for dishonest profit so nearly eliminated and partisan political influence so effectively minimized.

Wilson's leadership in the war effort was enlarged and enforced by his appreciation of the value of moral as well as military weapons. He strengthened the nation's determination by emphasizing that the war was a crusade on behalf of freedom. He weakened the enemy's determination by his reiteration that this crusade implied not merely the overthrow of the German government but also the liberation of the German nation. It was, he insisted, a "war for freedom and justice and self-government amongst all the nations of the world . . . the German people themselves included." These principles he re-emphasized in the more important of his war speeches, notably that on Jan. 8, 1918, in which he enumerated the Fourteen Points (*q.v.*) which he regarded as an essential basis of a just and lasting peace. These principles he elaborated in the course of the following eight months. It was natural that when the Germans faced complete defeat in early Oct. 1918, they should turn to Wilson and offer to accept his Fourteen Points and later speeches as the basis of peace.

The British and French were by no means prepared to accept Wilson as arbiter of peace conditions and were slow to recognize his speeches of 1918 as an adequate foundation for the peace treaties. They yielded, however, to the persuasive diplomacy of Colonel House, who represented the United States in the Supreme War council during the armistice conferences. Upon his insistence, the Fourteen Points (with certain exceptions) were accepted by the Allied chiefs and Germany as the basis of the forthcoming settlement. This strategic advantage to Wilson in the coming peace negotiations was offset by a serious political handicap which was laid upon him at home. Wilson's appeal for a Democratic majority in the campaign for the congressional elections in Nov. 1918 was denied by the voters. Substantial reverses were sustained by his party, which thereby lost control of the senate in the new congress. The president's prestige suffered both at home and abroad; he also had to face the fact that the vitally important senate foreign relations committee was henceforth to be controlled by his personal and political adversaries.

Wilson was determined to go to the peace conference at Paris and to lead the battle for the principles he had been advocdting. These principles constituted a threefold and interlocking concept: the liberation of peoples; justice alike to friend and enemy; and the assurance of peace through the establishment of a League of Nations. Such an organized system, he insisted, was essential to the maintenance of an international regime of freedom and justice. Wilson summarized his principles in compelling phraseology: "a universal dominion of right by such a concert of free peoples as shall bring peace and safety to all nations and make the world itself at last free." The president sailed for France on Dec. 4, 1918, on the "George Washington," arriving at Brest on Dec. 13. He was received in France, England and Italy with tumultuous enthusiasm, but his prestige rested upon a precarious footing and it inevitably became clouded when he confronted the nationalistic aspirations of individual peoples.

The president achieved an early triumph at the conference in winning acceptance of the principle that a League of Nations should be an integral part of the treaties of peace. This was emphasized by his success in leading the commission on the League to agreement upon a preliminary draft of a convenant for the League, which was unanimously adopted in plenary session by the peace conference on Feb. 14. A two-weeks visit to the United States convinced Wilson of the necessity of inserting certain amendments in the covenant in order to satisfy U.S. sentiment. These he was able to secure upon his return to Paris, but not without meeting the demand that he should himself show a correspondingly benevolent appreciation of the interests of European states. On April 28 he won unanimous approval by the conference of the final draft of the covenant.

Wilson's success in the establishment of the League as the main foundation of the treaties was to some extent obscured by the concessions he was forced to make to national territorial and economic demands. The peace of reconciliation which he had preached was not achieved. On every debatable issue, the defeated enemy got the worst of it. Much against his own feelings, Wilson yielded to Japanese claims in Shantung at the expense of China. The unilateral disarmament imposed on Germany made a mockery of the program he had outlined in the Fourteen Points. The problem of reparations was left for final decision to a reparations commission and what amounted to a blank check was exacted from Germany. But the over-all settlement, if it could actually be carried into effect, promised the security that everyone demanded. It recognized the claims of the smaller nationalities to a degree that had never hitherto been approached. It provided for a working partnership of the new world with the old. On June 28, 1919, the Versailles treaty (*q.v.*) with Germany was signed. The following day Wilson sailed for the United States.

The strain of the peace conference had told upon the president's physical and nervous strength. He was thus not well equipped to carry on successfully the contest with his Republican opponents in the senate that developed upon his presentation of the treaty. It was at once obvious that reservations would be presented by the foreign relations committee. Ratification of the treaty would depend upon conciliation of the Republican "mild reservationists" in such numbers as would compel the chairman, Sen. Henry Cabot Lodge, to accept ratification. Wilson could not bring himself to make the necessary concessions. In search of popular support that would overwhelm the senate, he set forth upon a crusade in behalf of the treaty and the League. The enthusiasm of the west matched the lukewarmness of the east, but his physical strength was drained. In Colorado, Sept. 25, 1919, after 34 major addresses and scores of interviews, parades and rear platform talks, he was compelled to give up his tour and return to Washington in a state of complete collapse. On Oct. 2, he suffered a thrombosis that impaired the control of the brain over the left side of his body.

The physical prostration of the president left him isolated from men and affairs. Entirely apart from the confusion that was thus occasioned in the conduct of public business, it shattered hopes of a speedy ratification of the treaty. No one else was capable of leading the fight for ratification or possessed enough authority to arrange a compromise. On Nov. 13, the senate approved reservations uhich, from his sickroom, the president denounced as providing "not for ratification but rather for the nullification of the treaty. . . . I sincerely hope," he added. "that the friends and supporters of the treaty will vote against the Lodge resolution of ratification." Party discipline held. On Nov. 19, the two-thirds vote needed for ratification was blocked by a combination of Republican irreconcilables and Democrats personally loyal to Wilson.

Efforts to arrange a compromise during the succeeding weeks proved fruitless. With something of his physical health regained, with his niind nervously active, but with his grasp of affairs unrealistic, the president drafted a farfetched plan for submitting the issue to popular vote at a special election. Recognizing the practical difficulties of such a plan, he insisted that the only way out was to "give the next election in the coming November the form of a great and solemn referendum." Wilson thus excluded the possibility of immediate compromise with Senator Lodge. Efforts to achieve agreement were made in a bipartisan conference of the senate, but they foundered upon the bitter-end opposition of Republican irreconcilables. On March 19, 1920, the final vote was taken on the ratifying resolution which again contained a reservation on article x—the article that provided for collective security—strong enough to evoke Wilson's condemnation. Once more lie urged his followers to vote against ratification and 23 of them did so. The vote on the resolution was 49 for and 35 against, 7 votes short of the necessary two-thirds. The United States was thus kept out of the League of Nations at the behest of the man who had done more than any other to create it.

Wilson's physical condition, despite some improvement in the spring and summer of 1920, was such as to prevent his taking an active role in the presidential campaign of that year. His hope that the election would serve as a popular referendum settling the issues drawn between himself and Senator Lodge was not fulfilled. Indeed, many ardent and influential advocates of the League supported the Republican candidate, Warren G. Harding, and the election proved to be an overwhelming victory for the Republicans. The bitterness of Wilson's disappointment at the result of the election was to some extent alleviated by the 1919 Nobel peace prize awarded him in Dec. 1920. His annual message to congress, while it sounded the note of national duty, made no reference to what always lay nearest his heart—the League of Nations. This reticence on world affairs he maintained until the end of his administration, March 4, 1921.

Upon his retirement from office, Wilson lived quietly in Washington, D.C., refraining from political comments and avoiding political contacts. The legal and the literary activities which he had anticipated lay beyond his waning physical powers. On Armistice day, 1923, he appeared on the porch of his house on S street to greet his admirers with a short speech. Thereafter, he failed steadily. On Feb. 3, 1924, he died in his sleep.

Woodrow Wilson was qualified in the highest degree for a career in public affairs by his personal and mental qualities and especially by his sense of responsibility to the public welfare. To those who worked sympathetically with him and under him, he displayed a magnetic personality. He was genial, humorous, considerate and had broad cultural interests. From his subordinates he evoked admiration and affection, but in dealing with men whom he did not like or trust he could not capitalize upon his personal assets. The depth of his idealistic fervour gave force to his political leadership, which was further strengthened by his outstanding oratorical capacity. But the intensity of that fervour crippled his ability for effective compromise. He was impatient of partisan opposition and there was much of the intolerant Calvinist in his refusal to temporize or deviate from the path which he believed himself appointed by providence to tread. His illusion that the nobility of ideals would suffice to obliterate the stubborn facts of political life took his international policy down the road to bankruptcy. A great leader, he lacked the political intuition and deftness which might have saved him at Princeton, strengthened his contribution to the peace conference and brought the United States into the League of Nations.

That failure should not blind us to the impressive success of Wilson in earlier years. He brought an educational ideal to the college world which was to serve as an active and permanent force in the revival of literary and intellectual interest on the U.S. campus. The legislative reforms of his first two years as president of the United States accomplished a far-reaching and permanent transformation of American social and economic mores. He led the nation to complete triumph in the greatest war that until then mankind had ever waged.

The magnitude of the almost unbroken success which he attained in every enterprise of his political career up to the final test heightens the tragedy of his defeat at the hand of the senators. His claim to high rank as a statesman is inevitably weakened by the collapse of his ultimate effort to bring the United States into the League of Nations, for which he himself was largely responsible. But his rank as outstanding political prophet is nonetheless assured. The clarity and eloquence of his appeals on behalf of freedom and justice are unmatched. The wisdom that informed his insistent demand for international organization obtained almost universal recognition in the years that followed the next world war 20 years after his death. *See* also Index references under "Wilson, (Thomas) Woodrow" in the Index volume.

The following are the most important writings of President Wilson: *Congressional Government: a Study in American Politics* (1885); *The State: Elements of Historical and Practical Politics* (1889); *Division and Reunion 1829–1889* (1893); *An Old Master and Other Political Essays* (1893); *Mere Literature and Other Essays* (1896); *Leaders of Men* (ed. by T. H. V. Motter, 1952); *George Washington* (1897); *A History of the American People* (1902); *Constitutional Government in the United States* (1908); *The New Freedom* (1913); *On Being Human* (1916); *International Ideals* (1919).

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WILSON, a city of North Carolina. U.S.. 46 mi. E.S.E. of Raleigh; the seat of Wilson county. Incorporated in 1819, long after the establishment of most other cities in the North Carolina coastal plain, Wilson soon became an important trading centre, with emphasis on tobacco. Since the first Wilson tobacco auction was held in 1890, the tobacco warehouse facilities have expanded until the combined area of the auction floors is approximately 2,000,000 sq.ft., and it has become one of the largest bright-leaf tobacco markets in the world.

Though tobacco is the key to Wilson's economy, diversification is provided by a number of small manufacturing plants. a major meat packing plant and grain and feed mills. Atlantic Christian college, a four-year co-educational institution related to the Christian (Disciples of Christ) Church, was established in Wilson in 1902. The city has a council-manager form of government, in effect since 1933.

For comparative population figures *see* table in North Carolina: *Population.* (Da. St.)

WILSON CLOUD CHAMBER: *see* Cloud Chambers.

WILTON, a municipal borough in the Salisbury parliamentary division of Wiltshire. Eng., 3 mi. W.S.W. of Salisbury. Pop. (1951) 2,858. On the site of the present Wilton house a priory was established by Egbert in the 8th century which became an abbey under Alfred the Great. At the Dissolution the abbey was given to William Herbert. 1st earl of Pembroke by the second creation. The gardens, with ancient cedars. lawns 200 years old and a Palladian bridge. were mostly laid out in the 18th century. Wilton became a residence of the Wessex kings; and in 871 Alfred was defeated there by the Danes. It was burned in 1003 by Sweyn, the Danish king. It obtained its first charter in 1100. The church of St. Nicholas and Mary (19th century! is in the Lombardic style and has a campanile. Wilton carpets. Brussels and Axminster carpets are made there. The Royal Carpet factory dates from 1655. Felts and agricultural machinery are also produced. Wilton. anciently a centre of the sheep trade, has four annual sheep fairs.

WILTSHIRE, a county of England, bounded north by Gloucestershire. east by Berkshire and Hampshire, south by Hampshire and Dorset and west by Somerset and Gloucestershire.

Physical Features.—About two-thirds of the county is chalk upland and the remainder is a series of clay plains and scarps bordering it on the northwest. The uplands consist of the broad western end of the Kennet syncline with drainage eastward of the Marlborough downs (400–900 ft.): the narrow anticlines of Ham and of the Vale of Pewsey (200–400 ft.) with drainage eastward to the head streams of the Salisbury Avon and westward to tributaries of the Bristol Avon; the wide-rolling Salisbury plain (400–800 ft.) dipping to the southeast. though rising in Cranborne Chase on the south to 500–600 ft.. and drained by the Salisbury Avon, the Wylye, the Nadder, the Ebble and the Bourne, all of which unite at or near Salisbury. Savernake forest, famous for its beeches, covers about 20 sq.mi. on the eastern edge of the uplands.

The Tertiary rocks of the Hampshire basin rest upon the chalk uplands in the extreme southeastern corner of the county. Reading Beds and London Clay east of Downton and on the Clarendon hills; these are covered by Bagshot Sands at Alderbury. Grimstead and Hamptworth common; Tertiaries of the London basin appear as outliers southeast of Marlborough, Reading Beds and London Clay occurring round Great Bedwyn. 'The edge of the chalk uplands forms a scarp to the northwest, from beneath which outcrops a fringe of Upper Greensand and Gault — the former is well exposed in the Yale of Pewsey and forms an elevated tract from Mere through Stourton to Warminster. Lower Greensand appears from beneath the Gault at Poulshot and follows the same line of outcrop northward. At Dinton in the Vale of Wardour the Wealden formation appears. The rest of the northwestern area is occupied by 'Jurassic rocks. Beyond the Lower Gr'eensand lies a narrow belt of Gimeridge Clay.

Beyond the plain rises the irregular scarp of the Corallian Oolitic limestones and marls, and again beyond this, the Oxford Clay and Kellaways Beds of the Middle Oolite. forming a broad. low plain (known at its northeastern end as the Vale of White Horse, draining northeastward to the Thames) on which stand Trowbridge, Melksham, Chippenham and Cricklade, and which is drained by the Upper Bristol Xvon flowing southwest. This is succeeded farther west by the Great Oolite series which includes the building stones of Bath, quarried at Winsley down, near Bradford. and at Box. Corsham down and elsewhere. Above the freestones near Bradford comes the Bradford Clay (with fossil *Apiocrinus*) followed by the Forest Marble Limestones and Clays. Still farther west follows a rim of Inferior Oolite and fuller's earth giving place to Upper Lias in the valley of a tributary of the Avon near Box. (X.)

Archaeology. — In Neolithic and later prehistoric times Wiltshire was one of the most populous areas of England, and it is correspondingly rich in prehistoric remains. Stonehenge (*q.v.*), which is the most famous of these, stands about 7 mi. N.N.W. of Salisbury and 2 mi. W. of Amesbury and is. in its present form, the latest of a class of religious buildings or earthworks which date back to Neolithic times and which are known to archaeologists as "henges." In the north of the county Avebury (*q.v.*), a vast circle of stones enclosing two smaller circles and surrounded by a ditch and external bank. and the "Sanctuary," to which it was connected by an avenue of stones. are well known. Silbury hill. an enormous artificial mound to the south of Avebury, is of comparable date but of unknown purpose. It is possible that the Mount at Marlborough was a similar monument. In the south the earthwork known as Durrington walls, and the structure immediately south of it known as Woodhenge, are both within a short distance of Stonehenge, nhich itself had more than one antecedent on or near the same site, and various earthworks known as the Avenue. the Cursus and the Lesser Cursus were intimately connecied with one or another phase of its construction. The long barrows, clan or family burial chambers. also belong to the Neolithic period. In the south of the county they are usually made of chalk, with a flanking ditch on each side, but in the north they are faithful copies of their prototypes in the Cotswolds, containing stone-lined passages and usually four chambers. Ritual ceremonies have been suggested in connection with the long barrows which may have some relation to the religion of the "henge" monuments. Of a purely domestic nature are the causewayed camps, which may have been cattle enclosures, best known at Windmill hill near Avebury (a fine series of Neolithic pottery from this site is in the museum at Avebury) and Robin Hood Ball in the parish of Netheravon.

Field works of the Early and Middle Bronze Ages are notoriously lacking except for their burial mounds. the round barrows of various forms which are still to be seen on'most of the chalk downs in the county though plowing has taken a heavy toll. Impressive groups of these barrows in the neighbourhood of Stonehenge, such as the Winterbourne Stoke group, are an indication of the late survival of Stonehenge as a religious centre. For the Late Bronze Age one can point to rectangular field systems in various parts of the county and rarely. as on Thorny down, traces of a village site.

The Early Iron Age must have been a period of many wars, since to it belong the numerous hill forts, sometimes consisting of a single bank and ditch as at Clearbury. Figsbury ring and Ogbury in the Salisbury region, and sometimes strengthened at a later date with additional ramparts and complicated entrances. Of this type are Yarnbury near Wylye and Battlesbury near Warminster, to mention only two out of an imposing number. Many village sites or farmsteads of this date have also been found, but their remains are seldom visible at ground level. An exception is Stockton earthworks, which survived well into the Roman period.

Old Sarum, a modified Iron Age hill fort. became Sorviodunum in Roman times. and has been regarded as a military "station" but. though situated at the crossing of two military roads, little evidence of Roman occupation has so far been discovered. There was a villa at Downton, but apart from native villages and small country houses there can have been little settlement by official classes in south Wiltshire, and the more important villas are found on the line of the London to Bath road which passes through Cunetio (Mildenhall) and Verlucio (Sandy Lane). In the south of the county Bokerly dike was a defensive work thrown across the Dorchester road in the 4th century to protect Dorset from invaders who had presumably penetrated Wiltshire and, though the road was opened again, the danger recurred and the road was cut for good. Wansdyke (Woden's dike) which runs from a point east of Savernake forest for nearly 60 mi. toward the Bristol channel, facing north, was probably intended to oppose a Saxon thrust up the Thames valley. (H. DE S. S.)

History. — Settlements on the Greensand consist of small scattered homesteads; on the Chalk there are compact villages along spring lines, and parishes lie in long narrow strips across the scarp so as to include hill pasture and valley arable or meadow. Parishes originally in forest clearings seem to be characterized by churches placed centrally with roads radiating from them. The valleys also suggest downward migration of settlement from Chalk ridgeway to hillside road and, later. to lowland routes. Cynric's victory at Old Sarum (552) began the conquest of the present Wiltshire; his victory at Barbury hill in jj6 extended the West Saxon kingdom to the Marlborough downs. At this period the district south of the Avon and the Nadder was dense woodland, of which Cranborne Chase survives, and at first West Saxon colonization was chiefly confined to the valleys of the Avon and the Wylye. There was a definite administrative and territorial organization in the 9th century, Weohstan, ealdorman of the Wilsaetas, being mentioned as repelling a Mercian invasion (802). Wiltunscire is mentioned by Asser (878) and in that year the Danes established their headquarters at Chippenham. The white horse in the turf on the downs near Westbury was possibly cut in celebration of Alfred's victory over the Danes later in the same year, though it has been modified since. In Edgar's time there were mints at Malmesbury and Wilton, and at Cricklade, Old Sarum and Warminster by the reign of Ethelred. After the Conquest more than two-fifths of the county fell to the church and one-fifth to the crown.

In 1086, after the completion of Domesday Book. Salisbury was the scene of a great council, in which all the landholders took oaths of allegiance to the king, and a similar council assembled at Salisbury in 1116. At Clarendon in 1166 was drawn up the assize which remodeled the provincial administration of justice. Parliaments were held at Marlborough in 1267 and at Salisbury in 1328 and 1384. In 1139 Stephen wrested the castles of Salisbury, Devizes and Malmesbury from Roger, bishop of Salisbury, having become suspicious of his loyalty. In 1216 Marlborough castle was surrendered to Louis the dauphin by Hugh de Neville. Hubert de Burgh escaped in 1233 from Devizes castle. In the Great Rebellion, Wiltshire supported the parliamentary cause, displaying a spirit of violent anti-Catholicism; nevertheless, in the earlystages of the struggle the royalists had some success. In 164j the "Clubmen" of Dorset and Wiltshire were organized to punish any member of either partydiscovered plundering. Devizes, the last stronghold of the royalists, was captured by Cromwell in 1645. In 1655 a rising organized on behalf of the king at Salisbury was dispersed.

At the time of the Domesday survey Wiltshire was almost exclusively agricultural; 390 mills are mentioned, and vineyards at Tollard, Wilcot, Tisbury and Lacock. Under the Cistercians, sheep farming developed, and in the 13th and 14th centuries the monastery of Stanley exported wool to the Florentine and Flemish markets. Wiltshire was among the chief of the clothing counties, the principal centres being Bradford; Malmesbury, Trowbridge, Devizes and Chippenham. In the 16th century Devizes was noted for its blankets, Warminster for its corn market and north Wiltshire for cheese. During the 17th century the clothing trade went through a period of depression, partly because of the constant outbreaks of plague. Amesbury was well known for its tobacco pipes.

Architecture. — Among the monastic buildings are the ruined abbeys of Malmesbury and of Lacock near Melksham. There are traces of the hospital for leprous women (afterward an Austin priory) at Maiden Bradley. Monkton Farleigh had its Cluniac priory, founded as a cell of Lewes in the 12th century. A college for a warden and five other priests, afterward a monastery of Bonhommes, was founded in 1351 at Edington. The church, Decorated and Perpendicular, resembles a cathedral in size and beauty. The finest churches of Wiltshire, generally Perpendicular, were built in districts of good stone. In the chalk region flint was used. Small wooden steeples and pyramidal bell turrets are not uncommon; the church of Purton has two towers, one of which is surmounted by a spire, and that at Wanborough has a tower and a lantern. St. Lawrence's at Bradford-on-Avon is one of the most perfect Saxon churches in England and there is a so-called chapel on the 13th-century bridge. Three arches in the nave of Britford church, within a mile of Salisbury, the east end of the chancel at Burcombe and parts of the churches at Avebury, Alton Barnes, Bremhill and Manningford Bruce in the Vale of Pewsey are Saxon. Norman work is found in the churches of Devizes, Preshute, Ditteridge or Ditcheridge, Netheravon and Great Durnford. Early English is illustrated by Salisbury cathedral, its purest and most beautiful example; and. on a smaller scale, at Amesbury, Bishops Cannings, Boyton, Collingbourne Kingston, Downton and Potterne. Bishopstone has the finest Decorated church in the county with incorporated work of Norman date. Mere has a Perpendicular church, with a medieval chantry chapel, used as a schoolhouse by William Barnes, the Dorset poet.

The castles of Wiltshire have almost disappeared. At Old Sarum. Marlborough and Devizes only a few vestiges are left. The ruins of Wardour castle (14th century) consist of a high hexagonal outer wall, enclosing an open court. The 18th-century castle, one mile distant, was once noteworthy for its collection of paintings, and for the "Glastonbury cup," said to be made of wood from the celebrated thorn (see GLASTONBURY: *St. Joseph of Arimathaea).* Place house, in Tisbury, and Barton farm, at Bradford, date from the 14th century. Fifteenth-century work is best exemplified in the manor houses of Norrington (Vale of Chalk); Teffont Evias (Vale of Nadder); Potterne; Great Chalfield near Monkton Farleigh; and South Wrexall, the seat of the Lords Long. The great early Renaissance house of Longleat, near Warminster (*q.v.*), is the seat of the marquess of Bath; and Wilton (*q.v.*) house, Salisbury, the seat of the earl of Pembroke and Montgomery, is a fine example of the work of Inigo Jones. Longford, built in the form of a Trinity symbol in Elizabethan times, contains, like Wilton, many works of art, and belongs to the earls of Radnor. At the Tudor mansion of Lacock abbey, near Melksham, built round the remains of a 13th century abbey, W. H. Fox-Talbot invented his photographic process. Lydiard park, Purton, dates from medieval times but was reconstructed in 1743–49. Corsham court, Chippenham, is Elizabethan and Georgian.

Agriculture, Industries and Communications. — The downs of the uplands are mostly covered with coarse grass and support sheep (more than 90,000 in the late 1950s). The valleys are fertile and well wooded. The lowlands and clay plains are mostly under grass for dairying purposes and in the late 1950s about 48% of the total area of the county was under grass. The principal crops are wheat, oats and barley, which together covered nearly 158,500 ac. at that time.

Three ancient forests remain: Savernake, south of Marlborough; Cranborne Chase (partly in Dorset); and No Man's Land and Hamptworth common, which are outlying parts of the New forest (Hampshire). The National trust owned 6,168 ac. in Wilts in 1957 and one-seventh was in use by the services. Many hands are employed in the railway locomotive works at Swindon (*q.v.*) and there are large engineering and tobacco works at Devizes. Cloth is woven, especially at Trowbridge; boots and shoes are made at Salisbury; rope and sacking at Melksham; rubber at Melksham and Bradford-on-Avon; bacon at Calne; processed milk, railway signals and brakes at Chippenham; and gloves—an ancient industry—at Westbury. Wilton carpets are known the world over. Portland and Bath stone are quarried. The main London-Bath railway line crosses the county in the north; the line from London to the west passes through Salisbury. Swindon, Salisbury and Westbury are big junctions. The Avon is navigable as far as Salisbury. The Thames and Severn canal passes through the northeast of the county and the Kennet and Avon canal traverses the Vale of Pewsey.

Population and Administration. — The area of the administrative county is 1,344.7 sq.mi. with a population (1951) of 386,692. The municipal boroughs are: Calne (pop., 1951, 5,5531, Chippenham (11,851), Devizes (7,897), Malmesbury (2,510), Marlborough (4,557), Salisbury, a cathedral city (32,911), Swindon (68,953), Wilton (2,858). The county is in the western circuit and assizes are held at Salisbury and Devizes. It has one court of quarter sessions and is divided into 16 petty sessional divisions. The boroughs of Salisbury and Devizes have separate courts of quarter sessions and commissions of the peace and Swindon also has a separate commission of the peace. There are 5 urban and 12 rural districts. Wiltshire has no county town, Trowbridge being the administrative centre and Salisbury the diocesan centre. Most of Wiltshire is in the diocese of Salisbury but there is a large part in that of Bristol and smaller parts in those of Gloucester, Oxford, and Bath and Wells. The four county constituencies are Chippenham, Devizes, Salisbury and Westbury; Swindon is a borough constituency.

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WILUNA, a mining district and settlement in Western Australia. situated in the Central division about an equal distance (approximately 120 mi.) east of Meekatharra and north by east of Sandstone. Wiluna has been linked with Meekatharra by railway (Meekatharra–Perth: 600 mi.; Sandstone–Perth: 575; Meekatharra–Geraldton: 334; Sandstone–Geraldton: 309 mi, by rail.) Auriferous deposits of large extent have been discovered there and the area is under vigorous development. It is the chief town of the East Murchison gold field, which, however. ranks behind Kalgoorlie, Meekatharra, Laverton and Menzies as a gold producer. Pop. (1954) 367 for the locality.

WIMBLEDON, a municipal borough (1905) of Surrey, Eng., and a residential suburb of London, 8 mi. S.W. of Charing Cross. Pop. (1951) 58,141. Area 5 sq.mi. Wimbledon common covers more than 1,000 ac. Wimbledon is famous for the annual lawn tennis championships played at the All-England Lawn Tennis and Croquet club since 1877 *(see* LAWN TENNIS AND TENNIS). It is supposed to be the site of the battle of Wibbandune (568) between Ceawlin, king of Wessex, and Aethelbert, king of Kent, in which the latter was defeated. An earthwork on the common is known as Caesar's camp. There are the John Evelyn museum and several large schools and colleges.

WIMBORNE MINSTER, a market town and urban district in the North Dorset parliamentary division of Dorset, Eng., 22 mi. E.N.E. of Dorchester by road. Pop. (1951) 4,487. Area 1 sq.mi. It is on the river Allen (formerly the Wim) near its confluence with the Stour, and a few miles S.E. of Badbury Rings, an Iron Age earthwork. Cuthburgha and Cwenburh, sisters of Ine, king of Wessex, founded a nunnery there in 718. The present minster, reputedly built on the site of that nunnery, is called St. Cuthburgha and dates from 1120. It contains a chained library and an astronomical clock, possibly made by Peter Lightfoot in

1320. In 871 King Ethelred was mortally wounded in a nearby battle with the Danes and brought to Wimborne for burial. The minster contains his grave slab (with 14th-century brass inserted). In the early 11th century Wimborne, with its convent and church, was completely destroyed by the Danes. In place of the convent a college of secular canons was established by Edward the Confessor; later it became a royal free chapel. In 1496 Margaret, countess of Richmond and mother of Henry VII. founded a chantry and seminary which, although dissolved with the college in 1547, was re-established as a grammar school with 12 governors under a royal charter of Elizabeth I. This Peculiar Jurisdiction lasted until 1846, but the 12 lay governors are still patrons of the benefice. St. Margaret's hospital (13th century) now used as almshouses, was originally a leper hospital. The town's industries are market and nursery gardening and fruitgrowing.

WINBURG, the first capital of the Orange Free State, Union of South Africa, was laid out in 1836 and is the oldest township in the province. It is 71 mi. from Bloemfontein on the Cape Town-Johannesburg national road. Pop. (1951) 3,944, including 1,502 Europeans, 2,268 natives and 174 coloured. The town has broad streets, beautiful gardens and a modern town hall. It is in close proximity to the Vet river and Laaispruit, which have magnificent mimosas and willows on their banks and offer excellent bathing and fishing. A progressive and attractive town, Winburg is also the trading centre of a large grain and pastoral district.

WINCHCOMBE, a town in Gloucestershire, Eng., 7 mi. N.E. of Cheltenham by road, on the edge of the Cotswold hills, in the valley of the river Isbourne. Pop. of parish (1951) 2,781. Area 8.5 sq.mi. The town originated in a mitred abbey founded for Benedictines in the 8th century by Kenulf, king of Mercia, and burned down by the Danes. Twice rebuilt, the abbey was dissolved by Henry VIII. The parish church of St. Peter, which is Perpendicular, was built by the parishioners, with the help of Lord Seymour of Sudely (*q.v.*), on the site of a former church. The galleried George inn (1583) was one of the pilgrim inns.

Sudely castle (½ mi. S.E.) belonged to Lord Seymour of Sudely whose wife, Catherine Parr, is buried in the chapel. He demolished Winchcombe abbey in 1539 and also the Cistercian abbey at Hailes (National trust property, 2 mi. N.E.) founded in 1246 by Richard, earl of Cornwall (brother of Henry III), who is buried there with his wife Sanchia. On the hills southeast of Winchcombe is Belas Knap, an important (restored) Stone Age burial mound.

WINCHELSEA, ROBERT DE (d. 1313), archbishop of Canterbury, was probably born at Old Winchelsea. He studied in Paris, and was rector of the university at some period before 1267; he then taught at Oxford, where he became chancellor of the university in 1288. He held prebendal stalls in the cathedrals of Lincoln and St. Paul's, and was made archdeacon of Essex about 1283. In 1293, he succeeded Peckham as archbishop of Canterbury. His consecration, which took place at Aquila in Sept. 1294, was delayed as a result of the vacancy in the papacy, but he found no difficulty in obtaining the temporalities of the see from King Edward I. Winchelsea is chiefly renowned as a strenuous upholder of the privileges of the clergy and the authority of the pope, and as a fearless opponent of Edward I. He assisted the barons in their struggle with Edward II by a frequent use of spiritual weapons, and took part in the proceedings against the Templars. He died at Otford on May 11, 1313. Miracles were said to have been worked at his tomb in Canterbury cathedral, but extensive efforts to procure his canonization all proved unavailing.

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WINCHELSEA, an unreformed prescriptive borough in the Battle rural district of the Rye parliamentary division of Sussex, Eng., 11½ mi. N.E. of Hastings by road. Pop. (1951) 173. Winchelsea is old, but the site of a still older town lies out to sea, about 3 mi. to the southeast. It is reputed to have had 700 householders, 50 inns and many churches, but it stood on low ground and in 1297 it was overwhelmed by the sea. To replace it Edward I built a great town of which the present Winchelsea is the lovely remnant. It stands on an abrupt hill spur rising above flat lowlands which form a southward continuation of Romney marsh. Two gates, one of the time of Edward I, the other early 15th century, overlook the marshes which until the 15th century were a great inlet of the sea. The silting up of this inlet marked the end of Winchelsea's days as a large port. A third gate stands some way to the west, its position pointing the contrast between the extent of the ancient town and that of the village of today. The town was laid out with regular streets intersecting at right angles; in the centre stands the church of St. Thomas a Becket. This comprises only the chancel and aisles of a building which, if entire, would rank as one of the finest parish churches in England. As it stands it is of great interest, showing Decorated work, windows of unusual design and a magnificent series of canopied tombs.

The "ancient towns" of Winchelsea and Rye had become members of the Cinque Ports by the time of Henry II. Winchelsea is governed by 12 jurats, including the mayor. It returned two members to parliament from 1368 till 1832, when it was disfranchised. Winchelsea was once a great resort for smugglers when the vaults originally constructed for the Gascon wine trade were used for storing contraband.

WINCHESTER, a city and municipal borough in the Winchester parliamentary division of the county of Southampton, Eng., 64 mi. W.S.W. from London by road. Pop. (1951) 25,721. Area 6.1 sq.mi. It occupies a hilly and picturesque site in and above the well-wooded valley of the Itchen, lying principally on the left bank. The surrounding hills are chalk down.

The Cathedral.— The erection of Winchester into an episcopal see may be placed early in the second half of the 7th century, though it cannot be dated exactly. The West Saxon see was removed there from Dorchester on the Thame, and the first bishop of Winchester was Hedda (d. 705). The modern diocese including nearly the whole of Hampshire, part of Surrey and small portions of Wiltshire, Dorsetshire and Sussex, was found to be too unwieldy and in 1927 was divided into the dioceses of Winchester, Guildford and Portsmouth, the first including the greater part of Hampshire together with the Channel Isles. St. Swithun (852–862), known through the connection of his feast day (July 15) with the superstition that weather conditions thereon determine those of the next 40 days, is considered to have enlarged the cathedral, as are Ethelwold (963–984) and Alphege (984–1005). The history of the Saxon building, however, is very slight, and as usual, its place was taken by a Norman one, erected by Bishop Walkelin (1070–98). The cathedral church of St. Swithun lies in the lower part of the city in a wide and beautiful walled close. It is not very conspicuous from a distance, a low central tower alone rising above the general level of the roof. It consists of a nave, transepts, choir and retrochoir, all with aisles, and a Lady chapel forms the eastward termination. The work of the exterior, of whatever date, is severely plain.

The cathedral, however, is the longest in England, and indeed exceeds any other church of its character in length, which is close upon 556 ft. Within, the effect of this feature is very fine. The magnificent Perpendicular nave is the work of Bishop Edington (1346–66) and the famous William of Wykeham (1367–1404), by whom only the skeleton of Walkelin's work was retained. The massive Norman work of the original building, however, remains comparatively intact in both transepts. The central tower is Norman, but later than Walkelin's structure. The choir is largely Edington's work, though the clerestory is later, and the eastern part of the cathedral shows construction of several dates. There appears the fine Early English construction of Bishop de Lucy (1189–1204) in the retrochoir and the Lady chapel, though this was considerably altered later. The square font of black marble is a fine example of Norman art, its sides sculptured with scenes from the life of St. Nicholas of Myra. The magnificent reredos behind the high altar must have been erected late in the 15th century. Under many of the arches of the nave and choir are a number of very elaborate chantry chapels, each containing the tomb of its founder. The most notable are the monuments of Bishops Edington, Wykeham, Waynflete, Cardinal Beaufort, Langton and Fox. The door of iron grilles, of beautiful design, now in the north nave aisle. is considered to be the oldest work of its character in England; its date is placed in the 11th or 12th century. The mortuary chests in the presbytery contain the bones of Saxon kings who were buried there. The remains were collected in this manner by Bishop Henry de Blois (1129–71), and again after they had been scattered by the soldiers of Cromwell. The choir stalls furnish a magnificent example of Decorated woodwork, and much stained glass of the Decorated and Perpendicular periods remains in fragmentary form. The library contains a Yulgate of the 12th century, a finely ornamented manuscript on vellum. In 1905 the cathedral fabric showed serious signs of weakness, and it was found that a large part of the foundation was insecure, being laid on piles, or tree trunks set flat, in soft and watery soil. Extensive works of restoration, including the underpinning of the foundations with cement concrete, were carried out between 1906 and 1912. Much of this work was done by one man. William Walker the diver. who for months worked submerged in liquid mud. where he could work by touch alone. Each year on St. Swithun's day he is remembered by name in the cathedral among the benefactors.

The Minster and Hyde Abbey.— King Alfred founded a minster immediately north of the present site of the cathedral. and there he and other Saxon kings were buried. The house, known as Hyde abbey, was removed (as was Alfred's bodyj to a point outside the walls. considerably north of the cathedral, during the reign of Henry I. There foundations may be traced. and a gateway remains. To the east of the cathedral are ruins of Wolvesey castle, a foundation of Henry de Blois, where the bishops resided. They now live in a wing of the adjacent Wolvesey palace. built by Wren. The rest of the palace was pulled down in 1800. On the southern outskirts of the city. in the pleasant water meadows by the Itchen, is the Hospital of St. Cross. This also was founded by Henry de Blois, in 1136. whose wish was to provide board and lodging for 13 poor men and a daily dinner for 100 others. It was reformed by William of Wykeham and enlarged and mostly rebuilt by Cardinal Beaufort (1405–47). The buildings form three sides of a quadrangle. with a lawn and sundial in its midst. while the fourth side is partly open and partly formed by the magnificent cruciform church. The earliest parts of this building are late or transitional Norman, but other parts are Early English or Decorated. The work throughout is very rich and massive. St. Cross is a unique example of a medieval almshouse, and its picturesqueness is enhanced by the curious costume of its inmates. It is still customary to provide a dole of bread and beer to all who desire it. King's gate and Westgate alone remain of the gates in the walls which formerly surrounded the city. The Westgate is a fine structure of the 13th century. In the High street stands the graceful Perpendicular city cross. The great hall is all that remains of the castle begun by William the Conqueror and finished by Henry III in 1235. In it is preserved the so-called King Arthur's Round Table which is thought to be a 13th-century table repainted in the reign of Henry VII. The county council offices of Castle hill were opened in 1911. The Stanmore housing estate was developed after World War I as part of a district planning scheme covering 80 sq.mi., including the city.

Winchester is famous as an educational centre. and in addition to Winchester college and St. Swithun's girls' public school there are several modern preparatory schools. Winchester college. the proper name of which is the College of St. Mary, lying to the south of the cathedral close, is one of the greatest of English public schools. While a monastic school was in existence there from very early times, the college was originated in 1387 by William of Wykeham, whose famous scheme of education embraced this foundation and that of New college. Oxford. The buildings were completed about 1395. The quadrangles, with the fine chapel, toner, hall and cloister, are noteworthy.

HISTORY

The history of the earliest Winchester (Winton. Wynton) is lost in legend; earthworks and relics show that the downs above the Itchen valley were occupied by Celts, and it is certain from its position at the centre of six Roman roads and from the Roman relics found there that the Caer Gwent (White City) of the Celts was, under the name of Venta Belgarum, an important Romano-British country town. The Romans had a clothmaking industry there, and later one of the first weavers' guilds was established. Hardly any traces of this survive, but mosaic pavements. coins, etc., have been discovered on the south side of High street. The name of Winchester is indissolubly linked with that of King Arthur and his knights, but its historical greatness begins when, after the conquest of the present Hampshire by the Gewissas. it became the capital of Wessex. When the kings of M'essex became kings of all England. Winchester became: in a sense, the capital of England, though it always had a formidable rival in London, which was more central in position and possessed greater commercial advantages. Under Alfred it became a centre of learning and education, to which distinguished strangers resorted. It was the seat of Canute's government; many of the kings. including Ecgbert, Alfred. Edward the Elder and Canute. were buried there.

Winchester was very prosperous after the Conquest, and its omission. together with London, from Domesday Book is probably an indication of its peculiar position and importance; its proximity to the New forest commended it to the Norman kings, and Southampton, only 12 mi. distant, was one of the chief ports for the continent. The Conqueror wore his crown in state in Winchester every Easter. as he wore it at Westminster at Whitsuntide and at Gloucester at Christmas. The royal treasure continued to be stored there as it had been in Anglo-Saxon times, and was there seized by William Rufus. who, after his father's death, "rode to Winchester and opened the Treasure House."

Under the Norman kings Winchester was of great commercial importance; it was one of the earliest seats of the woolen trade, which in its different branches was the chief industry of the town, although the evidence furnished by the *Liber Winton* (temp. Henry I and Stephen) indicates also a varied industrial life.

The Merchants' guild of Winchester claims an Anglo-Saxon origin. but the first authentic reference to it is in one of the charters granted to the city by Henry II. The *Libcr Winton* speaks of a "cnihts' gild." which certainly existed in the time of the Confessor. The prosperity of Winchester was increased by the St. Giles's fair. originally granted by Rufus to Bishop Walkelin. It was held on St. Giles's hill up to the 19th century. and in the middle ages was one of the chief commercial events of the year.

From the time of the Conqueror until their expulsion by Edward I. Winchester was the home of a large colony of Jews. whose quarter in the city is marked to the present day by Jewry street; Winchester is called by Richard of Devizes "the Jerusalem of England" on account of its kind treatment of its Jews. and there alone no anti-Jewish riots broke out after the coronation of Richard I.

Winchester seems to have reached its zenith of prosperity at the beginning of the 12th century; the first check was given during the civil wars of Stephen's reign. when the city was burned. However, the last entry concerning it in the Anglo-Saxon Chronicle says that Henry Plantagenet, after the treaty of Wallingford, was received with "great worship" in Winchester and London. thus recognizing the equality of the two cities; but the latter was rising at Winchester's expense, and at the second coronation of Richard I (1194) the citizens of Winchester had the significant mortification of seeing in their own city the citizens of London take their place as cupbearers to the king. The loss of Normandy further favoured the rise of London by depriving Winchester of the advantages it had enjoyed from its proximity to the continent.

During the Great Rebellion the city suffered much for its loyalty to Charles I and lost its ancient castle founded by William I. After the Restoration a scheme was started to restore trade by making the Itchen navigable to Southampton. but without success. Charles II, intending to make Winchester again a royal residence, began a palace there, which, being unfinished at his death. n-as used eventually as barracks. It was burned down in 1894 and rebuilt in 1901. Xorthgate and Southgate were pulled down in 1781, Eastgate ten years later. Westgate still stands at the top of High street. The guard room was formerly used as a debtors' prison, now as a museum.

Winchester sent two members to parliament from 1295 to 1885, when the representation was reduced to one, and since 1918 it has been included in the county division which bears its name.

Apart from its famous single buildings, such as the cathedral or St. Cross, the Winchester of today contains visible relics of every phase of its long history and almost every disaster or good fortune it has experienced through the centuries.

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WINCHESTER, the seat of Frederick county, Va., U.S., at the northern end of the Shenandoah valley, 9 mi. from the West Virginia line and 68 mi. N W. of Washington. D.C. Noted for its annual Shenandoah apple blossom festival, Winchester also has many historic buildings. Founded in 1744 by Col James Wood, the town was named for Winchester, Eng. George Washington maintained an office there while surveying the land west of the Blue Ridge mountains for Lord Fairfax. Following Gen. Edward Braddock's defeat in 1755 Washington built Ft Loudoun, the first of a series of forts stretching south to the Carolinas The city was the site of three important battles during the Civil War and changed hands many times (*see* SHENANDOAH VALLEY CAMPAIGNS) It served as headquarters for Generals "Stonewall" Jackson and Philip Sheridan.

Located in the heart of a fertile apple growing region, Winchester has huge cold storage houses and is a large export msrket for bulk apples Numerous apple products, rubber goods, plastics. steel conveyers, tin cans and woolen goods are produced there.

Winchester pioneered in the field of municipal services. Its modified form of council-manager government (introduced in 1915) won recognition for work in sanitary engineering. The public high school and large public library were endowed by Judge John Handley, a Pennsylvanian. Gen. Daniel Morgan, Revolutionary officer. and Adm. Richard E. Byrd, the polar explorer, lived in Winchester.

For comparative population figures *see* table in VIRGINIA: *Population.* (G. M BE)

WINCHILSEA, ANNE FINCH, COUNTESS OF (1661–1720), English author, daughter of Sir William Kingsmill of Sidmonton, near Southampton. was born in April 1661. In 1683 Anne was one of the maids of honour of Mary of Modena, duchess of York.

In 1684 she married Col. Heneage Finch, who in 1712, on the death of his nephew Charles, became the 4th earl of Winchilsea The countess of Winchilsea died in London on Aug. 5, 1720

A poet, at her best poignant and graceful, but uneven in accomplishment, she nrote on manners (satirically), on nature (lyrically) and on themes of morality, piety and ardent sentiment (devotion to her husband. to fallen royalty and to friends) Much of her poetry nas published in her lifetime, notably "The Spleen" in Charles Gildon's *New Miscellany* (1701); and many pieces. including her Arcadian tragedy, *Aristomenes*, in her own *Miscellany Poems on Several Occasions Written by a Lady* (1713; acknowledged in the second issue, 1714). Wordsworth gave her poems foremost place in a manuscript anthology made for Lady Mary Lowther (1819; published 1905)

Most of the countess of Winchilsea's verse was edited by Myra Reynolds, with a substantial introduction, from early editions then known and manuscripts belonging to the earl of Winchilsea and Edmund Gosse. *The Poems of Anne Countess of Winchilsea* (1903). Edward Dowden, in *Essays Modern and Elizabethan* (1910), quotes unpublished poetry from another manuscript in his possession. *See* also selections in J. Middleton Murry (ed), *Poems by Anne Countess of Winchilsea* (1928), and H. I'A. Fausset (ed.), *Minor Poets of the Eighteenth Century* (1930). (M M LS)

WINCKELMANN, JOHANN JOACHIM (1717–1768), German archaeologist, was born at Stendal, Prussian Saxony, on Dec. 9, 1717. Winckelmann's study of ancient literature had inspired him with a desire to visit Rome. He became librarian to Cardinal Passionei in 1754 and embraced Catholicism

In 1755, before leaving for Rome, Winckelmann published his *Gedanken über die Nachahnung der griechischen Werke in Malerei und Bildhauerkunst* ("Thoughts on the Imitation of Greek Works in Painting and Sculpture"), followed by a pretended attack on the work and a defense of its principles, nominally by an impartial critic.

He gradually acquired an unrivaled knowledge of ancient art. In 1760 appeared his *Description des pierres gravées du feu Baron de Stosch;* in 1762 his *Anmerkungen uber die Baukunst der Alten* ("Observations on the Architecture of the Ancients"), including an account of the temples at Paestum. In 1758 and 1762 he visited Naples, and from his *Sendschreiben von den herculanischen Entdeckungen* (1762) and his *Nachricht von den neuesten herculanischen Entdeckungen* (1764) scholars obtained their first real information about the treasures excavated at Pompeii and Herculaneum.

His masterpiece, the *Geschichte der Kunst des Alterthums* ("History of Ancient Art"), issued in 1764, was soon recognized as a permanent contribution to European literature. In this work Winckelmann sets forth both the history of Greek art and the principles on which it seemed to him to be based. Many of his conclusions based on the inadequate evidence of Roman copies have been modified or reversed by subsequent research, but the fine enthusiasm of the work, its strong and yet graceful style, and its descriptions of works of art give it enduring value. It was read with intense interest by Lessing, who had found in Winckelmann's earliest works the starting point for his *Laocoon.*

In 1768 Winckelmann went to Vienna, where he was received with honour by Maria Theresa. At Trieste on his way back he was murdered by a man named Arcangeli to whom he had shown some coins presented by Maria Theresa (June 8, 1768).

WIND. Winds are classified according to whether they are general or local. General winds include those that stretch thousands of miles over the earth's surface, following semipermanent directional patterns both near the earth and in the atmosphere. Within the great wind currents move some local winds, *e.g* , the cool squalls that accompany thunderstorms. Other local winds are characteristic of particular geographical regions, such as coast lines and mountains. Local winds exert a pronounced influence on local climate and at the same time are themselves influenced by local weather conditions.

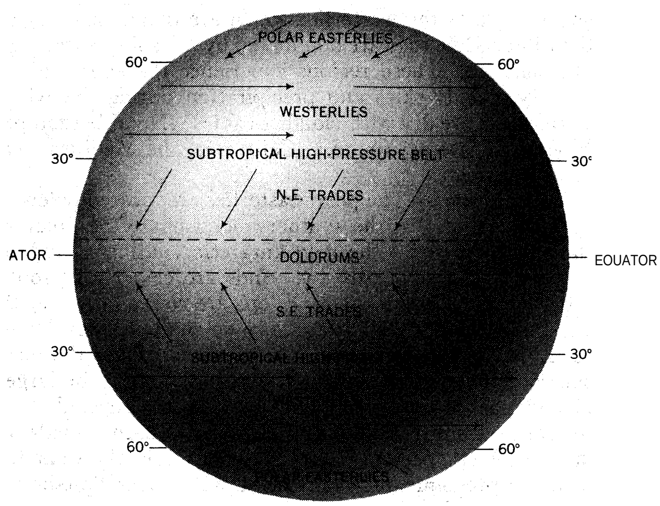
GENERAL WINDS

The pattern of the general circulation is primarily determined by the unequal heating of the atmosphere at different latitudes and altitudes and by the effects of the earth's rotation (*see* METEOROLOGY). The distribution of the winds is closely related to that of atmospheric pressure, and both must be discussed together.

In general, the pressure distribution gives a good indication of the prevailing winds, the latter generally following Buys Ballot's law. According to this law the wind in the northern hemisphere blows in such a manner that an observer facing downwind has the lower pressure to his left, the higher pressure to his right. In the southern hemisphere the lower pressure is to the right of the observer, the higher pressure to the left. In both hemispheres the wind near the ground does not flow exactly parallel to the isobars but has a component toward lower pressure because of surface friction. Near the equator where the change in direction from one hemisphere to the other takes place, this rule does not hold, and the winds are more irregular and more subject to local influences. Even at higher latitudes the topography of the earth's surface and changing atmospheric conditions often modify the wind direction so that Buys Ballot's law is not always well satisfied.

General Circulation, Schematic. — Schematically, the general circulation near the earth's surface can be described as follows (*see* diagram): between roughly latitude 30° N. and 30° S., easterly winds prevail (note that winds are named after the direction from which they are blowing) with components toward the equator, the northeast trades of the northern hemisphere and the southeast trades of the southern hemisphere. These winds blow toward an equatorial zone of light winds or calms, the doldrum belt, in which the pressure is low. On the poleward side the trade-wind belts are followed by the subtropical high-pressure belts in which calms or light winds prevail and in which precipitation and cloudiness are on the whole light. In the days of sailing ships the doldrums and the subtropical high-pressure belts were often difficult to cross, and the latter zones received the name "horse latitudes." The explanation given for this name is that ships aith cargoes of horses were often becalmed in these regions and ran out of water, so that the horses had to be disposed of. Poleward, beyond the horse latitudes, are the zones of the westerlies which extend roughly from latitude 35° to 65°. These zones are the regions of interaction between cold and warm air masses and of migrating centres of high and low pressure. In connection with the moving pressure systems, winds from directions other than west are frequently observed in these zones. Poleward from the regions of the westerlies the polar easterlies with components toward lower latitudes are found. However, the predominance of the easterly direction over the others is not pronounced, and other wind directions occur frequently.

Seasonal Variation, Effects of Land and Water.—The actual distribution of pressure and mind over the globe is considerably more complicated than indicated by this schematic description. Seasonal variations of position and intensity of these wind belts are produced by the annual march of the sun, and further complications are caused by the physical differences between water and land. Before entering into a detailed discussion of these



SCHEMATIC DIAGRAM OF THE WIND SYSTEMS OF THE EARTH

modifications, the disturbing effects of the continents will be considered in general. During the summer the land is warmer than the water because the sun's heat is distributed to a greater depth in the turbulent ocean than it is in the solid ground. Further. as a rule, more heat is used for evaporation over water than over land. In minter the ocean surface is warmer than the land because the cold surface water is mixed nith the warmer water from below. The air tends to assume the temperature of the surface. so that in summer the air is warmer over land, in minter over nater. Since cold air is in general heavier than narm air, the pressure over the land in winter is higher than over water, and an anticyclonic circulation develops. This circulation is clockwise in the northern hemisphere, counterclocknise in the southern hemisphere with a component outward from the high pressure because of surface friction. For instance, on the east coast of a continent in the northern hemisphere a northmest wind will be observed, nhile in the southern hemisphere a southwest wind would result in the same location. During the summer the land is heated more strongly than the water so that a low pressure develops over the land. The resulting cyclonic circulation is counterclockwise in the northern hemisphere, and clockwise in the southern hemisphere, both with a component of inflow toward the centre of low pressure. Hence on the east coast of a continent in the northern hemisphere, for instance. the wind would be southeast, in the southern hemisphere northeast. When the wind direction varies as much as 180° as in the example quoted here, one speaks of a monsoon (from the Arabic word for season). Typical monsoon winds are found along the east coast of Asia where cold and dry northwest winds from the interior prevail during the winter, warm and moist southeast ninds from the Pacific during the summer. However, in most regions in temperate latitudes the shift of the prevailing wind direction from summer to ninter is not so large, and it is rarely possible to discover a monsoonal tendency in the wind shift. For instance, on the east coast of North America the prevailing wind direction changes from northwest during winter to southwest during summer, through 90° only.

Description of the Wind Belts.—In order to consider the wind distribution and its seasonal modifications in detail the various wind and pressure zones will now be discussed separately.

The Zone of Doldrums.—Near the equator the earth is surrounded by the doldrum belt where the pressure is lower than farther north or south. The winds in this zone are, as a rule, light and irregular in direction with frequent calms. The effect of the earth's rotation on the air flow being negligible, the winds at the equator do not obey Buys Ballot's law. Instead. the air can move across the isobars so that any existing large pressure differences mould be destroyed quickly During January, which may be taken as a typical month for conditions during the northern minter. the belt of highest temperature is at or slightly south of the equator, nith larger displacements south over the continents where the temperature maxima extend considerably farther south than over the oceans. Consequently the doldrums during January are consistently near the equator over the oceans. Only over the warm land masses of South America and Africa and over the East Indies is their position farther south, at about 15° latitude. The northerly displacement of the zone of maximum temperature during the northern summer is much larger than the comparable displacement during the southern summer into the southern hemisphere because the large continental masses of the northern hemisphere become very hot in the northern summer. Consequently, the zone of doldrums too is displaced far northward. In July, for instance, the doldrum belt is considerably north of the equator, especially over Central America. north Africa and Asia. In the latter region, especially over India, the name doldrum belt is, however, hardly appropriate, since this is one of the regions where the monsoon is well developed.

The width of the doldrum belt is very variable from day to day and from place to place. This zone represents the region toward which the northeast trades of the northern hemisphere and the southeast trades of the southern hemisphere converge. These two wind systems meet often directly without being separated by a zone of calms. The line along which the two trades meet is called the intertropical front, a name which is frequently applied to the zone of doldrums even if a sharp front is absent. The convergence of the two trade-wind systems produces ascent and cooling of the air, and thus precipitation. Because of the seasonal motion of the doldrum zone there are few regions which are under its regime throughout the whole year.

The Trade-Wind Zones.—The trade winds, northeast in the northern hemisphere. southeast in the southern hemisphere, blow betneen the subtropical high-pressure belts and the zone of doldrums. They are characterized by the steadiness of their direction and speed, especially over the oceans. Variations occur. of course, in the trade-nind zones, but they are much smaller than the variations in other wind belts. The average speed of the northeast trades over the Atlantic has been estimated to be about 11 m.p.h.; that of the southeast trades to be about 14 m.p.h. There is an annual period of the wind speed and direction. The direction of the trade winds is not uniform throughout the whole trade-wind region. On the east side of the subtropical highs, that is, near the west coasts of the continents, the component toward the equator is developed best, and the trade-wind zones reach farthest north and south in these locations. Toward the nest the easterly component of the trades becomes more pronounced. The average limits of the trade winds and doldrums over the Atlantic and the Pacific are shown in the table after Hann-Suring (*Lehrbuch* der *Meteorologie*, 4th ed., Leipzig, 1929). The months shown are those when these zones have their extreme positions. In conjunc-

	March		September	
	Atlantic	Pacific	Atlantic	Pacific
N. E. trade	26°–3° N.	25°–5° N.	35°–11° N.	30°–10° N.
Doldrums	3° N.–0°	5°–3° N.	11°–3° N.	10°–7° N.
S. E. trade	0°–25° S.	3° N.–28° S.	3° N.–25° S.	7° N.–20° S.

tion with the displacement of the doldrum belt into one or the other hemisphere, the trade winds cross the equator in some regions. In this case they change their direction because of the different effects of the earth's rotation on air currents in the two hemispheres. Near the west coast of Africa, for instance, the southeast trades cross the equator into the northern hemisphere and become southwest winds blowing into the African low-pressure trough. This deflection is particularly well developed during the northern summer when the pressure is low over the hot Sahara. Another example is found in the Pacific during winter where the northeast trades become northwest winds after crossing the equator and blowing toward the Australian low-pressure centre.

Monsoon *Circulations*.—Over the large continental mass of Asia the changes in pressure distribution from summer to winter are very pronounced. Hence a typical monsoon regime is established along the east coast of Asia as well as over India and the adjoining countries to the west where the southwest monsoon blows during the summer season, the northeast monsoon during the winter season. During the regime of the southwest monsoon a continuous flow of air takes place from the subtropical high of the south Indian ocean toward the low pressure over Asia. Thus, the southeast trades cross the equator and become the southwest winds of the summer monsoon, demonstrating the change of the deflecting effect of the earth's rotation from one hemisphere to the other. The Indian monsoon is strongly affected by the Himalayas so that the summer monsoon blows from southwest over the Indian peninsula, from south into the Bay of Bengal and from southeast up the Ganges valley. The speed of the southwest monsoon varies from place to place. Over the Arabian sea between 5°–15° N. and 50°–60° E., its speed during June and July is, on the average, 20 to 25 m.p.h.; over Bombay, 14 m.p.h. The speed of the northeast monsoon is not much more than half the speed of the southwest monsoon. The southwest monsoon blows with great steadiness compared with the winds of other regions but its onset is often delayed for a considerable period, resulting in drought and famine in India. In no other region is the monsoon so strong as in Asia, although the north coast of Australia shows well-developed monsoon tendencies. Monsoonal tendencies in the seasonal wind variation are found also along the east coast of the United States and along the Guinea coast of Africa.

The *Subtropical* High-Pressure Belts.—During the northern summer the high-pressure belt of the northern hemisphere is not continuous but is interrupted by thermal lows over Africa-Asia and over h'orth America. In the southern hemisphere, on the other hand, which then has winter, the continents are cold, and the high-pressure belt surrounds the earth without interruption. During the northern winter conditions are reversed. The southern hemisphere then has summer, and the pressure is low over the continents, while in the northern hemisphere the pressure is high over the continents. However, the North American high is not a very permanent feature, as the daily weather maps show. In the first place, the continent is not so large as Asia; secondly, there is no barrier like the Himalayas preventing warmer air from invading the continent, and consequently cold anticyclones are often replaced by cyclones which derive their energy from the warm, moist air. The Asiatic high, on the other hand, is very pronounced and has a high persistence during the cold season.

The Westerlies.—On the poleward sides of the subtropical high-pressure belts are the regions of the westerlies which extend approximately from 40° latitude to the polar circles. While the prevailing ninds in the westerlies are from the west or southwest, the wind direction is much less steady than that of the trades because in the uesterlies the main frontal and cyclonic activity takes place. Hence in these belts a steady succession of migrating cyclones occurs, causing frequent changes of wind direction. Conditions in the westerlies are more complicated in the northern hemisphere than in the southern because of the disturbances produced by the large land masses of North America and Asia. The continental areas of the southern hemisphere are very small. There the belt of westerlies, the roaring 40s, is one of the stormiest regions throughout the year. In the northern hemisphere during the winter, high-pressure centres are found over North America and Asia and centres of low pressure near Iceland and the Aleutians. The Asiatic anticyclone is very strong so that the westerlies and the cyclone paths lie along the northern margin of the continent. Cyclones penetrate occasionally into the region under the regime of the Asiatic anticyclone, but their frequency here is much smaller than over western Europe and especially over the North Atlantic which during the winter often has winds of gale force. Since over North America the high-pressure centre is much less permanent than over Asia the westerlies with their succession of cyclones can cross the western mountains and the whole width of the continent alternating with migrating highs produced by the cold polar continental air. In summer the Icelandic low is much less intense while the Aleutian low has completely disappeared from the mean pressure map. This indicates that the strength of the westerlies and the cyclone frequency are much reduced during the warmer season in the northern hemisphere.

Since the subtropical high-pressure belt, the equatorial limit of the westerlies, shifts with the seasons, there are marginal zones on the equatorial side of the westerlies which are under their regime during the winter while they are dominated by the subtropical highs during the summer. These regions experience the effects of cyclonic activity, cloudy skies and precipitation during the winter while the summers are dry with cloudless skies. h'otable examples of this type of climate are found in California, the Mediterranean lands and south Africa.

The Polar Easterlies.—The polar easterlies are located poleward beyond the westerlies. In the southern hemisphere the polar region is largely covered by the cold antarctic continent, and the pressure is high. Consequently the winds are easterly or southeasterly, but local topographical variations are common. Over the high antarctic plateau the winds conform to the upper-level pressure pattern rather than to the sea-level isobars. Over the north polar zone conditions are complicated by the fact that the largest glaciated land mass in this region, Greenland, is not centred at the pole, and that in winter northern Siberia and northern Canada are colder than the Arctic ocean. Thus, the winds over the Canadian archipelago are predominantly northwest while over Spitsbergen and Franz Josef Land winds uith an easterly component are more frequent although changes in the wind direction occur often. During the summer the pressure gradients in the north-polar region are weak, and the winds are light and variable. (B. Hz.)

Winds in **the** Upper Atmosphere.—The pressure decreases more rapidly with height in cold air than in warm air, so that at altitudes of several miles above sea level the lowest pressure is located where the coldest air is found, and the highest pressure is associated with the warmest air. At these altitudes, then, the lowest pressures are found in the arctic and antarctic regions and the highest pressures are normally found in regions close to the equator instead of near 30°. In accordance with Buys Ballot's law, the easterly trade winds decrease in speed with height, and at heights of several miles become westerly winds, so that winds from a westerly direction prevail over almost all of the globe at these heights. The strongest west winds are still found in middle latitudes, however, where they are frequently concentrated into a narrow current, the so-called "jet stream." Maximum speeds of 100 to 200 m.p.h. are observed in the centre of this current in winter, when it is most developed and when it may be found at latitudes as low as 30°. In summer the jet stream is weaker and is normally found only poleward of 40°.

The jet stream and the weaker winds surrounding it do not always blow from due west but frequently have some poleward or equatorward component as well, appearing as a northwest wind at some longitudes and as a southwest wind at other longitudes. These deviations are caused partly by the disturbing influence of the continents (especially in the northern hemisphere) and partly by the large traveling centres of high and low pressure at sea level which effect the day-to-day changes in middle latitude weather. In January, for example, the coldest air in the northern hemisphere is usually located over the Canadian archipelago and over northeastern Siberia, so that the upper-level winds usually blow from west-southnest over the Atlantic and Pacific oceans, and from the west-northwest over the North American and Eurasian continents. Similar effects exist in summer when the air over the southern parts of the continents is very warm. The continents seem to have very little influence in the southern hemisphere. so the wind directions there are much more westerly in all seasons.

The westerlies increase in strength up to the height of the tropopause. seven or eight miles above sea level. Above this height, in the stratosphere, the air is normally narmer at high latitudes than at low latitudes, so the trend to an increasing pressure difference between equator and pole is reversed. The westerlies therefore begin to decrease in speed above this height, and at sufficiently high altitudes may even become easterly. (N. A. P.)

LOCAL WINDS

Local winds may be classified as slope winds, coast winds and mountain winds, and will be considered accordingly, noting that many winds do not always fit readily into any simple classification.

Slope Winds. — Perhaps the most familiar of all local winds are the gentle doanslope winds which occur inland on clear nights during quiet weather. They represent the slow drainage into the valleys of air which has been chilled by contact with the cool ground, the ground having lost heat by radiation into the clear sky. This chilling causes the air on the slopes to become denser than the air at the same level over the valley floor. and consequently a slow overturning motion develops in which the air close to the slopes sinks into the valley bottoms and an extremely gentle lifting in the free air above the valley floor takes place. The cool slope minds have speeds of up to two or three miles per hour and are very shallow, usually becoming inappreciable 50 ft. above the slopes. Honever, in valleys flanked by mountains the cold air flood may accumulate to a depth of several hundred feet and reach a speed near the ground of five or even ten miles per hour. Winds of this type are well known in the Swiss alpine valleys: one is the "Wisper wind" which flows in the Wisper valley opening into the Rhine. In mountainous country downslope winds occasionally occur in intermittent sudden rushes. The reasons for this have not been clearly established.

Even in cloudy weather a glacier chills the air over it, and consequently a cool downslope wind often occurs over large glaciers. The effect is intensified during the day when surrounding rocky areas warm the free air. Aii which descends along the glacier is continually cooled, and maximum speeds of about ten miles per hour are reached a few feet above the glacier surface. This "glacier wind" rapidly dies away as it spreads out beyond the foot of the glacier.

Sea and Land Breezes. — Everyone who has enjoyed a stay at the seaside is familiar with the sea breeze and if he has bathed in the sea appreciates the cause: during the day the land becomes considerably warmer than the sea. Offshore the heat of the sun is mixed to a considerable depth by the restless motion of the sea, and so causes hardly any temperature change. whereas on land the heat is absorbed in a layer only a few inches deep, and so raises the surface temperature very considerably. Consequently, by midafternoon on fine days the temperature of the air near the ground a fen miles inland is commonly as much as 5° and sometimes more than 10° C. higher than that of the air just above the sea. At higher levels the temperature difference is smaller and usually it has almost disappeared at a height of 2,000 or 3.000 ft. Above this level, the atmosphere and its winds are practically undisturbed The expansion due to heating of the lower layer of air over land reduces the air density, causing the pressure at the ground (the weight of the atmosphere above) to fall. The fall is only slight: perhaps a millibar, or about $\frac{1}{10}$ of 1%. Nevertheless the resulting pressure gradient, directed from the sea toward the land, is sufficient to generate a fresh breeze in that direction. On occasions when there is a strong general wind the differential heating of the land air may be less marked and the resulting pressure change may barely modify the existing pressure gradients. This situation will prevent the sea breeze from becoming well developed.

In more settled weather the breeze from the sea sets in near the coast by about midmorning and then steadily strengthens and penetrates farther inland. Its leading edge may be very well defined, so that within a minute or two a wind of ten miles per hour may replace light airs, bringing a sudden rise of humidity and a fall of temperature amounting to a few degrees. The sea breeze reaches its maximum strength in the early afternoon and usually persists into the evening before dying away. The depth of the sea breeze varies considerably: similar minds near the shores of moderately large lakes may be only a few hundred feet deep, nhereas the sea breeze near tropical coasts sometimes extends as high as 6.000 ft. The breeze similarly penetrates a very variable distance inland, but in temperate latitudes often extends 20–30 mi in from the coast by late afternoon, and in the tropics is said to reach as far as 50 mi. into the interior. At the time of maximum development the breeze is present at distances of at least several miles out to sea, but good observations of its seaward extent have not been made. By evening it often blows not directly from the sea but more nearly parallel to the coast in the same sense as a geostrophic wind (*q.v.*); *i.e.,* with a westerly component near a southern shore (in the northern hemisphere).

Usually the sea breeze air is cloud free, in contrast to the air farther inland. which often contains cumulus clouds. When the leading edge of the sea breeze is sharply defined, it often has above it a belt of well-developed cumulus clouds, produced where the land air is ascending over the cool sea air. so that the sea breeze can be said to have a "front" possessing some of the characteristics of a cold front. In thunderstorm weather the first cumulo-nimbus clouds to grow inland are sometimes in regions where there is a pronounced sea breeze front. The great frequency of thunderstorms in Florida is thought to be associated with the strong low level convergence produced by the flow inland of sea breezes from the opposite coasts of the peninsula.

Theoretical studies of the sea breeze, such as that made by R. P. Pearce, have approached a quantitative explanation of most of the observed characteristics. including the much weaker seaward drift of land air just above the cool current from the sea, which completes the sea-breeze circulation. It has not yet been possible, however. to account satisfactorily for the formation of a sea-breeze front, and it seems likely that this will not be done until more refined models are tested. Such models would need to take into account the effect of friction, which is difficult to measure and has thus far been neglected.

During quiet nights the air close to the ground inland cools below the sea temperature, and a land breeze develops. Because only a shallow layer of air is cooled, the land breeze is feebler than the sea breeze. The land breeze extends a few miles out to sea, carrying the scents of vegetation. Sailboat fishermen take advantage of the land breeze to sail to fishing grounds in the early morning; they return on the sea breeze in the afternoon.

Coastal Slope Winds (**Bora**).—Strong winds develop over coasts nhen cold unstable air masses flow into regions where high snow-covered plateaus or mountains descend steeply into relatively very warm seas. Convection occurs predominantly or only over the sea, so that there the air becomes considerably warmer in the first few thousand feet than it is inland. Particularly when the resulting offshore breeze reinforces a general flow, the mind over the sea near the coast may become very strong, or even a squally gale. and a danger to shipping. An example is the notorious bora which affects the northern shores of the Adriatic; in the winter season this wind is strongly influenced by the general pressure distribution and cannot be ascribed to purely local causes. Its direction is usually from the northeast or east-northeast, rather than from the north as its name implies (Boreas = north uind). In fine weather it does not extend more than about ten miles out from the coast, although it may be violent and raise a very rough sea; in stormy weather ahead of a cyclone near southern Italy it may extend over the whole of the Adriatic. Winds like the bora occur elsewhere in the Mediterranean and in other parts of the world where the meteorological and topographical situation is favourable. Notable examples occur on the north Caucasian shore of the Black sea, on some arctic coasts and in southern California, where a wind known as the Santa Ana blows down the mountain passes and out to sea for a distance of up to 50 mi.

Mountain-Gap Winds (Mistral). — Another well-known wind is the dry, cold northerly mistral which blows down the Rhône valley and into the warm waters of the Gulf of Lyons. This wind has some of the character of the bora but is associated with the breakthrough of cold air masses from the north, whose path into the Mediterranean is restricted by the massive barriers of the Alps and the Pyrenees. It is an example of a mountain-gap wind but of much larger scale than the very local strong winds which are often encountered in mountain passes. Unlike winds produced solely by temperature gradients in the lowest few thousand feet it may be a very deep current; on occasions when it becomes very strong there is usually a fall of pressure in the lee of the Alps, and a depression forms in the Gulf of Genoa. It often blows persistently for days on end and in Provence is one of life's hardships.

The Strait of Gibraltar is an important gap in the arc formed by the Atlas mountains of north Africa and the extensive high plateau of Spain. The winds in the strait tend to be either westerly or easterly. Shallow cold air masses which invade the western Mediterranean from the north often stream through the strait as an easterly wind which is very strong in the lowest 2,000 or 3,000 ft. Such a wind is known locally as a levanter. It may reach very high speeds a few hundred feet above the sea in the narrows of the strait, where it is said to have brought eastward-traveling Catalina flying boats practically to a standstill.

Similar strong winds occur in other parts of the world where cold air streams break through mountain-chain gaps.

Winds in the Lee of Mountains (Foehn). — In all mountainous regions the winds which blow from the ridges into the leeward loalands are characterized by their warmth and dryness. They are known by various local names, but are known generally by the term foehn (fohn), which comes from the European Alps where these winds were first studied, and where they are very pronounced. In North America the foehn winds strongly influence the climate in a broad belt lying east of the Rocky mountains and are known as chinook winds. Near the Andes in the Argentine they are known as *zonda* winds. Local winds with foehn characteristics are also well known wherever prevailing winds cross a mountain chain, as those in Japan, New Zealand, central and eastern Asia and in Scandinavia.

The foehn occurs at all seasons; it is a gusty wind accompanied by unusually good visibility and often by well-broken or clear skies. The upper slopes of the mountains and their peaks are obscured by clouds, in which there is often rain or snow. This bank of cloud is called the foehn wall. In the lee of the mountain peaks, often extending in ranks far out over the lowlands, are elongated, lens-shaped clouds (lenticularis) revealing wave-like disturbances in the air stream set up during its passage over the mountains. Although the winds may be strong, the waves and their clouds are almost stationary, condensation occurring continuously on the windward sides and evaporation on the lee sides of the clouds.

The unusual warmth of the foehn wind is associated with the fall of rain or snow from the air which is passing over the upper slopes of the mountain. During its ascent on the windward slopes the air is chilled, but the cooling is diminished by the release of latent heat from condensing water vapour; during descent down the leeward slopes the air is warmed and the cloud evaporates, reclaiming its latent heat: but since some water was lost as rain or snow less latent heat is reclaimed than was liberated, and the air arrives at its original level warmer than before. During the winter this great increase of temperature often causes a rapid melting of snow at low levels. It is said that some persons are prone to ills or malaise during spells of foehn, but if the association is real its explanation is not known.

The Helm Wind. — The wavelike disturbances in the air stream which are sometimes set up when a wind current flows over a ridge may be accompanied by notable changes in the nature of the surface wind in the lee of the ridge. Under the crest of the first lee wave the wind close to the ground may be very light, or even reversed in direction. flowing toward the hills, while over the lee hill slopes the wind may blow with abnormal force, more appropriate to the strength in the free air at the level of the hilltops. Such peculiarities are often notable near rather small hill ranges nith smoothly falling hill slopes, rather than near precipitous mountains. A well-known example is the helm wind, a steady gale which blows down the western slopes and for some distance over the lowlands in the lee of the northern Pennines when moderate easterly winds prevail over northern England.

Local Names for Winds. — In some regions with strongly varied relief, winds from particular quarters bring characteristic kinds of weather and have popular names but are not, strictly speaking, local winds in the sense defined in the first paragraph of this section. The densely populated Mediterranean area abounds in these specially named winds. The central and southern Mediterranean are subject to very warm southerly winds which bring air from the hot desert interior of northern Africa. These winds are abnormally dry and hazy and are most prominent in the spring when cyclonic winds are common and the sea is much cooler than the desert. They bring oppressive weather and often damage to vegetation. The general name for these winds is sirocco, but locally they are known as khamsin (in Malta and Egypt), leste (Madeira and north Africa), simoom (northeast Africa and Arabia) and leveche (in southeast Spain). They arrive in the northern Mediterranean with somewhat reduced surface temperatures, but passage over the sea makes the air moist and muggy, and there may be dense clouds and rain near the north Mediterranean coasts. Near the Gulf of Lyons a strong, warm southerly or southeasterly wind is called a marin.

Near the northern shores of the Mediterranean the striking winds are cold winds, especially in the winter, such as the already described mistral and bora. In northern Italy a cold northerly wind is called a maestrale, arid the maestro is a cool northwesterly wind in Sardinia and Corsica. In the Mediterranean sea a strong northeasterly wind is called a gregale or Euroclydon, while in Italy cool northeasterly winds are often referred to as *tramontana*. The persistent northerly winds which are a feature of the summer season in the northeast Mediterranean and near Greece are called the etesian winds. Even when they reach gale force they are usually accompanied by cloudless skies.

Two other widely known names are pampero (used in the coastal plains of the Argentine) and southerly burster (of New South Wales). These refer to the strong cool squalls which occur during the passage of some cold fronts and are often accompanied by heavy rain and thunder. In southern Australia similar winds from the desert interior are known as brickfielders, a name said to have come originally from squalls which raised much dust from brickfields near Sidney. See also Index references under "Wind" in the Index volume.

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WINDAUS, ADOLF (1876–1959), German organic chemist. winner of the 1928 Nobel prize in chemistry for research on the constitution of the sterols and their relation to certain vitamins, was born in Berlin, Dec. 25, 1876. He was professor and head of the chemical institute at Gottingen (1915–44) after earlier appointments at Freiberg (1901–13) and Innsbruck (1913–15). His work establishing the structure of cholesterol was begun in 1901 and completed in 1932. Paralleling this work was his investigation of compounds with antirachitic activity, the so-called sunshine vitamin D compounds, and how they are formed from certain sterols by light. Besides these major achievements Windaus contributed to the spatial chemistry of condensed ring systems, discovered histamine through synthesis, showed that vitamin B_1

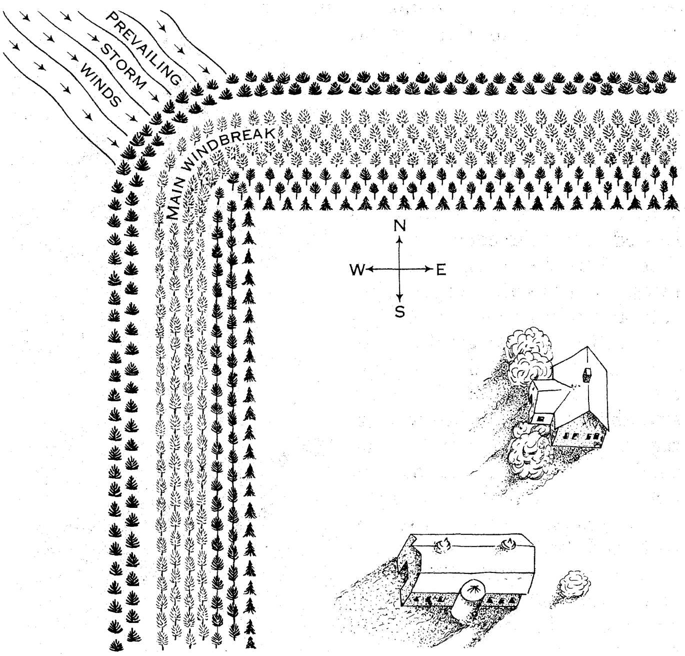
contained sulfur and contributed to the structural chemistry of colchinine, the cardiac glycosides and other naturally occurring compounds. Motivated by theoretical considerations, his work had tremendous practical significance. He died at Gottingen on June 9, 1959. (W. H. SN.)

WIND BRACES, in architecture. diagonal braces to tie the rafters of a roof together and prevent "racking." In many medieval roofs they are arched and run from the principal rafters to catch the purlins. In modern steel construction. wind bracing is necessary in the wall and floor framing of high buildings to withstand the diagonal stresses set up by the wind pressure on a side wall; the wind braces take the form either of diagonal tension rods. of diagonal angle, channel or I-beam bracing at the corners or of enlarged web or gusset plates at the intersections of framing members. See ROOF.

WINDBREAK (SHELTERBELT), rows of trees and shrubs ,planted to serve as a barrier to break the force of dust storms, winds and snon-storms. Windbreaks are of two kinds: those planted to protect the farmstead and those planted to protect field crops and conserve top soil.

A good farmstead windbreak consists of from five to eight rows of shrubs and trees. one or more shrub rows being planted on the windward side facing the prevailing winds. Behind these rows are planted fast-growing trees and the next two or more rows consist of hardy, long-lived, tall hardwoods with a few rows of conifers on the inside or leeward side. The hardwoods protect, from dust storms and dry winds in summer and in winter serve to break up wind gusts and prevent snow from drifting. The conifers. with their year-round foliage and with branches from the ground up, provide a nearly impenetrable barrier.

Farmstead windbreaks may be established in any region where climatic conditions are severe. In the U.S. prairie and plains areas, where prevailing storm winds come from the northwest, windbreaks are located on the north and west sides of a farmstead. The number of tree rows required depends upon wind velocity and the character of seasonal storms. Choice of tree species and planting



BY COURTESY OF THE DEPARTMENT OF AGRICULTURAL EXTENSION INSTITUTE OF AGRICULTURE, UNIVERSITY OF MINNESOTA

FIG. I.— STANDARDSHELTERBELT PLAN

arrangements are important factors in providing successful protection.

Field nindbreaks are planted across fields in prairie and plains areas to reduce the effects of drying winds, to hold soils from blowing and to trap winter snows. Snow thus trapped does not blow away but melts in the spring. adding to the soil moisture needed for crops. In areas of low rainfall. melting snon is espe-

BY COURTESY OF THE DEPARTMENT OF AGRICULTURAL EXTENSION, INSTITUTE OF AGRICULTURE, UNIVERSITY OF MINNESOTA

FIG. 2.—STANDARD WINDBREAK IN ITS DEVELOPMENT AND GROWTH

cially important to crop growth.

In sandy regions. field windbreaks reduce losses caused by drifting and blasting sand that otherwise might cover growing crops and cut down standing grain.

Field windbreaks planted at designated intervals across fields may consist of from one to three rows of trees depending upon protective needs. Climatic conditions, altitude and topography and the type of soil determine more specifically the location of windbreaks.

Information as to establishing windbreaks or shelterbelts in regions of the United States can be obtained from state colleges of agriculture. or state and federal forest service agencies. See also FARMSTEAD ARRANGEMENT. U.S. (P. O. A.)

WIND CAVE NATIONAL PARK, in the Black hills of South Dakota. U.S., was established on Jan. 9, 1903. Boundary changes were made in March 1931, June 1935 and Aug. 1946. Acreage, most of which is owned by the federal government, totals more than 28.000. A current of wind intermittently passes through Wind Cave. flowing inward when the barometer falls and outward when it rises. The cave contains limestone caverns. with beautiful formations called boxwood. tipped with white crystals. These formations, which are comprised of crystal fins in a honeycomb pattern, differ from the stalactite and stalagmite formations found in most large caves.

Above the cave a game sanctuary was established. Buffalo herds, breeding stocks of which were placed there in 1912 by the American Bison society, were permitted to roam throughout the area. Other animals placed on the preserve include the antelope, elk and deer. In addition to various deciduous trees found in the valleys, ponderosa pine and Rocky mountain cedar grow there.

WINDERMERE, the largest lake in England, is in the south-eastern part of the Lake district (*q.v.*), in the county of Westmorland. The boundary with Lancashire runs along the western shore, round the foot and northward along about one-third of the eastern shore. The lake is 10½ mi. long and 1 mi. wide; area 5.69 sq.mi. The shores are generally steep, beautifully wooded and fretted with numerous little sheltered bays. The hills immediately surrounding the lake rarely reach 1,000 ft., but the distant views of the mountains to the north and west contrast finely with the sylvan beauty of the lake itself. Immediately. opposite Bowness is a group of islands (Belle Isle, Tommy Holme, the Lilies and others) which divide the lake into two basins. The greatest depth sounded in the northern basin is 219 ft., and in the southern 134. The lake receives the Rothay and Brathay streams at the head; Trout Beck also flows into the northern basin, and Cunsey Beck from Esthwaite into the southern. The lake is drained by the Leven. Steamers ply on Windermere during the summer, the chief stations being Lake Side (south), Ferry (west), Bowness (east) and Waterhead, for Ambleside (north). The lake contains perch, pike, trout and char; there are several large hotels at Bowness and elsewhere on its shores.

The town of WINDERMERE, above the eastern shore adjacent to Bowness-on-Windermere, is an urban district lying in woods about three quarters of a mile from the lake by footpath. Pop. (1951)

6,315.

WIND EROSION AND DEPOSITION. The movement of sand and dust by wind is an important geologic process, particularly in desert regions, and produces highly distinctive landscape features and sedimentary deposits of widespread occurrence. The process comprises three stages: erosion, transportation and deposition. Erosion involves the picking up and blowing away of loose, fine-grained material. This occurs wherever dry sandy or dusty surfaces, unprotected by vegetation, are exposed to strong winds. The coarser material, of sand size, is carried along close to the ground, transported by a combination of rolling and leaping of the individual grains. Where the sand is abundant and the wind is very strong, the net effect may be described as having the appearance of "streaming" and a sandstorm results, so that the air seems to be filled with flying sand up to a height of several feet. As this sand is driven along before the wind, it exerts an abrasive effect on rocks and other materials in its path, thus continuing the work of erosion and carving out uniquely sculptured surfaces. Movement of the sand continues until the velocity of the wind slackens or until some obstacle is encountered and the sand accumulates to form heaps, mounds or ridges known as dunes, highly varied in size and shape. Finer material, a powdery dust classified technically as silt, when set in motion by the wind, is quickly carried upward, sometimes to great heights, by turbulent air currents, and is transported in suspension. Under suitable conditions this may result in dust storms, and the dust may be carried long distances. Sooner or later, however, it settles, and if this is continued long enough a characteristic deposit known as loess (*q.v.*) is formed.

The fine-grained material, or ash, from volcanic eruptions is transported in similar fashion, and forms characteristic deposits of a different type (*see* TUFF). Each of the above aspects of wind action is discussed more fully below. For meteorological aspects of sand and dust movement by wind *see* DUST: *Dust Storms*. For agricultural aspects *see* DRY FARMING; LAND RECLAMATION; SOIL EROSION AND CONSERVATION.

EROSION BY THE WIND

Wind erosion takes place partly by deflation, the simple blowing away of loose. fine-grained material, and partly by abrasion, the gradual wearing away of hard material through the continued impact of wind-driven sand. In general, the effects of deflation are important only on soil and on unconsolidated materials, while the marks of abrasion are retained only on rock and other resistant materials.

Erosion of Soil and Unconsolidated Deposits.—The effects of deflation are illustrated on dry, unprotected soil, such as occurred on a widespread scale in the western Great Plains of the United States during the middle 1930s. As a result of extreme drought, repeated crop failures and continued pulverization by farm implements, the soil became loose and powdery over wide areas. This material was easily picked up by the strong prevailing winds. The coarser material drifted along close to the ground, to be piled up along fences, hedges, farm buildings and other obstacles.

BY COURTESY OF H T U SMITH

HEDGEROW DUNE FORMED BY THE ACCUMULATION OF SAND AND SOIL BLOWN FROM A CULTIVATED FIELD

The finer material was swept up into the air, giving rise to blinding, destructive dust storms, described below. In places, many inches of topsoil were removed. Wind erosion of soil became a major economic problem of the region and remained so until increased rainfall brought relief. Meanwhile, much study was given to methods of controlling or alleviating erosion by conservation of available water, improved methods of cultivation and better planning of land use.

Under natural conditions, deflation occurs mainly in desert basins and along stream beds which are dry during a part of the year. It works primarily on material previously prepared by weathering and running water. Frequently the erosive effects of the wind are canceled out by the washing in of new material. In many situations the layer removed is so thin, and the area from which it is removed is so broad, that erosive effects are imperceptible. In certain locations, however, where rainfall is nearly zero, erosive effects are more concentrated and result in a gradual lowering of the surface, producing topographic forms ranging from small shallow depressions to broad basins hundreds of feet in depth. Examples on a relatively small scale are found in the High Plains and western deserts of the United States, and on a larger scale in the deserts of Peru, Mongolia and north Africa. The Quattara depression of the Libyan desert is a major example, with a length of roughly 175 mi., a width of up to nearly 80 mi., and a maximum depth of approximately 436 ft. below sea level. In the excavation of the larger basins, however, it is believed that the work of running water during cyclic episodes of greater rainfall, alternates with wind action.

Another effect of deflation in some places is the formation of desert pavement, a thin layer of pebbles, which occurs where the material originally exposed to the wind consisted of a mixture of pebbles and finer material. Gradual removal of the latter by the wind leads to a residual accumulation of the pebbles, tending to retard or inhibit further wind attack.

Wind Erosion on Rock.—Blown sand acts as a powerful abrasive agent. Under artificial conditions it is used to clean the masonry surfaces on buildings and etch designs on monumental stone. Under natural conditions, its effects quickly become evident on objects of glass, metal and wood. Bits of glass lying on the surface in windy, sandy areas soon lose their lustre and take on a dull, frosted appearance. Automobiles caught in severe sand storms have had their paint removed and their windshields frosted to translucency in a short time. The effect on rock surfaces, continuously exposed to natural sandblasting for long periods of time, is far greater. Individual pebbles and rock fragments are etched, faceted, smoothed or eroded in more irregular patterns, commonly assuming ridged, pyramidal or fluted forms known collectively as ventifacts. Larger masses of rock and bedrock surfaces are grooved, fluted and pitted on a larger scale, taking on an appearance unlike that produced by any other erosive agent. Under exceptional conditions, the bedrock is eroded into alternating ridges and furrows known as yardang, with a relief ranging from a few-feet to a few tens of feet and with unconnected hollows and other irregular shapes.

BY COURTESY OF H. T. U. SMITH

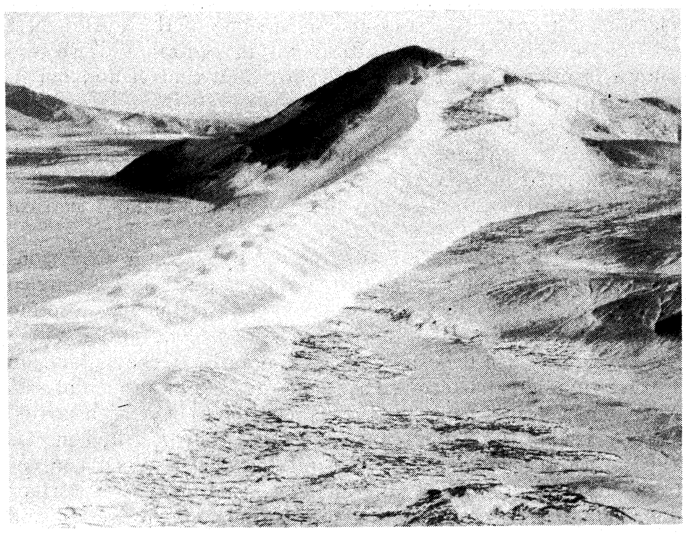
WIND EROSION ON A WOODEN POLE USED AS A BUFFER TO PROTECT THE POLE BEHIND IT

Ventifacts and wind-eroded rocks are known to occur in some places where sand is no longer blown about and where vegetation is now well established. In such circumstances, they serve as indicators of past climatic conditions much different from those of the present.

SAND DUNES

Sand dunes are perhaps the best-known and most striking result of wind action, and are of world-wide occurrence. They cover great areas in the deserts of Africa, Asia and Arabia, and lesser areas in the deserts of North and South America. They are prominent features also along many sea coasts and some lake shores and, in inactive form, are found in various interior areas of the United States, Germany, Poland, Hungary and other countries.

Dunes, in general, may be classified as being either active or stabilized. The active dunes—those still being built up, shaped or moved by the wind—may be subdivided into those with and those without vegetation, the forms of the two being distinctively different. In the absence of vegetation, sand blown from beaches, river beds or ancient stream deposits moves freely, much like drifting snow, until some obstacle or resistance causes accumulation. Topographic obstacles, such as hills or cliffs, may serve to trap sand and initiate dune building. Small hills may develop "attached" dunes on the downwind side, and, if the sand supply is abundant and the winds strong and constant in direction, these may develop into narrow, elongated ridges hundreds or thousands of



BY COURTESY OF H T U SMITH

SAND RIDGE LYING PARALLEL TO WIND DIRECTION ON THE LEEWARD SIDE OF A HILL IN THE PERUVIAN COASTAL DESERT. SAND IS BLOWN FROM THE SHORE BEHIND THE HILL

feet, or even miles, in length. Larger hills may give rise to sand drifts or sheets of more irregular shape, on one or more sides of the hill. Cliffs facing the mind may cause the sand to bank up and form "climbing" dunes, which in favoured localities reach heights of many hundred of feet. Cliffs facing away from the wind allow the sand to drop over into sheltered zones, and thus develop "falling" dunes.

In many places, dunes develop on relatively flat surfaces in the absence of any distinguishable obstacles. Here the dunes commonly are either crescentic or ridged in form and display remarkable regularity in their characteristics. Crescentic dunes, known as barchans, have their tips pointing downwind, and are markedly asymmetrical in cross section, with a gentle slope facing toward the n-ind and a much steeper slope facing away from the wind. These dunes gradually migrate with the wind as a result of erosion on the windward side and deposition on the leeward side. The rare of movement ranges from a few feet to a few hundred feet per year.

Ridged dunes are of two general types, asymmetrical and symmetrical. The asymmetrical type extends more or less at right angles to the direction of the sand-moving winds, and is thus commonly referred to as a transverse dune. Like the barchan, it has a gentle slope on the windward side and a steep slope on the leeward side, and migrates with the wind. In many places barchans and transverse dunes occur side by side, and transitional forms between the two are common.

Generally the transverse dunes occur in closely spaced groups, and together present the appearance of huge waves of sand. Individual ridges may be up to several hundred feet in height. Symmetrical dune ridges are of many varieties, and range widely in size and in detailed characteristics. It is believed by some that they are formed parallel to the dominant wind direction, and by others that they represent the action of convergent winds; possibly different varieties are developed in different ways.

The basic types of dunes discussed above are subject to countless modifications and complications, both in form and in pattern, and in addition there are other more complex forms in certain regions, reflecting different combinations of wind conditions and other factors.

The question remains as to what causes the accumulation of sand in dunes where no topographic obstacles are seen. An answer has been provided by experimental and observational studies on the mechanics of sand movement. In brief, it has been found that any accumulation of sand is in itself a partial obstacle, offering greater resistance to sand movement than sand-free surfaces adjacent.

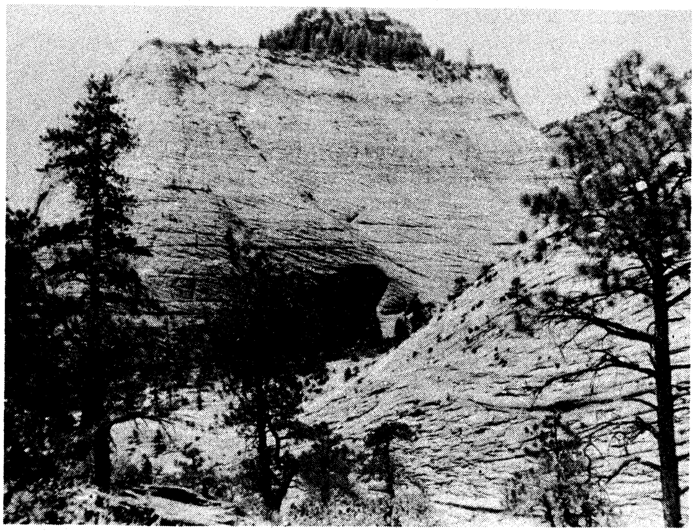
Fortuitous accumulations with small beginnings, started perhaps by minor topographic irregularities, thus tend to be more or less self-perpetuating, arresting more and more sand and growing larger and larger until other factors intervene. Thus initiated, subsequent molding and progression become a matter of aerodynamics, controlled by changes in wind velocity and direction, and by interaction with other dunes and other features in surrounding areas.

Where vegetation is present in significant degree, dune building progresses differently, and the resulting forms have their own individuality. When sand is blown from some bare area, like a sandy beach, to a bordering zone with vegetation, the latter serves to check sand movement. Certain varieties of plants thrive in blowing sand, and their continued upward growth progressively traps more sand, deveioping a well-defined mound or ridge. Dune building then is essentially a contest betn-een drifting sand and growing vegetation. Where the sand overpowers the vegetation, the accumulation moves forward. Where the vegetation retains control, the accumulation grows upward. As the sand accumulation grows larger, variations in the resistance offered by vegetation at different points commonly leads to relative forward movement at some places, and once well started these may channel the wind and perpetuate themselves. Ultimately, a U-shaped dune, open toward the wind, may develop. Such dunes, in fact, are characteristic of vegetated areas; although having some resemblance to barchans, they differ in having the relatively steep slope on the convex side, and in having this side facing away from the wind. Variations and combinations in dune form under the above conditions may be described as \--shaped, Y-shaped, fork-shaped, hairpin-shaped and rake-shaped.

It is seen above that the normal processes of dune development commonly involve either forward movement of the mass as a n-hole, or gradual extension of some part of the mass in a downwind direction. From the human standpoint, this may be a destructive process. Fields, forests, buildings, roads and even villages have been known to be overwhelmed and obliterated. To check such effects, various means have been devised to stabilize dunes or control sand movement. In some places the planting of suitable grasses, shrubs or trees is effective. In other places various types of mechanical barriers or protective coatings have been used.

Active dunes sometimes become stabilized or fixed naturally by the growth of a continuous cover of vegetation, due primarily to changed climatic conditions. Extensive areas of such "dead" dunes occur in the central United States and in various European countries. If the vegetative cover on such stabilized dunes is destroyed locally, wind action readily starts anew, developing "blowouts," saucer-, bowl- or trough-shaped hollows with bordering heaps of sand.

Dune building has been widely distributed in time as well as in space. Many sandstone formations, some dating back to very early periods of geologic time, have been identified as ancient dune sands, since consolidated. Some of these formations are of con-



BY COURTESY OF H. T. U. SMITH

SANDSTONE CLIFF REPRESENTING THE CONSOLIDATED DUNE SAND OF AN ANCIENT DESERT DATING BACK MORE THAN 100,000,000 YEARS. IN ZION CANYON NATIONAL PARK. UTAH

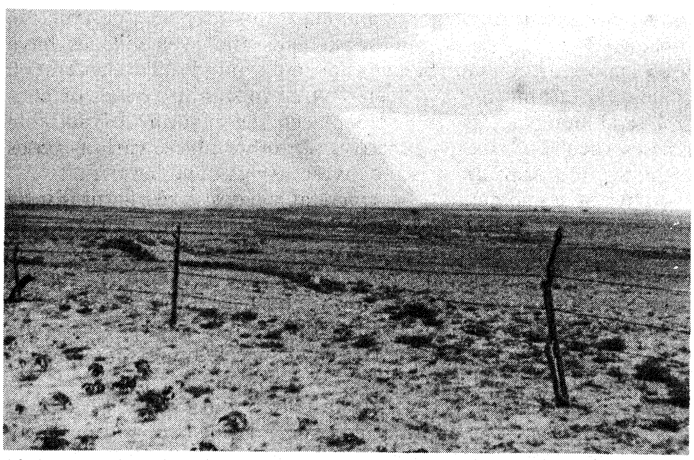
siderable extent and thickness, and serve as evidence of former deserts.

Wind-blown sand is characterized by physical properties different from those of other types of sand deposits. and thus is helpful in the identification of ancient dune sands which have lost their distinctive topographic form. The sand is particularly well sorted. and a major proportion of the grains are generally between $\frac{1}{2}$ and $\frac{1}{8}$ mm. in diameter. Well-rounded grains are relatively abundant, and grain surfaces typically display a frosted appearance. Cross bedding of a distinctive type is also present in many deposits. *See* also DUNE.

DUST STORMS AND DUST DEPOSITS

Severe dust storms are one of the more spectacular manifestations of wind action. Deflation supplies the material and atmospheric turbulence, together with convection currents, and carries it aloft for the wind to move along. When the amount of dust in the air reaches a high concentration, it may give rise to a dense, dark cloud of swirling dust with a steeply sloping, sharply defined front, hundreds of feet high, rolling irresistibly across the countryside. Frequently visibility is reduced to a few feet, and human activities come to a halt. As the storm moves along for tens and sometimes hundreds of miles, its vigour is gradually dissipated, dust settles out and the dust cloud gives way to a dry fog, which thins with increasing distance.

Dust storms are a common phenomenon where strong winds blow across desert areas, either natural or man-made, or across the temporarily dry beds of streams fed by glaciers. The man-made desert conditions of the central United States, in the 1930s, gave rise to dust storms nearly as severe as any on record. One storm, in 1933, was traced for a .distance of 1,300 mi., to northern New York. Around deserts such as the Sahara, dust storms have been known for centuries, leading to falls of reddish dust over much of southern Europe and occasionally even as far as England. A single storm, in 1901, was reported to have deposited from 3 to 30 tons of dust per square mile over an area of at least 300,000 sq.mi.—a total of about 2,000,000 tons of dust in Europe alone.



BY COURTESY OF H. T. U. SMITH

DUST STORM IN EASTERN COLORADO

The dust which settles to the ground may be held in place by vegetation and become a part of the soil. Ordinarily individual dust layers are too thin to retain their identity. But if dust storms recur with sufficient frequency over a long enough period of time, in places near the source area the accumulated dust gradually builds up a distinctive deposit, blanketing broad areas to depths of from a few inches to many feet. This is currently happening near the glaciers of Greenland and Alaska *(see* also GLACIER). The material so deposited, known as loess, is distinguished from other types of sedimentary deposits by its lack of distinct layering or bedding, by its occurrence on hills and valleys alike, and by its homogeneity and excellent sorting, with grains from $\frac{1}{16}$ to $\frac{1}{32}$ mm. in diameter generally predominant.

Loess deposits dating back to the Pleistocene epoch (*q.v.*) are widespread in many countries and form some of the world's best agricultural soil. Examples are found in central and western Europe. southern South America, China and central and northwestern United States.

In the Missouri-Mississippi drainage basin, thickness of the loess is up to more than 100 ft., and in China it is reported to reach several hundred feet. Where thick loess is exposed along valley sides. it commonly forms steep bluffs with conspicuous vertical cracks.

The dust, or ash, blasted into the air by volcanic explosions reaches much greater heights than ordinary dust, and is carried farther and deposited in greater thickness. After the eruption of Mt. Ratmai, in Alaska, in 1912, an area of about 2,000 sq.mi. was covered by ash deposits a foot or more in thickness, and an area ten times greater received at least a quarter of an inch of ash. After some volcanic explosions. ash is reported to have been carried halfway around the world. In many areas ash deposited in this way constitutes an important natural fertilizer. When concentrated in sufficient quantity and thickness, it provides an important source of material for scouring powder, ceramic processes and other uses *(see* VOLCANISM; VOLCANO). *See* also GEOLOGY: *Physical* Geology; SEDIMENTARY ROCKS.

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(H. T. U. S.)

WINDHOEK, the capital of South-\Vest Africa, is situated in the central part of the country at an altitude of 5,534 ft., about 400 mi. N. of the mouth of the Orange river and 900 mi. N. of Cape Town. Pop. (1961) 35,916.

The karakul (Persian lamb) industry has brought considerable prosperity to Windhoek which has become the buying centre. Local industries include meat canning, brewing, cold storage and bone meal manufacture. The mineral wealth and consequent development of mining in South-West Africa has added to Windhoek's commercial importance. As the capital of German South-West Africa, the town was called Windhuk; it was occupied by south African forces when the country surrendered to the Union of South Africa on July 9, 1915. (H. M. BE.)

WIND INSTRUMENTS may be loosely defined as those sound-producing instruments, generally for musical use, in which the sound is produced by blowing with the human lungs or with artificial bellows. By a closer definition, which excludes instruments of the "free reed" class (*e.g.*, accordion, harmonium, *qq.v.*), wind instruments are those in which sound is produced by a partially enclosed body of air that is caused to vibrate through some kind of primary vibrator or generator activated by wind from the lungs or bellows. Among these, three main classes are usually recognized, distinguished by the nature of the generator employed: flutes. reed instruments and trumpets.

Flutes. — The generator is here the eddy formation which occurs when the wind. issuing from a slit, strikes a solid edge cut in the wall of the instrument and open to its interior. The eddies. forming alternately above and below the edge. set up a rapid pressure oscillation which causes the air in the instrument to vibrate in a sound-emitting "stationary wave."

The ordinary flute (*q.v.*) is a transverse (*i.e.,* side-blown) flute, the slit formed and controlled by the player's lips, and the edge provided by the farther side of the mouth hole in the side of the instrument. With the near-eastern flute (*e.g.*, the Balkan *kaval*)—a so-called vertical flute—the top end of the pipe is open and put to the lips. its opposite rim providing the edge. Elsenhere. as in China. South America and Africa, sound generation at the open end is often facilitated by cutting a deep notch in the rim (the notched flute). With flageolets (*q.v.*). including the recorder (and also with organ flue pipes). an artificial slit directs the wind on to a beveled edge. While these are all tubular pipes. ocarinas and primitive gourd-flutes exemplify globular flutes; their pitch depends upon the volume of enclosed air and upon the sum area of apertures opened to the exterior at any moment while playing.

With a tubular flute, the pitch depends upon the length of the air column. which may be altered by uncovering the finger holes to make the basic scale. The air column may be further induced, generally by increased wind speed, to vibrate in half and other fractional lengths (overblowing), the scale then sounding at harmonic frequencies at the octave (second harmonic). twelfth (third harmonic), double octave (fourth harmonic), etc.. above the fundamentals. thereby adding upper registers to the compass. Most flutes have six or more holes, giving a diatonic scale. other semitones being obtained by "cross-fingering" (departures from the direct sequence in uncovering the holes! or. in modern western flutes. by key mechanism (*see* below). Severtheless, well over an octave can be obtained with only three holes by beginning the scale with the second harmonics (say. C, D. E. F j and continuing in third harmonics ((>. A. B. C). etc.: the vertical flute of ancient Egypt was typically three-holed, and this number is preserved in the pipe and tabor (*q.v.*), known in Europe from the 13th century: the pipe is played with one hand only, the other hand beating the tabor (drum).

A flute which is stopped at the end opposite to that at which it is blown gives a fundamental pitch approximately an octave deeper than an open flute and possesses a distinctive tone-quality through the absence of even-numbered harmonics among the overtone.;. Finger holes, though present in many primitive stopped flutes. cannot of course give a scale of stopped notes, and the best-known musical use of stopped flutes is therefore in unpierced sets with a different flute for each note of the scale. either combined as Panpipes or in a stopped-pipe organ register. or handed out separately to a group of players as in South African flute bands. The sliding stopper of the Swanee whistle shows an alternative expedient. An interesting variety of further applications of the flute principle is found among other whistles. paleolithic, primitive and modern (*e.g.*, cracker whistles and birdcalls).

Reed Instruments. — The wind here causes a "reed" to vibrate and so to engender a stationary wave within the pipe. (,There are, however. "reed horns." as. for instance. motor horns and reed hunting horns. in which the small pipe is unable to engage effectively with the powerful metal reed, and serves merely as an amplifier. the pitch being determined by the reed alone as with the free-reed instruments mentioned at the beginning.)

Reeds are single or double. The ancient form of single reed is made by cutting a vibrating tongue in the side of a piece of narrow cane or elderwood closed at the tip. This is widely used with peasant reed pipes and hornpipes in Europe and Asia. also among bagpipes (*q.v.*). The single reed was scarcely known in cultivated western music before the end of the 17th century, when the *chalumeau* appeared. at first little different from the peasant reed pipe and a toy for amateurs.

Other single reeds in folk instruments have a separate blade of cane. wood. etc., tied over an opening at the end of the pipe (cf. the metal reeds of organ reed stops). This idea was adopted with later *chalumeaux* and has become famous through the clarinet (*q.v.*). In all these instruments the single reed is associated with a ,cylindrical pipe, a combination which behaves acoustically like a stopped flute in that it yields deep-pitched fundamentals and only the odd-numbered overtones (rarely. however. practicable in overblowing except on the clarinet). It is the reed end of the pipe which is. in this analogy. stopped, the lower end being open, and hence finger holes present no problem.

The ancient double reed was made by pinching together one end of a piece of fresh-cut plant stem to give a narrow aperture which widened and contracted while the reed was blon-n. Such was the reed for the Greek *aulos* (*q.v.*). For the medieval (or possibly late classical) conical pipe or shawm (*q.v.*) and its successors. the double reed is mounted on a short metal tube or "staple": for Asiatic shawms it is again made by pinching one end of the material. but for European varieties—shawm. western bagpipe chanter. oboe. etc.—a strip of cane is folded over upon itself and bound to the staple (*see* OBOE) or to a temporary mandrel (*e.g.*, for the bassoon. *q.v.*). These conical pipes yield similar harmonics to those of open flutes and may be readily overblown to second and third harmonics. The 16th century contributed various fresh double-reed instruments in which the bore was cylindrical, and the acoustic behaviour that of the single-reed pipes described above. The crumhorn was the most important of these. The rest, all short-lived. included the *sordone,* with the bore doubled back in bassoon fashion. and the rackett, with a bore of about seven short tubes connected in series to sound a very deep compass with minimum over-all size. The opposite combination of single reed with conical pipe, is found among reed pipes of bird bone and Bulgarian bagpipe chanters; also in the saxophone (*q.v.*) and the *tárogató*, a popular folk instrument of Hungary and Rumania (historically a redesigned shawm) recalling a soprano saxophone in shape but of wood and with smaller tone holes. These both overblow to the octave, like an oboe. (The Sarrusophone, named after its French inventor, Sarrus. who designed it in 1856. has a saxophonelike bore and keywork but a tubalike shape and a bassoonlike reed; in contrabass form it has been used in French and other bands and—as a contrabassoon—in orchestras, but is now almost obsolete.)

Trumpets. — Inthe general classificatory sense, these are instruments in which the player's lips are tensed across an aperture in the instrument in order to vibrate under breath pressure. Conch shells. perforated gourds and hollowed branches are among primitive types. followed by animal horns blown in various ways and sometimes pierced with finger holes (*see* HORN; MUSICAL INSTRUMENTS). Most of these were signalling or ritual instruments sounding one note. though a tuned set may be used by a group of players, as in Uganda and in the Russian "horn bands" of the early 19th century. Bronze trumpets began historically with the Danish *lur* of mammoth-tusk shape followed by Irish examples. the Celtic animal-belled *carnyx,* the Roman trumpets (*tuba*, straight; *lituus,* hook-belled; and *cornu,* hooped) and also possibly by wooden versions (*see* ALPHORN). It is not known whether players cf these early instruments exploited the wide range of natural harmonics which tubes of such lengths will readily sound (they are the same as for an open flute; *see* TRUMPET) hut specimens of *lur* and *cornu* show remarkably kvell-developed cup-shaped mouthpieces for the lips. closely anticipating those used with later and modern brass instruments. Among these. trumpets and trombones (*qq.v.*) are distinguished by mainly cylindrical tubing. A wide conical bore without bell flare, deriving from the medieval cow horn, was retained in 16th-century wooden instruments with cup mouthpiece and finger holes: the cornett (see CORNET) and the serpent. The latter. a bass version named from its shape, was revived in the 16th century as a bass for wind bands, to give rise to numerous modifications built in a handier bassoon shape (bass horn, Russian bassoon, serpent Forveille, etc.). all used in early 19th-century bands before their replacement by large-bore brass instruments with keys (ophicleide, *q.v.*) or valves (tubas, saxhorns, *qq.v.*), these being partly descended from the bugle (*q.v.*), in which the old wide horn bore was developed in metal. A group of brass instruments with a narrow conical bore, reaching back to Renaissance hunting and post horns, now includes the post horn (straight in England, circular on the continent) with its valved derivative the cornet, and the French circular *trompe* de chasse (hunting horn) with its valved version the French horn (see HORN) ; though every bore is necessarily cylindrical through valve mechanism (see below), the smooth sound imparted by bore taper and deep mouthpiece cup is nevertheless preserved with these modern instruments, to contrast with the brighter sonorities of the trumpet group.

Technique. — Modern wind playing rests upon cultivation of "embouchure," breathing and tonguing, as well as upon fingering and interpretation. The term embouchure covers the physical contact with the player's mouth, including position of the lips and use of the facial muscles. Breathing is from the diaphragm. Tonguing by which the playing is articulated on all wind instruments except bagpipes and organs, is basically a tongue movement similar to pronunciation of the letter "T," made against the upper teeth in playing flutes and most brass instruments, but against the tip of the reed in playing reed instruments. For very quick articulation this mav be alternated with a "K" made with the back of the tongue ("double tonguing").

Tuning.—Modern wind instruments are built to the standard pitch of A = 430 vibrations per second; all except the conical-bore reed instruments are provided with a tuning slide or socket for temperature adjustment during performance. Many instruments built to other pitches formerly in use survive, especially in Great Britain; those built to "high pitch" (A = 452) are virtually useless, except for the brass instruments, which can be lowered by a lengthened tuning slide.

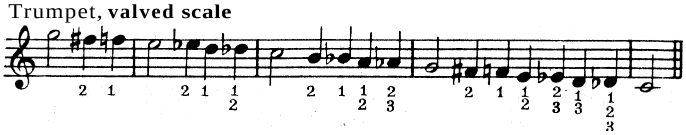
Mechanism. — For discussion of the mechanism of wind instruments the customary orchestral headings of woodwind (flutes and reed instruments — whether in fact made of wood or of metal), and brass may be followed. (See also ORGAN: General *Description.*)

Woodwind *Instruments.*—Woodwind mechanism or keywork began with a lever key fitted to larger shawms in *c.* 1400 to cover the lowest tone hole; it was termed in France a *clef* "key," and was sprung to rest in the open position. This open key in its modern form (*e.g.,* on large recorders), well illustrates the technological advance in keywork achieved in the first half of the 19th century: keys were formerly simple levers pivoted on pins held in the wood, sprung with a leaf spring and padded with strip leather; on modern instruments they are soldered to an axle or "barrel," turning on steel screws held in metal pillars screwed into the mood, and have a stuffed pad and generally a steel needle-spring bearing on the axle's rotation. Keys sprung to rest in the closed position were first employed for obtaining semitones outside the finger hole scale in the French bagpipe *musette,* about 1600. Modern instruments using only closed keys are the simple band flutes or fifes, preserving the system of the later 18th-century flute. Only the smallest possible number of keys, open or closed, were fitted to reed instruments before the 19th century. Ring keys or rings, though not Theobald Boehm's idea in the first place, appeared in their modern form in his 1832 conical flute; familiar on modern clarinets and many oboes, they enable one or more fingers independently to turn an axle to actuate a key in the same movement as covering a hole. Shortly after this, the saxophone and Boehm's cylindrical flute required larger holes than finger tips could cover, and therefore padded keys or plates for each finger were introduced. These necessitated in many cases the mechanical articulation (*e.g.,* by small cork-adjusted clutches) of the devices operated on other instruments by the rings, to allow one of two plates to be lowered without automatically lowering the other. (Clutches or equivalent devices are also needed when two rings or plates on one axle are to operate two separate mechanisms.)

The term articulation, however, is most used in keywork for instances where a closed key is arranged to rise when one lever is pressed and then, while the finger still presses this lever, to be closed by another lever. This involves fitting springs of two different strengths, the key being normally kept closed by the stronger spring of the first lever. The arrangement is used to facilitate various trills, and also in the automatic octave-key mechanisms of oboes and saxophones.

Brass Instruments. — The mechanism of nearly all brass instruments, namely, their valves, was invented in Berlin about 1815 and patented jointly by H. Stolzel and F. Blühmel in 1818. Valves enable the player momentarily to add to the total tube length in order to lower the pitch. The first valve is depressed by the first finger to deflect the air column through a small loop of tubing which lowers the pitch of the instrument by a whole tone; the second valve similarly lowers by a semitone; both together lower by a minor third. To the two original valves mas soon added the third valve, which by itself lowers by a minor third but is chiefly used in combination with the others to lower over larger intervals down to a diminished fifth.

The example shows how part of the chromatic scale is ordinarily fingered on the trumpet, the open notes (made without the valves) being indicated by white notes and the valves numbered 1, 2 and 3:

Trumpet, **valved scale**

The valves most commonly employed are of the piston type, sprung to resume their raised positions; they are E. F. Périnet's improvement (Paris, 1839) upon an earlier Berlin pattern in which the main tubing led through the bottoms of the valves (so-called Stölzel valves). The rotary valves employed in Germany, and with the German type of French horn now used in most countries, have rotors with the valve ports cut in them, turned against a spring by a system of levers. Many of the larger brass instruments have a fourth valve which transposes the instrument a fourth lower, mainly in order to complete the scale down to the fundamental open note (which in the example would be the C four lines below the stave, though in fact the fundamentals are musically useful only in instruments with large bore or wide mouthpieces, or, as in tubas, both). Though each valve can be tuned to its correct lowering interval by means of its own tuning slide, notes made with combinations of valves are by nature too sharp, especially those involving the third valve. For example, this valve tuned to lower an open note (say, G) to E would require, by proportion, longer valve-tubing to lower a first-valve note (say, F) by the same musical interval to D. The player has therefore to correct such notes with ear and lip, though the trumpet's first or third valve slide is often arranged to move easily for momentary extension to counteract sharpness. In combinations with a fourth valve, the sharpness becomes by nature very acute. A partial remedy is to provide a fifth valve tuned to a wider semitone than the second valve. More efficient but more expensive is D. J. Blaikley's compensating system (London, 1874), used on many British tubas: the tubing of the fourth valve actually runs through the three normal valves in such a way as to add small extra loops when any of them is depressed while the fourth valve is also depressed.

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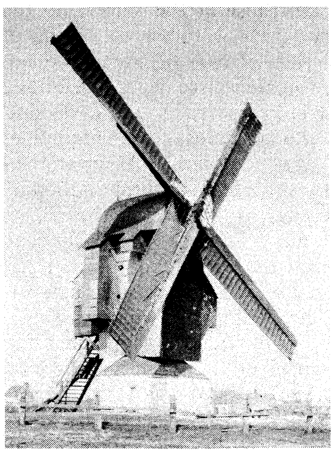
(A. C. BA.)

WINDLASS, a large cylinder, conventionally termed the wheel, turning a smaller cylinder or barrel termed the axle, the difference in size giving a gain of power. Like the lever, the increased applied force for the windlass is proportional to the ratio of the radii of the barrel and the axle. A rope. partly coiled around the axle, is attached to the load. In some cases the wheel is turned by means of a rope coiled around it, *e.g.,* light hand cranes, but in many hoists and cranes the function of the wheel is taken by a winch handle, and in other cases by a toothed wheel driven from a pinion, hand or motor driven. The Chinese windlass gives a great gain of power by the use of axles of two diameters. A ship windlass is a more complicated apparatus, hand. steam or electrically driven, with chain wheels by means of which the anchor chain is hoisted and let out. Powerful brakes, and often coned warping drums for whipping purposes, are fitted. (L. E. G.)

WINDMILL. The utilization of an uncontrollable source of power to produce work is the problem overcome by man in building windmills. Their use was increasingly widespread in Europe for 650 years from the 12th century until the early 19th century. Their slow decline, due to the development of steam power, lasted for a further 100 years. Their rapid demise, except in the Netherlands, began after World War I with the development of the internal-combustion engine and the spread of electric power: but from that time on electrical generation by wind power has been the subject of more and more experiments.

History. — The earliest-known references to windmills are to a Persian millwright in A.D. 644 and to windmills in Seistan, Persia, in A.D. 915. These windmills are of the "horizontal mill" type, with sails radiating from a vertical axis standing in a fixed building, which has openings for the inlet and outlet of the wind diametrically opposite to each other. Each mill drives a single pair of stones direct, without the use of gears, and the design is derived from the earliest water mills. Persian mill\\-rights, taken prisoner of the forces of Jenghiz Khan, were sent to China to instruct in the building of windmills; their use for irrigation there has lasted ever since: but the mills are freestanding with feathering sails. The horizontal windmill was used in the Crimea and has been re-invented and used, though not extensively. in most of the western European countries and in the United States. Its limitations are considerable and its most satisfactory manifestation is in the S-rotor of S. J. Savonius of Finland.



REX WAILES

FIG. 1.—POST MILL WITH FOUR "COMMON SAILS." THE CLOTHS OF WHICH ARE FULLY SET. AT MARCKE. PAS DE CALAIS. FRANCE

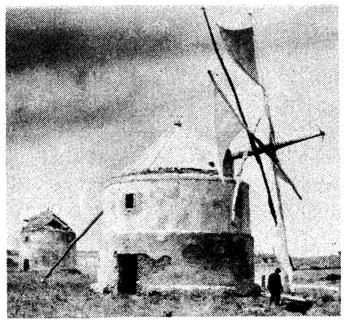
The "vertical windmill," with sails on a horizontal axis, derives directly from the Roman water mill with its right-angle drive to the stones through a single pair of gears, although the actual idea of utilizing wind power may have been brought back from the east by crusaders. and the first European references are to one in France about 1180 and in England in 1187.

The first detailed description from which a windmill could be built was published in France in 1702, and the first satisfactory working drawings were published in the Setherlands in 1727.

Development.—The earliest form of vertical mill is known as the '(post mill." It has a boxlike body containing the gearing, millstones and machinery and carrying the sails. It is mounted on a well-supported wooden post socketed into a horizontal beam on the level of the second floor of the mill body. On this it can be turned so that the sails can be faced into the wind; access to the mill body is by a ladder at the tail of the mill. Usually the post and its substructure are above ground; but sometimes they are buried in a mound and the mill is then known as a "sunk post mill." The substructure is often protected by a "roundhouse," which is simply a storeroom.

The next development was to place the stones and gearing in a fixed tower. This has a movable top or "cap," which carries the sails and can be turned around on a track or "curb" on top of the tower. Brick and stone towers are usually round; timber towers are usually octagonal and tapering and are known in England as "smock mills." The earliest-known illustration of a tower mill is dated about 1420. Both post and tower mills were to be found throughout Europe and were also built by the British, Dutch, French and other settlers in America.

At first both post and tower mills drove a single pair of stones for grinding grain through single-stage gearing. By 1430, however. the Low Countries needed more than just animal and man power for draining the land; the Dutch therefore invented the "hollow post mill." An upright shaft takes the drive through the hollow post of the mill and drives a "scoop wheel," resembling a paddle wheel, which scoops the water up from a lower to a higher level. Two pairs of gears were used. at the top and bottom of the upright shaft respectively, and this opened the way for the larger tower mills with several pairs of stones and ancillary machinery.



REX WAILES

FIG. 2.—STONE TOWER MILL WITH EIGHT JIB SAILS OF WHICH FOUR ARE SET. THE CAP, ONCE THATCHED. HAS BEEN COVERED WITH GALVANIZED IRON. IN MOLINO CATALINA, VEJER DE LA FRONTERA. SPAIN

To work efficiently, the sails of a windmill must face squarely into the wind, and in the early mills the turning of the post-mill body, or the tower-mill cap, was done by hand by means of a long "tailpole" stretching down to the ground. Later a series of posts were placed around the mill, a winch fixed to the lower end of the tailpole and a chain run out from the winch to one of the posts. Winches were also placed in the caps of tower mills and operated from inside or from an endless chain from the ground.

In 1745 Edmund Lee in England invented the automatic "fantail." This consists of a set of five to eight vanes mounted on the tailpole or the ladder of a post mill at right angles to the sails and connected by gearing to wheels running on a track around the mill. When the wind veers it strikes the sides of the vanes, turns them and hence the track wheels also, which turn the mill body until the sails are again square into the wind. The fantail is also fitted to the caps of tower mills, driving down to a geared rack on the curb.

Sails. — The sails of a mill are mounted on an axle or "windshaft" inclined upward at an angle of from 5° to 15° to the horizontal. On this shaft, inside the mill, is the first geared wheel known as the "brake wheel" because a contracting brake acts on its rim. The first mill sails were wooden frames on which sailcloth was spread; each sail was set individually with the mill at rest. The early sails were flat planes inclined at a constant angle to the direction of rotation; later they were built with a twist like that of an airplane propeller.

In 1772 Andrew Meikle, a Scot, invented his "spring sail," substituting hinged shutters, like those of a Venetian blind, for sailcloths and controlling them by a connecting bar and a spring on each sail. Each spring had to be adjusted individually with the mill at rest according to the power required; the sails were then, within limits, self-regulating.

In 1789 Stephen Hooper in England utilized roller blinds instead of shutters and devised a remote control to enable all the blinds to be adjusted simultaneously while the mill was at work. In 1807 Sir William Cubitt invented his "patent sail" combining Meikle's hinged shutters with Hooper's remote control by chain from the ground via a rod passing through a hole drilled through the windshaft; the operation was comparable to opening and closing an umbrella, and by varying the \\-eights hung on the chain the sails were made self-regulating. Patent sails and fantail: widespread in England, were also adopted in Denmark, Germany and the Netherlands.

In 1860 R Catchpole, in England, successfully applied air brakes to patent sails; the idea was revived in the Netherlands after the application of airfoils to the leading edges of mill sails was initiated by A. J. Dekker, advised by 4. G. von Baumhauer, in 1927. Others followed and greatly increased the output of mills by enabling them to do useful work in lighter winds. First L. Burne in England, then K. Bilau in Germany and later G. ten Have and others in the Netherlands produced sails hinged longitudinally with the same object. Of other varieties of sail the most common are triangular jib sails wrapped around poles which are braced to a bowsprit extending from the front of the windshaft. These sails are found in the Iberian peninsula, the Azores, the Mediterranean islands, Greece and Turkey; from 8 to 12 sails are used.

The normal number of sails for a windmill is four. John Smeaton in England in 1759 was the first to investigate windmill sails scientifically. He preferred five sails, however; six- and eight-sailed mills were also built. He and others in England first used cast iron in mill work at this time. At this time, too, the windmill was put to a wide variety of uses by the Dutch in addition to corn grinding and water raising by scoop wheel, Archimedean screw and a chain of pots. The most important of these uses were sawing timber, pressing oil from seeds and paper making. The centrifugal governor was applied to corn mills in England by Thomas Mead in 1787 and was used for maintaining constant the gap between the stones and hence the fineness of grinding. Wind power mas used to drive the sack hoist to raise the grain into bins and so feed the hoppers of the stones by gravity, and automatic bell alarms were provided to give warning when the hoppers needed replenishing.

Wind Pumps.—The annular-sailed wind pump was brought out in the United States by Daniel Hallady in 1854, and its production in steel by Stuart Perry in 1883 led to world-wide adoption, for although inefficient it is cheap and reliable. The design consists of a number of small vanes set radially in a wheel. Governing is automatic: of yaw by tail vane, and of torque by setting the wheel off-centre with respect to the vertical yaw axis. Thus as the wind increases the mill turns on its vertical axis, reducing the effective area and therefore the speed.

Electrical Generation.—The windmill has been used as a source of electrical power since P. La Cour's mill, built in Denmark in 1890 with patent sails and twin fantails on a steel toner. After World War I experiments were carried out with windmills having three sails of airfoil section like the blades of an airplane propeller, notably by G. Darrieus in France; and in 1931 a windmill of this type was built in the Crimea and the power generated fed into the low tension side of the local supply. Experimental twin-bladed mills were built and run in the United States in the 1940s and in France and England in the 1950s; but the most successful generator mas developed in Denmark under J. Juul with three blades braced to each other and to a bowsprit on the front of the windshaft.

REX WAILES

FIG. 3.—TOWER MILL WITH FIVE SELF-REGULATING PATENT SAILS. IN WEINBOHLA. DRESDEN DISTRICT. GER.

In the meantime in the Netherlands three old-fashioned corn mills had been adapted to use surplus energy to generate electricity. An asynchronous motor is used, which can drive the mill or be driven by it as a generator; the gearing incorporates an overrunning clutch so that the motor will not drive the mill sails. The cap is turned by a servomotor controlled by a wind vane.

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(R. WA.)

WINDOW, an opening in the wall of a building, for the admission of light and air. A window that opens on hinges is called a casement. Fenestration (*q.v.*) is an architectural term pertaining to the arrangement of windows as an element of the exterior decoration of a building. For the historical development of houses from earliest times in all parts of the world, *see* HOUSE. For discussions of the factors determining the design of windows in contemporary dwellings. *see* HOUSE DESIGN; ORIENTATION; INTERIOR DECORATION. *See* also SHOP FRONT DESIGN; ROSE WINDOW.

(X.)

Early History.—Windows are obviously a very ancient invention, probably almost coincident with the development of fixed and enclosed houses, particularly in those parts of the world in which courtyards were of little importance. Representations of windows occur alike in early wall paintings in Egypt, reliefs from Assyria and terra-cotta plaques from Crete. The Egyptian examples show openings in house walls covered with mattings, like the doors, as in the jth-dynasty tomb of Ti. Well-known examples of Egyptian windows also exist in the hypostyle hall of the great temple at Karnak, built by Seti I and Rameses II, and in the so-called pavilion at Medinet Abu, nearby. In the hypostyle hall the central aisles have much higher columns than those at the sides, and the space between is filled by clerestory (*q.v.*) windows consisting of huge granite slabs pierced with two tiers of narrow, vertical openings. In the pavilion at Medinet Abu there are several windows consisting of simple rectangular openings with a small. decorative frame. These were probably originally closed by hangings of matting or cloth. (*See* EGYPTIAN ARCHITECTURE.) Assyrian windows are almost always wider than they are high, and subdivided by little colonnettes. Many such openings are shown in the palace reliefs of the 9th and 8th centuries B.C. They are generally high in the wall. Cretan plaques show many house fronts; in these there are indications of several tiers of windows, as though the houses were two or three stories high, and in the windows themselves representations of frames, dividing the large opening into four smaller ones by means of a central mullion and a horizontal transom bar. (See PRE-HELLENIC ARCHITECTURE.)

Greek and Roman.—The devotion of the Greeks to the house built around a court led to an almost total disappearance of windows. and such remains as those of Delos, although they are principally of Alexandrian and Hellenistic date: show scanty signs of windows. each room being lighted only by a door to the central, colonnaded court. In temples. also, windows are usually lacking, and the interior was lighted only by what light entered through the door or percolated dimly through the marble tiles of the roof. In exceptional cases, however. windows of very marked architectural character occurred. In the Erechtheum (*q.v.*), for instance, although the windows in the western wall date from a Roman reconstruction, the great eastern door was, from the beginning, flanked by window openings, with an architrave band around and a cornice above, and the existence of such highly developed window forms in the 5th century B.C. would seem to indicate that similar forms had long been well known. (*See* GREEK ARCHITECTURE.)

In Roman imperial times the glazed window first definitely appeared, and fragments of glass in a bronze frame have been found in Pompeii, as well as many other fragments of glass in the remains of Roman villas in England. Moreover, it is obvious that the great windows in the baths (*q.v.*) of Rome must have been enclosed in some way, in order to retain the heat. The general hypothesis is that these great segmental-headed clerestory openings, whose shape is perfectly preserved to the present day in the tepidarium of the baths of Diocletian at Rome, now the church of Sta. Maria degli Angeli, were filled. originally, with frames of bronze which subdivided the whole into small areas, each of which held a pane of glass. There is much debate as to how common glass was during the early empire, and whether the *speculares* which Pliny refers to, in his letter (no. 217) describing his villa at Laurentum, were glazed windows or not; they, without doubt refer to transparent or translucent windows. In addition to glass, the Romans are known to have used thin sheets of translucent marble, panes of mica, shells and horn. (See ROMAN ARCHITECTURE.)

Byzantine church windows were glazed from an early period. Thus it is known that from the beginning, the windows of Hagia Sophia at Constantinople (begun 532) were filled with pierced, marble frames enclosing panes of glass, and it is possible that some of the glass still existing may be the original glazing. (See BYZANTINE ARCHITECTURE.)

Islamic builders copied this Byzantine technique of inserted, small pieces of glass, in a masonry frame, and by substituting cement for marble, obtained great freedom and richness in pattern design, so that with the use of different colours of glass in the small openings. brilliant effects were produced. In addition to the mosque windows which followed Byzantine prototypes, the Islamic builders of Egypt and Syria developed an extremely rich type of domestic window which was usually unglazed. This consisted of a projecting, bracketed, framework of wood with its sides entirely filled by intricate grillwork formed by carved, turned, wooden spindles. (See ISLAMIC ARCHITECTCRE.)

Medieval.—It was probably also during .the Byzantine period that windows covered by a complete arch superseded the segmental and square heads common in Roman work, and it is the arched window that became the governing form throughout medieval Europe, at least for masonry buildings. The history of the window in the domestic architecture of the early middle ages is difficult to trace. From existing reliefs, representing early Romanesque houses, it appears that semicircular, arched windows were the rule in masonry town houses, and square-headed windows in timber-built country work. From an early period, however, the tendency appeared to use square-headed openings in masonry houses. Thus in the *hôtel* de *ville* at St. Antonin. France (12th century). the main hall is lighted by 12 little square-headed openings in groups of four, forming practically an open loggia. There are indications that these openings n-ere closed by shutters. The rooms above, however. have semicircular windows in pairs. With the gradual introduction of the glazed sash in secular work. which apparently began during the 12th century. the tendency toward the use of rectangular openings was much increased, due to the ease with which sash could be framed in them. During the late 12th century. transitional forms were found; especially in south France: in which arch-headed openings were divided by a heavy frame member at the spring, so that at least the lower part of the window could have a rectangular sash, as in the 12th century house at Monpazier, illustrated by Viollet-le-Duc, *Dictionnaire raisonné*. The 12th-century Jew's house in Lincoln. Eng., preserves traces of original arch-headed windows, which were later altered to square heads. From the middle of the 13th century on, the square head became almost universal, even in masonry buildings, although traces of the arch tradition remained in the arch forms often carved upon the stone lintels. (See ROMANESQUE ARCHITECTURE.)

The desire for light and air increased continuously with the growing cheapness of glass, but the necessity for small sashes remained: the inevitable result was the development of the mullioned and transomed window, generally rectangular in shape in which the entire opening is subdivided into convenient sizes by vertical bars known as mullions and horizontal bars known as transom bars. The climax of the development appears in France in such 15th-century work as the Cluny museum at Paris and the house of Jacques Coeur at Bourges; in England. in countless Tudor and Jacobean houses. In some of these, as in Sutton place, Surrey (1525), the small, rectangular sections made by the mullions and transoms are decorated with cusped arches. The glazing of these medieval. secular windows was probably originally done by assembling many small pieces of glass in a wooden framework or sash. There was a great use of roundels. Later, leading was introduced, although the whole leaded sash was set in a wooden frame. The leading was usually in panes, either rectangular. with the long dimension vertical, or in diamonds. Toward the end of the period, especially in England, metal sashes began to be introduced.

The development of ecclesiastical windows was quite different, for two reasons: first, the necessity for large size, which rendered the arch head inevitable; and second, the development of stained glass (*q.v.*). The combination of these two elements, together with the general use of stone, vaulted forms, in church architecture, led to, first, the grouping of several small windows in one composition; as in much early English Gothic work, and later, during the early 13th century, the evolution of tracery (*q.v.*). The leaded glass in these windows was inserted in a groove cut in the inside edge of the jamb and held in place by iron bars or an iron framework. A characteristic feature of almost all medieval windows is the splaying of the jambs on the interior, so that the opening on the inside face of the wall is much larger than that on the outside. In this manner the illumination was increased and the large openings inside offered great opportunities for decorative richness. (*See* GOTHIC ARCHITECTURE.)

Renaissance. — Early Renaissance palace windows in Italy show many attempts at compromise between the arched and mullioned windows of Gothic tradition and the classic feeling that the rectangular opening was more dignified. Thus most of the 15th-century Florentine palaces had twin, arched windows under a single enclosing arch; in many cases the opening itself was square topped and the arches above mere panels. During the High Renaissance period, the rectangular window was the most popular form. It was frequently decorated with an architrave, and a cornice and pediment. Pilasters and columns were often added at the sides. During the baroque period these decorative window enclosures were often elaborately scrolled and ornamented with fantastic cartouches, consoles, masks and human figures. Arched windows appeared spasmodically throughout the Renaissance, usually in churches or enclosed loggias. The general system of glazing in Renaissance Italy was the use of wooden-hinged frames subdivided by small wooden bars known as muntins; the tendency was continuous toward the use of larger and larger panes of glass.

In the countries north of Italy, the persistence of medieval window forms into the Renaissance was marked. In France. for instance. debased Flamboyant tracery forms occurred in churches well into the reign of Henry II (1547–59), as in the church of Notre Dame at Grand Andely, and mullioned and transomed windows were a distinctive feature of the châteaux of the time of Francis I. Similarly in England, rectangular, mullioned windows, with hinged sashes and leaded glass, and occasionally decorated with cusped arches, were built particularly in the collegiate buildings at Oxford and Cambridge, well into the 17th century.

The later Renaissance in France produced and developed the type of large casement window that has remained the accepted form on the continent of Europe ever since — popularly known as the French window. In this type the opening is high and comparatively narrow, frequently extending down to the floor and is glazed with two large, hinged, wooden sashes, arranged to swing in, each subdivided into three or more lights of comparatively large size. An iron railing or stone balustrade is built on the outside for safety. It is largely the use of such windows that has given the stimulus to the extensive use of balconies in modern continental apartment houses. In England the late Renaissance development was determined by the common use of the type of window known as "double hung," which during the late 17th and 18th centuries almost superseded the swinging casement. In this the window is divided into two sashes, horizontally, the lower one on a plane slightly inside the upper one. By lowering the upper sash and raising the lower, any desired amount of ventilation up to half the area of the entire opening can be produced. In the cruder kinds of double hung window. the sashes are supported in position by pegs or spring cams, or elbows. The more developed type, now universal. has the sash hung on ropes or chains, which pass over pulleys and are connected at the other end to counter weights concealed in the window frame or box. (T. F. H.)

Modern. — The impact of industry on many processes of contemporary building has led to the use of metal frames for windows in most residential construction. These metal window frames are constructed of stock shapes that are either rolled (stainless or ordinary steel) or extruded (aluminum and bronze). The window itself has tended to become larger, often wall to wall and floor to ceiling, and frequently when the building is air-conditioned no longer has opening sash members. Shop windows and other similar large glass areas are, in fact. both wall and window, and to ithstand wind pressures must be of a prescribed thickness per square foot of exposed area. Vertical supporting members, called mullions, which transfer the wind forces to the structural frame, also vary in thickness and depth in accordance with the glass area they stiffen.

The glass itself may also be designed to perform a specific function such as "Thermopane" (two panes of glass with a hermetically sealed dry air space between)—used to restrict the heat lost through a window, and "heat absorbent" green glass—used to restrict the passage of heat producing infrared rays of the sun. (See MODERN ARCHITECTURE.) (H. MN.)

Oriental.—A great difference in window design between the orient and the west is due to the almost total lack of window glass in oriental countries. In China and Japan windows are usually covered with paper. cloth or shell. All of these require a large amount of subdivision of the window area; shell, because of the small size of the elements, the other materials because of their fragility. Japanese windows are usually arranged to slide horizontally. Ordinarily the whole opening is of great width in relation to its height, and is subdivided into a number of small sashes! each sliding in a different plane, and all arranged so as to slide back into a pocket or case, bracketed out from the outside face of the wall. The patterns of Japanese window subdivisions are more limited than those of China and are universally based on the subtle relationships of rectangular shapes. with their long dimensions horizontal. *See* CHINESE ARCHITECTURE; JAPANESE ARCHITECTURE ; INDIAN ARCHITECTURE ; see also references under "Window" in the Index volume. (T. F. H.)

WINDOW TAX, a tax first levied in England in the year 1696 for the purpose of defraying the expenses and making up the deficiency arising from clipped and defaced coin in the recoinage of silver during the reign of William III. All houses inhabited save those not paying Church or Poor rates were assessed two shillings a year. An added tax was laid according to the number of windows—on 10 to 19 windows the additional tax was 4/-.

In its first year the tax raised £1,200,000. It was increased six times between 1747 and 1808, but was reduced in 1823. After a strong agitation in the ninter of 1850–51, it was repealed on July 24, 1851, and replaced by a tax on inhabited houses.

WINDPIPE (TRACHEA), the tube that carries air between the larynx and the bronchi of the lungs; the windpipe lies partly in the neck and partly in the chest. See RESPIRATORY SYSTEM, ANATOMY OF.

WIND RIVER RANGE in west-central Wyoming is one of the highest ranges of the central Rockies. The 100-mi. northwest-southeast axis of the range is located on the water divide between the Gulf of Mexico and the Pacific. The elongated range. lifts 4.000 to 5,000 ft. above the surrounding Wyoming basin; it contains the highest point in Wyoming, namely, Gannett peak (13,-785 ft. above sea level). The huge anticlinal fold exposes Pre-Cambrian rocks along the axis with younger upturned sedimentary rocks on the flanks. At the southern end of the range is historic South pass. (H. B. HA.)

WINDSOR, DUKE OF: see EDWARD VIII.

WINDSOR, HOUSE OF: see GEORGE V.

WINDSOR, a city and port of entry in Essex county, Ontario, Can., on the left bank of the Detroit river opposite Detroit, Mich., U.S., and 230 mi. S.W. of Toronto. Pop. (1961) 111.367; metropolitan area 193.365. In 1701 the French founded a fort at Detroit and soon settlement spread lo the Canadian side of the river. The survey pattern was French Canadian: long. narrow farms. stretching back from the river banks. In 1748 Jesuits established a mission for the Huron Indians. The French settlers remained after the fort became British in 1763; in the latter part of the 20th century about 20% oi the population was of French origin. The hamlet was known as "the Ferry"; during the War of 1812 it was occupied by U.S. forces. Later it was called Richmond and after 1836. Windsor (for Windsor, Eng.). Because of its strategic location opposite the heart of Detroit, Windsor became an important railway terminal: U.S. railroads used the short cut through southern Ontario between Buffalo, N.Y., and Detroit. Windsor was incorporated as a village in 1854, as a town in 1858 and as a city in 1892. At the close of the 19th century, when tariff agreements gave Canada preferential treatment in British markets, it became an attractive site for U.S. branch plants. Between 1908 and 1928 the population of Windsor and adjacent towns grew from 20,760 to 105,200; this rapid growth was caused largely by the expanding automotive industry. In 1935 East Windsor, Walkerville and Sandwich were amalgamated with Windsor into the city of Windsor. In the 1950s R'indsor embarked upon extensive redevelopment of the river front: the program included a park with the Hiram Walker museum nearby. a civic auditorium and convention hall and a new city hall. The city is governed by a mayor. ten aldermen and a city manager. Windsor is the commercial centre for a rich farming area producing fruits, vegetables, corn, soybeans. grain, tobacco and potatoes. The chief industries are transportation equipment, medicinal and pharmaceutical preparations, industrial machinery and other iron and steel products. Large salt deposits sustain important salt and chemical works. Railroads connect Windsor with the United States by means of a tunnel and large car ferries; vehicular traffic uses the Ambassador bridge, with a suspension span of 1,850 ft.. and also a tunnel of 5,160 ft. South of the city there is a modern airport, a main terminus of Trans-Canada Air Lines. Windsor is the site of Assumption university, a Roman Catholic institution founded as a college in 1857, and the Western Ontario Institute of Technology, founded in 1958. (JB. S.)

WINDSOR (properly NEW WINDSOR), a municipal borough in the R'indsor parliamentary division of Berkshire. Eng. Pop. (1961) 27,126. Area 7.2 sq.mi. The town, famous for its royal castle, lies on the south bank of the Thames. 21 mi. W. of London by road. There the Thames makes a loop adjoining Eton college playing fields.

Windsor Castle.—The castle lies at the northeastern edge of the town, on a slight but commanding eminence made by the projection of the underlying chalk through the clays and gravels which cover the rest of the district. The massive round tower in the centre, on its artificial mound, is conspicuous from far over the flat land surrounding it. The site of the castle, an irregular parallelogram. occupies 13 ac. On the west the walls enclosing the lower ward with the Curfew, Garter and Salisbury towers overlook Thames street, from which the "hundred steps" give access to the ward on the north. with the Henry VIII gateway opening from Castle hill on the south. This ward contains St: George's chapel in the centre, with the Albert Memorial chapel on the east and the Horseshoe cloisters on the west. To the north are the deanery and the canons' residences and to the south the guardroom and the houses of the military knights. The round tower occupies the middle ward; on its flag turret the royal standard or Union Jack is hoisted according to the sovereign's presence or absence. The buildings in the upper ward, east of this. form three sides of the quadrangle; the state apartments on the north. the private apartments on the east and the visitors' apartments on the south.

Along the north side of the castle extends the north terrace commanding, from its position above a steep slope, splendid views across the river to Eton on the Buckinghamshire side, and far over the valley. The east terrace continuing the north overlooks the gardens in front of the private apartments, and the south terrace continues farther, as far as the George IV gateway. The Home park lies adjacent to the castle, on the south, east and north. The Great park extends south of Windsor, where the land. rising gently. is magnificently timbered with the remnants of the old royal forest.

In Saxon times a royal residence of some importance existed at Windsor. a few miles from the site of the present castle. This latter site. a chalk hill overlooking the river. formed almost a natural fortress within a day's march of London and was convenient for hunting in Windsor forest. Attracted by it. William the Conqueror obtained the land by exchange from Westminster abbey to which Edward the Confessor had given it On the highest point of the escarpment he constructed a mound, upon which he built some form of wooden stockade about 1070. This structure was replaced by Henry II in 1180 uith the stone "Round touer," the walls of which were heightened by George IV, in whose reign the flag turret was added Henry II also added the outer walls of the castle to the north, east and south His nork was finished by his grandson Henry III, who completed the western end of the lower ward on the same plan as that of his grandfather. The interesting difference is that by this time the towers had assumed the D shape which the advance of military architecture had substituted for the square towers customary before the Third Crusade. Little else of Henry III's work inside the castle remains, but a portion is preserved at the east end of St. George's chapel behind the altar and in the south wall of the beautiful little dean's cloister, forming the north wall of the Albert Memorial chapel, which stands on the site of the chapel built by Henry III It was this latter chapel which Edward III made the centre of the newly formed Order of the Garter in 1348. The order included a dean, canons, minor canons, choristers and the Poor Knights. known after 1833 as the Military Knights of Windsor, nho live in the lower uard opposite the south side of the chapel. The deanery, adjoining the dean's cloister, is dated 1500, but the chapter library and Horseshoe cloisters, to the uest of St. George's chapel, are earlier. The latter uere restored by Sir Gilbert Scott in 1870, and again in 1953 by Lord Mottistone.

Edward III was also responsible for the conversion to residential apartments of the fortresslike buildings in the upper ward. It is evident that by this time the chief purpose of the castle as a fortress was subordinated to the need for comfort in the royal quarters, and indeed the castle was only twice besieged throughout its history. In connection with these extensive works Edward III employed William of Wykeham, founder of Winchester and of New college, Oxford, as his clerk of works. The Winchester tower, to the northeast of the deanery, and the so-called Norman gate, dividing the upper nard from the rest of the castle and protecting the keep. date from this reign The poet Chaucer figures as clerk of works m the following reign.

The rebuilding of the royal apartments in the upper ward and the continuation of the north terrace (built first in wood by Henry VIII and later reconstructed in stone by Elizabeth I) around the upper ward on the east and south were among the achievements of Charles II's reign. His equestrian statue is a feature of the quadrangle. The state apartments include St. George's hall, the audience and presence chambers and the grand reception room, adorned with Gobelins tapestries, and the guardroom with armour. All these rooms also contain splendid pictures and other objects of art; but most notable in this connection are the picture gallery, the Rubens room and the magnificent Van Dyck room. Three of the rooms retain their original ceilings by Antonio Verrio and there is some beautiful carving by Grinling Gibbons. In the royal library is a famous collection of drawings by old masters. including important examples of Leonardo da Vinci. Michelangelo and Raphael. There also is a magnificent series of Holbein portrait drawings representing the chief personages of the court of Henry VIII.

But the greatest restoration was carried out by George IV, the whole of the work being under the supervision of Sir Jeffery Wyatville; his work has been criticized, but there is no doubt that he transformed the castle into a comfortable sovereign's residence.

St George's Chapel.—This was designed to be the chapel of the Order of the Garter and was begun by Edward IV. It is one of the finest examples of Perpendicular architecture in England. The chapel was built in two stages, the choir and its aisles being completed and roofed by 1483, the nave by 1496, but the stone vaulting u-as not finished until 1528. Later, cracks appeared in the fabric and in 1681 Sir Christopher Wren was invited to make a survey. But little was done until Sir Harold Brakspear undertook a complete restoration between 1921 and 1930 when the uhole roof was removed, repaired. cleaned and reassembled Above the dark oak stalls hang the insignia of the Knights of the Garter, their swords, helmets and banners. to the backs of the stalls are affixed their heraldic stall plates. forming a notable assemblage of heraldry from medieval times. The large nest window with its fine late 15th-century glass, and the painted roof bosses are among other remarkable features of the chapel.

The chapel ranks next to Westminster abbey as a royal mausoleum, and it became customary for royal funerals to take place there. Edward IV and his predecessor Henry VI. whose bones mere removed from Chertsey, are buried here The former's tomb is enclosed by the most remarkable piece of ironwork of its type in England. wrought in 1483 by John Tresilian. In the middle of the choir floor a vault contains the bodies of Henry VIII and his third wife Jane Seymour, and of Charles I, who was once a prisoner in the castle walls. Edward VII and Queen Alexandra are buried on the right-hand side of the high altar, their effigies being the work of Sir Bertram Mackennal. Those of George V and Queen Mary. by Sir William Reid Dick, are to be seen in the nave. When George VI died it was decided that his tomb should lie between the nesternmost pillars on the south flank of the nave.

Albert *Memorial* Clzapel—This chapel, to the east of St. George's, was designed by Henry VII as a royal tomb house. and at one time intended by Wolsey as his onn tomb. It was restored by Queen Victoria in memory of Prince Albert, whose cenotaph stands before the altar. In the crypt beneath it are buried George III and members of his family, including George IV and William IV.

The Parks.—South of the castle, beside the Home park, is the royal mews. Within the bounds of the park is Frogmore, in the gardens of which stands the mausoleum of Queen Victoria and Prince Albert. and the home farm and kitchen gardens. An oak tree marks the supposed site of Herne's oak, said to be haunted by the ghost of Herne the Hunter. a keeper who figures in Shakespeare's Merry *Wives of Windsor* and in Ainsworth's *Windsor* Castle. The Long walk, a three-mile avenue leading into the Great park, was planted by Charles II in 168j; it consisted of 1,650 elms. but these became dangerously large and were cut down and replaced by young plane trees and horse chestnuts in 1945. Another fine straight avenue is Queen Anne's ride, planted in 1707. Among various buildings within the Great park is Royal lodge, once a favourite residence of George IV, but after 1932 remodeled as the private residence of the royal family. At the southern boundary of the park is a beautiful artificial lake called Virginia water.

Windsor Town.—A few old houses remain in the town of Windsor. including Nell Gwynn's, but the greater part is modernized. The parish church of St. John the Baptist was rebuilt in 1822, but contains fine examples of Grinling Gibbons' woodcarving. The town hall was completed in 1686 by Sir Christopher Wren, son of a dean of Windsor and for a short time the borough's representative in parliament. His plans were thought unsafe, and he had to promise to insert pillars to support the floor above the corn market: these he arranged so that they did not touch the beams, as may still be seen.

History.—Windsor (Wyndeshour, Wyndsore, Windlesore), perhaps a variant of "winding shore." was probably the site of a Roman settlement. Two Roman tombs mere discovered at Tyle-Place farm in 1865. while various Roman antiquities were unearthed at St. Leonard's hill in 1705. The early history of Windsor centres round the later unimportant village of Old Windsor, which was a royal residence under Edward the Confessor. By the Confessor it was granted to Westminster abbey but was restored in exchange for other manors by William I, who erected the castle about 2 mi. northwest of the village and within the manor of Clewer, around which the important town of New Windsor grew up. The earliest existing charter of New Windsor is that from Edward I in 1277. This constituted it a free borough, granted to it a gild merchant and other privileges and finally separated Kew and Old Windsor. Further confirmations of existing privileges were granted by later monarchs, and a fresh charter granted by James I in 1603 was renewed by Charles II and remained the governing charter until the Municipal Corporation's act in 1835. New Windsor sent two members to parliament from 1302 to 1335 and again from 1446 to 1865, omitting the parliaments of 1654 and

1656. By the act of 186; it lost one member. and by the 1918 act was included in the Windsor division of Berkshire. In 1922 it became a "royal borough," an honour shared with only four other English towns.

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WIND TUNNEL. A wind tunnel is a device for producing a carefully controlled stream of air in which the reactions of the air on scale models of airplanes or their component parts or any other such objects that involve movement through air can be studied experimentally.

The wind tunnel has played a major role throughout the history of aviation, helping man to a better understanding of the mechanism of flight and providing experimental data essential to the successful development of every new aircraft. The first wind tunnel was designed in 1871 by Francis Herbert Wenham in England.

The nature of the flow over a body and, consequently, the forces and pressures developed on the body are similar whether the body is moving through still air or is held stationary in moving air. This flow similarity forms the fundamental principle of the mind tunnel, for in the wind tunnel a stationary model is suspended in a stream of air of known velocity, pressure and temperature such that an accurate determination may be made of the pressures and forces acting on the model.

The requirements of a carefully controlled air stream and devices for both supporting the model and measuring its reactions under different test conditions constitute the basis for design, construction and operation of most wind tunnels.

Design.—In its simplest form the wind tunnel consists of a straight, open-ended duct of varying cross-sectional area through which air is drawn by a fan. The duct is large at its entrance but reduces abruptly to a much smaller area at the beginning of the model test section. Beyond the test section the duct expands gradually back to a large size. The fan is often located just past the expanding portion of the duct.

The air travels slowly through the large part of the duct ahead of the test section. As it moves into the contracted area or nozzle the air speeds up rapidly. It remains at a high speed over the entire length of the test section. Once past the test section the air is brought back to a low velocity in the expanding region or diffuser and then continues on through the fan and out the duct exit. The open-ended tunnel is known as an open-circuit tunnel. for the air which is drawn through the system has no passage to guide it back to the inlet. Very little control can be maintained over the pressure, temperature and humidity of the air since the ends of the tunnel circuit are open to the atmosphere.

The disadvantages of the open-circuit are largely overcome by connecting the inlet and outlet with a return passage. The system is then classed as a closed-circuit tunnel, the most common of all wind-tunnel designs. Typical form of the closed-circuit wind tunnel is shown in fig. 1.

The return passage permits the same air to be circulated continuously around the tunnel, making it relatively easy to control

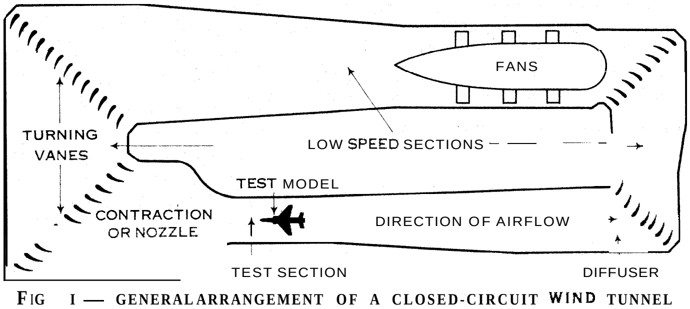
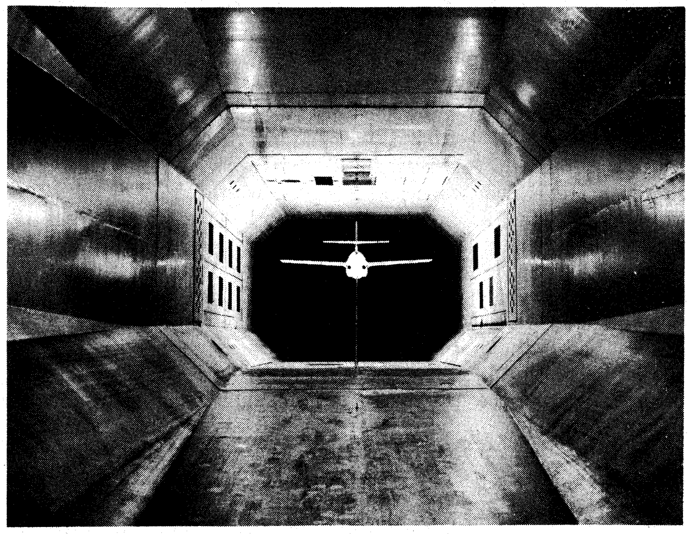


FIG 1 — GENERAL ARRANGEMENT OF A CLOSED-CIRCUIT WIND TUNNEL

Air flows slowly through the low-speed sections, speeds up in the test section and slows down again in the diffuser. Fans provide power to move air through the tunnel, and turning vanes guide the air smoothly around sharp corners. Measurements are made on the model supported in the test section



BY COURTESY OF CORNELL AERONAUTICAL LABORATORY, INC.

FIG 2.— AIRPLANE MODEL INSTALLED IN A 12-FT. WIDE TEST SECTION OF A HIGH-SPEED WIND TUNNEL, AS SEEN FROM THE DIFFUSER LOOKING UPSTREAM INTO THE TEST SECTION

the conditions of the air. The closed-circuit tunnel has a further advantage in that the pressure in the tunnel can be varied to produce different levels of air density.

The tunnel shell is usually circular although rectangular and square shapes have been incorporated in some low-speed atmospheric pressure tunnels. The majority of the variable pressure tunnels have circular shells to carry the high loads imposed on the structure. Test-section shapes are somewhat arbitrary, although the selection often depends upon the special test requirements of the tunnel. These shapes may be square, circular, oval: rectangular or rectangular with beveled corners.

The air velocity in the tunnel is controlled either by changing the rotating speed of the fans or by adjusting the angle at which the individual fan blades are set relative to the rotating axis of the fans.

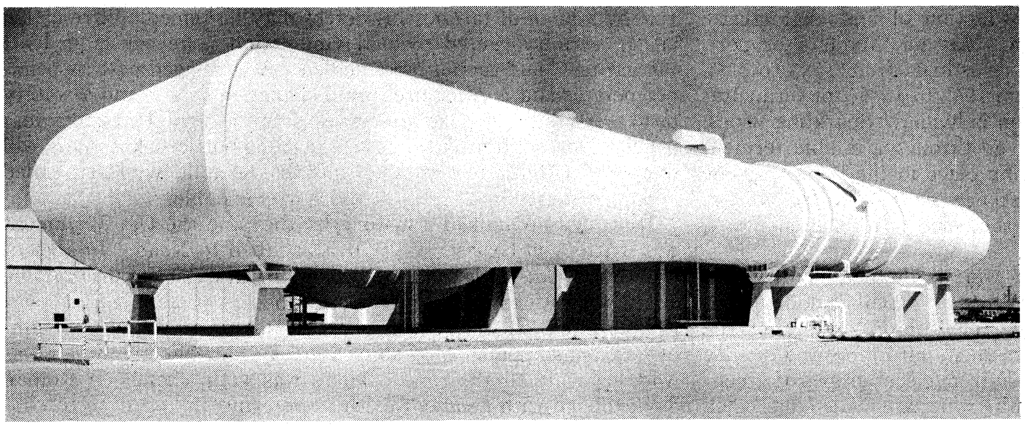
Fan system designs vary all the way from simple two-bladed propellers for small, low-speed tunnels to multibladed devices requiring thousands of horsepower and moving large quantities of air through the 10- to 20-ft. wide test sections of high-speed, high-pressure wind tunnels. Reliability and operating ease make the electric motor a usual choice for fan-drive systems.

The energy which the wind-tunnel fans impart to the air stream causes a rise in air temperature. In tunnels of low power, the heating of the air is not severe enough to require special cooling. However, to remove excess heat from tunnels whose energy input is numbered in thousands of horsepower, cold water is pumped through cooling radiators, not unlike automobile radiators, that span clear across the low-speed section.

Wind tunnels are placed in a number of categories depending upon their speed range, specialized testing capabilities and general design. Low-speed tunnels include performance to several hundred miles per hour. Subsonic or high-speed tunnels cover speeds just short of the velocity of sound (about 760 m.p.h. at sea level). Transonic tunnels, as the name implies, bridge the gap across the speed of sound. Supersonic tunnels go to around five times the speed of sound. The range beyond is covered by hypersonic tunnels.

Among the more specialized tunnels are the vertical spin tunnels in which scale models are suspended freely in a vertical column of air to study their spinning characteristics.

Construction.—Many different materials and methods are employed in wind-tunnel construction. The shells or ducts of low-speed tunnels that operate at or near atmospheric pressure are often made of wood. Concrete shells have been used successfully on very large, low-speed atmospheric tunnels where wood is impractical and steel too costly. Welded steel construction is necessary in tunnels designed for high pressures. Regardless of the type



BY COURTESY OF NORTHROP AIRCRAFT, INC.

FIG. 3.—EXTERIOR VIEW OF 7 × 10-FT. SUBSONIC WIND TUNNEL

of structure, the interior surface of the tunnel shell must be quite smooth, particularly in the test section where any roughness on the walls would disturb the air flow. The steel test-section walls of tunnels that operate at many thousands of miles per hour are ground and polished to a mirror finish.

Operation.—Since the primary objective of the typical wind tunnel test is to measure the various reactions imposed upon the model by the moving air under conditions that most closely duplicate those of actual flight, the basic operating principles and procedures of the tunnel centre on accurate control of the air stream, proper positioning of the model relative to the air stream, and the measurement of the forces and pressures on the model itself.

From the velocity, pressure and temperature of the air, the engineer can determine the test Reynolds number, the criterion for similarity of flow between the tunnel and flight. Reynolds number is the product of the air velocity, air density and a characteristic length of the model (usually the wing chord) divided by the air viscosity. If the test Reynolds number is equal to the Reynolds number of the full-scale airplane in flight, then the nature of the flow over the model and, consequently, the reactions of the air on the model will correctly represent full-scale values.

The forces acting upon the model and the moments or torques that these forces produce about a point in the model (usually its centre of gravity) are measured by the weighing system or "balance" upon which the model is supported in the tunnel.

The behaviour of the airplane under such conditions as diving, climbing, turning or rolling can be examined in the tunnel by moving the model about its supporting structure and recording the forces and pressures on the model at each different position. Thus, for example, to determine how the lifting force on a wing will vary with its angle of attack (angle between the wing chord and relative wind) the engineer need only set the wind tunnel at the proper air velocity and measure the lift on the wing each time he has moved it to a different angle of attack.

Research Uses.—The wind tunnel finds broad application in the solution of many aerodynamic problems, ranging all the way from fundamental work on the flow around bodies to routine tests on new airplane designs.

Much of the basic research on the flow about bodies involves study of the boundary layer, the slow moving layer of air adjacent to the body surface. Notable contributions to a better understanding of boundary layer flow and its influence upon the aerodynamic behaviour of the airplane have come from wind tunnel experiments.

The evaluation of new airplane designs touches upon nearly every useful application of the wind tunnel. Selection of wing and body shapes; location of the wings and tails on the body; orientation of the tail surfaces and control effectiveness of ailerons, rudders, elevators, flaps and dive brakes are but some of the design problems that receive thorough attention in the wind tunnel.

In the structural design of aircraft it is extremely important that the engineer not only know what total loads will be imposed upon the wings, tail, fuselage and other components but also know how these loads are distributed over the surface. Here the wind tunnel plays an important role. Measurements of the air pressure at many points on the model yield information about the way in which the total load is spread over the surface. These same pressure data, when reduced to velocity measurements, are very useful in a detailed study of the flow over the various parts of the airplane.

The nature of the flow may be studied further by introducing smoke or other visible compounds into the air stream ahead of the model. These compounds visibly trace the exact path of the air as it flows around the test model.

The success of the wind tunnel as a research tool has not been restricted solely to the aeronautical field. Aerodynamic studies on automobiles, boats and trains, as well as the effects of wind pressure on buildings and bridges, attest further to the wind tunnel's versatility in scientific research.

See Alan Pope, *Wind-Tunnel Testing* (1954); R. C. Pankhurst and D. W. Holder, *Wind-Tunnel Technique* (1952). (R. S. K.)

WINDWARD ISLANDS, an island group in the West Indies, consisting of the British islands of St. Lucia, St. Vincent, Grenada and Dominica, along with the Grenadines (*q.v.*) chain. Geographically, the name Windwards applies to the chain of islands between but not including Dominica and Trinidad. (L. W. BE.)

WINE is the fermented juice of the grape (*q.v.*). Of the grape genus, Vitis, one species, V. vinifera, is used almost exclusively, the exception to this being the use of species native to North America in the eastern U.S.

From V. vinifera comes the enormous variety of grape types used in making wine. The culture of wine is known from the earliest records of man and has developed a multitude of tastes, all distinct to the palate.

Wine types have specific correspondences with specific foods; thus the choice of wine for drinking at meals is closely related to gastronomic art.

The excellence and the proper gastronomic use of wine is known best by the name of the region or even more specific locale where it is produced; for the diversity of wine results from the unique character given wine by the climate, soil and topography of particular vineyard areas and by the techniques peculiar to individual vintners or to their communities. A vine producing a certain wine type in one region will, if planted elsewhere, give wine of a quite different nature.

After a consideration of the classification of wines, grape varieties, the terminology of wine tasting, the relations of wines and foods, and defects of wine, this article is concerned with the history of wine, classification of wines by region in France, Germany, elsewhere in Europe and in the world, and the chemistry of wine.

See also the separate articles on individual wines; MADEIRA; MALMSEY; MÉDOC; MOSELLE; PORT WINE; RHINE WINE; and SHERRY.

Classification. — Place of origin, however, is not sufficient to classify wines. A primary classification is that of (1) still or natural wines, called also beverage or table wines; (2) fortified wines; and (3) sparkling wines. This classification depends on the technique of production, called vinification. Table wines are made from juice pressed from the grape, called must, which is allowed to ferment naturally, perhaps only with the addition of controlled amounts of a yeast, sugar or a very small amount of sulfur. Fortified wines receive a dosage of alcohol, usually a grape brandy, at some time during their vinification; controlled interferences with natural fermentation typify the production of and characterize fortified wines as vermouths, sherry, Marsala, Madeira or port. The alcoholic content of fortified wines is high, from 15% to 22% by volume. Natural wines range from 10% to 15%, for fermentation stops when alcohol concentration is higher. Sparkling wines, the type exemplified by champagne, go through a double fermentation, the second fermentation taking place in the bottle. Some natural wines have a slight effervescence, called *pétillement* but this effervescence is slight and is not the result of interference with the fermentation process.

Another essential classification of wine is that into red, white, and. of lesser importance, *rose'*, or wine of a pink colour. Red wine is made from black grapes only. The colour comes from the skins; the must is left in contact with them until a desired quality is attained. White wines may be made from either grapes of greenish colour or from black grapes; if white wines are made from black grapes, the must is separated immediately from the skins. White wines are greenish or yellowish, these colours being sometimes quite pronounced. *Rosé* is made by leaving the skins in contact with the must for a short time.

Whether a wine is sweet or dry is of great importance to its gastronomic use. The term dry is the only acceptable opposite of sweet in wines, sour wine being bad wine. Dryness describes taste, which may vary due to other elements in a wine; wines are sometimes said to have a dry finish, meaning that the aftertaste removes the effect of sweetness.

Grape Varieties. — The precise variety of grape determines the nature and quality of n-ine; however. the production of a grape variety varies greatly n-ith soil and climate. A high quality yield in one soil, or a yield of a certain character, may not be so in another; hence the significance of a mine named by the grape variety is not a criterion unless the locale is specified.

Wine Tasting. — Wine tasting is an old and honoured profession and has developed a vocabulary to describe the effects of wine as it is experienced in drinking. This vocabulary is quite diversified, seemingly imprecise, yet meaningful. The term body describes the impression of substance in wine. a full-bodied wine giving more of this impression than a light-bodied wine. The term balance describes the relation of such elements as alcoholic content, flavour and body. Balance is an essential; but a light or heavy-bodied wine has its proper place, and thus both may be esteemed. Flavours are spoken of as rich, round; nines as robust or thin. Bouquet, or scent. colour and taste are criteria of evaluation.

Gastronomy. — The classifications given above suffice to classify generally the uses of nine. Fortified wines are not served with main dishes; such wines are *apéritifs,* served before or at the beginning of a meal, or dessert wines. Typical *apéritifs* are dry sherry or dry Madeira, and vermouth. either dry or sweet; these should be served chilled. Among dessert wines are the sweeter sherries. Madeira, port and Marsala. A dryish champagne may be served throughout the meal; other sparkling wines are generally too sweet. Of table wines the following combinations are usual: dry wines or *rosé* with appetizers. hors d'oeuvres; Chablis or other dry whites with oysters; with shellfish, fish. light fowl, dry whites; turkey with light reds, as Bordeaux; with pork or veal, dry white or *rose';* roasts with lighter reds; ham with *rose';* heavy-flavoured meats or game with heavy red nines; salads nith dry whites; cheese with most wines; desserts with sweet whites, as sauternes.

These accompaniments of wine and food have been historically stable and not greatly changed by fashion. Wines and foods are so varied in character and preparation that many exceptions are possible according to taste; however, traditional accompaniments are given high value among gastronomes.

White and *rose'* wines are served chilled; reds at room temperature. Ice should not he put in glasses, as it dilutes the wine, enfeebling its character. Red wines should not be suddenly warmed; the practice is to withdraw the cork an hour or so before serving, thus allowing the bouquet to volatilize. Various shapes of glasses are conventional; they should be colourless, in order for the wine to be seen, and with a cup that narrows toward the top so as to retain the bouquet.

Defects of Wine. — Acidity caused by immaturity is recognizable by a taste of tartar; this defect may be remedied by further aging. Acidity caused by bad vinification is recognizable by a vinegar taste and cannot be remedied. A wine aged past its prime degenerates and is recognized by a change in colour and a watery taste. A nauseating flavour appears for a period in red wines mainly, shortly after bottling; this is called bottle sickness and will disappear within a few weeks or months. A mildewy taste, called corked, is caused by a bad cork and is irremediable.

History. — Wine had a history by the time the Old Testament was written; in Genesis ix. 20, it is ascribed to Noah. In ancient Greece wine was dark and usually drunk with water (to drink it unmixed was riotous); a four-year-old wine was venerable as Theocritus testifies. It was kept in casks. goatskins or earthenware amphorae and stoppered with oil or a greasy rag; effectively, air was working on it all the time. There was little change in Roman days, though with greater wealth there came an approach to connoisseurship. Horace shows us that Falernian wine was famous, and one vintage year (42 B.C., *consule Planco,* the consulate of L. hlunatius Plancus) is known. But the full maturing of wine was impossible until the bottle and the cork were generally used. Wine in the wood commonly reaches its maturity in about three years; retained longer it may not improve and may deteriorate. Hocks were indeed kept in cask for as long as 20 years until the end of the 18th century and considered to improve; but the habit has long been abandoned and what virtues connoisseurs found in it is a matter for speculation.

During the dark ages. the production and quality of wine, so far as can be ascertained, fell steadily from classical days. The Romans had planted vines wherever the climate would tolerate it, in north Africa. Spain. Gaul, Britain and Illyria in particular. Their cultivation continued for local consumption, and because of the need of wine for the communion service the care of the vineyards was particularly an ecclesiastical preoccupation. The reappearance of good wines and famous vineyards invariably resulted from the efiorts of monks or of monarchs distinguished by their devotion to the church. Much of the wine thus locally made was of bad quality and in areas now found to be too northerly; the *vin de Suresnes* outside Paris became a byword for thinness. Wine was made at Glastonbury and elsewhere in England, and until late in the 19th century there was even some Welsh champagne from near Cardiff.

The planting of vines in some of the most famous Rhenish and Burgundian vineyards is traditionally ascribed to Charlemagne, but it was not until the 12th century that the great winegrowing areas were planted and found a larger market. Due to the limits of medieval transport vineyards had to he by riversides; and the most famous wines came from the Rhine, the Garonne and the Loire, of n-hich the last was the least important. Gascony wine came either from St. Emilion (where the Château Xusone claimed to date from the Roman poet Ausonius) or from the uplands beyond. Sack was a name of disputed or vague meaning. used for a dryish n-ine — sherris sack from Spain, Canary sack from the Canaries. Malvoisie or malmsey nas a rich wine made from the malvasia grape. originally coming from the Venetian-controlled part of Greece and later from Madeira. where vines were planted soon after 1420. Rhenish meant any Rhine wine. Hippocras was spiced and sweetened wine.

Use of wine bottles and corks as it is known in modern times seems to have become common toward the end of the 17th century, the development of both resulting largely from the work of Dom Pierre Pérignon of Hautvilliers, the father of the champagne trade. Another important change was the discovery, by accident in the year 1775 in the Rheingau, that grapes left to rot on the vines produced a sweetness and bouquet unobtainable otherwise. This *pourriture noble* is caused by the presence of a special mycoderm that alone makes possible the great hocks and sauternes. In the middle 1750s the Sladeira shippers first began scientifically fortifying their wines by adding a proportion of brandy to them, a process essential for the manufacture and maturing of all dessert wines except those few which make naturally nearly 20° of alcohol. The fortune of the port-wine trade was made by this and by the Anglo-French wars of the 18th century. as the latter led to the Methuen treaties from 1703 onward, by which Portuguese wines were admitted to Great Britain at one-eighth of the duty on French. This discrimination was ended in 1862, by W. E. Gladstone, when claret and Burgundy regained some of their old markets.

European vineyards were visited by a disaster that threatened at one time to wipe them out completely when in 1863 there was accidentally imported an American louse called Phylloxera (*q.v.*) which fed upon the roots of vines. Large winegrowing areas were devastated as the pest spread; 2,500.000 ac. were reckoned to have been ruined in France; and in Madeira and the Canaries wine production ceased completely. The ravages were checked eventually by the importation of louse-resisting stocks from California. on which the older vines were grafted. Pre-Phylloxera vines are now extremely rare except in countries such as Chile, which have never been visited by the pest. The only comparable disaster was the enactment of prohibition by the United States in 1919, whereby a large market was destroyed and a promising industry ruined.

REGIONAL CLASSIFICATIONS OF WINE

Wine producing regions of the world are in the south and north temperate zones. In volume the greatest wine-producing nations are France, Italy. Spain, Algeria. Argentina and Portugal. France is the greatest producer, and also is the greatest importer. Historically, France is the centre of wine culture in the modern era; France has produced most of the table wines of great excellence and the greatest variety of wine types. Only Germany, in its Rhine and Moselle wines. has contributed wines of such character.

Regions of France and Appellations **d'Origine.**—Six regions of France produce its finest wines and major wine types. These are Bordeaux, Burgundy, Champagne, Côtes du Rhône, the Loire valley and Alsace. The quality of these wines, as well as of those of many lesser regions, is maintained by a codification first instituted by commissions of the wine industry, and later largely guaranteed by French statutes, known as the laws of Appellations *d'Origine*. Wines so codified, and only those, may use the names of the wines of the region, district, or even specific vineyard and are labeled Appellation controlke.

The difference between blended and unblended wines must be appreciated before the sense of these codes can be fully seen. A wine is a blend if it is composed of wines from different years, called vintages, or if it is composed of wines from the same year but from different vineyards. By extension, if wines typical of a certain region are mixed with wine from another, the typicality of the wine is destroyed. The quality of wine being extremely sensitive to differences in soil and season, unblended wines are generally superior to blended wines. Wine from a specific vineyard, if it has character, is superior to a blend of wines from the vineyards of the district surrounding. The practice, known in France as *coupage*, of blending a good regional type wine, Burgundy for example, with an inferior wine such as ordinary Algerian, and labeling it Burgundy, is a fraud that all wine-producing countries have experienced. The French classifications and statutes were instituted to prevent such mislabeling and to guarantee the authenticity of their best wines. The mine trade and governments of wine-producing nations, with the exception of Germany, have tended to follow the practice of France, though with less exactitude.

Laws of Appellation *d'Origine* define many other characteristics of wine: the vine and care of it, alcoholic content, acidity, time of harvest of the grapes, amount of tannin, soil and undersoil and topography of the vineyards, days of sun in the growing season, bouquet of the new wine and its bouquet when aged, and others depending on regional peculiarities.

Bordeaux. — Claret is the traditional English name for the mine of the region surrounding the city of Bordeaux, France. Bordeaux has a long history in wine culture; like Burgundy and the Rhine region it was known in Roman times. During the English occupation of Bordeaux a charter was granted, first by Richard I and second by John in 1199, to the still-functioning jurade, a controlling body dating originally from the 12th century, which in its ceremonies still observes its medieval ritual and uses its traditional robes of the St. Emilion district for the supervision of wine making. Claret meant in those days a pale wine made by mixing reds and whites; the word claret is not used in modern French.

The modern Bordeaux region is the most important region making fine wines in the world. It is divided by the Bordeaux wine classification into 36 districts, which in turn are divided into communes. Within these communes, again, are certain individual vineyards, called chbteaux in this region, that produce the finest wines. The chbteaux bottle their own wine and label it under their names, thus guaranteeing it is not a blend. The chlteau-bottled wines rated best are classified as *crus* classes, which in turn have five categories called growths. These five growths are not altogether based on excellence, which in fine wines remains always a matter of taste to some degree; other criteria, such as market price, exportation and fame also formed these ratings. Rated in 1855, this classification is also somewhat outdated; nevertheless it has held up well over the years. After these cru classes are crus *exceptionnels,* comprising a half dozen wines, and several hundred wines named crus bourgeois and crus artisans or *paysans*. The last two categories are largely obsolete due to the growth of cooperative wineries, which have enabled small proprietor~to use up-to-date wineries managed by expert vintners, thus raising the quality of less expensive wine in Bordeaux and elsewhere. Although strict labeling is in force in Bordeaux chbteau-bottled wines, inferior wines are still sold as Bordeaux. Further, as a poor year produces wine of inferior quality, such wines must be known by vintage as well.

Wines of the Bordeaux region are labeled Bordeaux. Wines from specific districts of Bordeaux are usually of specific type and have more interest; they are labeled with the district name, as Médoc, or St. Emilion. Within the districts are communes, of specific wine type and of superior character; these are labeled with the name of the commune, St. Julien, or St. Esthphe. Of the 36 districts in Bordeaux, Médoc, Sauternes, Graves, St. Emilion and Pomerol are best known. Médoc, Sauternes and Barsac were classified in 1855, Graves in 1953, and St. Emilion in 1955.

Médoc.—These wines are red, generally of light body and strong flavour. Médoc, 50 mi. long and 3 to 7 mi. wide, has a dozen communes each possessing soil that produces wine of particular quality; Pauillac, Margaux, St. Julien, Cantenac, St. Esthphe are of these. Of the 62 red wines classified crus classes in 1855, all but one were from Médoc. First growth chbteaux are Lafite-Rothschild, Margaux and Latour; other crus classes number among them Mouton Rothschild and Kirwan.

Graves. — The genera1 reputation of Graves is for white wine, rich in taste and not too sweet. Actually Graves produces as much red as white. These balanced, fine-coloured and rather fruity reds are sometimes rated finer than the whites. Chbteau Haut-Brion was classified first growth in 1855; it is one of the 13 classified red wines of Graves in the 1953 official classification of Graves. Five chlteaux were selected as classified white wines of Graves in 1953.

Sauternes and Barsac. — The natural sweet wines, fruity with enduring rich flavour, of this district are usually considered the world's finest. To achieve their quality the grapes are left till overripe on the vines before harvesting, thus producing the ripeness known as *pourriture* noble, which leaves an abundance of sugar in the grape, sweetening the wine and producing a high alcoholic content. A label of Haut-Sauternes is also allowed for wines of this district, although no such area exists. Wines from the village area of Barsac, similar to Sauternes, are allowed the label of Sauternes or Barsac. Château d' Yquem is classified first superior growth, and 24 other chbteaux are classed in the first and second growths.

St. *Emilion.*—Sometimes called masculine wines, St. Emilions are full-bodied and of darker colour than Médocs. The 1955 classification listed 12 called first great growths of St. Emilion, among which are Chbteau Cheval Blanc and Chbteau Ausone, of long standing reputation. There were 63 chbteaux rated as great growths. These classes, like those of Graves, are peculiar to these districts, not part of the 1855 Médoc classification.

Other Bordeaux Districts. — White wines come from Sainte Foy, Entre-Deux-Mers, Langoiran. At their best the whites of Ste. Croix-du-Mont, Loupiac and Cérons have characteristics of Sauternes. Good red and white wines are produced in Bourg, Blaye, Cadillac and Camblanes-et-Meynac.

Vintages. — Some wines prosper in generally bad years or fail in good years. Thus vintage charts are not a certain guide. For Bordeaux reds 1957–55–53–49 were excellent and 1948 a little less so, 1952–50 good. For whites. 1955–53–52 were good years.

Age. — Bordeaux reds are at their peak 8 to 23 years after vintage. They are long-lived, however, and full-bodied reds will last 50 years, sometimes more. Dry whites may be ready to drink in 1 to 2 years, but age faster than reds or sweet whites, fading sometimes after 7 years. Sweet whites may be drunk about 3 years after vintage, will be at their peak at 10 years and may last 30 years.

Burgundy. — Burgundy extends from about 100 mi. S.E. of Paris, near Auxerre, through the *département* of Yonne, Côte-d'Or, Saône-et-Laire and RhBne, a length of about 230 mi. Beginning with the Chablis district, its vineyards include those of the Côtes de Nuits just south of Dijon, the area around Beaune and Mâcon, and end in Beaujolais just north of Lyons. It is a region of varied wines, rather than of a type. Its white wines are usually dry, its reds velvety and full-bodied. Burgundy-type wines made in other countries such as Italy, Spain, Chile or California imitate, with varying success, some wine of the region of Burgundy.

The best Burgundy wines are codified under the Appellations *d'Origine*. The use of the names of the districts, as Côte de Beaune, is controlled, as well as the names of communes, villages and individual vineyards. The last produce the finest wines; wines bottled on their properties are known as estate bottled, the counterpart of chateau bottled in Bordeaux.

Burgundy mines were known by the Romans and have a continuous history. The planting of some vineyards is ascribed to Charlemagne. By the 12th century great areas were planted and had found a market.

Wine properties in Burgundy are small and the tendency had been until the 20th century for growers to turn over their production for shippers to bottle. In the 1930s a classification of Burgundy wines was undertaken; the success of this and its guarantee by the *Appellations d'Origine* promoted another tendency for growers to bottle their own wine under a protected label showing their name and property.

Yonne.—This district produces mainly white wines. The famous Chablis is a very dry wine, light and with subtle bouquet; only wines from delimited areas in Yonne are allowed the name Chablis.

Côte-d'Or.—This district is divided in two parts, the Côte de Nuits just south of Dijon and the Côte de Beaune farther south. In the CBte de Nuits red wines are produced almost exclusively. Villages that have given their names to famous wines are Gevrey-Chambertin, Morey-St. Denis, Chambolle-Musigny, Vougeot, Vosne-Romanée and Nuits-St. Georges. Formerly these villages were simply Gevrey, Morey, Chambolle etc.; but as their mines, as Chambertin from Gevrey, became celebrated the villages adopted hyphenated names, the former village name first and the wine name last. Wines labeled with such hyphenated names are not the same as the original, though; the wine Gevrey-Chambertin is not the same as Chambertin. Well-known are the Chambertins, Clos St. Denis, Clos de la Roche, Musigny, Clos de Vougeot, Grands Echezeaux, Romanée-Conti, Richebourg, Nuits-St. Georges.

In Côte de Beaune both red and white wines, including most of the best white Burgundies, are produced. The important communes are Aloxe-Corton, Savigny, Beaune, Pommard, Volnay, Meursault, Puligny-Montrachet, Chassagne-Montrachet and Santeny.

Saône-et-Loire.—In this district are prolific but less distinguished vineyards. Mercurey and Givry are esteemed red wines. Around Mâcon are whites of good quality, notably Rully, Montagny and also Pouilly-Fuissé, a dry, heady wine with much bouquet.

Rhône.—Beaujolais, a tasty and fruity wine, is notable. It is made from the Gamay grape, which in other areas produces a large but low quality yield. It is drunk young.

The vintage wines of Juliénas, Fleurie, and Moulin-à-Vent have also the quality of aging well.

Côtes du Rhône.—South of Burgundy to the Avignon area is this region, typically producing full. strong red wines. Such fine wines are found as Côte Rotie, Hermitage and Chbteauneuf-du-Pape, the last being probably the most robust French wine of distinction. On the west side of the RhBne are the vineyards of Tavel, one of the few *rosés* of character.

Loire Valley. — Wines of this extended region are typically white. The vineyards follow the Loire from its source to the Atlantic at Nantes. Major districts are Muscadet, Anjou, Saumur, Touraine, Quincy, Reuilly, Sancerre, Pouilly. Muscadet is pale, delicate, sometimes showing pe'tillement, as with Vouvray, of fine quality and fruity. Saumur is a semidry white; this region and Anjou are often known by their rose's. The white wines of Sancerre, Quincy, Blancs Fumes of Pouilly and Reuilly are highly rated among French wines.

Alsace.—Alsatian wines are usually named according to the vine: Riesling, Traminer, Gewürztraminer, Sylvaner, Zwicker. Showing some similarity to the great Rhine wines of Germany, Alsatians are lighter and sometimes tend to become thin. The place of origin, including the vineyard, is usually shown on the bottle.

Other French Regions. — Most production of the champagne district is of the sparkling wine, but some still wine with a hard "flinty" taste is very worthy. In the Jura, near Switzerland, are red and white Arbois and a white wine. Chbteau-Chalon of a light sherry taste and highly esteemed. In Languedoc and the Midi, in the south and west from the Rhône, is a huge production of undistinguished but good vin ordinaire, the staple drink of the French worker and peasant.

Along the slopes, however, there are wines of superior quality classified by the Appellations *d'Origine*. The Pyrenees area produces estimable wines. East of Marseilles along the coast are the wines of Côte de Provence, and smaller districts of good quality such as Bandol and Cassis.

Germany. — German wine production is not large, but its great white nines are world famous. The major regions are along the Rhine and its tributary, the Moselle, whose mines were known by the Romans. The still-famous vineyards of Johannisberg and Steinberg were planted in 1106 and 1131. These wines have been known as hock or Rhenish; the trend no adays is to name Rhine as the type and to consider Moselle under that heading. Rhine and Moselle wines have similarities of taste and fragrance, often with a flowery bouquet. Rhine nines proper have greater body, and more vinosity as they age, and are the finest wines. The four main wine-growing districts of the Rhine are the Rheingau, Palatinate (Ger. Pfalz), Rheinhessen, and Nahe valley. The very best are from the Rheingau with such celebrated names as Rudesheim, Geisenheim, Johannisberg, Oestrich, Steinberg, Marcobrunn, Erbach, Rauenthal and many others The Palatinate produces much ordinary wine, but some of its specimens rival in generosity and fruity quality those of the Rheingau; famous names are Durkheimer, Wachenheimer, Forster, Deidesheimer, Ruppertsberger. These wines do not keep so well as the Rheingau wines, however. Rheinhessen is a large district and produces much good, robust wine. Especially in good years the wines of such places as Nackenheim, Bodenheim, Nierstein. Oppenheim equal the best of the other districts. Liebfraumilch, which means today a wine of soft, good quality, had its origin in Rheinhessen. Wines somewhat more elegant and not so full-bodied as those of Rheinhessen come from the Nahe valley, the best under such names as Schloss Bockelheim, Niederhausen, and Kreuznach.

Rhine wines are grand; Moselles are graceful. Moselles have low alcoholic content, some small but agreeable acidity, and a floweriness similar to Rhines. Some of the best-known varieties are Enkirch, Zeltingen, M'ehlen, Bernkastel, Brauneberg, Piesport, Dhron. Very similar wines are of the Saar and Ruwer, such as Scharzhofberg, Wiltingen, Ayl, Cassel, Grunhaus.

The quality and permanence of German wines have been strictly maintained by the industry and German wine law. The proportion of overripe grapes used and the selection of only the best grapes is indicated by the following categories, labeled on the better uines: Spatlese, picked late; *Auslese,* selected bunches; *Beeren-*

Auslese, from selected berries; *Trockenbeeren Auslese,* selected grapes picked when almost dried. Special selections such as these can only be made with a fine harvest, however, and the cost of such products is high.

Other European Wines. — Italy is the second largest producer of wine, in some years equaling the quantity of France. Many good wines are of Italian vintage, but none to rival the great wines of France and Germany. In the north is the red wine of the area of Barolo, the fine red. Valpolicella, and an excellent dry white Soave, the last two from the area of Verona. Other red wines of the north are Nebbiolo, Grignolino. Freisa and Barbera; these are names of grapes that. when used in specified locales, such as Nebbiolo in Barbaresco, Barolo or the Valtellina, produce excellent wines. Chianti, from Tuscany, is most widely known as an agreeable but undistinguished red wine sold in straw-covered flasks; this type is always drunk young. There is a much superior type called vecchio or stravecchio, that ages and comes in standard bottles. Farther south are Vesuvio, a dry white grown on Vesuvius. Capri, dry white from Capri and Ischia; and Lacrima Cristi, usually white but sometimes red.

Spain is third in world wine production. In the north is Rioja, a district producing Spain's best red and white wines. Good reds and whites from the central regions are Valdepeñas and Alicante. Portugal produces some very acceptable table wines; dry reds and whites are Collares, Torres Vedras, Dao, and sweet whites are Setubal and Bucellas. Switzerland produces a small quantity of good white wine, as Johannisberg and Neuchâtel. The great Tokay of Hungary, nor any wine approaching it under that name, was not available to western Europe in the second half of the 20th century; however, Hungarian production remained at pre-World War II levels for wines in general. Greek wines labeled retsina are spoiled for western taste by being heavily flavoured with resin. The Dalmatian coast, in Yugoslavia, has produced red nines and good aromatic whites, Rumania heavy reds. The U.S.S.R. produces a complete range of wines, particularly from Georgia and the Crimea.

Non-European Wines. — Wine culture followed the expansion of European empires. British plantings in North America date from 1617, Spanish in Central and South America even earlier, Dutch in south Africa from 1653 and French in Algeria, reversing the destruction of vines by Islam, from 1830.

Algeria. — A century of French planting has made Algeria the fourth largest wine-producing country. Its wines generally supplement the *vin* ordinaire of France, although some fine wines were being made in the second half of the 20th century.

South Africa. — By the early 1800s Cape reds and whites had good sales in London. After a drop in quality in the later 19th century the Co-operative Winegrowers' association was formed in 1917. It now includes most south African producers, has eliminated bad wines, standardized others and occasionally, as aith Nederburg wines or those from Constantia, has developed wines of character.

Australia. — Australian reds have had the reputation of being full, and ferruginous due to a generally high iron content. In fact, there is much good wine, often with no iron taste. The whites are clean and fresh. The Hunter river area is best known.

South America. — Wine is produced in all countries south of the equator, Argentina ranking generally fifth in world production. South American wine is generally undistinguished, except in Chile, where excellent wines come from such vineyards as Santa Rita, Tarapaca, Undurraga and Vial.

The United States. — Most wine of North America comes from the United States. Prohibition from 1919–33 destroyed an industry that was becoming respected even in Europe. Carefully chosen vines and locations were grubbed up or returned to wilderness. Establishing vineyards is a lengthy process; hence the first products after prohibition were usually coarse and heady and marketed under such names as Chablis or Sauterne to which they had no right and which showed the proprietors' lack of pride in origin. After World War II production began to recover and by the 1950s compared with Portugal in quantity. Great improvements in quality were made and selling of wines with labels showing place of origin and grapes used increased. Most states produce wines, but California is far ahead of the others. The best wines are chiefly from the San Francisco area, in the districts of Napa valley, Sonoma, Livermore and Santa Clara valley; some of these compare with Europe's, but there are as yet no great wines. The best established districts in the east are the Erie islands area near Sandusky, Ohio and upper New York state where interesting projects with native vines not of the V. vinifera were being carried on.

FORTIFIED AND AROMATIC WINES

Sherry. — Veritable sherry comes from the province of Jerez de la Frontera in Spain, "sherry" being an anglicization of "Jerez." A distinguished and venerable wine, sherry results from the soil and grapes of Jerez and a unique vinification. Essential is the action of *flor,* a mildewlike growth encouraged by a slight exposure to air after fermentation. Also unique is the Solera system of blending wines of many vintage years, maturing the newer mines and maintaining the historical continuity of a type. As ape'ritifs, four main types are: Manzanilla, Fino, Amontillado, and Vino de *Pasto.* All are dry and pale, descending in order named to vino de *Pasto*, sometimes characterized "not dry," and of a golden colour. Sweeter, heavier sherries are used as dessert wines; the usual types are Oloroso, Amoroso, Golden, all somewhat dry; and Cream, Brown and East Indian, all sweet and darker. Sherry-type wines are made in south Africa, Australia and the United States. No satisfactory duplication of the Spanish process has been achieved, though recent use of *flor* and Palomino grapes in California has resulted in a few wines comparable to some good Spanish sherries.

Madeira. — From the Portuguese island of Madeira, this wine is, like sherry, the result of a unique vinification and aging. The must is fermented and either before or after fortification heated in cask for weeks, then agitated artificially. This last operation attempts to reproduce the agitation of Atlantic voyages of the 17th century, which evidently contributed to the quality of Madeira. The result is an individual, dark brown, sweet wine with a hard undertaste. Apart from the wine of Camara de Lobos, the best Madeiras are classified according to vine. Lightest, and most dry, are rainwater, sercial and verdelho. Bual is a full, typical Madeira; Malmsey, or Malvasia, is rich and sweet. As with sherry, the range of types in Madeira permits their use as ape'ritifs or dessert wines and with certain foods.

Port. — Port, perhaps the most popular dessert wine, is produced within a region that is delimited by Portuguese law. Soil and grapes, and the skill of Oporto vintners in blending produce wines of remarkable character, with types running through a series of flavours. Vintage port, the finest, is not blended; but harvests deemed worthy to produce it are rare. The full richness of the port taste is found in dark vintage and vintage character ports; these types are taken from the cask after two or three years and complete their aging in the bottle. Vintage character port is a blend of best wines, sometimes called crusted port because, as with vintage port, it forms a crust within the bottle. Ruby port is a blend of younger wines. Tawny port is blended and matures in cask, changing its colour. Peculiar to the vinification of port is a large dosage of brandy given to the still fermenting must, by which the character of the wine is greatly changed. Much time is needed for the maturing of ports; in 1950, 1912 port was still excellent. There is some white port, usually made from white grapes, but it is not of equal distinction. The name "port" has been appropriated by certain wines of other countries, sometimes not aged, often not from the same grapes. There are, however, some acceptable American ports.

Marsala and **Malaga.**—These fortified wines have a world reputation. Marsala, from Sicily, is dark and sweet with a burnt taste; Malaga, from southern Spain, is a very heavy, sweet wine.

Aromatic Wines. — Vermouths are white wines, sweetened, fortified and infused with herbs. The French type is drier an'd paler, the Italian sweetish and brown in colour.

A number of drinks styled *apéritifs* in France are made by adding quinine and other ingredients to sweet heavy wines. They are marketed under brand names. such as Dubonnet, Byrrh. St. Raphael, Plessis, Lillet. Italy offers "Cin," Campari and Punt e Mes.

SPARKLING WINES

Champagne. — The premier sparkling wine is champagne, taking its name from a province of the *ancien régime.* The Champagne district today is defined as certain parishes in the *départements* of Marne. Aube and Aisne. The best champagne comes from vineyards along the Marne from Château-Thierry to Épernay and a belt to the south, called the Côte des Blancs. and those on a plateau called Montagne de Reims. It is made from only three wines: Pinot and Meunier. both black, and Chardonnay. white. Characteristic of champagne is a crisp. flinty taste, sometimes ascribed to the chalky soil. A small amount made from green grapes only is called *blanc des blancs.* Pink champagne is made by adding a little red wine.

Champagne first ferments in cask, but when fermentation stops temporarily in the first winter it is transferred to strong bottles. Just before bottling the wine is blended by experienced tasters, the artists of champagne. The wine now goes through a second fermentation in the bottle. making it naturally sparkline. If the year has been excellent, only wines of that year are used and the product is vintage champagne; if not, a blend with wines of different years will be made, improving and strengthening the wine and producing a nonvintage champagne. For the first three months in the bottle the wine is gradually moved and tipped by hand until the bottles are upside down and the impurities have fallen onto the bottom of the cork. The bottles are stood upside down for six months or perhaps years; when the wine is mature and ready for the market the cork is released and the sediment shot off with it. Next a small amount of sirup melted in old champagne is added and the wine recorked. Champagne to which little or none of this sugar is added is labeled *brut* or extra dry, somewhat sweeter is *sec,* and wine with larger quantities *demi-sec* and *doux.* All of these are sweeter than the words indicate. The second fermentation of wine to produce sparkling champagne is ascribed to Dom Pierre Pérignon, a Benedictine monk of the late 17th century.

Others. — Other sparkling n-ines are made throughout the world. In France such wines outside the champagne area are called *mousseux;* such wines are those of Saumur, the *blanquette* of Limoux and white, red and rose Burgundies. These wines. and their counterparts elsewhere. do not have the flinty taste of champagne and tend to lose their individual bouquets. Asti Spumante is the favourite Italian sparkling wine. At one time Rhine and Moselle sparkling wines of good quality were produced, not to be confused with the cheap imitation champagne, *Sekt.* In south Africa, Australia and the United States sparkling wines sometimes take the name champagne. an inaccurate designation. The prices these wines secure are below champagne, but their prices are high due to high taxes on them in non-Latin countries.

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CHEMISTRY

The main change taking place in the fermentation of grape must is the conversion of the sugars glucose and fructose into alcohol and carbon dioxide. This can be represented by the equation $C_6H_{12}O_6 = 2C_2H_5OH + 2CO_2$, but the reaction is complicated (*see* FERMENTATION), and small amounts of glycerol. acetic and succinic acids and traces of higher alcohols are also formed.

The surfaces of ripe grapes are covered nith large numbers of yeasts, molds and bacteria, including the true nine yeast *Saccharomyces ellipsoideus* Grape juice would ferment with the aid of the wild yeasts but it is usually inoculated nith a selected strain of wine yeast after adding sulfur dioxide to suppress the other organisms.

In making white nine the juice is separated from the crushed grapes before fermentation begins; for red wine part of the fermentation is conducted in presence of the skins of the grapes, when tannins and colouring matter are extracted. the "free-run wine" being drann off and fermentation completed in a closed vat. Red wine fermentation usually takes place at a higher temperature than nhite. In either case artificial cooling may have to be applied since heat is evolved by the fermentation and too high a temperature is undesirable. The main fermentation takes a few days but it continues at a slower rate for some time In dry nines only about 0 15% of sugar is left at the end of the fermentation The maximum strength of alcohol that can be formed is about 15% by volume. the yeast being inhibited at this concentration (although special strains of yeast can tolerate higher amounts).

When fermentation is complete the wine is racked off. or separated from the lees or sediment. This contains precipitated organic matter, yeast and acid potassium tartrate (cream of tartar), which is less soluble in presence of alcohol. Racking may be repeated several times at intervals, the wine being stored in wooden vats where aging takes place. During aging changes occur including reduction of acidity, ester formation and oxidation of tannin and alcohols by the small amounts of oxygen absorbed through the wood. The wine is cleared before bottling. Fining agents such as isinglass. gelatin or bentonite clay are used, assisted by processes such as heat treatment. refrigeration and filtration.

Wine is subject to a number of infections. The most important is the action of acetic bacteria and of the wild yeast *Mycoderma vini.* which convert alcohol to the volatile acetic acid. These organisms cannot act in absence of air and are inhibited by sulfur dioxide. Tourne disease is caused by a bacterium that can grow in absence of air and produces lactic acid, giving the wine a silky cloudiness and off flavours. The bacterium can be inhibited by sulfur dioxide and destroyed by pasteurization.

See also Index references under "Wine" in the Index volume.

See W. V. Cruess, *The Principles and Practice of Wine Making,* 2nd ed. (1916); J. Ribereau-Gayon, *Traité d'oenologie* (1950). (D. I. C.)

WING, a term used in the air forces of both the British commonwealth and the United States to denote an integral part of the air force that is adapted functionally to any one of a number of purposes. It is often compared with a division in army organization or to the Soviet air division. Although the term has become less applicable as rocket weaponry has modified concepts of organizations (*e.g.,* the missile squadron), it still remains more or less valid for units employing aircraft.

In the British commonwealth air forces: a wing is either a mobile tactical unit roughly equivalent to a combat wing of the U.S. air force. or one of the major organizational divisions at an R.A.F. station, *i.e.,* an administrative wing, a technical wing or a flying wing. In some instances, a training unit for apprentice airmen is also called a wing.

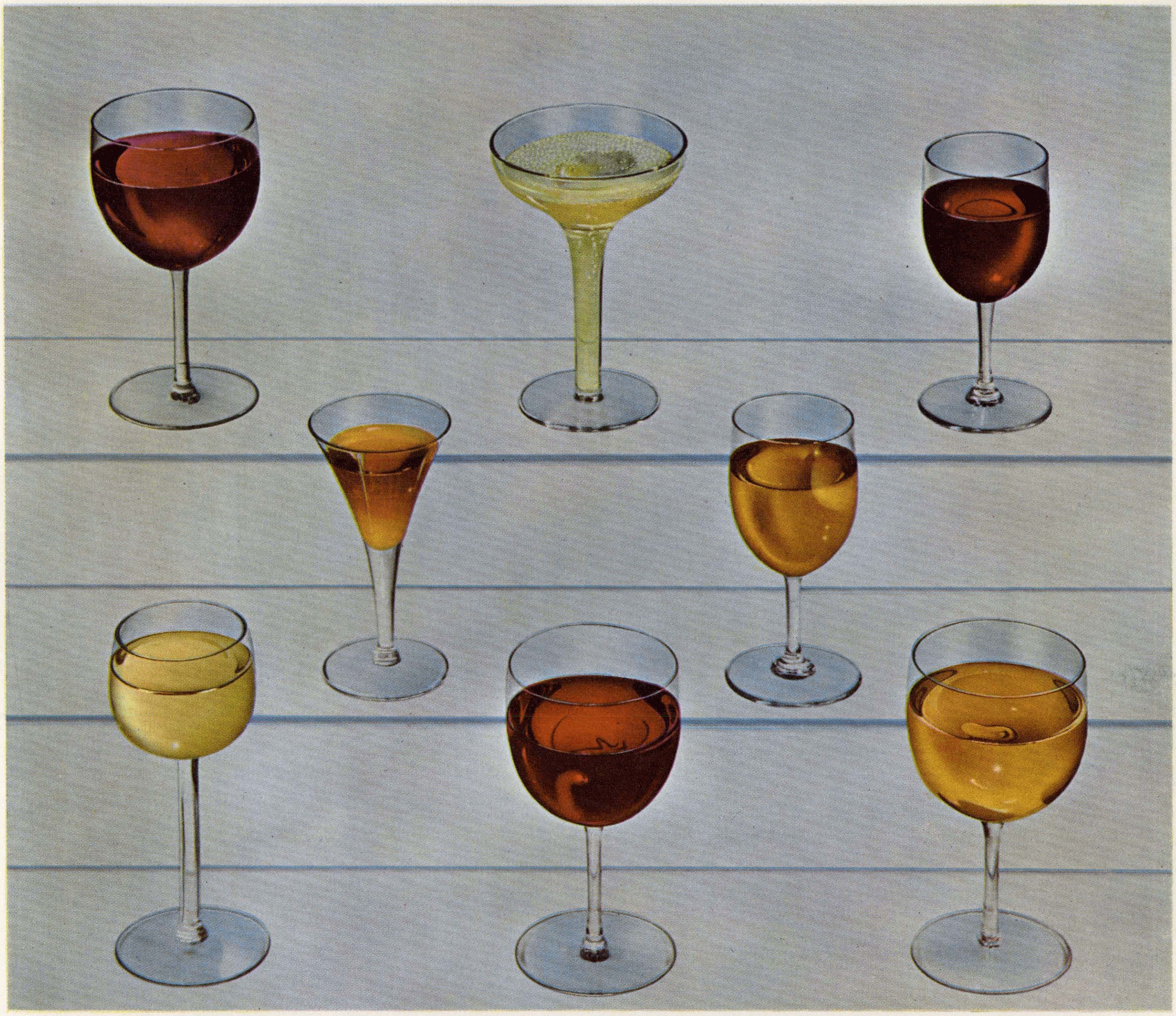
In the U.S. navy a fleet air wing is a basic mobile administrative unit for naval aviation. Tenders and aircraft squadrons are assigned to it for administrative control.

In the U.S. air force a wing is a more or less self-sufficient unit with all necessary equipment assigned, organized for combat, training, transport, or service. and normally made up of a headquarters and four groups. In a combat wing, for example, the primary mission group (*i.e.,* its aircrews. aircraft and armament) performs the combat; the direct support group provides maintenance and supply; the air base group provides administration and housekeeping; and the medical group provides medical services. Such a wing is usually at a level of command below a numbered air force. The wing concept in the U.S. air force! however, is adapted to other organizational structures. and provides the basic pattern for flexible control and operation of training stations: air depots and air bases, as well as of combat air forces.

(WD. A. H.)

WINGATE, SIR FRANCIS REGINALD (1861–1953). British general and administrator in the Sudan, was born at Broadfield. Renfrewshire. on June 25, 1861. He was educated at the Royal Military academy, Woolwich. and became a lieutenant

WINE



WIDELY KNOWN WINES IN TRADITIONAL GLASSES

Top row, **left. Burgundy—full-bodied,** deep red table wine. **Glass 2 13/16** in. wide, **5 13/16** in. **high**

Top row, **centre. Champagne—pale** gold or **straw-coloured** sparkling wine. **Glass 3 9/16** in. wide, **5 5/16** in. high

Top row, **right. Port—rich, heavy-bodied, dark red dessert wine. Glass 2 1/16** in. wide, **5 3/16** in. high

Middle row, left. Sherry—appetizer wine of amber **colour. Glass 2½ in.** wide, 5Ms in. **high**

Middle row, right. **Muscatel—golden-coloured, amber-toned dessert wine. Glass 2 1/16** in. wide, **5 3/16** in. high

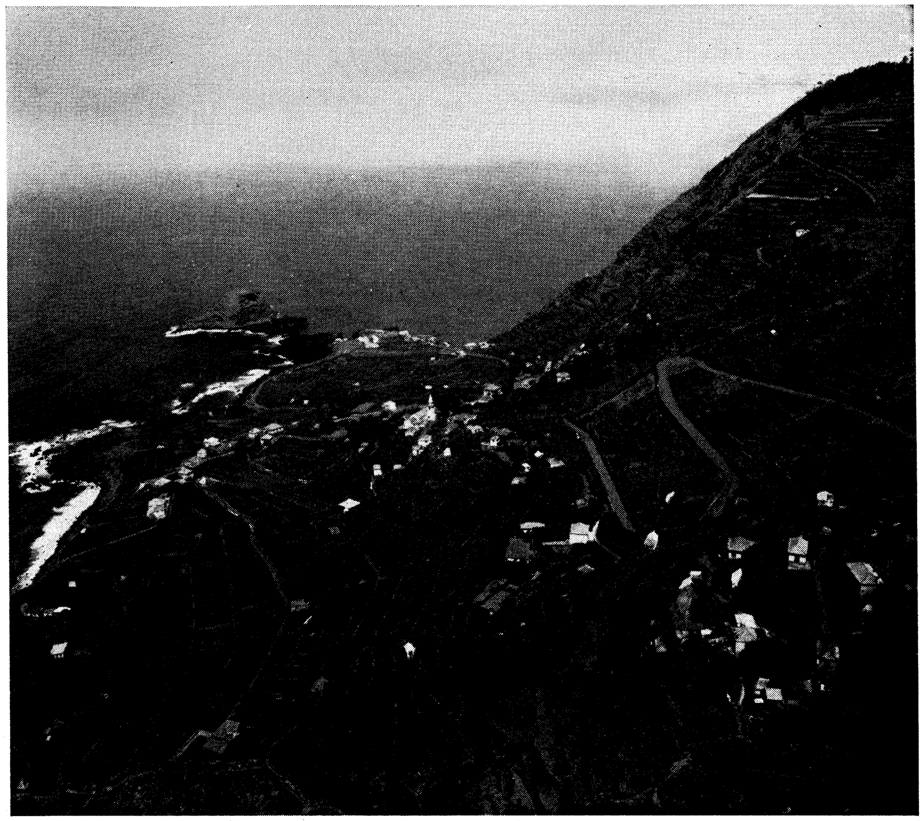
Bottom row, left. Rhine Wine or "Hock"—dry white table wine, light-bodied, **pale** golden or slightly **greenish** in hue. **Glass** 2⅝ **in. wide, 6¼ in.** high

Bottom row, centre. Claret—light-bodied, red **table** wine. **Glass 2 13/16 in.** wide, **5 13/16** in. high

Bottom row, **right.** Sauterne-semisweet white **table wine,** golden-hued, full-bodied. Glass **2 13/16** in. wide, **5 13/16** in. **high**

Grapes from the Oppenheimer Sackträger vineyards of the Pfalz or Palatinate, southern Germany

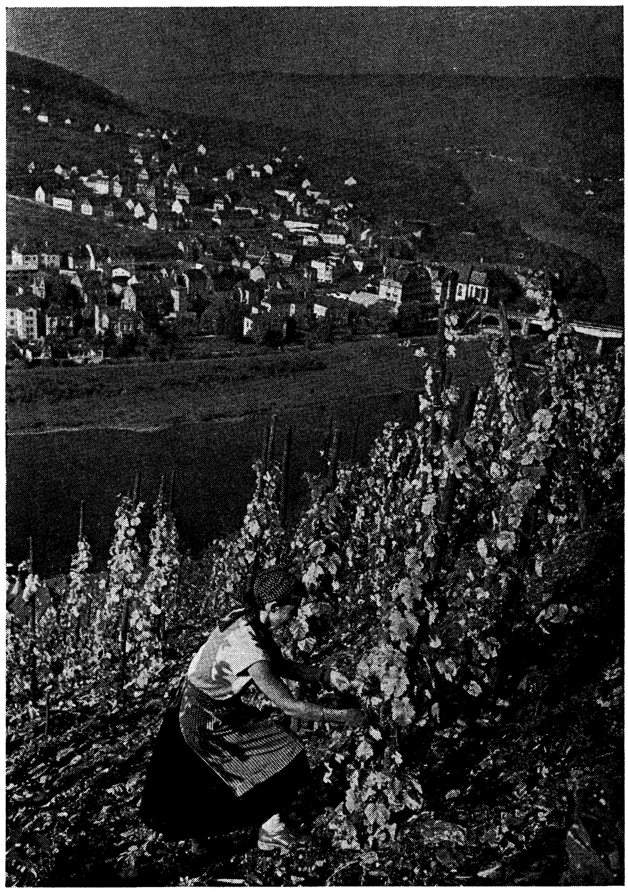
Grape picking in the Bordeaux region of France



Terraced vineyards at Porto Moniz, Madeira, Portugal

Gathering baskets of grapes during harvest in the champagne district of France

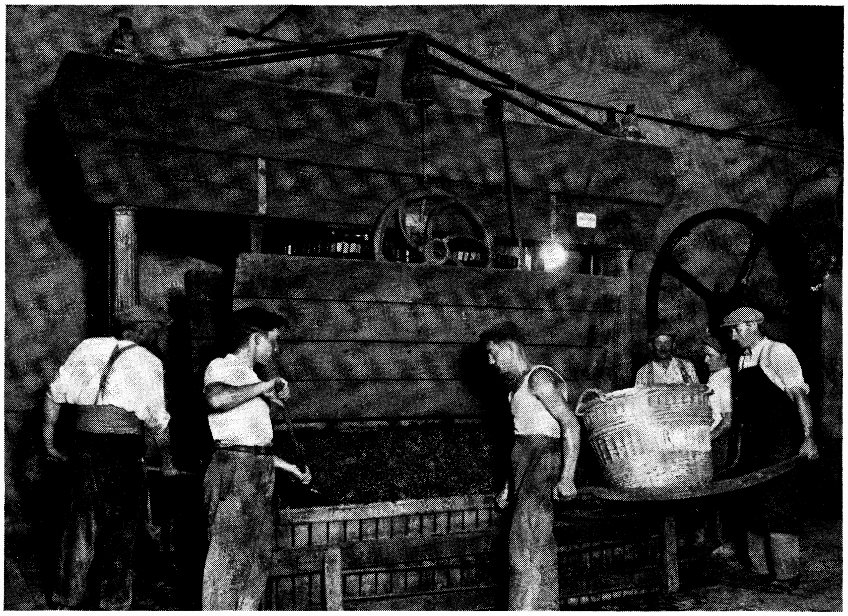
Baskets of grapes arriving at a wine press, France



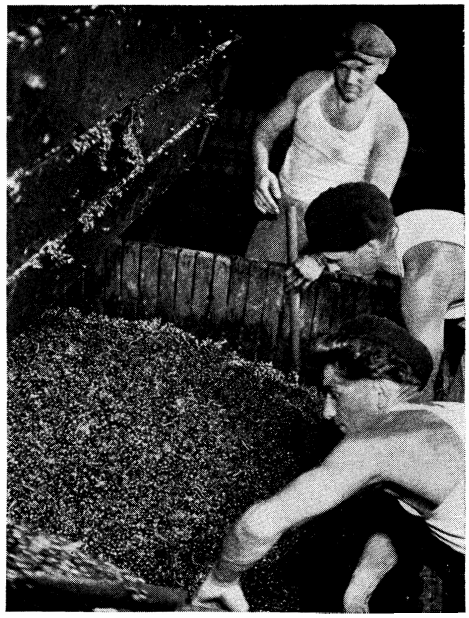
Vineyards near Bernkastel, in the Moselle region of Germany

VINEYARDS AND GRAPE HARVESTING IN EUROPE

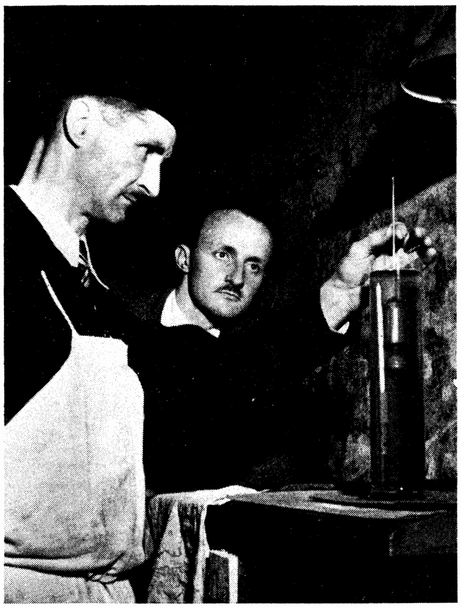
BY COURTESY OF (TOP LEFT BOTTOM RIGHT) GERMAN TOURIST INFORMATION OFFICE (TOP RIGHT) PORTUGUESE STATE OFFICE, LONDON, (SECOND LEFT) CITY OF BORDEAUX AND RAY-DELVERT, VILLENEUVE SUR-LOT, (THIRD LEFT, BOTTOM LEFT) THE CHAMPAGNE PRODUCERS OF FRANCE



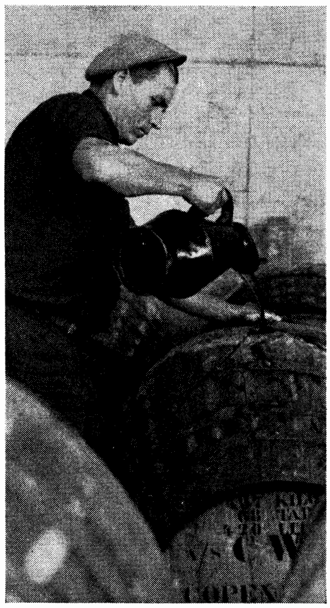
Filling a wine press with Pinot noir grapes, Champagne, France



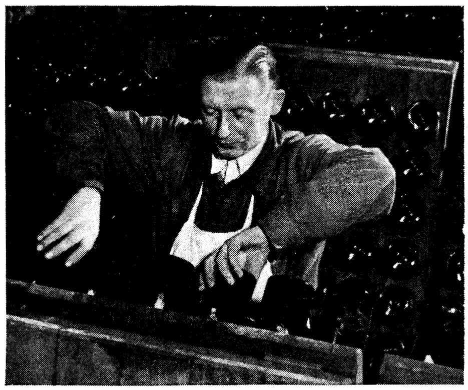
Leveling pulp after pressing grapes, Champagne; the best wine comes from the first pressings of a blend



After the grape juice is placed in casks for fermentation, it is tested for sugar and acid content

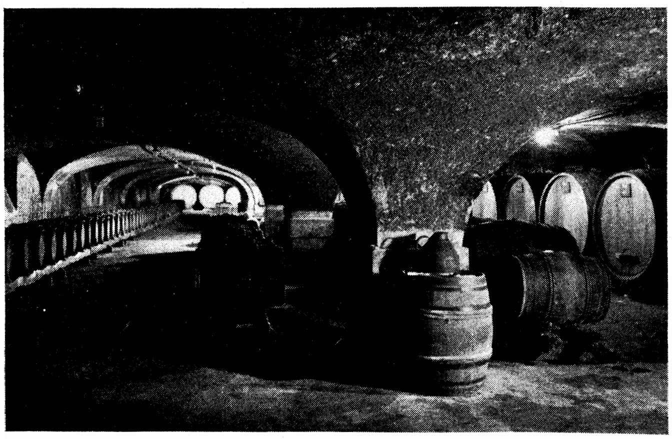


Making a *solera*, Madeira. In both Madeira and sherry making the butts are regularly half emptied and refilled



Making *rémuage*, Champagne: bottled wine is turned and tilted to collect impurities on bottom of cork. These are later removed, and the bottle recorked

Bas-relief on the ceiling of the Veuve Clicquot-Ponsardin cellars, France. The black spots are a fungus peculiar to wine cellars



Wine cellar of the Château de Pizay, Rhône valley, France

WINE MAKING

BY COURTESY OF (TOP LEFT, CENTRE RIGHT) THE CHAMPAGNE PRODUCERS OF FRANCE; (TOP RIGHT, CENTRE LEFT, BOTTOM RIGHT) HOLIDAY MAGAZINE, PHOTOGRAPHS BY ROSA HARVAN; (CENTRE) PORTUGUESE STATE OFFICE, LONDON; (BOTTOM LEFT) FRENCH GOVERNMENT TOURIST OFFICE in the royal artillery in 1880. He served in India and Aden from 1881 till 1883, when he joined the Egyptian army, and in the Gordon relief expedition of 1884–85 was aide-de-camp and military secretary to Sir Evelyn Wood. He took part in the operations on the Sudan frontier in 1889 and 1891. In 1894 he was governor oi Suakin. His principal work was in the intelligence of which he became director in 1892. He mas a master of Arabic. He published in 1889 *Mahdiism and the Egyptian Sudan*, an account of the rise of the mahdi and of subsequent events in the Sudan. He helped Father Ohrwalder and two nuns to escape from Omdurman in 1891. Wingate also arranged for the escape of Slatin Pasha in 1895. He translated Father Ohrwalder's narrative, *Ten Years' Captivity in the Mahdi's Camp* (1891), and Slatin's book. *Fire and Sword in the Sudan* (18951.

As director of military intelligence, he served in the campaigns of 1896–98 which resulted in the reconquest of the Sudan. Wingate led an expeditionary force which in Nov. 1899 deieated the remnant of the Dervish host at Om Dehreikat, Kordofan. In December, on Lord Kitchener being summoned to south Xirica, Wingate succeeded him as governor general of the Sudan and sirdar of the Egyptian army. In 1909 Wingate undertook a special mission to Somaliland to report on the military situation. In Dec. 1916 he relinquished the governorship of the Anglo-Egyptian Sudan, and mas high commissioner for Egypt until Oct. 1919. He died in Dunbar, East Lothian, Jan. 28, 1933.

WINGATE, ORDE CHARLES (1903–1944), British army officer. leader of the "Chindits" who harassed the Japanese in the Burmese jungle in World War II. was born at Naini Tal, India. on Feb. *26. 1903.* Educated at Charterhouse and the Royal Military academy. Woolwich. he was commissioned in the royal artillery in 1923, serving in the Sudan and making some exploration of the Libyan desert *(1928–33).*

In 1936 he went to Palestine as an intelligence officer, being awarded the distinguished service order for his part in organizing and leading guerrilla forces during the Arab revolt. In *1940–41* he organized and led Ethiopian and Sudanese forces on an advance from the west against the Italians at Addis Ababa and was given a bar to his D.S.O. In *1942* he commanded a mixed brigade of British. Gurkha and Burmese guerrillas in Burma. later known as the "Chindits" or "Wingate's raiders." Supplied from the air, his small force was able to penetrate and remain for weeks a long way behind the Japanese lines. For this brilliant work he was promoted to acting major general and awarded a second bar to his D.S.O. In *1944* Wingate was appointed to command the air-borne force which carried out the invasion of central Burma, but at the opening of the campaign. on March *24.* this most unorthodox but extremely successful commander was killed in an air crash.

See C J. Rolo, *Wingate's Raiders* (1944); *L.* O. Mosley, *Gideon Goes to War* (1955). (E. B. BN.)

WINKELRIED, ARNOLD VON. The incident with which this name is connected is. after the feat of William Tell, the best known and most popular in the early history of the Swiss confederation. We are told how. at a critical moment in the great battle of Sempach, when the Swiss had failed to break the serried ranks of the Austrian knights, a man of Unterwalden, Arnold von Winkelried by name, came to the rescue.

Commending his wife and children to the care of his comrades, he rushed toward the Austrians. gathered a number of their spears together against his breast and fell pierced through and through, having opened a way into the hostile ranks ior his countrymen.

The earliest known mention of the incident is found in a Zürich chronicle (discovered in 1862), which is a copy, made in 1476, of a chronicle written about 30 years earlier; it occurs also in De *Helvetiae origine,* written in 1538 by Rudolph Gwalther. In both the hero is nameless.

Finally. one reads the full story in Giles Tschudi's chronicle (1564), where the hero becomes "a man of Unterwalden, Arnold von Winckelried by name." K. Bürkli *(Der wahre Winkelried,—die Taktik der alten Urschweizer,* Zurich. 1886) concluded that the phalanx formation of the Austrians, as well as the name and act of Winkelried, have been transierred to Sempach from the fight of Bicocca, near Milan (April 27, 1522), where a real leader of the Swiss mercenaries in the pay of France. Arnold Winkelried, met his death in much the same way.

WINNEBAGO, a Siouan-speaking tribe of North American Indians. They lived in what is now eastern Wisconsin when first encountered by Jean Nicolet in *1634.* Archaeologically they show relationships with the cultures of the lower Mississippi valley. but in historic times, they more closely resembled their Xlgonkian neighbours such as the Menominee and Fox Indians *(qq.v.)* rather than their prehistoric antecedents or their closest linguistic affiliates. the Iowa. Oto and Missouri. In response to the fur trade the Winnebago began a westerly expansion during the mid-17th century. By the early 19th century they claimed most of southwestern Wisconsin and the northwestern corner of Illinois. This land was ceded to the U.S. government in three parcels by treaties in *1829, 1832* and *1837.* The Winnebago considered the *1837* treaty to have been signed under duress and, therefore. not valid. However, part of the tribe submitted to its terms and were moved to a series of reservations; they were finally settled in 1865 on their present reservation in northeastern Nebraska where about *1,000* were enrolled in the *1960s.* The rest of the tribe resisted the terms of the *1837* treaty and despite forcible removals persisted in returning to their homeland. In 1875 they were permitted to take up homesteads in Wisconsin where about 1,500 resided in the 1960s. Winnebago in the Wisconsin and Nebraska enclaves recognize their common ancestry and frequent visiting occurs between the two groups. The Nebraskans are somewhat more acculturated in that English is rapidly replacing the Winnebago tongue. Also. the Nebraskans are nominally Christian, being about evenly divided between the quasi-Christian peyote religion (see PEYOTISM) and white Christian denominations. In Wisconsin. Winnebago is commonly spoken and about a third of the group adheres to traditional pre-Christian religious practices. *See* also SIOUAN INDIANS. (N. O. L.)

WINNETKA, a village of Cook county in northeastern Illinois. U.S., *17* mi. N. of downtown Chicago on Lake Michigan, is one of several North Shore residential suburbs of Chicago *(q.v.).* Incorporated under a special charter in *1869.* it established a council-manager plan of government in 1915. The municipality operates and owns water and electric utilities. Its public schools are nationally recognized for their experiments in teaching, with emphasis on individual progress. New Trier Township high school is there. as is the North Shore Country Day school (private), and the Hadley School for the Blind. a privately supported institution (incorporated in *1922* j which teaches by mail.

For comparative population figures see table in ILLINOIS: *Population.* (H. H. GR.)

WINNIPEG, the fourth city of Canada and the capital of Manitoba, is situated at the confluence of the Red and Assiniboine rivers. *60* mi. N. of the U.S. border. Pop. *(1961)* city *265.429;* metropolitan area *475,989,* including the adjoining city of St. Boniface *(q.v.)* and the city of St. James *(33.977);* Winnipeg sends *4* members to the federal parliament and *12* to the Manitoba legislature. The name is from the Cree Indian words win, "muddy," and *nipee,* "water."

Winnipeg owes its origin and growth to its geographical position in relation to communications. Its early development as a fur-trading post (Fort Rouge established by Pierre de la Vérendrye, *1738;* Fort Gibraltar built by the Northwest company. *1804:* Fort Garry. by the Hudson's Bay company. *1821)* was due to its location where the westward route following the Assiniboine joined with the north-south course of the Red river. The fertility of the Red river valley led Lord Selkirk to plant a Scottish colony there in *1812* which survived the hostility of the fur traders and was joined by European immigrants *(see* RED RIVER SETTLEMENT). Numerous French-speaking half-breeds. or métis, also inhabited the district. Further development of the area was handicapped by the difficult access route across northern Canada from Hudson's bay. This isolation was ended in *1859* by steamboats from the U.S. on the Red river and by a railway from Minnesota in 1878.

The formation of the dominion of Canada as a "coast to coast" nation (1867–71), followed by the building of the Canadian Pacific railway across the country (1885), enhanced the importance of Winnipeg's position: the rugged terrain of the Canadian shield there approaches close to the U.S. border. so that east-west routes across Canada are compelled to converge. Settlers began to arrive from the east in the late 1860s and by *1570* the little village of Winnipeg had grown up half a mile north of Fort Garry; it was incorporated in *1873* with a population of 1,869, and in *1576* began to ship wheat eastward.

As the prairie was opened up. more and more wheat moved into the city until Winnipeg became the largest grain market in North America. Manufactured goods from eastern Canada and the U.S.

were distributed throughout the Canadian west and this, together with a large mail-order business serving the rural communities of the prairies, remains a prime function of the city. Growth was rapid until the agricultural depression of the 1930s, the population rising from 42,430 in 1901 to 221,960 in 1931. The 1950s saw renewed expansion, mainly in the suburban areas. Increased mining activity made Winnipeg an important supply centre for the northland and it retains its original function as a fur market. The air age added to the city's function as a communications centre; the airport, located 4 mi. W. of the city centre, is one of the busiest in Canada.

Cheap and plentiful supplies of hydroelectric power, natural gas (after 1958), and soft water, favour industrial development. The leading industries are slaughtering and meat packing flour milling, clothing, printing, brewing, baking and food processing.

Extensive railway freight yards, branch lines and the rivers divide the city into separate parts; the rivers have necessitated several long bridges. The streets, arranged on a rectangular plan. are wide. The city centre, where the commercial and financial buildings are located, is formed by the junction of Main street, which follows the Red river, and Portage avenue, which was originally a trail to the northwest. Most of the imposing buildings are on Broadway: the parliament building, the law courts and the Fort Garry hotel. The post office (1958) is particularly noteworthy. Many older wooden houses in the centre have been pulled down, leaving open spaces used as car parks. The chief public parks are Assiniboine park, on the banks of the river of that name (300 ac.) and Kildonan park on the Red river (98 ac.).

Winnipeg is cosmopolitan; although the British element prevails. there are large French. Jewish, Ukrainian, Polish. German and Scandinavian groups. An active cultural life finds expression in the Royal Winnipeg ballet, a symphony orchestra, a musical festival and various societies. The University of Manitoba is situated south of the city in the suburb of Fort Garry. (W. H PR.)

WINNIPEG, LAKE AND RIVER, a water system of Manitoba, Can. The lake has an area of 9,094 sq.mi., is at an altitude of 713 ft., is 264 mi. long, 25 to 68 mi. wide, and has several islands, including Reindeer (55 sq.mi.). The lake has an average depth of 40 to 60 ft. and is navigable its entire length for sizable boats. Its shores on the south are extremely marshy. It receives the drainage from a large part of the Great Plains, including waters from the Red and Saskatchewan rivers from the south and west and Winnipeg river on the east. The lake is drained to the north by the Nelson river into Hudson bay. The fisheries of Lake Winnipeg, operating out of Gimli, are of considerable commercial importance. Winnipeg beach on the southwest shore is a popular summer resort.

Winnipeg river drains an area of 48,880 sq.mi. from the Lake of the Woods to Lake Winnipeg It was discovered about 1733 by Pierre de la Vérendrye and Christophe de la Jémeraye and for many years was on the route of the explorers and fur traders from Lake Superior to the west The falls and rapids of its lower course, which earlier made travel difficult, supply most of the electrical power used in Manitoba There are power plants at Seven Sisters and Great Falls. Pointe du Bois and Slave Falls, Pine Falls and McArthur Falls. (F. A. CK)

WINNIPEGOSIS, LAKE, in western Manitoba, Can.; its greatest length is 152 mi.; greatest width, 32 mi.; shore line. 570 mi.; and area. exclusive of islands, 2,086 sq.mi. Its greatest depth has been ascertained at 59 ft. and mean altitude. 831 ft. above sea level; it is navigable for vessels drawing 10 ft. The name means "Little Winnipeg"

The lake was discovered by Pierre de la Vérendrye in 1739 and in early fur trade days was an integral part of the western voyageur route. Rail service reaches the lake at the village of Winnipegosis The lake drains through Waterhen river into Lake Manitoba and thence by the Dauphin river into Lake Winnipeg. (F. A. CK)

WINONA, a city of southeastern Minnesota, U.S., and seat of Winona county, is picturesquely situated beneath steep bluffs along the Mississippi river about 100 mi. S.E of St. Paul. It was founded in 1851 by New England settlers followed by Polish and German immigrants. When the town was platted in 1352 it was named Montezuma (for the Aztec emperor) but was soon renamed Winona, an application of the Indian Wenona, a name commonly given by Sioux families to girls who were first-born. It was chartered in 1857. Winona is located on a wide shelf of level land easily accessible from the farming regions to the west. This made the city an important river port and it became a great wheat shipping centre. Giant sawmills were established and were fed by logs rafted down the Mississippi. Business leaders accumulated large fortunes and Winona was once reputed to have had 20 millionaires.

When the booms in wheat and lumber ended, other industries arose. About 40% of Winona's workers are employed in manufacturing. Medicines, cosmetics, flour, appliances, metal goods, lubricating equipment and fertilizers are the leading products. River shipments to Winona have increased steadily and in 1958 a new barge dock was opened. There are numerous boat shelters for the growing number of pleasure craft on the river.

About one-half the population is Protestant and one-half Roman Catholic. Winona State college (1858), St. Mary's college (Roman Catholic; 1913) and the College of St. Teresa (Roman Catholic; 1907) are located in the city.

For comparative population figures *see* table in MINNESOTA: *Population.* (H. T. H.)

WINSLOW, EDWARD (1595–1655), a founder of the Plymouth colony, was born in Droitwich, Eng., on Oct. 18, 1595. In 1617 Winslow moved to Leyden, united with John Robinson's church, and in 1620 was one of the "Mayflower" Pilgrims. His first wife, Elizabeth (Barker) Winslow, died soon after their arrival. He married, in May 1621, Mrs. Susannah White, the mother of Peregrine White (1620–1704), the first white child born in New England. This was the first marriage in the New England colonies. Winslow was one of the assistants from 1624 to 1647, except in 1633–34, 1636–37 and 1644–45 when he was governor of the colony. In 1643 he was one of the commissioners of the United Colonies of New England. On several occasions he was sent to England in the interests of Plymouth and Massachusetts bay. He left on his last mission as the agent of Massachusetts bay, Oct. 1646, and spent nine years in England, where he held minor offices under Cromwell. Winslow's portrait, the only authentic likeness of any of the "Mayflower" Pilgrims, was preserved in the gallery of the Pilgrim society at Plymouth, Mass. His writings, though fragmentary, are of great value to the historian of the Plymouth colony. Some of them were reprinted in Alexander Young's *Chronicles of the Pilgrims* (1841)

WINSOR, JUSTIN (1831–1897), U.S. historian, was born in Boston, Mass., on Jan. 2, 1831. As a student at Harvard he wrote historical and literary articles and for a number of years thereafter continued his newspaper and periodical work. He found his true vocation, however, when his success as temporary superintendent of the Boston Public library caused him to receive the permanent appointment and when in 1877 Prcs. Charles Eliot took him to Harvard as librarian. He edited *The Narrative and Critical History of America,* 8 vol. (1884–89), a mammoth co-operative work, for the rich bibliographical and historical notes of which he was largely responsible; he also wrote histories: *Christopher Columbus* (1891), *Cartier to Frontenac* (1894), *The Mississippi Basin* (1895) and *The Westward Movement* (1897). He died in Cambridge, Mass., on Oct. 22, 1897.

WINSTON-SALEM, a city of western North Carolina, U.S., located about 35 mi. S. of the Virginia boundary in the north central piedmont; the seat of Forsyth county. Pop. (1960): city 111,135, an increase of 26.6% in the decade; standard metropolitan statistical area (Forsyth county) 189,428, an increase of 29.6%. (For comparative population figures for the city *see* table in NORTH CAROLINA: *Population.)*

Winston-Salem is a union of two towns representing respectively the new south and the colonial period. Salem was founded in 1766 by Moravians *(see* MORAVIAN CHURCH) and remained under Moravian control until 1849. In 1856 land was first sold to outsiders and the town was incorporated. Many of the original buildings are still standing. Old Salem, Incorporated has begun a major effort to restore the colonial town, and a museum is maintained. The Moravian Easter sunrise service annually attracts thousands of worshipers from all over the United States.

Winston, to the north of Salem, was founded in 1849 as the seat of Forsyth county and was named in 1851 for Maj. Joseph Winston, one of the heroes of the battle of Kings Mountain. The two towns were originally about a mile apart but they gradually grew together and in 1913 they united. Winston-Salem became a centre of the tobacco industry in the nation; other important industries include nylon hosiery, men's and boys' underwear. electric communication equipment, woolen blankets, furniture, textiles and dairy products.

Four-year colleges in the city are Winston-Salem Teachers college, a state-supported institution established in 1892; Wake Forest college (Baptist; chartered in 1833) and its affiliated Bowman Gray Medical college (1902); and Salem college (Moravian; founded 1772). The city has hospitals, parks, a city-county library and an art council. It is the economic centre of about 15 surrounding counties. Winston-Salem has a council-manager form of government, in effect since 1948. (D. J. WR.)

WINTER, JOHANN WILHELM DE (1761–1812), Dutch admiral distinguished in the French Revolutionary and Napoleonic wars, was born at Kampen. He entered the naval service at the age of 12 and had reached the rank of lieutenant when in 1787 the "Patriot" party to which he belonged was overthrown. He fled to France and on the outbreak of the revolution there joined the army and was soon promoted to brigadier general. When Charles Pichegru overran the Dutch republic in 1795, De Winter returned with the French army to his native country. The new Dutch government decided to use his experience for reorganizing the navy. In 1796 he was appointed vice-admiral and commander in chief of the fleet. On Oct. 11, 1797, he encountered the British fleet under Admiral Duncan off Camperdown. After an obstinate struggle the Dutch were defeated and he was taken prisoner. Liberated by exchange in December, he was Dutch ambassador to the French republic from 1798 to 1802 and was again appointed commander of the fleet. Sent with a strong squadron to the Mediterranean to repress the Tripoli piracies, he negotiated a treaty of peace with Tripoli. He enjoyed Louis Bonaparte's confidence while the latter was king of Holland and Napoleon's after the annexation of Holland to the French empire. Napoleon appointed him inspector general of the northern coasts and, in 1811, commander of the fleet gathered at the Texel. Soon afterward De Winter became ill and moved to Paris where he died on June 2, 1812. (E. H. K.)

WINTERBERRY, the name of several deciduous shrubs of the holly genus (Ilex), but particularly applying to Virginia winterberry (I. verticillata), a large arborescent shrub of moist lands from Nova Scotia to Florida and west to Missouri. It is also called black alder for the elliptical to obovate leaves that turn black in the fall. The winterberry is dioecious, bearing small, unisexual flowers in axillary clusters. The persistent berries, usually red but occasionally varying to yellow, are liked by birds. An attractive landscape border plant, its berried twigs are used for winter decorations. Propagation is by softwood cuttings or seed. Smooth winterberry (I. laevigata) bears single, orange-red fruits. Mountain winterberry (I. montana) is native to mountain slopes. (F. C. G.)

WINTER FAT (Eurotia lanata), a small North American shrub of the goosefoot family (Chenopodiaceae), native to subalkaline soils from Saskatchewan to Washington and south to Texas and California. It is a low white-woolly shrub, one to two feet high. with many slender branches, narrow leaves and small flowers in axillary clusters, the fruiting involucres bearing tufts of silvery-white hairs. It is a valued winter forage for cattle.

WINTERGREEN (Gaultheria procumbens), a member of the heath family (Ericaceae; *q.v.*), a small. creeping. evergreen, herblike shrub with numerous short, erect branches bearing in the upper part shortly stalked, oval, thick, smooth, shining leaves with a sharp-toothed edge. The flowers are borne singly in the leaf axils and are pendulous, with a pale pink waxy-looking urn-shaped corolla. The bright crimson-red subglobular, berrylike fruit consists of the much-enlarged fleshy calyx which surrounds the small, thin-walled, many-seeded capsule. The plant is a native of shady moods on sandy soil, especially in mountainous districts, in the northern United States and southern Canada; it is quite hardy in England. The leaves are sharply astringent and have a peculiar aromatic smell and taste due to a volatile oil known as oil of wintergreen, which is used in medicine in the treatment of muscular aches and pains. Oil of wintergreen is chiefly a synthetic product. An infusion of the leaves was used, under the name mountain tea, in some parts of North America as a substitute for tea, and the fruits are eaten under the name of deerberries. Other names for the plant are teaberry, checkerberry, boxberry, spiceberry and ground holly. Its counterpart on the Pacific coast is the salal or shallon (G. shallon), a slender shrub, one to six feet high, with black berries; it is found in the coastal redwood belt of California and northward to British Columbia. The name is also applied to the pipsissewa (*q.v.*).

WINTERHALTER, FRANZ XAVER (1806–1873), German portrait painter of the French second empire, was born at Menzenschwand, Black Forest, April zo, 1806. In 1823 he went to Munich to study under Stieler, and later he established himself in Karlsruhe, where he became a protégé of Grand Duke Leopold. Winterhalter excelled in the representation of elegant ladies, and his portraits include those of Louis Philippe (Calais), Prince Albert (National Portrait gallery, London), Queen Victoria, Napoleon III and others. Probably the best known is that of "Empress Eugénie and Her Ladies." He died at Frankfurt on July 8, 1873.

WINTER'S BARK, the bark of Drimys *winteri,* an evergreen tree belonging to the magnolia (*q.v.*) family (Magnoliaceae). It was formerly officinal in Europe, and is still held in esteem in Brazil and other parts of South America as a popular remedy for scurvy and other diseases. The plant is a native to mountains and highlands from Mexico to southern Chile.

WINTER SPORTS. Throughout the world nearly every country with sufficient snow and freezing conditions has some form of winter sport. Though there are many, the major winter sports are generally considered to include skiing, skating, tobogganing, coasting, ice hockey, curling and ice yachting. (This article deals with the history of winter sports in general and briefly with each of the major sports, all of which are covered in detail in separate articles; *e.g.,* ICE HOCKEY, ICE SKATING, SKIING, etc.)

The date of origin of each winter sport is obscure. Many centuries were required for the development of the first crude paraphernalia for moving over snow and ice. Man's early need for a means of travelling and for conveying goods in winter gave birth to the original skis, snowshoes, toboggans or sledges, and skates. The first skis, according to authorities of the Djugarden museum at Stockholm. Swed., may be traced to a period several thousand years in advance of the Christian era. Some ethnologists claim that the first skis date back to the Stone Age, citing certain carvings as evidence. There are many early references, to some type of snowshoes or skis used by the Mongols of northwestern Asia, the inhabitants of the Scandinavian countries and northern Europe. There are also references to several types of skates, which like the early skis and snowshoes were fashioned from the bones of animals, bound on the feet with strips of leather and used for sliding on ice surfaces. Bone skates appeared in Sweden sometime between the 8th and 10th centuries and elsewhere in Europe at a later date. The Dutch versions. which were to become commonplace on the many frozen canals and waterways, are mentioned in the 16th century.

In the United States and Canada the Indians used several types of snowshoes and possibly some type of ski when the first colonists appeared. It seems likely that in the other countries with a snow belt the first skis and other early types of sleds and skates were introduced at a much later time, and only after considerable development of various forms of sport, as distinguished from practical applications. Japan. Australia. New Zealand and certain mountainous regions of South America are examples.

It was only after continuous usage throughout many centuries ior practical purposes of conveyance and travel. and many modifications from bone to wood to metal, that skis, sledges and skates were adapted to the first simple forms of winter sports. Man's fascination with snow coupled with competitive spirit and a desire for recreation brought the development of each winter sport in their present recognizable forms by the 18th and 19th centuries. As late as this. however. winter sport was still little more than informal play on snow and ice. except for occasional organized competition. Equipment used in the various winter sports, even at the beginning of the 20th century. was relatively crude and non-standardized. Modern inventiveness, improvements in fabrication and manufacturing and the adaptation of steel and other light metals were necessary to help standardize the equipment. At the same time basic rules of play were evolving on a limited scale. This concept of forming rules led toward the standardization of certain sports. such as ski jumping and cross-country ski races. The first official Norwegian contests, held at Holmenkollen in 1892. aroused popular interest. and the award of the king's cup helped make skiing a national sport in Norway.

Speed skating gained earlier recognition when. in 1814, the first skating competition in England was recorded Only a few years later. Nemburgh. N.Y., became the US. headquarters for speed skating Tobogganing might be said to have come of age in 1884, when the construction of the famous Cresta run was begun at St. Moritz Switz. With the formation of the Amateur Curling club of Scotland in 1834 and the Grand Caledonian Curling club in 1838, curling was well on its way to becoming the national sport of Scotland. In the middle 1800s ice hockey was also beginning to emerge as a team sport in Canada: although it should be noted that a simple form of the game was played in Europe during the middle ages. Ice yachting. which probably originated in the Netherlands, was recognized as a sport by the mid-I700s.

Winter sports, nevertheless, were plaved with few exceptions under local rules until the late 1800s. National and international competitions'on a grand scale were infrequent until the 20th century. when they started to gain stature and recognition. Norway had already given skiing events a national status. A small group of outstanding speed skaters and bobsledders had crossed national boundaries to gain international recognition. The concept of team sports, as in the case of hockey, curling and. in a sense, ice yachting, was responsible for attracting both participants and spectators.

Important factors which influenced and encouraged the growth of winter sports were improved means of communication and travelling, so that both players and ideas moved faster. The national presses and international news services gradually began to record a few of the winter sports contests and speed records. The decision of the delegates to an international athletic congress in 1894 to hold the first modern Olympic games in Athens, in 1896, was another important factor in the growth of winter sports. Though the Olympics of 1908 included only an ice skating program, it was inevitable that ainter games would eventually be included in the world championships. (See OLYMPIC GAMES.)

Other factors which influenced the growth of winter sports in general were the increased standards of living in the 20th century and more leisure time. Club organizations stimulated the development of basic rules and formal codes, which in turn led to competitive meets between individuals and teams. National pride, coupled with the rebirth of the Olympics. seemed to further interest in sports in general More countries became known as "sporting countries." Physical fitness and prowess began to take on the importance attached to it centuries ago when the first Olympiads were held in ancient Greece. Winter sports were to profit greatly from the general interest in sports. A report of a downhill ski racer attaining speeds in excess of 60 m.p.h over a measured course dramatically drew attention. News of an ice yacht racing a steam-driven railroad train was enthusiastically received. And the idea of a ski jumper spectacularly flying through the air for more than 100 ft. excited tremendous acclaim and interest.

Motion pictures. in addition to accounts in newspaper and sporting periodicals, also did much to focus attention on winter sports and promoted further interest and participation.

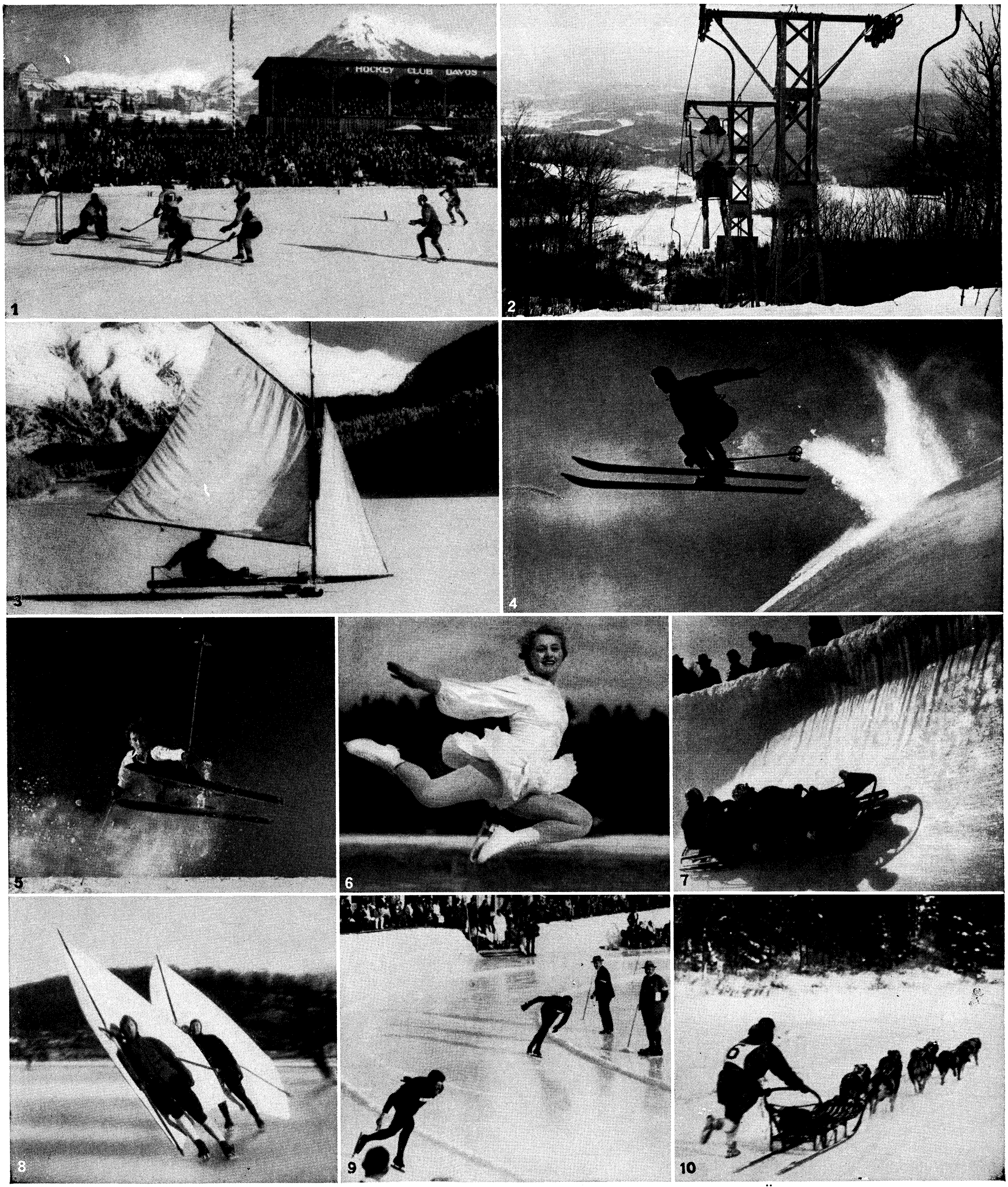
Skiing. — An outstanding individual sport, skiing grew in popularity at an astounding pace after the winter Olympic games at Chamonix, Fr., in 1924, and the founding of the Federation Internationale de Ski in the same year. Modern skiing could be said to date back to that time, for previously there was little standardization of equipment. basic techniques were only beginning to take form and teaching methods were still to be developed. The sport of skiing flourished thereafter and by the end of World War II skis the world over had become more or less uniform in length, width and general conformation. Whereas formerly they had been made of many kinds of wood, maple, ash, pine and hickory. the latter became the wide choice. Selected hickory, exported from southern U S. and usually laminated, became a standard material. Many manufacturers made skis of magnesium. aluminum, Fiberglas, or of combinations of wood laminates with metal alloys. In every case, good skis have hard steel edges to ensure better control. Length, width and weight of skis vary according to the height and weight of the skier, his proficiency, the kind of skiing terrain and purpose; *i.e.,* for downhill, slalom or cross-country skiing or for jumping. Downhill and slalom skis usually have one groove in the centre of the bottom running from the heel (or back) up to the shovel (or start of the upturned tip at the front), though some designs have a multigrooved base. Cross-country skis are longer and narrower, and jumping skis are heavier and have several grooves in the base. Plastic soles, for protection and wear resistance, are common, although many types of lacquer bases on conventional wood skis accomplish the same purpose

There are many types of ski bindings, varying according to purpose; *i.e.,* downhill. cross-country or jumping. And for each purpose there are many different designs, especially in the case of downhill bindings. The binding, in any case, is the device fitted on the top of the ski, which receives the boot and marries the skier to his skis. Little vertical movement and no lateral movement of the boot is allowed. Cross-country and touring bindings are designed to allow considerable vertical movement of the heel in order to increase mobility and freedom of movement in a more normal walking-sliding manoeuvre and to facilitate climbing. Relatively new "safety" bindings are of still different designs. Though many of the safety release devices vary radically, their purpose is common—to release the boot and skier from the skis in the type of fall which might otherwise result in a bone-shattering accident. Though many skiers continued to use the older, conventional bindings, the trend among average skiers was toward the use of safety bindings. Many experts and most racers steadfastly clung to the "long-thong" binding, which literally straps the boot, and hence the skier, to his skies. Experience and skill, in this case, is counted on to outweigh accident prevention.

Poles, roughly varying in length from 4 to 5 ft., are made for the most part from steel and tonkin. The purpose of the poles, carried in each hand, is to assist in propelling the skier forward by employing them in a rhythmic pushing motion and as an aid in climbing. They also help to give added balance and can be employed in other manoeuvres such as pole-jumps. Boots are an important part of the skiing equipment. Most of them have double lacings or "inner boots" and are reinforced with steel shanks in the soles to allow for greater stability and support.

The idea of the ski school was originated by a number of skiing pioneers. Sondre Norheim, Mikkel Hemmestvedt, C. C. T. Bjerknes, O. Kjelsberg and others are credited with contributing the Norwegian concept of skiing, which spread to central Europe and other parts of the world. In central Europe, Wilhelm Paulke and Henry Hoek of Germany, Col. Christopher Islin of Switzerland, Mathias Zdarsky, Col. Georg Bilgeri and Hannes Schneider of Austria, Sir Arnold Lunn of Great Britain and Émile Allais of France, along with many others, contributed much to the development of modern skiing and teaching methods. The so-called Norwegian, Swiss, French and the Arlberg schools evolved basic techniques which, along with modifications and adaptations in the United States. Canada and elsewhere in the snow-covered regions of the world, are taught regularly in ski schools.

Each school or technique is by no means confined within national boundaries. The fimile Allais technique, for instance, was officially adopted by the French Ski federation as the French method in 1937, but soon spread to many other countries to be taught as one of several popularly accepted techniques. The



BY COURTESY OF (1, 3, 4, 7) SWISS FEDERAL RAILROADS (2) MONT TREMBLANT LODGE. (6) LAKE PLACID CLUB PHOTOGRAPHS, (1) E. MEERKÄMPER, (2) VILLA DU LAC PHOTO SERVICE, (3) A. STEINER, (4) A. KLOPFENSTEIN, (5) ODIE MONAHAN, (6) I. L. STEDMAN, (7) BLAU, (8, 9, 10) UNDERWOOD & UNDERWOOD

WORLD-WIDE PARTICIPATION IN WINTER SPORTS

1. Ice hockey match at Davos, Switzerland
2. General view of chair lift on Mt. Tremblant, Quebec
3. Ice sailing at St. Moritz, Switzerland
4. A skier at Adelboden in the Bernese Oberland, Switzerland
5. Tom Murstad, Norwegian skier, in single pole jump turn
6. Mlle. Melitta Brunner in a fawn leap on Lake Placid Club rink
7. American four-man team at the famous sunny corner of bobsleigh run at St. Moritz, Switzerland
8. Dave Cruickshank and W. C. Capes skate sailing on Lake Hopatcong, N. J.
9. International speed skating contest on the rink at Davos, in the Grisons, Switzerland
10. Hiram Mason, Jr., in dog-sled derby at Lake Placid, N. Y.

Alpine method, fathered by Zardsky and Bilgeri, was perfected and transformed into the Xrlberg method. notably by Schneider. It was the Xrlberg method which was to have tremendous influence. on U.S. and Canadian skiing and, in turn. to reach other parts of the world. The Swiss Ski school, founded by Christian Rubi, Fritz Steuri and Rudolf Rominger, also remains one of the most solidly based techniques. The modern school of Norwegian skiing owes much of its free-style design to Eric Horn, Einer Bergsland and Jacob Rytter Kielland.

These schools. then, provided the basic systems. Other national skiing groups were free to adopt one or another. or to take certain parts of one system and combine it with another. Eventually. the streamlined Arlberg technique evolved in the United States and Canada: the Canadian Ski alliance developed its own technique, borrowing for the most part from several of the original systems. Similarly, in Italy. Sweden, Chile, Japan, Australia. New Zealand and in other countries are found an officially adopted technique or a choice of several.

In a broad sense. it should be recalled that the Scandinavian countries. particularly Norway and Sweden. contributed the concept of cross-country skiing and jumping, but in the Alpine countries of central Europe ski-mountaineering and downhill and slalom skiing were developed and refined. The credit for the concept of controlled downhill running goes to the Austrians. Swiss. Germans and French for the most part. Though the word "slalom" originated in Norway and the technique was developed there in simple form, the main credit for the concept of modern slalom racing belongs to an outstanding group of British ski pioneers, led by Sir Arnold Lunn, the inventor of the modern slalom.

Much of the growth and popularity of modern skiing may be attributed to ski clubs and associations. Though not the earliest, the Ski Club of Great Britain, founded in 1903, is typical of a number of clubs which played a vital role in bringing about unification and standardization and the acceptance of rules and procedures for racing events. Other important clubs include the Kandahar Ski club (Switz.), the Ski Club Munich, the Downhill-only club (Wengen, Switz.), the Norwegian Ski association. the Swiss Ski club (Glarus), the National Ski association (U.S.), the French Ski federation and the Canadian Amateur Ski association.

Pressures brought from certain of these great ski clubs in part resulted in the formation of the Federation Internationale de Ski (F.I.S.) in 1924. with a membership of 26 countries. This first world-wide governing body assumed responsibility for world championship competitions in downhill, slalom! jumping and cross-country.

The inclusion of several Scandinavian events at the first winter Olympic games at Chamonix, Fr., in 1924 was a milestone for skiing. It required the so-called Kandahar revolution, and the insistence of many prominent European sportsmen, to gain recognition of the Alpine events, downhill and slalom. by the International Olympic committee. finally accomplished at the 1936 Olympic games in Garmisch-Partenkirchen. Ger. Special mention should be made of the founding of the Kandahar Ski club in 1924 in Murren. Switz., for it presaged the advent of several "unofficial world championships" in downhill and slalom racing. such as the Arlberg-Kandahar which followed in 1928. Some observers felt that the Xlpine forms of competitive and pleasure skiing supplanted in popularity the classic Scandinavian events, cross-country and jumping. In Scandinavian countries. however, these time-honoured events continued. with undiminished popularity. to hold public interest and enthusiasm. (See SKIING.)

Ice Yachting. — Sometimes called iceboating, ice yachting is primarily a racing sport. It apparently originated in the Baltic countries and the Netherlands. The earliest designs, dating back to about 1768. show that a conventional sailboat, usually sloop-rigged, was converted into an ice yacht simply by fastening a strong cross plank. with runners on each end, to the hull near the bow. The same rudder with an iron shoe attached to the bottom became the steering mechanism. The speed of these boats over the ice was comparatively slow.

In 1928 a group of European ice yachtsmen met in Riga. Latvia, and organized the Europnischen Eissegel union for the purpose of promoting international competitions. By 1933 Sweden, Latvia, Lithuania, Estonia, Germany and Austria were represented in the union. Their annual competitions were confined to several classes, including a one-design class similar to the American Class C.

Typical European iceboats are steered by wheel from a partially enclosed cockpit fitted into a fuselage-type hull or "backbone." usually carry a "cat," or Marconi rigged single sail (with full-length battens). and have a streamlined pivoting mast. Some designs allow for one passenger in addition to the pilot.

Ice yachting in the United States and Canada was centred on the Great Lakes area. as well as in New York and New Jersey. The early history of racing competitions and speed demonstrations is colourful. X number of famous Hudson river families provided the classic "big yachts" characteristic of the late 1800s and the early years of the 20th century. Though the ice yachts were very fast, they gave way rapidly to the trend toward smaller. less expensive craft. Their design was superseded by Starke Meyer's invention of a bow-steered boat in Milwaukee, Wis., about 1931. Thereafter the size of the boats and the sail area continued to be reduced. By the 1950s the single-seater skeeter (75 sq.ft.) class and the Yankee two-seater were among the most popular craft. The fast, lighter, trimmer and more manoeuvrable iceboat promised to widen the appeal of this winter sport. Nearly four times the speed of the available wind could be reached (providing over-the-ice speeds oi as high as 140 m.p.h.). In the United States many active clubs were listed by the Eastern Ice Yachting association and the Northwestern Ice Yachting association. (See ICE YACHTING.)

Ice Hockey. — Ice hockey is a fast and rigorous game. Played by teams of men exclusively. the game has attracted an increasingly large and enthusiastic following, especially in Canada, where it became the national sport.

The development of the modern game of ice hockey is credited to that country. The Royal Canadian Rifles. of Kingston, Ont., claim the first recorded ice hockey activity as early as 18jj. At McGill university in Montreal. the first ice hockey match played under a formal set of rules was held about 187j. In early contests, as many as 1j players on a side were allowed. Shiny sticks, or crude bent branches. were used. The 1j-man sides soon proved unwieldy and the number of players on a team was reduced to 7 and eventually to 6. After 1926 six was the universally accepted number for teams.

By 1885 popular acclaim for the sport resulted in the organization of the first ice hockey league in Kingston, Ont. The sport soon spread throughout Canada. In the eariy 1890s a group of visiting U.S. college students witnessed, and played in, a few games in Canada. After their return to the U.S. the game was introduced at Yale and Johns Hopkins universities and a number of colleges. Amateur clubs were formed and soon stimulated enough interest in the sport to warrant the growth of professional play.

By 1891 international matches were taking place in Europe. In that year the Bandy association was formed in England and a contest was held with a team from Holland. At about the same time Norway, Sweden. Denmark and Switzerland were beginning to organize the sport. During these years, however, Canada, and the United States to a lesser extent. took the lead, and new amateur and professional teams continued to appear. The presentation of the Stanley cup to the team winning the championship of Canada in 1893 set a precedent for an award which still marks world supremacy among the professional ranks. The National Hockey league, comprised of U.S. and Canadian teams, was formed originally as a Canadian league in 1917.

Internationally. amateur teams are controlled by the Ligue Internationale de Hockey sur Glace. In modern Olympic games Canada proved the most consistent winner. (For rules of the game and technique of play, see ICE HOCKEY.)

Bobsledding.—After the introduction of the automobile, the old sport of coasting or sledding down hilly roads covered with snon· or ice declined in popularity. Although many still enjoy riding sleds or toboggans. the most organized form of coasting came to be knon·n as bobsledding.

The toboggan (forerunner of the bobsled) was originally a utility vehicle, used for the most part to carry supplies. In fact, the toboggan is still used in many parts of the world for practical purposes. But the toboggan, made of narrow strips of wood fitted together and curved in the front, has for many centuries lent itself to the sport of coasting. It can be pulled or allowed to run freely and guided down almost any snow- or ice-covered incline.

In 1884 a group of vacationers in Switzerland laid out a toboggan run near St. Moritz. The thrill of the new sport was immediately apparent, both for participants and spectators. The Toboggan club at St. Moritz was formed soon after. Some of the avid thrill-seekers devised a method of fastening sledlike runners on the toboggan frame to provide a much faster and more dangerous run. However, the addition of ballast on a heavier designed frame produced a more acceptable sled, called a bobsleigh, and a new club was organized, named the St. Moritz Bobsleigh club. It was the design, laid out by this club, that called for the building of the famous Cresta run.

Bobsledding continued to gain in popularity, and by the time of the first winter Olympics, in 1924, there were a number of well-designed runs in Europe. At these games a Swiss four-man team won the event, marking the first recognized international championship. Organized in 1923, the Fédération Internationale de Bobsleigh et Tobogganning (F.I.B.T.) became the official organization of the sport.

By the beginning of World War II there were about 60 recognized runs in Germany, France, Italy. Austria, Switzerland. Norway and Sweden. A U.S. run. the Mount Van Hoevenberg, was built near Lake Placid, N.Y. In Canada there are a number of well-maintained toboggan chutes or runs.

The bobsled went through many stages of design and improvement. When the U.S. team came to the 1936 winter Olympics with an extremely sharp V-type edge bobsled the F.I.B.T. disqualified it, for it mas discovered that, while increasing speed greatly, the sled also damaged the runs. Thereafter, a less sharp runner mas adopted, approved and standardized. The wooden plank forming the body between the front and rear runners gave way to a steel plank, affording more flexibility. Push-handles were introduced to give faster starts, closely followed by independent knee-action on each runner to allow more speed through reduction of friction. These innovations were ultimately followed by streamlining of the cowl which resulted in a functional design for high speed.

The recognized events call for the skeleton (one-man), t o-man and four-man teams. In competition, speeds reaching close to 90 m.p.h. are attained; thus the sport demands great skill. judgment, split-second precision of manoeuvring and co-ordination of effort. Especially is this true in the four-man event. where the driver, number 1 and number 2 man. and the brakeman must "bob" to gain speed, *i.e.,* thrust their combined weight forward with exact timing. (See also BOBSLEDDING.)

Curling. — Curling is a winter sport of great antiquity. A curling stone with the date "1551" etched'upon it was found in the bottom of a pond near Dunblane. Scot.. in the 1880s. Though its exact place of origin is disputed. curling, it is generally conceded, was developed primarily by the Scots.

Curling, often referred to as "the ageless game," seems to possess endless fascination. Although less spectacular than certain other winter sports. there is a spirited atmosphere attached to it and even the most hotly contested game is traditionally played with a feeling of warmth and friendliness.

The oldest curling club extant is the Dudingston Curling society, founded in Edinburgh in 179j. The Amateur Curling club of Scotland was formed in 1834 but did not survive. The Grand Caledonian Curling club. organized in 1838, upon receiving royal approval in 1842 officially changed its name to the Royal Caledonian Curling club. Much of the growth of the sport can be attributed to the more than 1.000 member-clubs who hold allegiance to their "mother club." the Royal Caledonian.

Switzerland. France, Germany. Belgium, the Netherlands. the Scandinavian countries. Canada and the United States adopted the sport. In Canada alone there were more than 1.500 clubs in the latter 1950s.

Since curling was first played outdoors, it was often necessary to clear snow off the ice and then clean it. From that came the idea of using a broom, which is still an important piece of equipment for the modern game. Brooms are not only used to clear frost in front of the moving stone but as a designator in the hands of the "skip," or captain, for directing the plays. (For equipment, rules of the game, technique of play, glossary, etc., see CURLING.)

Skating. — The first skating club was organized in Edinburgh in 1642. By that time the wooden-bladed skate had been superseded by the iron skate. Iron skates were used in Canada and the United States before the 19th century. It was not until 1850, however, that steel-bladed skates appeared. They were invented by E. W. Bushnell. of Philadelphia. Pa. With this radical improvement, skating began to make more progress toward becoming an accepted sport.

Modern figure skating was developed by a U.S. ballet master, Jackson Haines. While he was in Vienna in 1864, Haines discovered that the more-or-less aimless fashion of skating needed only to be put to waltz music to transform it into precise. rhythmic movements. The result was the first concept of figure skating, sometimes called fancy skating. His innovation soon spread throughout Europe, the United States and Canada.

Many skating clubs and organizations undertodk the responsibility of setting the standards and prescribing rules. Their recommendations and rulings transformed a somewhat haphazard recreation into a highly developed sport. The International Skating union of Europe, the National Skating association of Great Britain, the U.S. Figure Skating association, the Canadian and the U.S. Amateur Skating unions played an important role in its development.

The introduction of artificial skating rinks (indoor as well as outdoor) was important for figure skating. Built in heavily populated areas and at many of the famous resorts, and making precise control of ice conditions possible. such rinks encouraged the promotion of ice carnivals and public demonstrations. Outstanding individual performers, notably Sonja Henie, captured public attention, an outgrowth of which was numerous highly successful ice shows. As in the case of figure skating, speed skating also profited greatly from the building of artificial rinks.

From the first winter Olympics in 1924, skating races became an important part of the program. (See ICE SKATING; OLYMPIC GAMES.) (J. D. O'R.)

WINTERTHUR, a flourishing industrial town in the Toss valley, canton of Ziirich, Switz., and by rail 17 mi. N.E. of Zurich. It is 1,450 ft. above sea level and has a rapidly increasing population (in 1870, 19.496; in 1880, 25,924; in 1900, 40.961; in 1920, 49.969; in 1930, 53,925; in 1941, 59,192; and in 1950, 66,925), nearly all Gernian-speaking and two-thirds Protestants.

The Roman settlement of *Vitudurum* (Celtic *dur,* water) was a little northeast of the present town, at the place now known as Ober Winterthur. It was refounded in the valley in 1180 by the counts of Kyburg (their castle rises on a hill, 4 mi. to the south of the town). who granted it great liberties and privileges, making it the seat of their district court for the Thurgau. In 1264 the town passed with the rest of the Kyburg inheritance to the Habsburgs. who showed very great favour to it and thus secured its unswerving loyalty. It was a Habsburg stronghold for two centuries; but after the conquest of the Thurgau by the Swiss Confederates (1460–61) it was sold to the town of Zurich (1467), its rights and liberties being reserved, and its history after that was that of the other lands ruled by Ziirich.

Winterthur is the point of junction of several railway lines.

WINTHER, CHRISTIAN (1796–1876). Danish lyrical poet. was born on July 29, 1796, at Fensmark. Praesto. He went to the University of Copenhagen in 1815 and studied theology, taking his degree in 1824. He began to publish verses in 1819, but no collected volume appeared until 1828. In 1851 he received a pension from the state, and for the next quarter 'of a century he resided mainly in Paris. In addition to nine or ten volumes of lyrical verse, Winther published *The Stag's* Flight (185j), an epical romance in verse; In *the Year* of *Grace* (1874), a novel; and other works in prose. He died in Paris on Dec. 30, 1876, but was buried in Denmark in the heart of the woods.

WINTHROP, JOHN (1588–1649), Puritan leader and first governor of Massachusetts, was born in Edwardston, Suffolk, Eng., Jan. 12 (old style), 1588. In 1602 he matriculated at Trinity college, Cambridge, but he did not graduate. He next practised law and achieved considerable success, being appointed, about 1633, an attorney in the court of wards and liveries, and also being engaged in the drafting of parliamentary bills. His income rose to the sum of £700 a year, when, for reasons now unknown, he suddenly in 1629 lost his appointment. A Puritan, he had made wide acquaintance among the leaders of the Puritan party. On Aug. 26, 1629, he joined in the "Cambridge agreement." by which he and his associates pledged themselves to move to New England, provided the government and patent of the Massachusetts colony should be removed there. On Oct. 20, 1629, he was chosen governor of the "Governor and Company of the Blassachusetts Bay in New England," and sailed in the "Arbella" in March 1630, reaching Salem, Mass.; June 12 (old style). accompanied by a large party of Puritan immigrants. After a brief sojourn in Charlestown, Winthrop and many of his immediate associates settled in Boston in the autumn of 1630. There he lived until his death on March 26 (old style), 1649.

Winthrop's history in New England was largely that of the Massachusetts colony, of which he was 12 times chosen governor by annual election, serving in 1629–34, 1637–40, 1642–44 and 1646–49, and dying in office. He was usually deputy governor and always assistant when not actually governor. He gave all his strength, devotion and fortune to the colonies. He was conservative and somewhat aristocratic, but just and magnanimous in his political guidance even under circumstances of great difficulty. In 1634–35 he was a leader in putting the colony in a state of defense against possible coercion by the English government. We opposed the majority of his fellow-townsmen in the so-called "Antinomian Controversy" of 1636–37 (*see* HUTCHINSON, ANNE). He was the first president of the Commissioners of the Cnited Colonies of New England organized in 1643. He defended Massachusetts against threatened parliamentary interference once more in 1645–46. The colony's early success was due largely to his skill and wisdom.

Winthrop's *Journal*, an invaluable record of early Massachusetts history, was printed in part in Hartford in 1790; the whole in Boston, edited with valuable notes by James Savage, as *The History of New England from 1630–1649*, in 1825–26, and again in 1853; and in New York, edited by James K. Hosmer, in 1908. Many letters to him are iound in the *Winthrop Papers* published by the Massachusetts Historical Society (*Collections*, series 4, vol. vi and vii; series 5, vol. i, 1863–71). His biography was written by Robert C. Winthrop, *Life and Letters of John Winthrop* (1864, new ed. 1869); and by Joseph H. Twichell, *John Winthrop* (1892). *See* also Mrs. Alice M. Earle, *Margaret Winthrop* (1895).

WINTHROP, JOHN (1606–1676), known as John Winthrop the Younger, son of the preceding, born at Groton, formerly a small rural village lying about midway between Wadleigh and Sudbury in Suffolk. Eng., Feb. 12, 1606. He attended the Bury St. Edmunds grammar school and Trinity college, Dublin, studied law for a short time after 1624 at the Inner Temple, London, accompanied the expedition of the duke of Buckingham for the relief of the Protestants of La Rochelle. In 1631 he followed his father to Massachusetts and was an "assistant" in 1635, 1640, 1641 and from 1644 to 1649. He was the chief founder of Agawam (now Ipswich), Mass., in 1633; went to England in 1634 and returned the following year as governor (for one year) of Connecticut, under the Saye and Sele patent, sending out the party which built the fort at Saybrook. He was again in England in 1641–43, and on his return to Massachusetts established ironworks at Lynn and Braintree. He became magistrate of Connecticut in 1651; in 1657–58 was governor of the colony; and in 1659 again became governor, and was annually re-elected until his death in Boston on April 5, 1676. In 1662 he obtained in England the charter uniting the colonies of Connecticut and New Haven. In 1675 Winthrop was further honoured by being chosen a commissioner of the United Colonies of New England. In England he was elected to membership in the newly organized Royal Society.

His correspondence with the Royal Society was published in series 1 vol. xvi of the *Massachusetts Historical Society's Proceedings*. *See* T. F. Waters' *Sketch of the Life of John Winthrop the Younger* (Ipswich, Mass., 1899); *John Winthrop* by E. T. James (London, 1925); *John Winthrop, Jr.* by F. J. Kingsbury—Amer. Antiq. Soc. (Worcester, 1898).

WINTHROP, ROBERT CHARLES (1809–1894), U.S. orator and political leader, a descendant of Gov. John Winthrop (1588–1649), was born in Boston. Mass., on May 12, 1809. He graduated at Harvard in 1828, studied law with Daniel Webster and in 1831 was admitted to the bar. He was a member of the Massachusetts house of representatives in 1834–40—for the last three years as speaker.

From 1840 to 1850, except for a short intermission (April–Dec. 1842), he was a representative in the lower house in congress. He soon became prominent and was speaker of the 30th congress (1847–49), though his conservatism on slavery and kindred questions displeased extremists, north and south, who prevented his re-election as speaker of the 31st congress. In July 1850 he was appointed to the seat in the U.S. senate left vacant by Daniel Webster's resignation, but was defeated in the regular election held in the following year by a coalition of Democrats and Free Soilers.

In the same year (1851) he was defeated for governor of Massachusetts by the same coalition. Thereafter he was never a candidate for political office. With the breaking up of the Whig party he became an independent, and supported Millard Fillmore in 1856, John Bell in 1860 and Gen. George B. McClellan in 1864. He was president of the Massachusetts Historical society from 1855 to 1885.

He died in Boston, on Nov. 16, 1894.

Among his publications were *Addresses and Speeches* (1852–86); *Life and Letters of John Winthrop* (1864–67); and *Washington, Bowdoin and Franklin* (1876).

See Robert C. Winthrop, Jr., *Memoir of R. C. Winthrop* (1897); C. F. Adams, Jr., *Theodore Lyman and Robert Charles Winthrop, Jr.* (1906).

WINWOOD, SIR RALPH (c. 1563–1617), English politician, was notable for his hearty dislike of Spain. He was born at Aynhoe in Northamptonshire and educated at St. John's college, Oxford.

He was a fellow of Magdalen college, 1582–1601. In 1599 he became secretary to Sir Henry Neville (c. 1564–1615), the English ambassador in France, and he succeeded Neville in this position two years later, retaining it until 1603. In that year Winwood was sent to The Hague as agent to the states general of the United Provinces, and as the English member of the Dutch council of state according to the 1585 treaty.

He was anxious to see a continuance of the war between Spain and the United Netherlands, and he expressed both his own views and those of the English government at the time when he wrote, "how convenient this war would be for the good of His Majesty's realms, if it might be maintained without his charge." In June 1608 Winwood signed a new treaty between England and the United Provinces, and he was in Holland when the trouble over the succession to the duchies of Jiilich and Cleves threatened to cause a European war. In this matter he negotiated with the Protestant princes of Germany on behalf of James I.

Having returned to England, Sir Ralph became secretary of state in March 1614 and a member of parliament. In the house of commons he defended the king's right to levy impositions, and other events of his secretaryship were the inquiry into the murder of Sir Thomas Overbury (*q.v.*) and the release of Sir Walter Raleigh (*q.v.*) from the Tower in 1616. Raleigh was urged by Winwood to attack the Spanish Aeet and the Spanish settlements in South America, and the secretary's share in this undertaking was the subject of complaints on the part of the representatives of Spain. In the midst of these complex activities he died in London on Oct. 27, 1617.

Winwood's official correspondence and other papers were published by the Historical Manuscripts Commission, *Buccleugh MSS. at Montagu House*, i (1899).

See Edmund Sawyer (ed.), *Memvrials of Affairs of State*, 3 vol. (1725).

WINZET, NINIAN (1518–1592), Scottish Catholic controversialist and author of polemical tracts in the vernacular, was born in Renfrew in 1518 and was probably educated at the University of Glasgow. He taught in the grammar school at Linlithgow, but was "expellit and schott out" from this office in 1561 because of his opposition to the Reformation. He escaped to the continent, lectured at the University of Paris, studied at Douai, visited Rome and in 1577 was appointed abbot of the Benedictine monastery of St. James at Regensburg. where he remained until his death on Sept. 21, 1592.

Winzet's polemical tracts *(Certane Tractatis for Reformatioun of Doctryne and Maneris,* 1562; *The Last Blast of the Trompet of Godis Worde,* 1562; *The Buke of Fourscoir-thre Questzons,* 1563) are of some historical value, and his determined use of "auld plane Scottis" is interesting at a time when many prose writers in Scotland were turning to English.

His vernacular writings were edited by J. K. Hewison (2 vol., 1888–90) for the Scottish Text society.

See A. C. Southern, *Elizabethan Recusant Prose (1950).*

(E. G. M.)

WIRE. The first known writing relating to wire and its manufacture appears in the Bible (Ex. xxxix, 3): "And they did beat the gold into thin plates, and cut it into wires. . . ." When round wire was required, the plates probably were cut into narrow strips. which were then hammered and filed to form threads or wire. Since these wires were very short, it was necessary to braze or hammer several pieces together to make longer lengths. Later, instead of hammering and filing to shape. the narrow strips were pulled through shaped holes in dies made of a harder material, the strips taking the shape of the hole through which they were pulled. It is believed that the first such dies were made of stone. since no other explanation has been accepted for the perforated stones found in ancient sites. Eventually wire-drawing dies were made of metal, usually hard iron.

For several centuries wire was drawn through such dies by manual labour, and always in short lengths. The section to be drawn was first pointed; *i.e.*, the end of the section was hammered down to a diameter smaller than that of the hole through which it was to be drawn. This end was pushed through the hole in the die. The wiredrawer grasped it with his hands, or with tongs, and pulled it through the die, the amount of reduction being limited by the strength of the wiredrawer.

Various means were used to augment his strength, such as seating him in a hanging chair so that by bracing his legs against the die-holding structure he could pull with his arms and push with his legs, thus having more pulling power. Again, however, the amount of wire he could draw at each pull was limited by the length of his arms and legs. He pulled out as much as he could and then grasped the remaining wire close to the die and repeated the operation until the length was completed.

There were a number of modifications of this method in use, but all depended on the strength of the wiredrawer. Consequently, except for very soft metals, no large-diameter wire could be drawn. Larger wire had to be made by hammering or rolling or both.

Water power for wire-drawing machinery was used first in Germany about the middle of the 14th century. in England in 156j and in the United States about 16j0 and. together with the advent of the steam engine in 1769, eliminated the manual-drawing practice. Wire was produced thereafter in somewhat larger sections and longer lengths, but it was still relatively small in section and short in length.

It was not until the demand for wire rope about 1840 and the development of the telegraph beginning in 1844 that the requirements for larger tonnages and longer lengths of both steel and copper wire became acute. Thereafter the invention of the telephone. barbed wire and wire fencing and a greater use of wire nails and other wire products all added to the demand for enormous tonnages of wire.

The invention of the Bessemer steelmaking process in 1856 and the Siemens-Martin (open-hearth) process in 1867 and the invention of new machinery and methods of rolling rods about 1880, along with improvements in machinery and methods for the manufacture of wire, made it possible to produce wire in large tonnages and greater lengths.

WIRE MANUFACTURE

Wire is made from various metals and alloys, such as brass, bronze. copper. aluminum and zinc, as well as steel and the precious metals. gold, silver and platinum. The description of wire manufacture which follows. however, is limited to steel, since the process used for the other metals is fundamentally the same.

TABLE I.—*Comparison of Wire Gauge Systems*

Gauge number	Steel Wire dec. inch	American or B. & S. dec. inch	Birmingham or Stubbs dec. inch	British Imperial dec. inch	Music or Piano Wire Cec. inch
7/0	.490	—	—	.500	—
6/0	.4615	.580	—	.464	.004
5/0	.4305	.5165	.500	.432	.00 j
4/0	.3938	.460	.454	.400	.006
3/0	.3625	.4096	.425	.372	.007
2/0	.331	.3648	.380	.348	.008
1/0	.3065	.3249	.340	.324	.009
1	.283	.2893	.300	.300	.010
2	.2625	.2j76	.284	.276	.011
3	.2437	.2294	.259	.252	.012
4	.22j3	.2043	.238	.232	.013
5	.207	.1819	,220	.212	.014
6	.192	.1620	.203	.192	.016
7	.177	.1443	.180	.176	.018
8	.162	.1285	.165	.160	.020
9	.1483	.1144	.148	.144	.022
10	.135	.1019	.120	.128	.024
11	.1205	.0907	.109	.116	.026
12	.1055	.0808	.096	.104	.029
13	.0915	.0720	.083	.092	.031
14	.080	.0641	.072	.080	.033
15	,072	.0571	.065	.072	.035
16	.0625	.0508	.058	.064	.037
17	.054	.0453	.049	.056	.039
18	.0475	.0403	.042	.048	.041
19	.0410	.0359	.035	.040	.043
20	.0348	.0320	.032	.036	.045
21	.0317	.0285	.028	.032	.047
22	.0286	.0253	.025	.028	.049
23	.0258	.0226	,022	.024	.051
24	.0230	.0201	.020	.022	.055
25	.0204	.0179	.018	.020	.059
26	.0181	.0159	.016	.018	.063
27	.or73	.0142	.014	.0164	.067
28	.0162	.0126	.013	.0148	.071
29	.0150	.0113	.012	.0136	.07j
30	.0140	.0100	.010	.0124	.080
31	.0132	.0089	.009	.0116	.085
32	.0128	.0079	.008	.0108	.090
33	.0118	.0071	.007	.0100	.095
34	.0104	.0063	.005	.0092	,100
35	.0095	.0056	.004	.0084	.106
36	.0090	.0050	—	.0076	.112
37	.0085	.0044	—	.0068	.118
38	.0080	.0040	—	.0060	.124
39	.0075	.0035	—	.0052	.130
40	.007	.0031	—	.0048	.138

Gauges. — The wire gauge almost universally used is the steel wire gauge. The Birmingham gauge, the only gauge recognized in the United States by an act of congress. is used for gauging imported wire. It is practically obsolete for any other use in the United States or England.

The American or B. & S. (Brown & Sharpe) gauge is used for copper wire and other nonferrous wire. By the 1950s all wire gauges were gradually passing out of use, being replaced by decimal or circular mil designations.

Rods.—Wire is drawn from a hot-rolled section of steel, called a rod. (For some of the softer metals, rods may be formed by extrusion or casting instead of rolling.) The size of the rod to be drawn into wire varies from the smallest size, 5 gauge, $\frac{7}{32}$ in. (nominal 0.218 in. diameter), to the largest size, $\frac{47}{64}$ in. (0.734 in, diameter).

When the rods leave the last pass in the rod mill they are coiled into bundles weighing from 300 lb. in some mills to 450, 600 and 1,000 lb. in others. Since rods are rolled and finished at high temperatures. about 2,000° F.. a hard oxide of iron, called scale, forms on the rod surface. This scale is very abrasive and must be removed before the wire can be drann: if not removed. it will cut the wire-drawing die during the drawing operation and also cause the wire to break.

Cleaning. — The removal of scale is known as the cleaning process. There are several methods for doing this. The most widely used method is to immerse the rods in a 3% to 10% solution of sulfuric acid and water heated to about 150" F. The acid treatment is called pickling. The acid also contains an inhibitor, an organic compound used to prevent the acid from attacking the metal after the scale has been removed.

Other acids, such as hydrochloric, nitric and hydrofluoric, are also used, depending on the material being pickled. Scale may also be removed by subjecting the rods to the action of a molten salt bath, such as sodium hydride, or to the action of mechanical descalers which break the scale from the rod by means of a deforming action. Metallic grit blasting is sometimes used to clean spring wire.

After the rods have been cleaned in the sulfuric acid bath, they are washed with water to remove the acid and are immersed in a coating solution which may be a lime emulsion, a phosphate base solution or some other.

If lime is used, the coated rods are transferred to an oven, called a baker, and heated to from 250° to 450° F., the time of heating varying from about ten minutes to several hours, depending on the kind of steel and the purpose for which it is to be used. If borax or phosphate solutions are used, baking is not always necessary. These coatings, especially the lime coating, not only help neutralize any remaining traces of acid on the rods but also act as a lubricant carrier in the subsequent wire-drawing operations. After this last step, the rods are ready for the wire-drawing operation.

Wire *Drawing.*— Either before the rods are cleaned or after they are removed from the baker, several bundles of rods are placed on holders called pins or flippers. Electric resistance butt welders are used to weld the back end of the front bundle on the pin to the front end of the next bundle and so on for the entire pin. This permits the use of long lengths of rods for mire drawing.

The wire-drawing process consists of three steps: (1) pointing the rod; (2) threading the pointed end of the rod through the die; (3) attaching the end to the drawing block.

Wire Dies.— The wire die (see fig. 1) is made from a very hard material. usually tungsten carbide, although other materials such as tantalum carbide, hard chrome steels and chilled iron may be used. For very fine wire, e g., 0.010 in. in diameter and smaller, diamond dies may be used.

The hole in the tungsten carbide die, through which the wire is drawn, is actually a taper at the entrance end and a reverse taper at the exit end, with a small surface between having the exact shape and size of the wire being drawn. There are four zones in the carbide die, the first being the cone-shaped entrance end, designed so that the rod or wire entering the die will pull in with it some of the lubricant. The second zone, which is also tapered, is the working and shaping part of the die, and it is in this section that the actual reduction takes place. The angle of this taper is an important part of the reduction in size of the rod or wire. the degree of angularity depending on the kind of steel, the amount of reduction of area required and the kind of lubricant used. Then comes a very short cylindrical zone known as the bearing. There the actual roundness and size of the wire is formed. This is followed by the exit, or reverse taper, which strengthens the exit end of the die and prevents the end of the bearing from spalling.

Since tungsten carbide is very brittle and, used by itself. would not have enough strength to be used as a wire-drawing die. a steel case is shrunk around the carbide nib to act as a reinforcing member.

Because of the heat generated by the draning process, it is usually necessary to water-cool the dies, as shown in fig. 1.

Tungsten carbide dies are made in single units— only one hole in each die. The hole may be any shape desired, round, flat hexagonal, half-round, rectangular, etc. When the tungsten carbide dies used for round wire wear out on their original size, they may be opened up for a larger size until the ultimate strength of the carbide nib is reached.

Lubricants — Bare rods or wire cannot be drawn through dies, since heat generated by friction would cause the metals to seize, or the wire would be scratched and the die worn and the wire uould eventually be off-gauge or break, or both. Many lubricants are used for wire drawing, depending on whether dry drawing or wet drawing is used.

For dry drawing the lubricants used are soap powders, usually sodium soaps, metallic stearates, lime and greases, lime and tallow, or some combination of these. For wet drawing, soap solutions, soluble oils and the like are used. The wire may be coated with copper, brass or bronze by displacement from salt solutions of these metals prior to wet drawing.

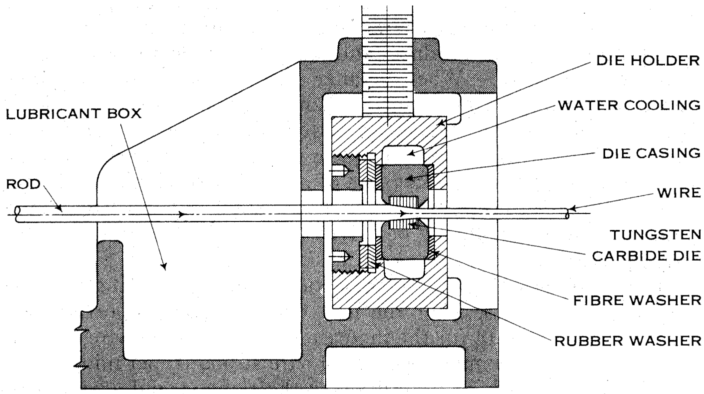


FIG. I.— CROSSSECTION OF A WIRE DIE

Wet drawing is usually associated with fine-wire drawing, but is used for coarser wire in some cases when special clean, smooth surfaces are required. The dry lubricant is carried in the lubricant box shown in fig. 1. For wet drawing the lubricant may flow on the wire in the lubricant box or it may be used inside a wire-drawing machine designed for that purpose.

Drawing Operation.—\$'ire drawing may be carried out on a single-block, single-draft unit, or on a multiple-block multiple-draft machine, depending upon the amount of reduction required.

A single-block unit is shown in fig. 2. The rod is first pointed by means of reciprocating rolls or a swager so that the pointed end of the rod can be threaded through the die and fastened to the cylindrical block.

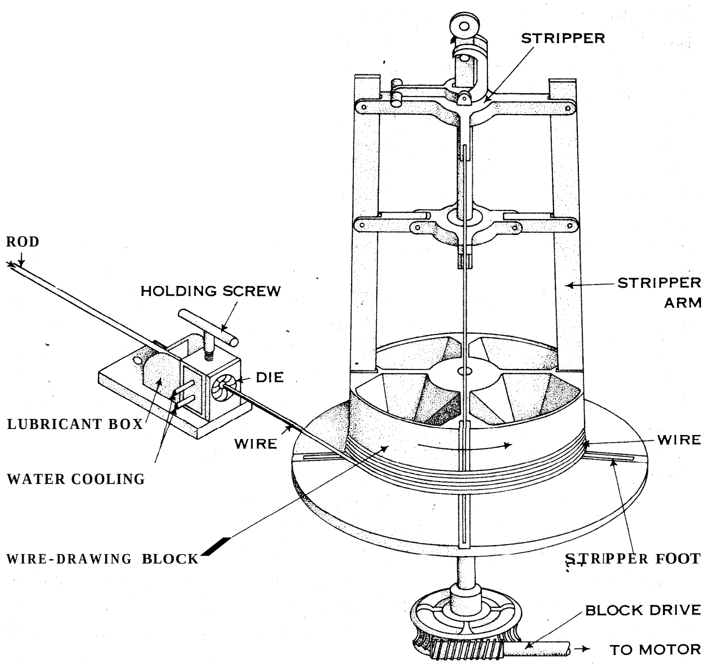


FIG. 2.— SINGLE-BLOCK WIRE-DRAWING UNIT AND STRIPPER

The block, driven by an electric motor, is revolved and pulls the rod through the die. thus reducing the rod in diameter and increasing its length in the form of wire.

The wire as it coils around the bottom of the block keeps pushing the strands up until the top of the stripper, shown in fig. 2. is reached. The block is then stopped, the wire cut, a crane lifts the stripper with the drawn wire from the block, the stripper is again collapsed and the wire deposited on a truck or other conveyance. The stripper is then replaced on the block, the wire fastened and the block again rotated.

The block, depending on the kind of wire being drawn, may be air- or water-cooled, this function taking place out of direct contact with the wire.

There is a limit to the amount of reduction the wire may be given at each draft, depending upon the tensile strength of the wire and other physical characteristics, because the drawing operation increases the hardness and stiffness and decreases the ductility of the wire. When smaller sizes of wire are required. therefore, and since the reduction cannot be performed in a single draft, a number of drafts are required. When several drafts are necessary a multiple-block machine is used. In substance. this type of wire-drawing machine consists of a number of single-block machines built together in one unit. Each block may be driven by a separate motor, or all may be driven by one motor having suitable driving gears for each block on a single shaft.

The wire. as it is reduced in section. increases in length. The speed of each block after the first one must he proportionately faster to compensate for the increase in length of the wire. so that while the first hlock may he drawing wire at 600 ft. per minute. the final finishing block may be drawing the same strand at 1,500 ft. per minute.

The first block in the multiple machine may be a double block! that is. one block superimposed on the other. In this case, the wire passes through the first die and around the top of the two blocks. the latter being. in effect. a short cylinder or spool. The wire is given a few wraps around this spool. then pointed. passed through the bottom die to the bottom hlock and then for each single block of the series to the stripper block.

As a rule. the wire-drawing luliricnnt is required only for the first draft. since enough will be carried over on the wire to finish the entire drawing. If. for some reason. more lubricant is required. it can be added at any of the subsequent drafts.

For wet drawing fine n-ire. the same principles are used, hut the wire-drawing machinery is different. The blocks, instead of being vertical. are usually horizontal and are revolved in the drawing solution. Or the blocks may consist of two step-down cones, parallel in position and opposite each other.

The wire passes from one cone to the other and back again alternately. and passes through a die between each reversal until the wire reaches the final hlock. which is usually vertical and on the outside of the machine. The cone blocks and the dies which are enclosed within the wire-drawing machine are kept constantly drenched with lubricant. Instead of coiling on the final hlock. the wire may he wound directly on a removable spool, or it may be given a few turns around the finishing hlock before passing to the spooler.

Annealing and Heaf *Treating.*—Wire cannot always be finished directly from the rod since the steel becomes so hard before the finished size is reached that unless softened it will break. Softening is accomplished by heating the wire to a point below the critical range for a period of time long enough to relieve the drawing strains. This operation, while not true annealing (softeningj, is suitable for the subsequent drawing operation. In some cases, especially for high-carbon or alloy-steel nire, several annealings may be necessary. each at a different step of the wire-drawing process. This is known as process annealing.

In some cases, such as for certain cold-heading stock, rope wire or spring wire, the rods are given a special heat treatment called patenting before the drawing operation. Or, for stock to be subjected to cold heading, or similar operations, the rods or wire may be spheroidized.

MANUFACTURERS' WIRE

This type of nire is used for the manufacture of wire products. such as merchant wire, which is used to make fence wire, barbed wire. bale ties, wire nails. wire for concrete reinforcing, stucco mesh. etc.

Manufacturers' wire is finished as bright wire, bright basic wire, annealed or othernise heat-treated wire, mire requiring highly finished surfaces, such as that used for electroplating; rope wire, spring wire, bolt and screw wire, telephone and telegraph wire, music wire. box nire, florists' wire, cotton-pin wire, welding wire and wire for many other purposes.

Wire can be made in almost any shape desired and to any analysis. and with specified physical characteristics, although it is not customary to specify both chemical and physical requirements for the same wire.

Some of the products made from this wire are not new. In England in 1565, for example. mire was used to make "knitting needles, nayles, pack-needles, chaynes, burde caiges, mouse trappes, buckles, iron rings, and like iron wyre wares."

The steel for manufacturers' mire may be made by the basic or acid open-hearth process, basic or acid electric-furnace process, the Bessemer process or a modified Bessemer process. It may be made from low-. medium- or high-carbon steel or one of the many alloy steels. It may be wet drawn, dry drawn or drawn and rolled, as is the case with some shaped nire.

It may be hard, soft, medium hard or tempered to suit specific requirements. The coils of wire may be pot annealed. strand annealed through molten lead or molten salt, sull finished, liquor finished (copper, brass or bronze-colour finish), galvanized (zinc coated), tin coated, lead coated or aluminum coated.

FENCING AND NETTING

Kinds of Fences.— Landed property formerly was marked out by stones or posts, set up so as to ascertain the division of family estates. Later, fences or enclosures were built either from stones, hedge, sod, turf, wood or other easily available materials. The building of fences from most of these materials involved the clearing of the land and other backbreaking labour.

What was true for the labour required for rail fences was also true for stone, turf, stump and other types of fences. Hedge fences, of course. were a product of the soil. being principally prickly pear or Osage orange. They required a long time to grow and it took a great deal of time and labour to maintain them. Furthermore. they would not afford adequate protection from animals. Many of these fences are still in use. however. though they occupy space which could be used for crop production.

Plain wire was used for fences in England as far back as 1840, and galvanized wire was used for the same purpose in 1851 (woven wire ience, except netting, n-as not manufactured at that time).

That n-as the situation until 1874, when barbed wire made its appearance. It was developed principally as a result of the invention of improved machincry for its manufacture. Barbed wire was thought to be the last word in fencing and. to a certain extent. that was true, since a practical loom for weaving woven wire fence had not yet been built. A number of styles of woven wire fencing were developed between 18;; and 1909, but it was not until the early 1890s that practical looms for weaving fence fabric were introduced.

Woven Wire Fencing and Netting.— There are several kinds of woven mire fence, each adapted more or less to a particular use.

Farm, Field and Poultry Fence.—This is made up of horizontal wires. called line wires. and vertical wires called stay wires. The vertical and horizontal wires are held together at their respective intersections by joint.; called ties or knots or by welds or twists.

There are three types: (1) the stiff-stay fence. which uses a staple-tie knot or welded joint. and whose stay wires are one piece froni top to bottom; (2) cut-stay fence, which uses a wrapped joint or knot. known as the hinge joint. which has a separate stay wire between each pair of line nires: (3) tn-ist-stay fence. which is also a cut-stay type. Wire for all of these fences is usually zinc coated (galvanized). although it may be coated with lead. aluminum. enamel or plastic.

These types of fence are made from various gauges of wire. 9 gauge being the heaviest used except for sonic railroad right-of-way fence. for which 7-gauge top and bottom wires are used The lightest gauge used is 20 gauge for some types of poultry fence and for netting.

Chain-link fence is essentially an industrial fence, although it is widely used for other purposes such as for enclosing large estates, playgrounds, athletic fields and cemeteries. This fence is made from wire pickets spirally wound and interwoven in the form of a continuous link fabric, without knots or ties except at the top and bottom of the fence where it is twisted (barbed) or folded over in a single interlock (knuckled). This fence is usually galvanized after it is woven: although a small amount is made from galvanized wire. It is made from 6-, 9- or 11-gauge wire, only one gauge to a fence, which is not always the case with woven wire fence.

Ornamental fence is sometimes called lawn fence. It gets its name from its appearance which is both ornamental and decorative. It did not come into widespread use until about 1920; prior to that time automatic looms for weaving this fence had not been invented.

It is made of crimped stay wires, called pickets, which have their tops formed into semicircles, with the short end of each picket tied into the top line wire (called cable, if the top wire is formed of two longitudinal wires twisted together). The line wires are locked in the crimp of each picket and the picket ends are locked into the cables by means of the cable twist. Sometimes the twist is not used and the wires are welded together at their respective intersections.

Variations of the structures described are principally in the number of wires used and the method of interlocking.

Wire netting is the oldest of woven wire fences and was first made in England in 1844 by Charles Barnard. The first netting was made by hand twisting on a wooden machine. In 1855 Barnard built a power-driven machine which made netting having meshes of $1\frac{5}{8}$ in. Most of the netting made at that time, either galvanized or varnished, was sold to Australian stockmen and farmers.

Woven wire netting is made in either diamond mesh or hexagonal mesh, with 1-, $1\frac{1}{2}$- or 2-in. mesh size. It is usually made from 17-, 18- or 19-gauge wire and from galvanized wire, or it may be galvanized after it is woven. This netting is also known as poultry netting or chicken wire.

Barbed Wire.—This wire is made up of two longitudinal wires twisted together to form a cable and having wire barbs wound around either one or both of the cable wires at regular spaced intervals. The barbs are made from round, half-round or flat wire, and are spaced four or five inches apart; for certain special barbed wire the barbs are spaced three or six inches apart. The cables are made from $12\frac{1}{2}$-, $13\frac{1}{2}$-, 14-, 15%-or 16-gauge wire, and the barbs from 12-, $12\frac{1}{2}$-, 14- or 163-gauge wire.

The gauge of the half-round or flat barbs is determined from the round wire from which the barbs are rolled. The barbs are diagonally cut in order to provide sharper points, and unless otherwise specified are one inch in length from tip to tip. The barbs have either two or four points, depending upon whether the barbs are formed from one wire or two mires.

Prior to the introduction of barbed wire it was customary to use 9-gauge round or oval wire or flat mire having serrated edges. However, this wire was easily broken since it would not stand the pressure of cattle running into or even leaning against it. Furthermore. expansion of the wire in hot weather and contraction in cold weather caused the wire to break. This mas the reason for the use of two wires twisted together in the later barbed wire, since it permitted contraction and expansion without breakage.

TABLE 11.— Standard Types of Barbed Wire

Number of points	Approximate spacing of barbs (in.)	Nominal Diameter		Shape of barbs
		Cable Wire gauge	Barbs gauge	
4	4	12	14	Round
2	4	12%	14	Round
2	4	14	16	Round
4	5	$12\frac{1}{2}$	14	Round
4	5	12%	14	Half-round
2	4	12%	$12\frac{1}{2}$	Flat

The first patents on barbed wire were taken out in 1867 in the United States, but it was not until 1874. when Joseph Glidden of De Kalb, Ill., invented a practical machine for the manufacture of barbed mire, that the industry began to be developed on a large scale.

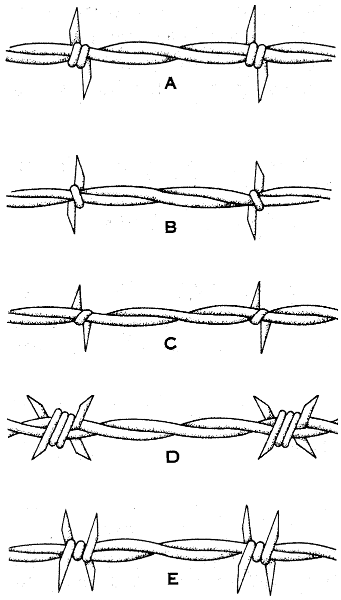


FIG. 3.—BARBED WIRE WINDINGS

(A) two-point round barbs wrapped around one cable wire; (B) two-point half-round barbs wrapped around both cable wires; (C) two-point flat-wire barbs wrapped around one cable wire; (D) four-point round barbs, one wire of each barb wrapped around one cable wire, second wire wrapped around both cable wires; (E) four-point half-round barbs wrapped around both cable wires

Barbed wire machines are fundamentally alike. The cable wires feed through the machine longitudinally and the wire for the two-point type of barb feeds into the machine at right angles to the cable wires, from one side of the machine; for four-point barbed wire, one wire from each side of the machine. The wire for the barbs feeds into a spinner head which revolves around one or both of the cable wires, depending upon the type of barbed wire being made. The spinner twists the barbs around one or both wires of the cable and cutoff knives cut the barbs to length and point.

The cables are then moved the proper distance from the barb spacing and the process is repeated, all of this being performed automatically.

In the meantime, the finished barbed wire is coiled on a reel, usually made of wire, into lengths of 80 rods or weights of 100 or 112 lb. The finished coil of barbed wire is removed from the machine manually, a new reel inserted and the operation repeated. Barbed wire is usually made of galvanized wire but, for use with galvanized-after-weaving chain-link fence, it is galvanized after fabrication.

WIRE ROPE

Uses.—This product requires wire made from steel, having a carbon content varying from 0.50% to 0.90%. although lower-carbon wire may be used for specific purposes. Wire rope is designated by the names cast steel, mild plow steel, plow steel and improved plow steel.

Wire rope is made in a wide variety of designs based on the purpose for which it is to be used. The wire may be plain or galvanized. this also being determined by the use. Wire rope is used for hoisting, elevators. hawsers, guys, oil-well drilling, power transmission, suspension bridges and many other purposes.

History.— The first wire rope was made by tying together single strands of straight wire and then grouping and tying several of these units together to form a rope of the diameter required. Such ropes were unsatisfactory; because the tie wires slipped and did not remain in position; there was too much variance in the physical characteristics of the individual wires; the straight wires were too stiff; and the rope lacked flexibility.

Furthermore, until about 1880 it was not possible to produce uniform grades of steel in suitable lengths to manufacture sound rope wire, although heat-treated steel (patented) wire had been produced since 1854.

The origin of the modern wire rope is highly controversial. An Englishman named Wilson claimed to have made wire rope in 1832, but a German, A. Albert: produced wire rope in 1834 which was used at a German mine, and some rope is still known as Albert lay.

Albert's rope was laid by hand. In 1840 a patent was issued in England to Robert Stirling Newall for the first wire-ropemaking machine. It is certain. however, that until the invention of the Bessemer and Siemens-Martin (open-hearth) processes for steelmaking and the development of the rod mill about 1580 it was not possible to make suitable steel and produce it in the long lengths and with the uniform chemical and physical properties required for rope wire.

Classes and Constructions.—?%'ire rope is made of a group of individual wires twisted together helically with a uniform twist (pitch) and direction around a hemp or mire core to form a strand. Several of these strands are then similarly grouped (laid) to form wire rope, although for rope to be used for guys or bracing only a single strand may be used.

As mentioned previously there are four classes of wire rope: cast steel, a low-carbon product; mild plow steel, with a carbon content ranging from 0.40% to 0.70%; plow steel, with a carbon content from 0.65% to 0.80%; and improved plow steel. with a carbon content from 0.70% to 0.90%. This range, of course, may vary somewhat between different manufacturers.

There are four standard constructions of wire rope: 6 x 7, 6 x 19. 6 x 37 and 8 X 19. This meansthat the rope is made up of 6 strands of 7 wires each. 6 strands of 19 wires each, etc. While these constructions are considered more or less standard, there are many other constructions used by the various wire rope manufacturers to meet specific requirements.

Ropemaking.—Rods to be used for rope wire are subjected to a heat treatment: called patenting, by which the rods are strand heated to a temperature above the critical range of the steel, and cooled through a selected range at a relatively rapid rate.

There are three methods for doing this. One is to heat the rods to the proper temperature in a furnace and cool them directly in air. By the second process, the rods are cooled in molten lead held at the proper temperature, depending upon the carbon content of the rods.

The third method involves heating in one bath of molten lead and cooling in another molten lead bath, the second bath carried at a much lower temperature than the Erst bath. Molten salt baths may be used instead of the molten lead.

The object of patenting is to produce a structure having a fine grain, with the iron carbide distributed through the ferrite in a finely divided form. This structure is metallurgically known as sorbite and makes a grain structure having good wire-drawing properties.

At different stages of the wire-drawing process, when necessary, the rope wire may be subjected to the patenting operation one or more times. and must be cleaned, coated and baked after each patenting operation.

The finished wire must be carefully tested, depending upon its ultimate use. Usually this requires gauge; tensile strength and torsion tests, but others may be required.

Fine wire for ropemaking is usually coiled on spools in the wire mill, or in coils for larger wire, and the coils later spooled on separate machines.

The spools are placed in the cradles of the stranding machine in such a manner as to prevent twisting of the wires. There the wires are led to the front of the machine where they are mechanically laid around a core wire at the point where the wires converge and the strand is then wound on drums. The drums are placed in another machine. called a closer, where they are subjected to the same process as in the strander, to form the finished rope. which is coiled on reels for shipment.

Rope is furnished in several types of lay. In the regular lay. the strands of the rope are laid in an opposite direction to that of the wires in the strands. The Lang (sometimes called Albert) lay has the wires in the strand, and the strands of the rope twisted in the same direction.

The preformed lay has the wires preformed before laying. The lay may be left lay or right lay.

In general, stiffness. tensile strength and surface wearing increase with the carbon content of the wire and the size of the individual wires. Flexibility is obtained by increasing the number of wires in the strand, the number of strands in the rope. or both.

Reverse bends are highly detrimental to the life of a rope, so the rope should travel and bend in the same direction in order to get the most effective life.

WIRE SPRINGS

There are countless uses for wire springs, varying from the fine spring for precision instruments to the large wire springs used for upholstery, mattresses. automobiles and heavy machinery.

Wire springs may be made of low-, medium- or high-carbon or alloy steels, as well as nonferrous alloys, and in many shapes, such as round. flat or rectangular. They may be used as drawn, or they may be heat treated. Wire springs may be classified as extension, compression and torsion and may be helical, spiral and some other shape.

Small coiled helical springs are made from hard-drawn steel wire having a carbon content from 0.45% to 0.75% and a manganese content ranging from 0.60% to 1.20%, or from music wire containing from 0.70% to 1.00%, and manganese from 0.20% to 0.60%. Some wire springs. such as valve springs, may be made from carbon steels or alloy steels.

The steels for valve springs will contain 0.60% to 0.70% carbon if straight carbon steel, or from 0.45% to 0.55% carbon with chromium content 0.80% to 1.10%, vanadium 0.15% minimum if chrome-vanadium steel. Another steel used is from 0.55% to 0.65% carbon with a silicon content of 1.80% to 2.20%.

The tensile strength of spring wire ranges from 150,000 lb. per square inch to 350.000 lb. per square inch.

Hard-drawn wire for spring steels is process annealed and not heat treated after drawing. This type of steel is used principally for springs not subjected to severe stress or duty.

Oil-tempered spring wire is tempered by a continuous process, first heating the wire to a temperature, depending upon the carbon content. but usually in the range 1,450" to 1,525" F.,then quenching in oil held at a temperature between 110° F. and 145° F. and coiling. It is more suitable for precision forming and coiling operations than hard-drawn wire.

Music wire used for springs is heat treated by patenting, in which the wire is heated above the critical range and tempered in molten lead. molten salt, or air cooled. Usually this wire is given no further heat treatment except to relieve coiling strains by heating the coiled springs to from 350° F. to 750° F. Annealed wire may be coiled into springs and then heat treated.

The wire used for high-grade springs must be exceptionally free of physical. surface or internal defects.

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WIRED WIRELESS: *see* Electric Power Transmission.

WIRELESS TELEGRAPHY: *see* Radio.

WIRE RECORDING: *see* Tape Recording, Magnetic; Phonograph.

WIREWORM, a popular name for certain slender, hard-skinned grubs or larvae of the click beetles or Elateridae, a family of the Coleoptera. These larvae pass a long life (up to six years) in the soil, feeding on the roots of plants. and they often cause much damage to farm crops. A wireworm may be known by its broad, quadrate head and cylindrical or somewhat fattened body, with firm, sclerotized cuticle. The subterranean habits of wireworms make it hard to exterminate them when they have once begun to attack a crop. and the most hopeful practice is, by rotation and by proper treatment of the land, to clear it of the insects before seed is sown.

See Beetle; Entomology: *Principles of Insect Control.*

WIRT, WILLIAM (1772–1834), U.S. lawyer and author, was born at Bladensburg, Md., on Nov. 8, 1772, and began the study of law in 1790. After the death of his first wife, whom he had married in 1795, Wirt moved to Richmond. where he was elected clerk of the Virginia house of delegates and in 1802 was named a chancellor of the state. His literary career began in Aug. 1803 with the publication of the first of "The Letters of the British Spy" in the *Argus* of Richmond. These essays, containing the reactions of a hypothetical English visitor to southern life, were well received, and the following year he published a second series, *The Rainbow*. About this time, too, he began work on a biography of Patrick Henry, which was published in 1817 as *Sketches of the Life and Character of Patrick Henry*.

In 1807 Wirt had attracted considerable public attention with his eloquent prosecution of Aaron Burr at Richmond. The next year he was elected to the house of delegates, and in 1816 Pres. James Madison appointed him U.S. attorney for the district of Richmond. On Nov. 13, 1817, Pres. James Monroe appointed him attorney general of the United States. He administered this office with such efficiency that John Quincy Adams persuaded him to retain it for another term in 1825. Wirt retired in 1829 upon the election of Andrew Jackson to the presidency, except for a brief time in 1832 when he himself was nominated for the presidency by the Anti-Masonic party. He died Feb. 18, 1834.

WIRTH, KARL JOSEPH (1879–1956), German politician who supported Germany's collaboration with the U.S.S.R. after World Wars I and II, was born at Freiburg im Breisgau, Baden, on Sept. 6, 1879, the son of a foreman mechanic. Educated at Freiburg university, he became in 1908 a master of science at a boys' high school in Freiburg. In 1914, as a member of the Centre (Roman Catholic) party, he was elected to the *Reichstag* and in 1919 to the Weimar national assembly. In March 1920 he succeeded Matthias Erzberger as minister of finance. In May 1921 he became chancellor, with an avowed policy of the fulfillment of treaty obligations. In Aug. and Sept. 1921 he came into conflict with A. R. von Kahr, the Bavarian premier, who refused to apply to Bavaria the state of national emergency which Wirth had proclaimed consequent on the murder of Erzberger. Wirth stood his ground, and Kahr was compelled to resign. The decision on the partition of Upper Silesia between Germany and Poland (Oct. 20, 1921) increased the opposition to the policy of fulfillment. Wirth resigned on Oct. 22, 1921, but resumed office four days later. He then sought to establish a "great coalition" which should include all but the Nationalists and the Communists, but failed to secure the support of both the Socialists and the Conservatives (Volkspartei), the latter objecting to the appointment of Walther Rathenau as foreign minister. Wirth and Rathenau represented Germany at the Genoa Economic conference, and on that occasion they concluded the German-Soviet treaty of friendship at Rapallo (April 16, 1922). Unable to carry out the necessary financial measures to stop the depreciation of the mark, Wirth resigned in Nov. 1922. He remained several years in the background. In 1929–30 he served as minister for the provinces occupied by the Allies. In 1930 he became minister of the interior. Wirth retired in Oct. 1931, returning to Freiburg. After Hitler came to power he went to Paris and afterward to Switzerland.

Returning to Germany in 1948, he opposed the policy of rearming the German Federal Republic and its joining NATO. supporting instead the policy of a reunited but neutral Germany. He visited Moscow, Dec. 1953 and Feb. 1954. In Dec. 1955 he was awarded the Stalin Peace prize. He died at Freiburg on Jan. 3, 1956.

WIRTH, LOUIS (1897–1952), U.S. sociologist well known for his studies of urban problems, was born in Gemiinden, Ger., on Aug. 28, 1897. Brought to the United States in 1911, he was naturalized in 1924 and earned his Ph.D. in sociology at The University of Chicago in 1926. In the same year he joined its sociology faculty on which, except for brief periods, he remained throughout his career.

As a theorist, critic and empirical investigator, and as an inspiring teacher and academic statesman, Wirth greatly influenced the development of sociology. In his main areas of activity—sociological theory, studies of the city, "urbanism as a way of life" and the minority group—he provided a good demonstration of the interplay between theory and empirical study. As president of the American Sociological society (1947) and as the first president of the International Sociological association (1949–52) he contributed materially to the emergence of sociology as a profession. Through numerous radio and platform appearances he was widely known to national audiences as an influential participant in public affairs. He died at Buffalo, N.Y., on May 3, 1952.

Wirth left a long list of distinguished writings. These include *The Ghetto* (1928) and *Community Life and Social Policy* (1956). The latter, a posthumous collection of his more important papers, contains his full bibliography. (P. M. HA.)

WISBECH, a market town, port and municipal borough in the Isle of Ely parliamentary division of Cambridgeshire, Eng., 43 mi. N. of Cambridge by road and on the river Nene 11 mi. from its outlet on the Wash. Pop. (1951) 17,432. Area 7.2 sq.mi. Georgian houses line the "Brinks" along the Nene, one of which is Peckover house (National Trust) with its rococo interior. The church of SS. Peter and Paul has a double nave and dates from Norman times. In the museum are manuscripts, including that of Charles Dickens' *Great Expectations,* and an archaeological collection. The town is predominantly agricultural with a cattle market, canning works for the locally grown fruit and vegetables, and engineering, brewing, printing and metal-box and basketmaking. Bulbs and other flowers are extensively grown, and timber, potatoes and fertilizers are exported. There is a technical college and school of horticulture—the first of its kind in England.

WISCONSIN, popularly called the "Badger state," is one of the north-central states of the United States. It is bounded north by Lake Superior and the upper peninsula of Michigan, east by Lake Michigan, south by Illinois and west by Iowa and Minnesota. The greater part of the western boundary is formed by the St. Croix and Mississippi rivers flowing southward. From south to north (approximately 42° 30' to 47° 3' N.) the greatest length of the state is 305 mi., and from east to west (approximately 86° 49' to 92° 54' W.) its extreme breadth is 253 mi. The lake shore boundaries on the north and east are more than 500 mi. in length. In area the state totals 56,154 sq.mi., of which 1,449 are water surface. In addition, the state includes 10,062 sq.mi. of boundary water in Lakes Superior and Michigan. It ranks 26th in size among the states (21st when the boundary waters are included). It ranks 15th among the states in population. Wisconsin was admitted to the union May 29, 1848, the 30th state. The capital is at Madison. The state flower is the wood violet, the state bird is the robin and the state tree is the sugar maple. Its slogan is "America's dairyland."

PHYSICAL GEOGRAPHY

Physical Features and Soil.—The surface of Wisconsin is generally of a rolling or undulating character, interrupted only by the sharper ridges of changing geological strata, the bluff lands along the Wisconsin and Mississippi rivers, and isolated hills and ridges of older rocks, which, especially in the north-central part of the state, have thrust themselves up through the younger sedimentary rocks. The Baraboo hills, a range in the south-central part of the state, are of the latter character. Sugar Bush hill (1,939.30 ft.), near Laona in the northeast, is the highest ground elevation; Rib mountain (1,940.76 ft.), near Wausau, has the highest point on the highest rock. The lowest part of the state is along the shore of Lake Michigan (579.76 ft. above sea level). The mean elevation is 1,050 ft. The divides which form the watersheds between Lake Superior, Lake Michigan and the valley of the Mississippi river and its tributaries—the three main drainage areas—are very slight. Of these areas, that of Lake Superior is much the smallest. Its short, rapid streams seldom rise more than 30 mi. S. of the lake shore.

Of the streams flowing into Lake Michigan the Fox river (175 mi.) is the most important. Rising in the south-central part of the state it flows north and east by a circuitous route through Lake Winnebago, and thence into Green bay. In its upper course it is joined from the north by Wolf river, an important tributary. The Menominee and Oconto are smaller rivers also flowing into

Green bay, while farther south the Sheboygan and Milwaukee rivers empty directly into the lake. The harbours along Lake Michigan are mainly enlarged mouths of rivers.

The largest by far of the drainage areas is that whose waters flow into the Mississippi river. The Wisconsin river, the principal tributary, rises on the upper Michigan border and flows south and west for 430 mi. through the heart of the state to join the Mississippi near Prairie du Chien. It is navigable for light craft as far as Portage, 200 mi. from its mouth. At this point the Fox river, flowing into Lake Michigan, is only one mile to the east across low, marshy ground. The proximity of the two rivers made this a frequent route for early explorers and fur traders traveling by canoe from the lake to the Mississippi; a canal later connected them. North of the mouth of the Wisconsin the Mississippi receives several rivers of considerable length, the most important of which are the Black, Chippewa and St. Croix, the latter forming the Wisconsin–Minnesota boundary line for 135 mi. The southern part of the state is drained by a number of streams, which find their way to the Mississippi after passing into Illinois. The largest of these are the Rock and Fox (of the Illinois) rivers.

The bedrock in the northern highland consists of crystalline rocks; in the central plain the bedrock is sandstone, underlain by granite and other crystalline rocks. A soft sandstone in the western upland is capped with limestone; in the east is limestone, of which a very striking feature is the Niagara escarpment bordering the eastern shore of Lake Winnebago and extending to the tip of Door county. Glacial ice sheets covered all but the southwestern quarter of Wisconsin and greatly influenced the topography and soils. They leveled the hills, filled in the valleys and ground and mixed the soils. In the terminal moraines invaluable sand and gravel deposits were left.

The glacial ice was further responsible for nearly 9,000 lakes, which help control the water flow of the rivers and prevent floods, and are sought increasingly as summer resorts. The largest is Lake Winnebago with an extreme length of 30 mi. and breadth of 10 mi. On its banks are several important manufacturing cities. In the southern and eastern parts of the state the lakes are beautiful, clear bodies of water with sandy or gravelly shores and frequently high, heavily wooded banks. Among them are Green lake, the "four lakes" near Madison and chains of lakes in Walworth, Waukesha and Waupaca counties. A second group of hundreds of lakes is found in the highland district of northern Wisconsin, chiefly in Vilas, Oneida and Iron counties. Many of these are small, but there are few parts of the world where so large a proportion (39%) of the total area is occupied by lakes. A third group, also consisting of hundreds of small lakes, is in northwestern Wisconsin, especially in Washburn, Burnett, Polk, Barron and Sawyer counties. In all parts of the state, except the driftless area of the southwest, numerous large and small marshes are to be found, many of them representing filled in or drained lake beds. The driftless area is rugged and without natural lakes. Within its limits much of the most attractive scenery of the state is to be found. Between the Wisconsin and Mississippi valleys is the western upland, a plateau about 1,200 ft. in elevation but dissected in every direction by tributaries of the two rivers into a succession of ridges and coulees. The bluffs are wooded and often capped by picturesque limestone cliffs.

Climate. — The climate of Wisconsin is influenced by storms which move eastward along the Canadian border and by those which move northmard up the Mississippi valley; that of the eastern and northern sections is moderated by the Great Lakes. The mean annual temperature varies from 48° F. in the extreme southern part to 39° in the north. Most of the north averages from 110 to 135 frost-free days, while in the south the growing season ranges from 135 to about 160 days, and along the southern border of Lake Michigan to about 175 days. The mean precipitation is about 31 in., most of the rainfall coming during the growing season from May through August. In the far north some sections average 55 to 60 in. of snowfall; the extreme south averages about 30 in.

Plant and Animal Life. — Originally about 85% of Wisconsin was covered with forests, with natural prairies occurring chiefly in the south and west. Across the north stretched a heavy growth of white and red (Norway) pine, interspersed with jack pine, spruce, balsam fir and hardwood. In the south and extending inland from Lake Michigan hardwood trees predominated, mainly oak, elm, hickory, maple, basswood, poplar and birch. Ruthless cutting of timber and forest fires rapidly depleted this immense natural resource. The 20th century has seen great strides in reforestation of the cutover area. Forest crop laws of 1927–29 have encouraged private owners and counties to put well over 2,000,000 ac. back into forests. Industry has added almost another 1,000,000 ac. as industrial forests.

There are about 1,500,000 ac. of federal forests in Wisconsin and about 374,000 ac. of state forests. Such measures as rural zoning laws, a forest fire control service and a program of education and information are designed to forestall further depletion of the timber supply. In addition to producing recurring forest crops for commercial use and stabilizing watersheds and stream flow, Wisconsin's state forests provide scenic attractions, outdoor recreation and facilities for hunting and fishing.

Wildlife has aluays been abundant in Wisconsin. The heavy forest cover, the alternation of open space and uplands, the numerous lakes and streams provided an ideal habitat for a variety of species of mammals, birds and fish. However, the white man with his rifle and trap, his ax, his plow and his cow changed the landscape and the wildlife community. Species continue to fluctuate in number and habitat with droughts, drainage, timber cutting, reforestation and hunting regulations. Pheasants, prairie chickens, quails, woodcocks, bears and otters are still found; ducks, geese. grouse, rabbits, squirrels, woodchucks, skunks, raccoons, muskrats, beavers, minks, foxes. coyotes and deer are still numerous. The impact of man on his environment has produced changes in the fish population but the quantity is believed to remain fairly constant. Of the approximately 150 species there, the muskellunge is regarded as the prize game fish

Parks and Historic Sites. — State parks encompass more than 19,000 ac. and, together nith the state forests, offer almost 393,000 ac. devoted to conservation and to the preservation of outstanding unique. scenic or historic places, and the provision of arras for public recreation. Chequamegon National forest and Nicolet National forest provide numerous additional recreational facilities, including several winter sports areas The larger state scenic parks include Copper Falls (1,400 ac.), Devil's Lake (2.500 ac), Peninsula (3,600 ac.) and Wyalusing (1,600 ac.). State historical-memorial parks include Aztalan, site of an ancient Indian village; Copper Culture mounds, preserving the remains of a prehistoric village; Cushing Memorial, a monument to William Barker Cushing (q v.) and his two brothers, American Civil War heroes; First Capitol, site of the territorial capital (1836), restored; Lizard mound, restorations of a number of Indian mounds; Lost Dauphin, home of Eleazer Williams, reputed Lost Dauphin of France; Nelson Deaey, home of Wisconsin's first governor; Old Wade house, restoration of an early stagecoach inn; and Tower Hill, site of historic shot toner. In addition there are a number of roadside parks with camping facilities, ranging in size from about 50 to more than 350 ac.

HISTORY

Exploration and Settlement. — The French from Canada were the first white men to reach the Wisconsin area. Impelled by such motives as the search for a "northwest passage," the lure of the fur trade, rumours of copper deposits or missionary zeal, they followed the Ottawa river and Lake Nipissing route from Montreal or ascended the St. Lawrence river and the Great Lakes to the unexplored west. 'They found a region inhabited by numerous Indian tribes, who frequently made war with one another and with the incoming whites and thwarted France's ambitions of strengthening its dominion in North America through a chain of posts betneen Canada and Louisiana.

Jean Nicolet is believed to be the first Frenchman to reach the Wisconsin region; he landed on Green bay in 1634. In 1654–56 Médard Chouart, sieur des Groseilliers, and an unidentified French companion explored Green bay and the region south and west. Des Groseilliers and Pierre Esprit Radisson spent the winter of

1659–60 on the south side of Lake Superior, making expeditions southward to Ottawa Indian villages and westward to the Sioux and Cree. Seven traders went to Chequamegon bay on Lake Superior in 1660, accompanied by the Jesuit Father René Ménard, the first missionary in Wisconsin. In 1665 other traders went to Chequamegon bay, taking Father Claude Allouez, who established a mission there and remained until 1669. In succeeding years Jesuit priests opened several missions around Green bay, including St. François Xavier at the present De Pere, which became one of their most successful western missions. Father Jacques Marquette, who succeeded Allouez at Chequamegon bay, was forced to abandon the mission in 1671, and in 1673 he accompanied Louis Jolliet on an exploratory trip across the Fox-Wisconsin waterway. On June 17 they "discovered" the upper Mississippi. Between 1679 and 1689 Daniel Greysolon, sieur Dulhut (Duluth), explored the western Lake Superior area and some tributaries of the Mississippi. Nicolas Perrot, too, explored in that area, extended French influence over the Indians, built posts, and in 1689 took formal possession of the upper Mississippi territory in the name of the king of France. By that date the Wisconsin region was occupied with strategically placed posts and missions and was regarded as an integral part of the French empire in North America.

The outbreak of wars between France and Great Britain and among Indian tribes foreshadowed the end of French supremacy. In 1712 the slaughter of a band of Foxes by Indian allies of the French near Detroit was the signal for hostilities which lasted almost continuously until 1740 and at one time or another involved every tribe in the Wisconsin country. The French and Indian War (1754–63) soon followed, bringing the overthrow of French dominion in continental North America. Britain's occupation of its newly won territory was briefly threatened by an Indian conspiracy led by Chief Pontiac, but the outbreak was crushed in 1765, and British traders, appropriating French posts, methods and personnel, took over the fur trade. In the American Revolution that broke out in 1776 most of the traders remained loyal to the British. The mixed-blood Charles Michel de Langlade, who had led a force of Wisconsin Frenchmen and Indians against the British in the earlier war, led his men against American frontier communities west of the Alleghenies. The treaty of 1783 made the Wisconsin region a part of the new United States, but British traders from Montreal continued to exploit the rich fur trade on both sides of the international boundary. Although Britain evacuated American military posts in 1796, its traders monopolized the western trade until the close of the War of 1812.

After the war a new era began for the region between Lake Michigan and the Mississippi. In 1816 military garrisons were established at Ft. Howard (Green Bay) and Ft. Crawford (Prairie du Chien) and, in 1828, after a brief Winnebago Indian uprising, at Ft. Winnebago near Portage. Beginning in 1818 civil government was administered from the Michigan territorial capital at Detroit. A part of the old Northwest territory, the Wisconsin region had been nominally attached to Indiana from 1800 to 1809, to Illinois from 1809 to 1818, and thereafter to Michigan until 1836. Gov. Lewis Cass of Michigan promptly established counties west of Lake Michigan, appointed local officials and, in 1820, made a long canoe voyage of inspection. In 1823 James D. Doty took office as federal judge over western Michigan and after 1824 Wisconsin representatives attended legislative sessions at Detroit. Conflicting Indian claims to the area were defined in three treaties in 1825, 1826 and 1827, and between 1829 and 1848 eleven treaties of cession extinguished Indian title to Wisconsin.

A law in 1816 excluded foreigners from the fur trade and enabled the American Fur company to rise to wealth and power. Exploitation of another of Wisconsin's natural resources, the lead deposits, brought a flood of miners into the southwestern area, reaching an estimated 2,500 by 1830. The influx was briefly halted by the Black Hawk War in 1832, but the war broke the Indian power in Wisconsin. It also widely advertised the attractions of the new country. Except for small private land grants to retired traders around the posts, no land could be legally owned until the public land offices opened, in Mineral Point in 1834 and Green Bay in 1835. Sales were large at first, totaling 878,014 ac. by the end of 1836. Most of the purchasers came from eastern states, occupying lands in the southeast and founding Milwaukee and other cities along the Lake Michigan shore.

Wisconsin Territory and Statehood.— In 1836 Wisconsin became a separate territory, with its western boundary at the Missouri river until 1838. The vigorous and populous mining area assumed control in organizing the territory. Henry Dodge, hero of the Black Hawk War, received the appointment as governor. The first legislature met in Old Belmont, now Leslie, in Lafayette county, but after a spirited contest selected Madison as the permanent capital. For a time such matters as banks, canals, roads and river and harbour improvements occupied the attention of the settlers. They also started newspapers, built churches, schools and colleges and laid the foundation for free public education. A great stream of immigration set in and as the population grew, agitation for statehood developed and on Aug. 10, 1846, a congressional enabling act permitted a call for a constitutional convention. The first constitution drafted by the convention was rejected because of liberal provisions relating to the rights of married women, prohibition of banks, an elective judiciary, etc. A second constitution which eliminated the objectionable features was approved by the electorate and on May 29, 1848, Wisconsin was admitted to the union with its present boundaries. Nelson Dewey of Cassville was elected the first governor.

The first years of statehood were a time of great social, economic and political activity. The population reached 305,000 by 1850; of these, over 36% were foreign-born, with Germans predominating. The temperance crusade, the nativist, or Know-Nothing, movement, and antislavery agitation sweeping the north found strong support in Wisconsin. Wheat became the first commercial crop and in 1860 Wisconsin produced the greatest wheat crop in its history. Lumbering ranked next to agriculture in importance, the industry spreading rapidly up the river valleys and along the eastern lake shore. Water power sites became flour mill and sawmill cities; Mississippi river and Lake Michigan harbours became flourishing commercial ports. A referendum in 1852 ended the ban on banks. Although want of capital delayed progress in railroad building, a short line began operation in 1851 and by 1858 two roads crossed the state from Milwaukee to the Mississippi. Strongly Democratic at the time of admission, Wisconsin gradually shifted its political faith. In passing on the case of an escaped Negro slave the state supreme court declared the Fugitive Slave law unconstitutional and void in Wisconsin. A protest meeting at Ripon in March 1854 proposed that a new party be formed, to be called the Republican party. A state organization was effected that July and in 1856 a Republican governor took office. Wisconsin helped elect Lincoln in 1860 and supported his administration during the Civil War. Out of a population of 775,881 in 1860, the state furnished over 91,000 men to the northern armies and suffered over 12,000 war casualties.

In the business boom that followed the war railroads expanded rapidly and small lines were consolidated into a few powerful companies. The postwar years saw the enormous expansion of the lumber business, which reached a peak in the decade 1890–1900. The uncontrolled power of the railroads and the fall of farm prices in the panic of 1873 turned numbers of voters to a political coalition which elected a Democratic governor in 1873 and enacted the Potter law, pioneer legislation to regulate railway rates, which was soon repealed. Noting diminishing returns from wheat crops, farmers began to turn to diversified farming and dairying.

The Wisconsin Idea — The decade of the 1890s saw a four-year reversal of the long Republican rule. The Democratic vote was largely a protest against national measures, accentuated in Wisconsin by the Bennett law, providing for the enforcement of the teaching of English in all public and parochial schools, which many foreign-born citizens regarded as a move to outlaw parochial schools. Dissension was brewing within the Republican party, dominated by lumber barons and railroad magnates. Against their rule Robert M. La Follette led a reformist revolt and won the governorship in 1900. Through a close working relationship with social scientists at the University of Wisconsin known as the "Wisconsin idea," the progressive faction instituted a number of reforms: equitable taxation of railroads, the direct primary and civil service, and in later years a stringent corrupt practices act, workmen's compensation, state income tax and industrial commission, and other pioneer social and economic measures. After 1905 La Follette continued his reform crusade in the U.S. senate, where he served as a leader of the progressive wing of the Republican party until his death in 1925. His long continuance in office mas remarkable in view of his open opposition to the declaration of war against Germany in 1916 and to the League of Nations. Although Wisconsin citizens, too, mere divided regarding war aims. they united in prosecution of the mar, sending nearly 125,000 men into service. The 32nd, or Red Arrow, division won glory in France. Later, in World War II, the division reinforced its gallant reputation in the Pacific. In the second war over 352,000 Wisconsin citizens served in the armed forces; the reported dead and missing totaled 7,083, three times the casualties in the earlier conflict.

Pattern of Modern Development. — The census of 1930 revealed that Wisconsin had become predominantly urban. By this time the pattern of modern development had been set. Wisconsin was an industrial state, with manufacturing concentrated on the Lake Michigan shore and in river basin areas. Industrialization brought problems connected with metropolitan life and demands of a labour population for recognition. Farms and farmers decreased in number, but farm production rose with the advance of scientific agriculture. The dairy cow still symbolized Wisconsin's pride. In politics the state maintained its liberal traditions but spread its party votes. A Republican, Alexander Wiley, mas elected to the U.S. senate in 1938 and re-elected in 1944. 1950 and 1956. Two La Follette sons held the offices of governor and U.S. senator for 6 years and 21 years respectively; each was succeeded by a conservative Republican. In 1934 the progressive wing formally set up a separate party but united with the Republicans in 1946. In national politics Wisconsin gave its electoral vote to the Democrats in 1932, 1936. 1940 and 1948. Joseph McCarthy, a conservative Republican, served in the U.S. senate from 1947 until his death in 1957. A Democrat, E. William Proxinire, followed him in office and was re-elected in 1958 when the Democrats won control of the lower house of the legislature and all but one state office.

GOVERNMENT

The original constitution of the state, adopted in 1848, is still in force, though a number of amendments have been made. An amendment may be proposed by either house of the legislature, and if passed by a majority of the members of each house in two successive legislatures, it must be submitted for ratification by a majority vote of the people.

A constitutional convention may be called if the proposal is adopted by a majority of the senate and assembly and voted upon favourably by the people at the following election. The legislature, composed of the senate and assembly, meets biennially in January of odd-numbered years. It may also be called into special session by the governor, but only to transact the specific business named in the governor's call. There are 100 assemblymen and 33 senators, the former chosen for two-year terms, the latter for four years. A joint legislative council of 15 members studies problems of government, prepares bills and introduces them in the legislature.

Executive power is vested in a governor and a lieutenant governor, both elected for two years. The governor has a veto on legislation ahich may be overridden by a two-thirds vote of the members present in each house. The lieutenant governor is president of the senate and is entitled to cast a vote only in the case of a tie. The administrative officers, a secretary of state, treasurer and attorney general, are elected for two years and in ex officio capacity act also as commissioners of public lands. A state superintendent of public instruction is elected for a four-year term. Some important governing commissions have been established, the chief ones being the industrial commission, with authority in matters involving relations between management and labour, and the public service commission, which has jurisdiction over the rates and service of railways and other public utilities. Other important commissions and departments are: the state highway, conservation and building commissions; the departments of agriculture, audit, banking, budget and accounts, motor vehicle, public welfare and taxation; the bureaus of engineering and of personnel; and the boards of health and of vocational and adult education.

The judicial power of the state is vested in a supreme and circuit courts. The supreme court has seven members, each elected for a term of ten years. The court has original jurisdiction in a limited number of cases of state-wide concern and appellate jurisdiction in all other cases. It holds one term, beginning in August, and is in session virtually continuously until July. Circuit courts have original jurisdiction in all other matters and appellate jurisdiction from justices of the peace and from some municipal courts. Wisconsin has 25 judicial circuits, some of which have more than one judge. Circuit judges are elected for six-year terms. Terms of circuit court are held at least once each year in every county of the circuit.

The New Englanders and New Yorkers who settled in eastern Wisconsin set up the town government system there, whereas the lead miners from the lower Mississippi areas who settled in the southwestern part of the state established the county form familiar to them. Eventually the New England town system prevailed and is now universal throughout the state.

Finance. — The assessed valuation of all tangible property for state tax purposes in 1929 was almost $6,000,000,000. It declined during the depression until in 1934 it stood at about $4,000,000,000, but by 1960 had risen to more than $9,000,000,000.

Tax receipts account for more than one-half the state's revenue; other income comes from federal aids, licenses and various lesser sources. The general property tax is the main reliance of local governments and school districts, while the state government depends primarily on income tax (of which it retains 40%, distributing the remainder to local governments), an ad valorem tax on certain public utilities and railroads, and certain gross receipts taxes and selective sales taxes on special commodities such as cigarettes, liquor, gasoline, and others. The various taxes produce income in the following order: income tax, taxes on public utilities and transportation companies, tax on insurance premiums, liquor taxes, cigarette tax and inheritance and estate taxes.

There are about 550 banks in Wisconsin, of nhich approximately 100 are national banks. In the 1950s the number of credit unions increased from fewer than 600 to more than 700, while membership grew from under 200,000 to more than 300,000 and assets rose from about $35,000,000 to almost $54,000,000.

POPULATION

The population of Wisconsin in 1840 was 30.945; in 1870 it was 1,054,670; in 1910, 2,333,860; in 1950, 3,434,575; and in 1960. 3,951,771. This last figure represented an increase of 15.1% over the population in 1950. The population per square mile in 1960 was 70.4, as compared with 61.2 in 1950. and with 49.9 for the U.S. in 1950.

Of the 1960 population, 2,449,532, or 62%, lived in incorporated places of 2.500 or more, as compared with 55.5% in 1950, when these places constituted the urban area. The entire urban population, which included also the thickly settled suburban area, or "urban fringe," adjacent to Milwaukee, Madison and Racine, and four unincorporated places of 2,500 or more outside this fringe, amounted to 2,522,179 or 63.8% of the state total.

The number of households in 1950 was 968.253, as compared with 827,207 in 1940. The average population per household had declined from 3.8 in 1940 to 3.5 in 1950.

The population of the state was distributed by colour and nativity in 1950 as follows: 92.4% native white; 6.4% foreign-born white; and 1.2% nonwhite. Of the foreign-born mhite population, 26.8% were born in Germany, 11.2% in Poland and 6.7% in Norway.

In 1950 there were 101.1 males per 100 females in the native mhite population and 115.8 in the foreign-born; 9% of the population was 65 years old or over; and 54.7% of the population 14 years old and over was in the labour force. Of the total number

*Wisconsin: Places of 5,000 or More Population (1960 census)**

Place	Population 1960	1950	1910	1920	1900
Total state	3,951,777	3,434,575	3,137,587	2,632,067	2,069,042
Antigo	9,691	9,902	9,495	8,451	5,145
Appleton	48,411	34,010	28,436	19,561	15,085
Ashland	10,132	10,640	11,101	11,334	13,074
Baraboo	6,672	7,264	6,415	5,538	5,751
Beaver Dam	13,118	11,867	10,356	7,992	5,128
Beloit	32,846	29,590	25,365	21,284	10,436
Broobfield	19,812	—	—	—	—
Brown Deer	11,280	—	—	—	—
Burlington	5,856	4,780	4,414	3,626	2,526
Cedarburg	5,191	2,810	2,245	1,738	1,626
Chippewa Falls	11,708	11,088	10,368	9,130	8,094
Cudahy	17,975	12,182	10,561	6,725	1,366
De Pere	10,045	8,146	6,373	5,165	4,038
Eau Claire	37,987	36,058	30,745	20,906	17,517
Fond du Lac	32,719	29,936	27,209	23,427	15,110
Fort Atkinson	7,908	6,280	6,153	4,915	3,043
Fox Point	7,315	2,585	1,180	—	—
Franklin	10,000	—	—	—	—
Glendale	9,537	—	—	—	—
Green Ray	62,888	52,735	46,235	31,017	18,684
Greendale	6,843	2,752	2,527	—	—
Greenfield	17,636	—	—	—	—
Haier Corner	5,549	—	—	—	—
Hartford	5,627	4,549	3,910	4,515	1,632
Janesville	35,164	24,899	22,992	18,293	13,185
Kaukauna	10,096	8,337	7,382	5,951	5,115
Kenosha	67,899	54,368	48,765	40,472	11,606
Kimberly	5,322	3,179	2,618	1,382	—
La Crosse	47,575	47,535	42,707	30,421	28,895
Little Chute	5,099	4,152	3,360	2,017	944
Madison	126,706	96,056	67,447	38,378	19,164
Rlanitowoc	32,275	27,598	24,404	17,563	11,786
Marinette	13,329	14,178	14,183	13,610	16,195
Marshfield	14,153	12,394	10,359	7,394	5,240
Menasha	14,647	12,385	10,481	7,214	5,589
Menomonee Falls	18,276	2,469	1,469	1,019	687
Menomonie	8,624	8,245	6,582	5,104	5,655
Mequon	8,543	—	—	—	—
Merrill	9,451	8,951	8,711	8,068	8,537
Milwaukee	741,324	637,392	587,472	457,147	285,315
Monona	8,178	2,544	1,323	—	—
Monroe	8,050	7,037	6,182	4,788	3,927
Neenah	18,057	12,437	10,645	7,171	5,954
New Berlin	15,788	—	—	—	—
New London	5,288	4,922	4,825	4,667	2,742
Oak Creek	9,372	—	—	—	—
Oconomowoc	6,682	5,345	4,562	3,301	2,880
Oshkosh	45,110	41,084	39,089	33,162	28,284
Platteville	6,957	5,751	4,762	4,353	3,340
Plymouth	5,128	4,543	4,170	3,415	2,257
Portage	7,822	7,334	7,016	5,582	5,459
Port Washington	5,984	4,755	4,046	3,340	3,010
Prairie du Chien	5,649	5,392	4,622	3,537	3,232
Racine	89,144	71,193	67,195	58,593	29,102
Rhinelander	8,790	8,774	8,501	6,654	4,998
Rice Lake	7,303	6,898	5,719	4,457	3,002
Ripon	6,163	5,619	4,566	3,929	3,818
St. Francis	10,065	—	—	—	—
Shawano	6,103	5,894	5,565	3,544	1,863
Sheboygan	45,747	42,365	40,638	30,995	22,962
Shorewood†	15,990	16,199	15,184	2,650	—
South Milwaukee	20,307	12,855	11,134	7,598	3,392
Sparta	6,080	5,893	5,820	4,466	3,555
Stevens Point	17,837	16,564	15,777	11,371	9,524
Stoughton	5,555	4,833	4,743	5,101	3,431
Sturgeon Bay	7,353	7,054	5,439	4,553	3,372
Superior	33,563	35,325	35,136	39,671	31,091
Tomah	5,321	4,760	3,817	3,257	2,840
Two Rivers	12,393	10,243	10,302	7,305	3,784
Watertown	13,943	12,417	11,301	9,299	8,437
Waukesha	30,004	21,233	19,242	12,558	7,419
Waupun	7,935	6,725	6,798	4,440	3,185
Wausau	31,943	30,414	27,268	18,661	12,354
Wauwatosa	56,923	33,324	27,769	5,818	2,842
West Allis	68,157	42,959	36,364	13,745	—
West Bend	9,969	6,849	5,452	3,378	2,119
West Milwaukee	5,043	5,429	5,010	2,101	—
Whitefish Bay	18,390	14,665	9,651	882	512
Whitewater	6,380	5,101	3,689	3,215	3,405
Wisconsin Rapids	15,042	13,496	11,416	7,243	—

*Populations are reported as constituted at date of each census.
†Known as East Milwaukee prior to 1920.
Note: Dash indicates place did not exist during reported census, or data not available.

of employed males, 21.9% was engaged in agriculture. 6.5% in construction. 33% in manufacturing, 5.2% in transportation and 15% in wholesale and retail trade.

EDUCATION

The free public-school system was established in 1848 and the first provision for free high schools was made in 1875. School attendance nas made compulsory for children between the ages of 7 and 15 in 1879, for those between the ages of 7 and 14 in 1903 and between 6 and 16 in 1949. The first kindergarten in the United States officially connected mith a state normal school (teachers college) was opened at Oshkosh in 1880. In the second half of the 20th century total annual expenditures for public schools amounted to about $280 per capita for elementary and almost $400 for secondary schools, as compared with the national median, for all schools, of about $330. Following the national trend toward consolidation, the number of school districts was reduced from 6.000 to 4,000 in a ten-year period following World War II.

It is estimated that more than 25% of all elementary pupils and somewhat less than 15% of all high school pupils attend private or parochial schools, mainly those supported by the Roman Catholic and Lutheran churches.

The public-school system is under the supervision of the state department of public instruction, headed by a state superintendent of public instruction. With rare exceptions the public elementary and secondary schools are operated by local school districts under the supervision of the state. The state department supervises the education and training of the physically and mentally handicapped under 16 years of age, including those at the state school for the blind at Janesville and for the deaf at Delavan. The 23 county teachers colleges, with an enrollment of about 1,200, are also under the jurisdiction of the state superintendent. Handicapped children over 16 (except for those who are institutionalized) are the responsibility of the rehabilitation division of the state board of vocational education, as part of its extensive program of vocational and adult education which annually enrolls over 100.000 persons.

Higher Education. — Public higher education is provided by the University of Wisconsin and nine state colleges. The state university and land-grant college, established at Madison in 1848 and supported largely by the state as a part of the public educational system. occupies a beautiful site extending for a mile along the shores of Lake Mendota. The University of Wisconsin—Milwaukee resulted from the merger of Milwaukee State college mith the university in 1956. The university includes a college of letters and science and the related schools of commerce, education, journalism, library science, music and pharmacy; a college of agriculture and a related school of home economics; a college of engineering; a law school; a medical school with a school of nursing; a graduate school; and an extension division which, in addition to offering adult education, group and community service programs, includes centres at Green Bay, Kenosha, Manitoxvoc, Marinette, Menasha, Racine. Sheboygan and Wausau where the first two years of university work are offered. Several scientific institutions are associated with the university, including the U.S. forest products laboratory, the U.S. weather bureau, the Washburn observatory, the Wisconsin psychiatric institute, the Wisconsin geological and natural history survey, the university hospitals, the state historical society, the Wisconsin Academy of Sciences, Arts and Letters, and the state laboratory of hygiene.

Stout institute, at Menomonie (a training school for teachers of vocational subjects, established in 1903), became Stout State college in 1955. Wisconsin State College and Institute of Technology, at Platteville, was founded in 1866, the name being changed from Wisconsin State Teachers college at Platteville in 1959 when it was combined with the Wisconsin Institute of Technology (1907). The other state colleges, nith their founding dates, are at Whitewater (1868), Oshkosh (1871), River Falls (1874), Superior.(1893), Stevens Point (1894), La Crosse (1909) and Eau Claire (1915) The state colleges provide teachers training and liberal arts education and grant the bachelor's degree. A law of 1955 created a co-ordinating committee for higher education composed of members of the boards of regents of the university and of the state colleges with broad powers over the finances, properties and programs of these institutions. County teachers colleges, schools of vocational and adult education, and private colleges in the state nork co-operatively with this committee.

Private institutions of higher learning in the state include Alverno (1936), Cardinal Stritch (1937) and Mount Mary (1872) colleges and Marquette university (1857), all Roman Catholic, at Milwaukee; Beloit college (1846). related to the Congregational and Presbyterian Churches. at Beloit; Carroll college (1840), affiliated with the United Presbyterian Church, at Waukesha; Lawrence college (1847). nonsectarian, and its affiliated Institute of Paper Chemistry (1929). at Appleton; Northland college (1892), affiliated nith the Congregational Church, at Ashland; Ripon college (1850), nonsectarian, at Ripon; St. Norbert college

(1898), Roman Catholic, at West De Pere; and Viterbo (1931), Roman Catholic, at La Crosse.

HEALTH AND WELFARE

Public Health. — Since 1876 Wisconsin has been officially concerned with the health of its people. Beginning with attempts to control communicable diseases through sanitation and quarantine, the state board of health has constantly expanded its responsibilities and its control over measures relating to public health. It maintains the state bureau of vital statistics and (in co-operation with the University of Wisconsin) a state laboratory of hygiene. It provides education in maternal and child health, in dental hygiene and in general health measures; administers hospital and nursing home licensure; and regulates the licensing of and inspects barbershops, beauty salons, public eating houses and funeral establishments. It co-ordinates the work on control of infectious and chronic diseases and serves as a channel of communication among all health agencies, local, private and state. A section on environmental sanitation supervises public water supplies, milk. refuse disposal, plumbing and similar safeguards to public health.

Public Welfare. — A department of public welfare is responsible for most of the state charitable, curative, correctional and penal institutions. It administers laws pertaining to the welfare of children and youths, including licensing and supervising private child welfare agencies and advising county agencies and juvenile courts. It supervises the state correctional institutions as well as prison farms and camps, the probation and parole system, the psychiatric field services and the program of correctional education. It also supervises the state hospitals for the mentally ill and defective and inspects county mental hospitals. A division of public assistance supervises the administration of aids to the aged, the blind, the disabled, and state dependents, administers programs of relief to needy Indians and to the blind, and supervises distribution of state relief monies.

In the second half of the 20th century 13 state institutions were under the supervision or operation of this department. The correctional institutions were the home for women at Taycheedah, the school for boys at Waukesha. the school for girls at Oregon, the state prison at R'aupun and the state reformatory (for males) at Green Eay. The mental institutions mere the Central State hospital at Waupun, the Central Colony and Training school at Madison. the Mendota State hospital at Madison, the Northern Wisconsin Colony and Training school at Chippewa Falls, the Southern Wisconsin Colony and Training school at Union Grove, the state hospital at Winnebago and the diagnostic centre at Madison. Finally, there was the child care institution at Sparta.

An interagency committee on human welfare studies conditions of health and public welfare in Wisconsin and recommends needed legislative measures to the legislative council.

THE ECONOMY

Agriculture. — Wisconsin is one of the leading agricultural states of the United States. In the 1950s 64% of the land area, or about 22,500,000 ac., was farm land, representing a decrease of about 3% in the ten-year period following World War II. Of this, 12,500,000 ac. were classified as crop land, 8,500,000 as pasture. The number of farms was 150,000 as compared with 175,003 after the war. During the same years the average size of farms increased from 117 to 146 ac. and the average value per acre from $53 to $100. The highest land values mere in the southern and eastern counties. The total value of all farm land and buildings was more than $2,250~000,000. Livestock was valued at about $500,-000,000 after the war and at $600,000,000 in the 1950s.

Annual cash farm income exceeds $1,000,000,000, of which more than $800,000,000 is from the sale of livestock products and the balance from crops. The chief crops, by acreage harvested, are hay, oats: corn, peas, barley, wheat, rye, potatoes and tobacco.

A small proportion of Wisconsin's crop is marketed directly; a greater amount, however, is fed to livestock on the farms, and the farmers receive their income chiefly from livestock production. Wisconsin ranks first in the nation in value of dairy products. Early Swiss, German and Danish settlers, producing the famous cheeses of their native lands, established and fostered the cheese-making industry. At the close of World War II Wisconsin produced almost 50% of all the cheese made in the United States, and was the nation's Swiss cheese capital. By 1955 the state supplied only 33% of the Swiss cheese, the decrease being due largely to the introduction of the rindless block type technique which was quickly adopted by other areas. Normally, more than 33% of the milk produced in Wisconsin is used for cheese, about 25% for butter, 12.5% is shipped to other states and the remainder is used for evaporated and condensed milk, home consumption and other purposes.

In addition to dairy herds Wisconsin produces cattle for beef and raises swine, sheep and lambs. and chickens. Horses and mules still are raised but declined from more than 500,000 annually before World War II to fewer than 100,000 by the 1950s.

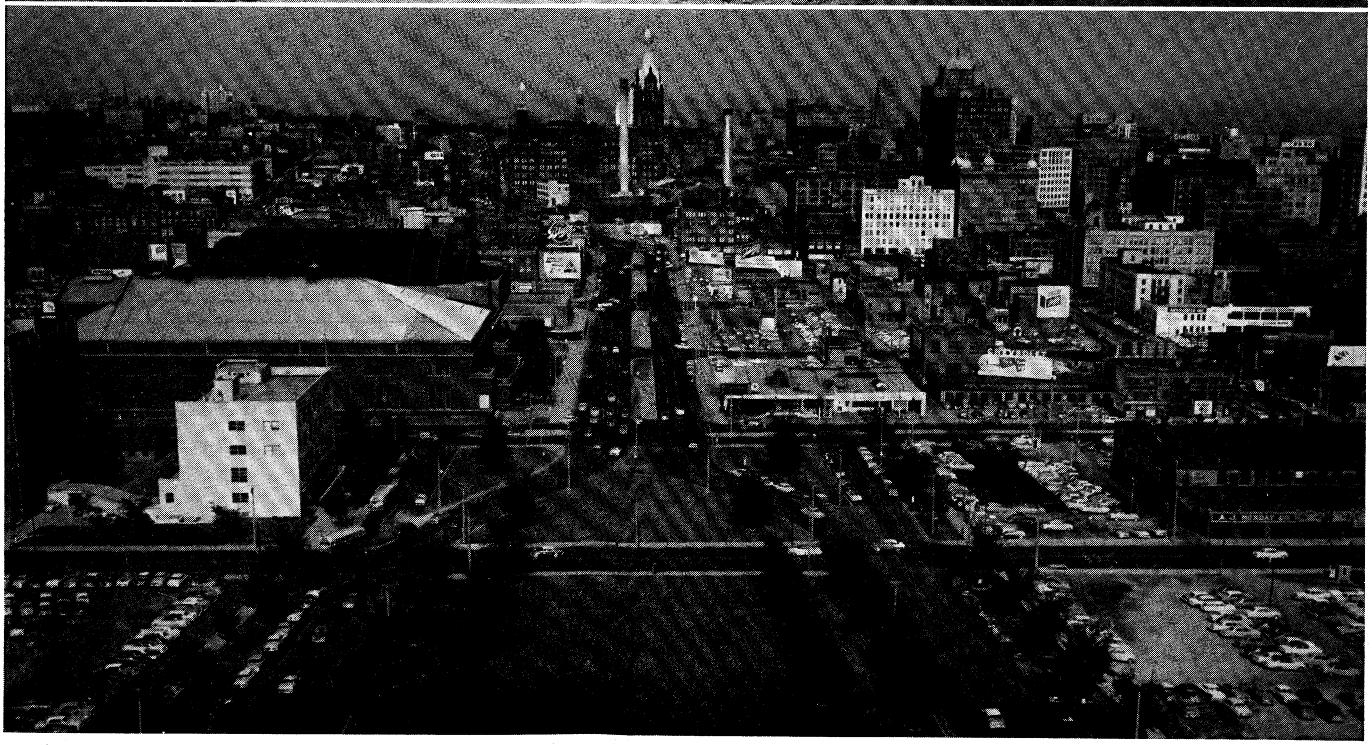
In addition to the more standardized farm products, Wisconsin produces some unusual crops. The state ranked high in the trees tapped for maple sap and in production of maple sirup. It produces about 110,000 tons of sugar beets annually. A relatively new industry is peppermint culture, begun in 1943. The domestic culture of fur-bearing animals has become an important source of revenue; more than 1,400 mink ranches annually produce about $30.000.000 worth of pelts.

Industry.—Manufacturing, increasing rapidly in the 20th century, became the chief industry in the state. The value of its products rose from $360,000,000 in 1900 to almost $700,000,000 in 1914 and to more than $2,000,000,000 in 1929. The depression reduced it to less than $1,000,000,000 in 1933 but World War II brought revival and by the end of the nar it was again more than $2,000,000,000 and before 1960 exceeded $3,000,000,000, ranking Wisconsin 11th among the states in the value of its manufactured products.

Wisconsin's chief branch of manufacture is that connected with its dairying industry, in which it leads the states The industry is nidely diffused, with many of the cheese factories being small and close to the supply of raw material. Next to the dairy industry in the value of its product is the paper and pulp industry. Other major manufactures are transportation equipment, malt and malt liquors, foundries, machine-shop products, printing and publishing, electrical machinery, apparatus and supplies, leather, meat products, canned vegetables and fruits, textiles, clothing, furniture and lumber and lumber products.

In 1910 Milwaukee was responsible for more than one-third of the state's manufacturing output and thereafter remained the chief industrial centre of the state. After 1914, however, other cities developed considerable manufactures, especially Kenosha, Racine and Janesville. Racine and Janesville are famous producers of farm implements. Important enterprises are also located at West Allis, Illadison, Oshkosh. Sheboygan, Beloit, Green Bay, Superior, La Crosse, Manitowoc, Fond du Lac, Eau Claire and Appleton. Madison, Beloit and Janesville are all in the Rock river valley, which is the route for two of the leading railroads from Chicago to the northwest. A more notable concentration of manufacturing cities is in the Fox river valley, including the shores of Lake Winnebago. Here are Oshkosh, Fond du Lac, Appleton and Green Bay. Their location makes them the centre for the papermaking and woodworking industries. This is also the region of greatest development in water power. It is noticeable that only one of the important cities, La Crosse, is on the Mississippi river, and one only, Superior, on Lake Superior.

Mines and **Quarries.**—Wisconsin's mineral products are varied and though in value they fall far below the farm, forest and factory products of the state, they nevertheless amount to considerable sums each year. During the decade 1920–30 the annual production ranged close to $20.000.000 and in 1929 exceeded $24,000,000. Mining activity, however, diminished in 1930 and subsequent years until 1933. when production stood at the low mark of $7,154,000. Thereafter, a slow recovery began, and with the added stimulus of World War II the state's mineral output again reached $20,-000,000 during the war and rose to $40,000,000 by 1950 and to $60,000,000 by 1960. Other important minerals include granite,

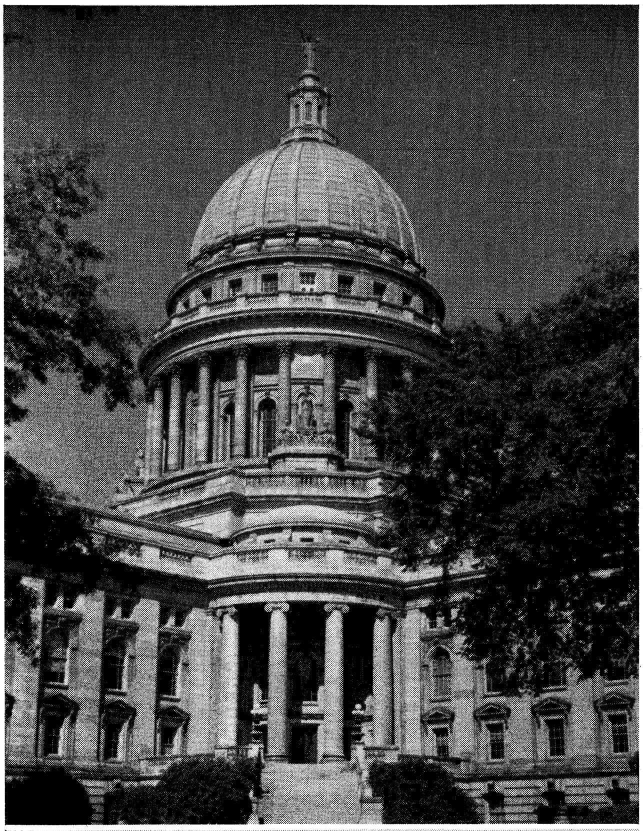


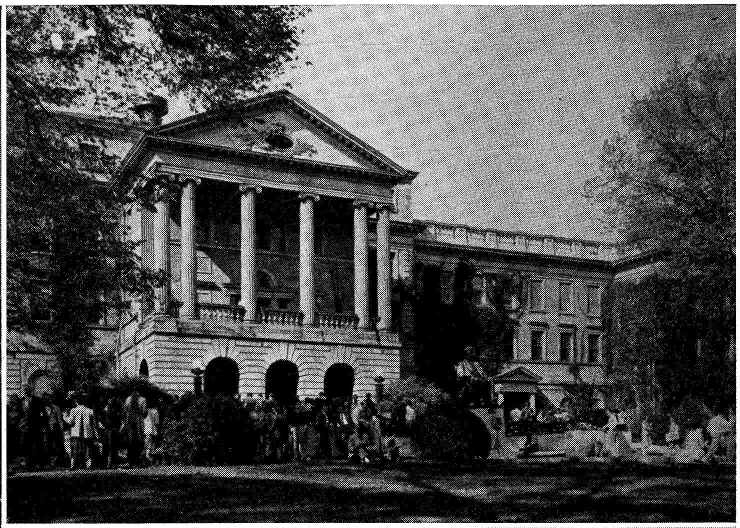
BY COURTESY OF (TOP) WISCONSIN CONSERVATION DEPARTMENT; PHOTOGRAPH, (BOTTOM) H. ARMSTRONG ROBERTS

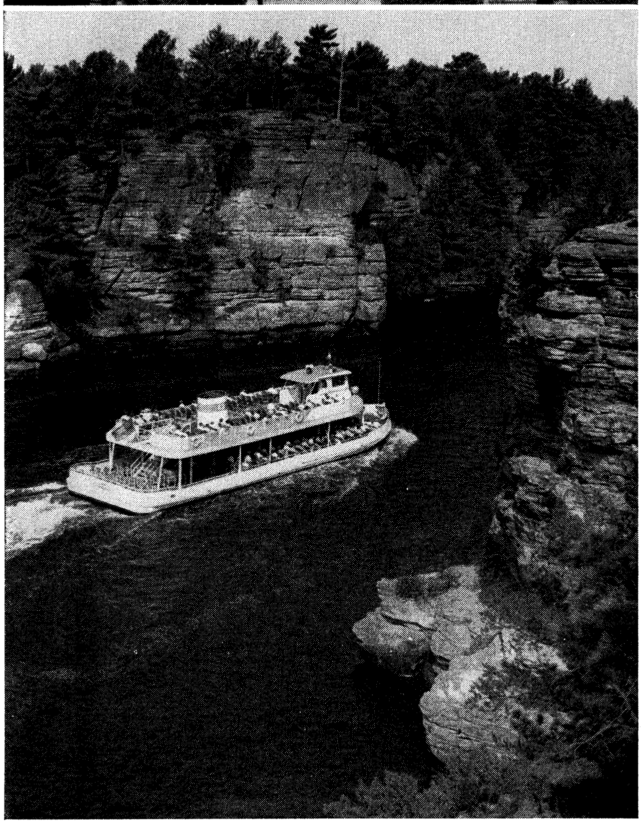
THE LAKE MICHIGAN SHORE AND MILWAUKEE

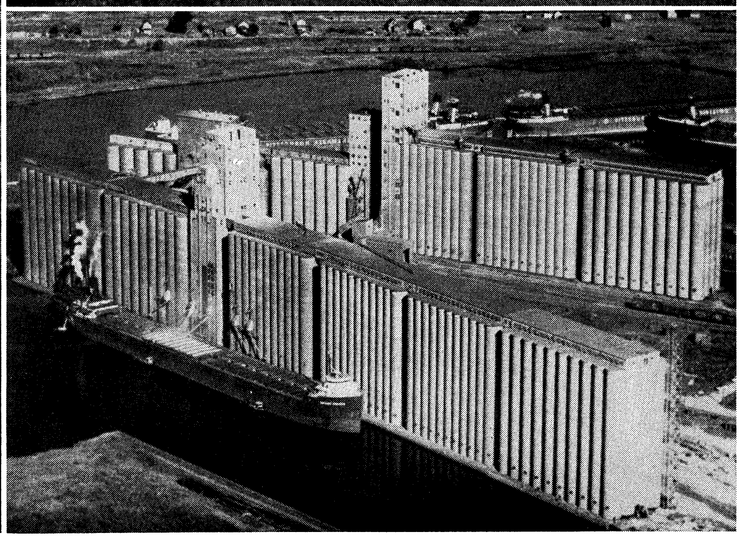
Top: Scene along the Wisconsin shore of Lake Michigan near Two Rivers. The state has more than 500 mi. of shoreline on Lakes Superior and Michigan on the north and east, and most of its western boundary is formed by the Mississippi and St. Croix rivers

Bottom: View toward City Hall in Milwaukee, largest city in Wisconsin and an important Great Lakes grain and coal shipping port









BY COURTESY OF (BOTTOM RIGHT) WISCONSIN CONSERVATION DEPARTMENT; PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) A. DEVANEY, (CENTRE RIGHT) H. ARMSTRONG ROBERTS. (BOTTOM LEFT) H. H. BENNETT

SCENES IN WISCONSIN

Top *left:* The state capitol, Madison, built of white granite, 1904–14

Top *dght:* Bascom hall, University of Wisconsin, Madison, overlooks a memorial terrace and bronze statue of Abraham Lincoln

Centre right: Wisconsin Holstein cattle and cornfields. The state is the nation's leader in dairying; corn is one of Wisconsin's largest crops

Bottom left: An excursion boat on the Wisconsin river near Wisconsin Dells

Bottom right: A cargo ship loading grain at Superior, one of the finest natural harbours in the world. With its sister city, Duluth, Minn., it ranks high among U.S. ports in the amount of commercial cargo handled limestone (dolomite), clay and sand and gravel. Another important resource of the state is its mineral waters.

The lead mines of southwestern Wisconsin were the earliest developed, and they reached a peak production in the decade 1840–50, after which they slowly declined. In 1918 there were produced 4.533 short tons. In 1938 production was down to 320 short tons. After World War II most of the lead was only a by-product of zinc mining. which has become of main importance in the same region, with annual production fluctuating between about 500 and 2,000 tons. The zinc-bearing ores are chiefly found below the water level, and their production was not stimulated greatly until the rise in price of zinc about 1900. The production of this metal fluctuates with widely varying prices. It amounted to 27.285 tons in 1920, 10,052 in 1922 and 26,800 in 1926. After World War II it ranged from about 5,000 to 20.000 tons. Whereas early lead mining was largely carried on by individuals in shallow mines, the deeper zinc ores are mined almost exclusively by large companies using modern power machinery for mining and milling.

Of the great Lake Superior iron-producing district shared by Minnesota, Wisconsin and Michigan, Wisconsin possesses the smallest part. Two producing ranges extend into north Wisconsin, but the richer portions of each are in the upper peninsula of Michigan. 'The Wisconsin portion of the Penokee-Gogebic range is in Iron county, where most of the ore is mined. The chief mineral output of Wisconsin, formerly building and ornamental stone. is sand and gravel and crushed stone for highway and building construction. Granite of many different colours is also quarried. At hundreds of places in the state, clay deposits suitable for making brick and tile are to be found.

Forests and Lumbering.— Originally all Wisconsin, except a few thousand square miles of prairie region in the south, mas covered with forests (see *Plant and Animal Life,* above). The great age of lumbering in Wisconsin was from 1890 to 1905, for the last five years of which Wisconsin was the leading lumber-producing state of the United States. Production reached nearly 3,500,000,000 bd.ft. annually. The cut of lumber steadily declined after 1900 to about 300,000,000 bd.ft. a year in the second half of the 20th century. In contrast to the decline in lumber production, wood pulp production reached its peak after 1950, exceeding 1,000,000 tons annually.

Transportation.— In Lake Superior, Lake Michigan and the Mississippi river, Wisconsin is supplied upon three sides by unusual facilities for water shipping. In addition to their actual commerce, these waterways are of great importance because of the continual check they supply upon iand transport rates. Each year the navigahle channel of the Mississippi transports nearly 700,-000 tons of coal, petroleum and other bulk products to or from Wisconsin ports. Wisconsin has 12 major and 10 minor ports on Lakes Superior and Michigan. By far the largest is its share in the port of Superior-Duluth. which handles more than 65,000,000 tons of freight a year, mostly iron ore, with coal and grain as leading secondary products. The other chief lake ports, all on Lake Michigan, are Milwaukee, Green Bay and Ashland.

The first railways were built east and west with the idea of connecting the waterways as quickly as possible, but as the railways grew more independent the main lines were built in a general northwest and southeast direction so as to connect Chicago and Milwaukee with the cities of St. Paul and hlinneapolis by lines as direct as possible. Other lines run from Milwaukee northwest to Ashland, Superior and Duluth. The railway mileage in the state, which reached more than 7,500 mi. in the 1920s. declined to about 6.000 mi. in the second half of the 20th century. There is a network of motorbus lines connecting the chief cities, and the state has over 70 publicly owned airports. There are more than 85.000 mi. of rural roads, of which about 88% are surfaced. The state highway system encompasses an additional 11.000 mi.

Tourist Trade.— The tourist trade is a major contributor to Wisconsin's economy. Attracted by the scenery, the climate, water sports, hunting game birds and animals, and forms of recreation provided in public parks and private resorts. uncounted numbers of tourists enter Wisconsin at all seasons. The Conservation commission, the Northern Great Lakes Area council and numerous private agencies encourage this so-called industry, which produces an annual revenue estimated as high as $300,000.000.

See also Index entries under "Wisconsin" in the Index volume.

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The *Wisconsin Blue Book,* published biennially by the state, furnishes much valuable information on contemporary conditions. Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of tlze Year,* American edition. (AL. E. SM.)

WISCONSIN, UNIVERSITY OF, a state-controlled coeducational institution of higher learning established at Madison, Wis., in 1848. *See* WISCONSIN: *Education.*

WISDOM, BOOK OF (titled WISDOM OF SOLOMON in Greek manuscripts). a book established in the Vulgate canon of the Bible by the Council of Trent (1546); Protestant editions of the Bible include it among the Old Testament apocrypha; it is not included in the Jewish canon. It belongs to the class of literature known as wisdom writings. of which Job, Proverbs, Ecclesiastes and Ecclesiasticus are earlier examples (see WISDOM LITERATURE).

The work may be divided into three sections: (1) ch. i–v deal with the problem of the oppression of the righteous by the unrighteous; (2) ch. vi–ix purport to be an oration delivered by Solomon in praise of Wisdom (regarded as a personified divine attribute); (3) ch. x–xix are a recital of Israel's history with a view to showing Wisdom as the defender of the righteous and the judge of God's enemies. The final section includes a lengthy digression (xiii–xv) condemning idolatry.

The book was produced at a time when pious adherents of Judaism rr-ere suffering under the domination of Gentile rulers and high-placed Jewish renegades. The author hoped to encourage the oppressed and bring about the reconversion of the apostates. The extensive treatment of Wisdom's protection of Israel and punishment of Egypt in ancient times (ch. x–xix) probably was intended as a warning against the writer's Alexandrian contemporaries. The recurrent theme is that Wisdom, the associate of God (ix, 4), is the only source of good, and that to know her is to gain life.

The name "Solomon" in the title is a pseudonym. The writer's good command of Greek and acquaintance with Hellenistic philosophy identify him as a member of the Diaspora. Whether the author incorporated earlier written sources in his book is a debated question. Scholarly opinion is all but unanimous in rejecting theories of Hebrew originals behind parts of the book.

Since the writer relied on the Septuagint version of Isaiah. a date of composition later than 150 B.C. is necessary. The probable use of the book by Paul and in the Epistle to the Hebrews requires a date prior to A.D. 50. Some scholars find a reference to full-fledged persecution in ii, 12–20, and place the writing of the book shortly after the anti-Semitic disorders in A.D. 38. Others favour a date in the 1st century B.C.

In any case, the book is an example of modification of Jewish thought by Alexandrian Greek philosophy. While "Solomon" probably had no formal philosophical education, he was imbued with Hellenistic culture. He accepted the Platonic doctrine of the pre-existence of the soul (viii, 19–20). He spoke of the creation of the world out of formless matter (xi, 18) and regarded the body as evil (ix. 15). His doctrine of the immanence of Wisdom in all things (i, 7; vii, 24) was taken from the Stoics.

Yet, his appropriation of Hellenistic ideas was not indiscriminate. He had no sympathy for any "love of wisdom" which was not expressed by the "keeping of her laws" (vi, 17–20). In i–v he inveighed against apostates who had accepted the Epicurean doctrine that men are born by chance and had adopted an ethic of greedy hedonism (ii, 2–11). In vi–ix he asserted that wisdom comes only as a gift of God (viii, 21); even the understanding of the sciences is divinely given (vii, 17–22).

His loyalty to his ancestral faith is apparent. Earlier nisdom writings were known to and echoed by "Solomon" repeatedly; his personification of Wisdom was rooted in such passages as Prov. viii and Job xxviii; his picture of the suffering but victorious son of God (ii, 10–v) was drawn from Isaiah. His account of Hebrew history (x–xix) is distinctive both in the freedom nith which he embellished the narrative and in his exaltation of Wisdom (= Spirit: i, 6–7; ix, 17) as the instrument of redemption; but the recital itself is evidence of his grounding in the faith of Israel.

"Solomon" had not yet achieved the level of assimilation of Greek philosophy to the Law found in Philo. Hellenistic and Jewish ideas sometimes occur side by side in an unrecognized tension. He polemized against idolatry like a Hebrew prophet (xiii–xv), but he adopted Euhemerus' theory of the origin of the gods (xiv, 15–21 He described a judgment scene in language that belonged to Jewish eschatology (iii, 7 ff.), but he obviously believed in the immortality of the soul (iii, 1–4).

It is important, however, that he found the two ways of thought compatible. In his work we recognize Wisdom as a bridge between philosophy and the Bible, and that bridge was crossed by Philo, the rabbis and the Fathers of the Church.

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(M. J. SU.)

WISDOM LITERATURE is the title given to certain writings of the ancient orient, of which those of the Hebrews are most widely known. The books of Proverbs, Job and Ecclesiastes (*qq.v.*), along with some Psalms (notably i, xlix and Ixxiii) and a few other brief passages, comprise the wisdom literature of the Old Testament. In the apocrypha the great wisdom books are the Book of Wisdom (Wisdom of Solomon) and Ecclesiasticus (*qq.v.*). The word "wisdom" was a technical term that covered much that is included under the modern usage but had a wider connotation as mell.

Wisdom is first heard of in Egypt soon after 3000 B.C. About 600 years later a vizier by the name of Ptah-hotep attained high repute for his wisdom. His precepts, in the form of a collection of proverbial sayings, were preserved and are claimed to be the oldest book in the world. They comprise a sort of ethical treatise that assumes the nature of the good life and undertakes to tell how this can be realized by the special group for whom it was written. Through the following 15 or more centuries many other wise men arose in Egypt. Some of them left bodies of proverbs, but others were led by circumstances to consider more deeply the worth and meaning of human life; in other words, they were compelled to think about metaphysical problems. Wisdom speculation arose also in Babylonia, where other writers composed bodies of proverbs or pessimistic writings that denied any value in life. This intellectual activity could not have been confined to a few favoured lands. Even uncivilized peoples ask and answer questions about the nature of the world and the meaning of human life, and such speculation is universal among more advanced cultures. And so wisdom was pervasive through the ancient east. The little land of Edom was famous for its wise men, and apparently there was a wisdom movement among the Canaanites before the Hebrews entered Palestine.

It is no accident that the Greek word "philosophy" means "love of wisdom." The full measure of Greece's debt to the orient has never been determined, but in any case Greek philosophy was heir to and in some measure disciple of the age-old speculation of the east. Yet wisdom was both more and less than philosophy. Much that is now included under the term had not then risen above the intellectual horizon, but also much that then was wisdom later attained an independent position. The practical shrewdness of the businessman and administrator, incipient science, general knowledge, reflection upon known facts and much else of the sort, as well as more strictly philosophic speculation, went into the total of wisdom. The educated man, particularly if he gave thought to human conduct and its ends, was the wise man. Wisdom was the total of the intellectual culture of the age.

It would seem that Israel was introduced to wisdom by the Canaanites, to whose culture it was deeply indebted. This explains its early appearance: even in the days of the Judges (about 1200–1050 B.C.) devices of the wise men, such as the fable and the riddle, were familiar. In David's time there were professional wise persons (II Sam. xiv, 2–20; xx, 16–22); interestingly enough, those who are mentioned were women. Solomon's wisdom became proverbial, although its true nature is widely misunderstood.

Through the following centuries the wise men were at times the object of stern rebuke by the prophets, who disliked their pragmatic realism. But the exile brought a change in Hebrew wisdom, as in much else of the nation's character. Wisdom became deeply religious. The wise men were convinced that religion alone possessed the key to life's highest values.

It was this mood that dominated the final shaping of the Hebrew wisdom literature. Though dependent on older materials and in part incorporating documents from before the exile, the wisdom books as they are now known were produced from approximately 400 B.C. to the beginning of Christian times. True to the character of the wisdom activity, the influence of foreign thought is evident in much of their total.

As literature the books are of varying worth. Ecclesiastes contains much of high quality; Job is freely recognized to be a classic. The maxims in Proverbs attempt no literary merit, but ch. i–ix are poetry that attains considerable excellence in parts. This section is the latest portion of the book and contains some of the most profound thinking of the Old Testament. It speaks of a reality pervasive through the world, indeed existent before the world, through which the world was made. This reality, which is wisdom, proceeded from God and is the expression of God's activity in all created things. In particular it operates in human life as the impelling force that insistently and unceasingly leads men to higher things.

This great thinker was an optimist. But the Book of Job is down among the bitter facts of experience. Its problem is that of the divine government of a world in which injustice is rampant. The book is composite; many thinkers have contributed their views. But the great author of the Dialogue, which is the core of the book, was also an optimist: he had an answer of faith and hope. Ecclesiastes was again different. Its author found no worth in life; all that remains is for each individual to find what enjoyment he can in his work and in the simple pleasures of the passing days. But Ecclesiasticus and the Book of Wisdom were in the succession of Prov. 1–9; the transcendent wisdom is the supreme fact of human experience. (W. A. I.)

WISE, HENRY ALEXANDER (1806–1876), U.S. politician and Confederate general, was born at Accomac Court House, Va., Dec. 3, 1806. After graduating with honours from Washington college (now Washington and Jefferson), Washington, Pa., in 1825, he studied law and opened an office in Nashville, Tenn., in 1828, but returned to Accomac in 1830. In 1832 he was elected to the U.S. house of representatives as a Jacksonian Democrat, but broke with his party on the bank question and served as a Whig until he followed President Tyler out of that camp. In Jan. 1844 he was appointed minister to Brazil, returning in 1847 to practise law in Accomac.

In 1855 Wise, as a Democratic candidate, was elected governor of Virginia and was a delegate to the secession convention of 1861. In May 1861 he was commissioned brigadier general in the Confederate army and served until the war ended at Appomattox. After the war he practised law in Richmond, and in 1872 published his *Seven Decades of the Union.*

Wise died at Richmond on Sept. 12, 1876.

See Barton Wise, *The Life of Henry A. Wise* (1899), and John S. Wise, *The End of an Era* (1899). (T. P. A.)

WISE, ISAAC MAYER (1819–1900) U.S. rabbi. America's greatest organizer of Liberal (Reform) Jewish institutions, all of which became prototypes for similar organizations of American Conservative and Orthodox Jews, was born in Bohemia on March 29, 1819. In his long career as rabbi after his arrival in the United States in 1846 he wrote many volumes of history, theology, polemics. novels, plays and hymns, of which only his *Reminiscences* will endure. After a brief stay as rabbi in Albany, N.Y., where he evolved his philosophy of moderate, gradualistic reform, he moved to Cincinnati, O. (1854), where he remained for the rest of his life the most influential rabbi of the Ohio and Mississippi valleys. Kindly, able, energetic, an astute politician, Wise gained a huge following through his English weekly the *American Israelite,* through his German paper *Die Deborah,* through his prayer book *Minhag America* and through his willingness to go almost anywhere to dedicate new synagogues. His goal in life was to bring about a united American Jewry. Thus, as chairman of a national committee to protest the treaty between the U.S. and Switzerland which discriminated against American Jews, he headed the first organized effort of American Jews to fight for their civil liberties. Because of his talents for leadership and his sense of realism, he was able to bring effective guidance in the adjustment of Judaism to American life. An excellent organizer, he created three basic American Jewish institutions: the Union of American Hebrew Congregations (1873), at first a union only of synagogues in the middle west and south; the Hebrew Union college (1875), a rabbinical school; and the Central Conference of American Rabbis (1889), an association of Reform rabbis. Firmly believing in the ultimate triumph of the liberal-universalistic approach of Reform Judaism, he frowned upon a Jewish national political state in Palestine, and he bitterly opposed the Zionist movement.

Wise died at Cincinnati on March 26, 1900.

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WISE, JOHN (1652–1725), American clergyman and pamphleteer in support of democratic government and liberty, was born at Roxbury, Mass., in Aug. 1652. He was graduated from Harvard university in 1673; and after studying theology, he preached at Branford, Conn., 1675–76, and at Hatfield, Mass., 1677–78. He was ordained in 1683 as minister of Chebacco, a parish of Ipsmich, Mass., where he remained until his death. Wise led the citizens of Ipswich to resist the efforts of Gov. Edmund Andros to levy a province tax, and in Oct. 1687 he was tried and convicted, fined, deprived of his clerical office and put under peace bonds. Andros later reversed that part of the court's judgment that prohibited him from acting as a minister. Wise brought an action against Joseph Dudley, who had presided over the court that convicted him, for refusing to grant him the right of habeas corpus, and it is said that he was awarded damages.

In 1705 Increase Mather published a pamphlet called *Questions and Proposals,* which outlined a plan to establish an organization of ministers in Massachusetts that would exercise the authority then invested in the individual churches. Fearing that this marked the beginning of a reactionary movement, Wise opposed the plan and in 1710 published the pamphlet *The Churches Quarrel Espoused.* In this he eloquently attacked the proposals of Mather, and the movement was completely defeated. In 1717 Wise published *A Vindication of the Government of New-England Churches,* a pamphlet examining the principles of both civil and religious government. His essays were reprinted in 1772 and in 1860. In support of the project of many liberal groups to establish a monetary system based on paper money, he published a pamphlet in 1721 entitled *A Word of Conzfort to a Melancholy Country.* He died in Ipswich on April 8, 1725.

WISE, STEPHEN SAMUEL (1874–1949), U.S. rabbi, for many years a leader of American Judaism and of the Zionist cause, was born March 17, 1874, in Budapest, Hung., and was taken to the United States in 1875, by his father, Rabbi Aaron Wise. He received his Ph.D. at Columbia university in 1901, and his rabbinical training from private teachers, among them Rabbi Gustav Gottheil. After serving as rabbi to Congregation B'nai Jeshurun, New York city (1893–1900), and Temple Beth Israel, Portland, Ore. (1900–06), he was invited to become rabbi of Temple Emanu-El, New York city, but not receiving adequate assurances of free speech in the pulpit, he declined the call, founding instead the Free Synagogue of New York city in 1907. Wise fought for civic morality and helped bring about the downfall of Richard ("Boss") Croker, and later, with John Haynes Holmes in the Civic Affairs committee, of Mayor James J. Walker. At Basel, Switz., in 1898 he was English secretary at the second Zionist congress, and thereafter became one of the foremost Zionist leaders. In 1915–16 Wise was associated with Louis D. Brandeis and others in the American Jewish congress; later he became president of the permanent American Jewish congress and the World Jewish congress. He helped represent the Jewish cause at the Versailles peace conference in 1919 and was the outstanding figure in mobilizing U.S. public opinion against Hitlerism in the 1930s. In 1922 he founded the Jewish Institute of Religion and ordained many leading American rabbis. He was a founder and editor of the magazine *Opinion,* author of *The Improvement of the Moral Qualities* (1902) and other works. For many years he conducted Sunday morning services at Carnegie hall, attracting great throngs of non-Jews and Jews. His work in synagogue social service and child adoption (in co-operation with his wife, Louise Waterman Wise) endures. Wise was of striking appearance, had a voice of remarkable resonance, and during his lifetime his name was a household word throughout the country. He died April 19, 1949.

See *Challenging Years,* his posthumously published autobiography (1949); *American Jewish Year Book, 1950,* pp. 515–518, 525–526; *Universal Jewish Encyclopedia,* vol. x, pp. 543–544. (L. I. N.)

WISEMAN, NICHOLAS PATRICK STEPHEN (1802–1865), English cardinal, was born at Seville on Aug. 2, 1802, the child of Anglo-Irish parents recently settled in Spain for business purposes. On his father's death in 1805 he was brought to Waterford. He was educated at Ushaw college, near Durham, and at the English college in Rome, of which he became vice-rector in 1827 and rector in 1828. He held the rectorship for 12 years. From the first a devoted student and antiquary, he studied the oriental manuscripts in the Vatican library, and a first volume. entitled *Horae Syriacae,* published in 1827, gave promise of a great scholar. Leo XII appointed him curator of the Arabic manuscripts in the Vatican and professor of oriental languages in the Roman university. His student life was broken by the pope's command to preach to the English in Rome; he visited England in 1835–36, and delivered lectures on the principles and main doctrines of Roman Catholicism in the Sardinian chapel, Lincoln's Inn Fields, and in the church at Moorfields, later pulled down. In 1836 he founded the *Dublin Review.*

In 1840 he was consecrated bishop, and sent to England as coadjutor to Bishop Walsh, vicar apostolic of the Central district, and was also appointed president of Oscott college near Birmingham. Oscott, under his presidency, became a centre for English

Catholics. The Oxford converts (1845 and later) added considerably to Wiseman's responsibilities. It was by his advice that Newman and his companions spent some time in Rome before undertaking clerical work in England. Shortly after the accession of Pius IX Wiseman was appointed temporarily vicar apostolic of the London district, the appointment becoming permanent in Feb. 1849. On his arrival from Rome in 1847 he acted as informal diplomatic envoy from the pope, to ascertain from the government what support England was likely to give in carrying out the liberal policy with which Pius inaugurated his reign. In response Lord Minto was sent to Rome as "an authentic organ of the British government," but the policy in question proved abortive. Wiseman threw himself into his new duties with many-sided activity. He was zealous for the establishment of religious communities, both of men and women, and for the holding of retreats and missions.

The progress of Catholicism was undeniable, but yet Wiseman found himself steadily opposed by a minority among his own clergy, who disliked his ultramontane ideas, his "Romanizing and innovating zeal." In July 1850 he heard of the pope's intention to create him a cardinal, and expected to be permanently recalled to Rome. But on his arrival there he Ascertained that a part of the pope's plan for restoring a diocesan hierarchy in England was that he himself should return to England as cardinal and archbishop of Westminster. When he reached London (Nov. 11) the whole country was ablaze with indignation at the "papal aggression," which was misunderstood to imply a new and unjustifiable claim to territorial rule. But Wiseman wrote an admirable *Appeal to the English People* in which he explained the nature of the pope's action, and argued that the admitted principle of toleration included leave to establish a diocesan hierarchy.

Two years later Manning was appointed provost of Westminster and he established in Bayswater his community of the "Oblates of St. Charles."

The last two years of his life were troubled by illness and by controversies in which he found himself, under Manning's influence, compelled to adopt a policy less liberal than that which had been his in earlier years. Thus he had to condemn the Association for the Promotion of the Unity of Christendom, with which he had shown some sympathy in its inception in 1857, and to forbid Catholic parents to send their sons to Oxford or Cambridge. though at an earlier date he had hoped (with Newman) that at Oxford at least a college or hall might be assigned to them. Wiseman died on Feb. 16, 1865. Wiseman was one of the most learned men of his time. He combined with the principles known as ultramontane liberality of view in matters ecclesiastical. He insisted on a poetical interpretation of the church's liturgy; and while strenuously maintaining its divine commission to teach faith and morals, he regarded the church as in other respects a learner; and he advocated a policy of conciliation.

(A. W. Hu.; X.)

WISHART, GEORGE (*c.* 1513–1546), Scottish reformer, was accused of heresy in 1538, and fled to England, where a similar charge was brought against him at Bristol in the following year. In 1539 or 1540 he started for Germany and Switzerland, and returning to England became a member of Corpus Christi college, Cambridge.

In 1543 he went to Scotland in the train of a returning embassy. Wishart began to preach in 1544, at Perth, Edinburgh, Leith and Haddington. At Ormiston, in Dec. 1545, he was seized by the earl of Bothwell, and transferred by order of the privy council to Edinburgh castle on Jan. 19. 1546 Thence he was handed over to David Cardinal Beaton, who had him burned at St. Andrews on March 1.

See Knox's *Hist.;* Reg. P. C. Scotland; Foxe's *Acts and Monuments;* Hay Fleming's *Martyrs and Confessors of St. Andrews;* Cramond's *Truth about Wishart (1898)*; and *Dictionary of National Biography,* vol. lxii.

WISLICENUS, JOHANNES (1835–1902), German chemist, who did pioneer research on isomers, was born on June 24, 1835, at Klein-Eichstedt in Thuringia and emigrated in 1853 to the U.S. with his father. He was assistant at Harvard to Eben Horsford, and in 1855 was appointed lecturer at the Mechanics' institute in New York. Returning to Europe in 1856 he continued his studies at Halle and Ziirich, where he was subsequently professor of chemistry (1864). He then obtained the chairs of chemistry at Wdrzburg (1872) and Leipzig (1885). He died at Leipzig on Dec. 5 1902.

Wislicenus' work on lactic acid resulted in the discovery of two substances differing in physical properties though possessing a structure of proved chemical identity. He maintained (1873), before publication of the doctrine of Jacobus H. van't Hoff and J. A. Le Bel, that the ordinary formulas did not afford an adequate explanation of certain carbon compounds, and suggested that account must be taken of the differing spatial arrangement of their atoms. He is also known for his uork on acetoacetic ester and its application as a synthetical agent and for his syntheses in the pentamethylene series.

WISMAR, a seaport town in the district of Rostock, Ger., in the former *Land* of Mecklenburg, at the southern end of the Bay of Wismar, one of the best harbours on the Baltic, 20 mi. N. by rail of Schwerin. Pop. (1950) 47,786. Wismar is said to have received civic rights in 1229 and came into the possession of Mecklenburg in 1301. In the 13th and 14th centuries it was a flourishing Hanse town, with important woolen factories. A plague carried off 10,000 of the inhabitants in 1376. By the peace of Westphalia in 1648 it passed to Sweden, and in 1815 to Mecklenburg. It was severely bombed in World War II.

WISSEMBOURG (Weissenburg), a town of France, capital of an *arrondissement* in the *département* of Bas-Rhin. on the Lauter, at the foot of the eastern slope of the Vosges mountains, 42 mi. N.E. of Strasbourg by the railway Basle-Strasbourg-Mannheim. Pop. (1954) 4.555. It grew up around a Benedictine abbey, founded in the 7th century by Dagobert II, and became the seat of a famous school. There Otfrid, a native of the district, completed (*c.* 868) his Old High German Gospel book. (*See* German Literature.) The town became a free imperial city in 1305. It has been the scene of two memorable battles. In Oct 1793 the Prussians and Saxons under the Austrian general Count D. S. von Wurmser stormed the "Weissenbourg lines." On Aug 4, 1870, the Germans, under the crown prince of Prussia, gained there the first victory of the Franco-German War (*q.v.*).

WISSLER, CLARK (1870–1947), **U.S.** anthropologist, best known as author of the standard book *The American Indian* (1917), for developing the culture-area concept and as discoverer of the universal culture pattern, was born Sept. 18, 1870, in Wayne county, Ind. In exhibiting the collections of material culture from the Indian tribes of North America at the American Museum of Natural History, New York city, where he directed the research and exhibits programs in anthropology for nearly 40 years, he divided the continent into geographical provinces, each of which was conceived as the home of a distinct type of culture and of a typical tribe. This classification made it possible to treat the American continents ethnographically and promoted discussion of culture centres and their problems.

Educated in the public schools of his home county, he taught in rural communities and attended the state university (B.A., 1897; M.A., 1899). In 1901 he received the Ph.D. in psychology under James McKeen Cattell at Columbia university, being one of the last professional anthropologists to be trained in another discipline. It was a natural progress from studies of mental differences to measurements of child development. And just as Franz Boas (*q.v.*) concentrated on developing anthropology as an academic discipline at Columbia, so Wissler became its leader in the museum world.

The preface to Robert and Helen Lynd's important sociological study *Middletown* (1937) attests his influence on the social sciences. He became a leading authority on the Dakota and Blackfoot tribes and wrote five books and more than 200 scientific and popular articles, chiefly on the North American Indians and related anthropological subjects. After 1924 he was also a professor in the Institute of Human Relations at Yale university and a leader in the scientific councils of the nation. He died in New York city on Aug. 25, 1947.

In addition to *The American Indian*, some of Wissler's more important works are: *North American Indians of the Plains* (1912); *Man and Culture* (1923); *The Relation of Nature to Man in Aboriginal America* (1926); *Introduction to Social Anthropology* (1929); and *Indians of the United States* (1940). He also edited about 40 numbers of the *Anthropological Papers* of the American Museum of Natural History.

For further information, *see* D. G. Mandelbaum, *Science*, 107:338–339 (1948); G. P. Murdock, *Amer. Anthrop.*, 50:292–304, with bibliography; N. C. Nelson, *Amer. Antiq.*, 13:244–247, for family history and museum career (1948); R. H. Lowie, *Amer. Anthrop.*, 51:527–528, with supplementary facts. (W. N. F.)

WISTER, OWEN (1860–1938), U.S. writer, whose novel *The Virginian* helped establish the cowboy as a U.S. folk hero and stock fictional character, was born in Philadelphia, Pa., July 14, 1860. He was a favourite grandson of the English actress Fanny Kemble (*see* KEMBLE [family]). On graduating from Harvard in 1882, he intended to devote himself to music and for two years studied composition in Paris. Ill-health forced his return to the United States; and he spent the summer of 1885 in Wyoming, on the advice of the physician-novelist S. Weir Mitchell (*q.v.*). In the fall Wister entered the Harvard law school, graduating in 1888, and, after being admitted to the bar in 1889, practised for two years in Philadelphia. He continued spending his summers in the west, and in 1891, after the enthusiastic acceptance by *Harper's* of two of his western sketches, he devoted himself to a literary career. He died at North Kingstown, R.I., July 21, 1938.

His novel *The Virginian* (1902), a humorous account of the misadventures of an easterner in Wyoming, was a great popular success and did as much to shape the romantic conception of the cowboy west as any other single work. Two earlier books, *Red Men and White* (1896) and *Lin McLean* (1898), also contributed to the legends of the cunning horse thief, the chivalrous rancher and the vanishing red man. *Philosophy 4* (1903), a diverting college story, and *Lady Baltimore* (1906), a romance of old Charleston, were also popular. Wister's other works include: *The Dragon of Wantley* (1892), a novel; *Ulysses S. Grant* (1900); *The Seven Ages of Washington* (1907); *Roosevelt: the Story of a Friendship, 1880–1919* (1930), concerning his long acquaintance with Theodore Roosevelt, a Harvard classmate; and two politico-social works on Anglo-American relations, *The Pentecost of Calamity* (1915) and *Neighbors Henceforth* (1922). He also wrote a number of books for children. Wister's collected writings were published in 11 volumes in 1928. His journals and letters from 1885 to 1895 were published in *Owen Wister Out West*, edited by Fanny Kemble Wister (1958).

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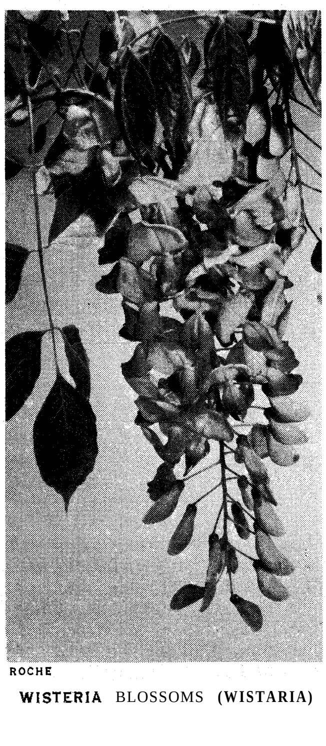

ROCHE

WISTERIA BLOSSOMS (WISTARIA)

WISTERIA, a genus of high-climbing woody vines (named after Caspar Wistar, distinguished U.S. physician and scientist, and later spelled *Wistaria*), of the pea family (Leguminosae), inhabiting China, Japan and eastern North America. The garden wisterias are mostly *W. sinensis* of China and *W. floribunda* of Japan; their violet-blue spring-blooming flowers, borne in long drooping racemes, are effective floral decorations against a house wall or on trelliswork. Varieties of these two species provide a wide range of colours from white through shades of pink, to red and purple. The North American species *W. frutescens*, found in southern states, has lilac-purple, fragrant flowers, and *W. macrostachya* of the central U.S. has much longer racemes of similar colour. Wisterias, propagated by seed, division, layering and cuttings, thrive in deep rich soil. They are hardy in mild climates of the northern U.S. and southern England. By pruning of the Asiatic species it is possible to make floriferous standards.

WITAN or WITENAGEMOT, the council of the Anglo-Saxon kings. It was in no sense a popular assembly, and its composition was determined by the king's pleasure. He would naturally wish to consult his greater nobles and his bishops, and such men were normally found in attendance at his councils. The ecclesiastical element was sometimes reinforced by the abbots of important monasteries. The king's household officers were usually present, and the council generally included a varying number of thegns without specific duties at court. The general character of the council underwent little change throughout the Old English period, though it inevitably tended to become a larger body as the king of Wessex developed into a king of all England. Its essential duty was to advise the king on all matters touching which he chose to ask its opinion. It attested his grants of land to churches or laymen, it consented to his issue of new laws or new statements of ancient custom, and it helped him to deal with rebels and persons suspected of disaffection. King Alfred asked its advice about the testamentary disposition of his private inheritance. In late Old English times the witan had ceremonial functions. It attended the king when he received ambassadors, and in the 11th century, if not earlier, joined him in public feasting at Easter, Whitsuntide and Christmas, commonly meeting for this purpose at Winchester, Westminster and Gloucester. At other times the king would summon his witan to attend him wherever he might choose. Important meetings of king and council were held in royal manors such as Wantage in Berkshire, Calne in Wiltshire and Andover in Hampshire. In its composition and duties the witan closely resembled its successor, the *Commune Concilium* of the Anglo-Norman kings, the fundamental difference between these bodies being the feudal tie which connected the baronial councillors of the Norman time with the king. (F. M. S.)

WITCHCRAFT. The actual meaning of this word appears to be the art or craft of the wise, as the word "witch" is allied with "wit," *to know*. From about the 15th century the word has been almost exclusively applied to workers of magic, whether male or female. Magicians and sorcerers are known in all parts of the world; among savage communities they are usually credited with supernatural powers by their fellow tribesmen (*see* MAGIC). Divination (*q.v.*) or foretelling the future is one of the commonest forms of witchcraft; when this is done in the name of the deity of one of the established religions it is called prophecy; when, however, the divination is in the name of a pagan god it is mere witchcraft. This distinction is very clear in the account of the contest between Moses and pharaoh's magicians as given in Exodus; but in the demotic story, which appears to give the Egyptian version of the incident, the wise priest of Egypt defeats the miserable foreign sorcerer whom he had saved from the water when a child.

Mediaeval Witches.—In England the legal definition of a witch is, according to Lord Coke, "a person who hath conference with the Devil to consult with him or to do some act."

The word "devil" (*q.v.*) is a diminutive from the root "div," from which we also get the word "divine." It merely means "little god." It is a well-known fact that when a new religion is established in any country, the god or gods of the old religion becomes the devil of the new.

When examining the records of the mediaeval witches, we are dealing with the remains of a pagan religion which survived, in England at least, till the 18th century, 1,200 years after the introduction of Christianity. The practices of this ancient faith can be found in France at the present day, though with the name of the deity changed; and in Italy *la vecchia religione* still numbers many followers in spite of the efforts of the Christian Church.

The number of the witches put to death by the inquisitors and other persecutors in the 16th and 17th centuries is a proof of the obstinate paganism of Europe. Whole villages followed the belicfs of their ancestors; and in many cases the priests, drawn from the peasant class, were only outwardly Christian and carried on the ancient rites; even the bishops and other high ecclesiastics took part. As civilization increased and Christianity becdme more firmly rooted, the old religion retreated to the less frequented parts of the country and was practised by the more ignorant members of the community. This is very noticeable in the innumerable trials of the 15th to the 18th centuries.

The Witch-cult. — The religion consisted of a belief in a god incarnate in a human being or an animal, and thus resembled in many ways the religions of numerous primitive peoples of the present day. This god, who was always called the Devil by the Christian recorders of the trials, appeared to his worshippers disguised in various animal forms or dressed inconspicuously in black. The earliest form of the animal disguise is the figure of the man clothed in a stag's skin with antlers on his head, which is among the palaeolithic paintings in a cave in Ariège in southern France. Another early example is carved on a slate palette of the prehistoric period of Egypt, in this case the man is disguised as a jackal. The goat disguise is not found in Great Britain though common in France and Germany, where it is probably the survival of the god Cernunnos. In the British Isles the usual forms were the bull, the dog and the cat.

The rites with which this god was worshipped are known to all students of primitive or savage religions, ancient and modern. The sacred dances, the feasts, the chants in honour of the god, the liturgical ritual, and above all the ceremonies to promote fertility, occurred at public assemblies as now in the islands of the Pacific or in Africa. The fertility rites attracted the special attention of the recorders of the legal trials. But to the followers of the old god these rites were as holy as the sacred marriage was to the ancient Greeks; to them, as to the Greeks, it was the outward and visible sign of the fertility of crops and herds which should bring comfort and wealth and life itself.

The assemblies or "Sabbaths" took place four times a year; on Feb. 2 (Candlemas), May-eve (known later as Roodmas), Aug. 1 (Lammas), and November-eve (All Hallow E'en). To these joyous meetings came all the worshippers, from far and near, to the number of many hundreds, old and young, men, women and children, till the scene was like a great fair with dancing and singing and feasting. The celebrations began in the evening, lasted all night, and ended at dawn. These were the great Sabbaths, and the dates show that the year was divided at May and November. This division shows that the religion dates back to a primitive period, probably before the introduction of agriculture though after the domestication of animals, for the festivals emphasize the seasons of the breeding of animals. There were, however, smaller meetings (known in France as *"esbats")*, which took place weekly or at short irregular intervals. To these came the principal members of the cult, who held a position analogous to the priesthood There were in each district a band of such persons, in number 13, *i.e.,* a chief or "devil" and 12 members. This band was known as a "Coven." They celebrated the religious rites, they practised as healers under the leadership and instruction of their divine master, and were the consultants in all cases where "witchcraft" was required. The earliest record of a Coven is in the *Handlyng Synne,* a work of the early 14th century, in which the (Christian) priest's daughter and 12 "fools" danced in the churchyard as a *coueyne*. The next record is in the 15th century in the trial of Gilles de Rais, where it is apparent that he and his associates were 13 in number in the practice of their rites. In the later trials the word Coven is continually used, and the number in a Coven is always 13.

One of the most impressive and important rites was the sacrifice of the god, which took place at intervals of seven or nine years. The accounts suggest that the sacrifice was by fire (for similar sacrifices see Frazer's Golden *Bough*).

The Familiars. — There are two kinds of familiars, the divining familiar and the domestic familiar. The divining familiar is common to the whole of Europe and is found in all records of the trials. In ancient Rome divination by animals, especially by birds, was known as "Augury," and was considered a legitimate means of learning the future, but when it was practised by "witches" in the 16th and 17th centuries their persecutors claimed that they were inspired by the Devil. As a rule the witches were instructed by their chief in the method of divining by animals, and he usually appointed the class of animal which each witch was to use. Thus Agnes Sampson of North Berwick divined by dogs, so also did Elizabeth Style in Somerset; John Walsh of Netherberry in Dorset had "a gray blackish culver," and Alexander Hamilton in Lothian divined by a "corbie" ar a cat. In France the familiar was always a toad, which was consulted before going on a journey or undertaking any enterprise.

Spells and Charms. — Forms of words with manual gestures are used in all countries and in all periods to produce results which cannot be obtained by physical means. They may be used for good or evil purposes, for the benefit of the user or for the benefit of someone else. A good harvest, a good catch of fish, a favourable wind for a ship, victory over an enemy, could all be obtained by formulae of words addressed to the appropriate power. But as the power was always incomprehensible, not to say freakish, it was necessary that it should be approached by those who knew the right methods. Sacrifice *(q.v.)* in the temples of the ancient civilization was among the means to propitiate the god and render him favournble to the petitions of his worshippers. When, however, there was more than one god, it is obvious that if a prayer were ineffectualin one temple nothing could be easier than to petition another deity.

Among the ritual methods to destroy an enemy one of the most ancient as well as the most dramatic was the making of an image, generally in wax, to represent the enemy, and gradually destroying it. The earliest recortl of this charm is in the trial of some women and officers of the harem of Rameses III. in Egypt, about 1100 B.C. They made wax images of the Pharaoh with magical incantations. but unfortunately the record gives only the outline of the trial without details.

Transformation into Animals (see LYCANTHROPY).—The belief that certain persons can transform themselves into animals is common to all parts of the world. The power belongs to the *shaman* or priest. A wound inflicted on a human being when in animal shape is believed to be visible when the person resumes his human form. The method of transformation was by putting on the skin of the animal, as did Sigmund the Volsung when he became a wolf. This being the case, it is obvious that the wounds received by the transformed person must certainly have remained when he returned to his proper shape.

The Suppression of Witchcraft. — In comparing the witches and witch-cult of the middle ages with the rites and beliefs of pagan religions, whether ancient or modern, it becomes abundantly clear that in Europe traces of the ancient heathenism survived the adoption of Christianity. It was only when the new religion had gained sufficient strength that it ventured to try conclusions with the old. Backed by the civil law, it overcame the old religion, not only by persuasion but by the use of force, just as it destroyed the ancient religion of Egypt and in later times the religion of the Aztecs. That the old religion mas not an ordinary heresy is clearly shown by the fact that in England. Scotland. France. Germany. Italy, Switzerland, the Netherlands and in New England in the days of Cotton Mather, the clergy as well as the laity hunted down and hrought to trial and death persons suspected of witchcraft. For particulars of the Salem witchcraft delusion. *see* SALEM.

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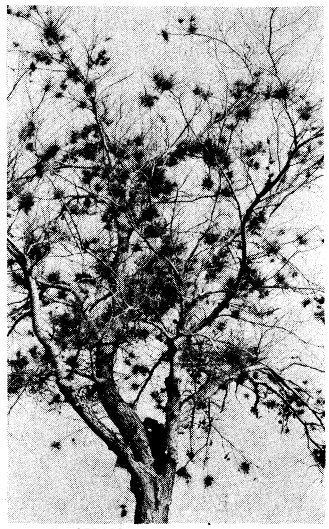
WITCHES'-BROOM (HEXENBESEN), the name applied to peculiar broomlike outgrowths on the branches of a number of trees. They consist of a closely set cluster of fine slender branches. generally arranged more or less parallel to each other and often originating from an enlarged axis.

The growths may be caused by the attack of a mite (*Eriophyes rudis)* associated with species of the fungus *Taphrina* but in most cases are due to a plant parasite alone, either a fungus or one of the scaly or dwarf mistletoes (*Arceuthobium*) found especially on pine, larch and fir.

Some witches'-brooms caused by fungi are *Taphrina laurencia* on ferns (*Pteris*), *Taphrina cerasi* on cherry and three other species affecting birch, alder and ironwood.



JOHN H. GERARD

WITCHES'-BROOM CLUSTERS ON A HACKBERRY TREE

WITCH HAZEL, the common name for a North American shrub, *Hamamelis virginiana* (family Hamamelidaceae). native to low woods from Nova Scotia to Minnesota and south to Florida and Texas. It grows from 10 to 25 ft. high, with smooth. wavy-toothed leaves, somewhat unequal at the base. The showy bright-yellow flowers, borne in profuse axillary clusters, appear in autumn as the leaves are falling. The fruit, a hard, woody capsule that matures during the ensuing summer, contains two black shining seeds, which are forcibly ejected mhen the fruit is ripe. A fluid extract, prepared from the leaves: is used as a tonic and as an astringent lotion. The name witch hazel is derived from the use of the twigs as divining rods, just as hazel twigs were used in England. The North American witch hazel is occasionally planted for ornament, as are the allied H. *japonica* of Japan and *H. mollis* of China. *H. macrophylla,* with leaves roughened by persistent tubercles, is a small tree of the southern Gulf states of the U.S.

See E. J. Fulling, "American Witch Hazel: History, Nomenclature and Modern Utilization," *Econ. Bot.*, *7*:359–381 (1953).

WITCHWEED, any plant of the genus *Strign* in the figwort family, including about jo species of the old-world tropics and one species introduced into the southeastern United States. About ten species are destructive as parasites on such crops as maize, sorghum. rice, sugar cane and tobacco. Witchweeds are branched herbs, six inches to two and one-half feet tall, with opposite or alternate. usually narrow and rough or sometimes scalelike leaves. The two-lipped flowers. solitary in axils of upper leaves, are red. yellow, purplish, bluish or white. Witchweed seeds, minute and produced in great numbers, germinate when in contact with a host root. Roots of the parasite establish and maintain connection with the host.

The first four to six weeks of the life cycle are spent underground. where the young plant is entirely dependent upon its host. After emergence, the plant can photosynthesize its own food but takes water and minerals from the host. The parasite dies when its seeds mature or when the host is harvested. Host plants appear stunted and chlorotic, often showing signs of wilting; they may not yield at all, or their yield may be sharply reduced. Severe infestation may kill the host.

Control measures include the use of herbicides and the growing of catch crops (in this case, host plants that are plowed under before the witchweeds can mature seeds, thereby killing both host and parasite) or trap crops (plants that stimulate witchweed germination but do not serve as satisfactory hosts). The growing of catch or trap crops over several years can almost eliminate witchweeds from an area. Among certain crop plants, especially sorghum, witchweed-resistant varieties have been developed.

Members of the genus *Alectra* (also in the figwort family), some of which parasitize legumes and tobacco in Africa and sugar cane in tropical America, are sometimes called witchweeds. *See* also SCROPHULARIACEAE.

See Hilda McGrath *et al.*, *Witchweed (Striga Asiatica), a New Parasitic Plant in the United States,* U.S. Department of Agriculture, Agricultural Research Service, Plant Disease Epidemics and Identification Section, Special Publication no. 10 (May 15, 1957). (J. W. TT.)

WITHER, GEORGE (1588–1667), English poet and satirist, son of George Wither, of Hampshire, was born at Bentworth, near Alton, June 11, 1588. He went to Magdalen college, Oxford. He wrote an elegy (1612) on the death of Prince Henry, and a volume of gratulatory poems (1613) on the marriage of Princess Elizabeth. but his uncompromising character soon got him into trouble. In 1611 he published *Abuses Stript and Whipt,* 20 satires against revenge, ambition, lust and other abstractions. In 1613 five editions appeared, and he was lodged in Marshalsea prison. The influence of Princess Elizabeth, supported by a loyal "Satyre" to the king, secured his release after a few months. He had figured as one of the interlocutors, "Roget," in his friend William Browne's *Shepherd's Pipe,* with which were bound up eclogues by other poets, among them one by Wither, and during his imprisonment he wrote what may be regarded as a continuation of Browne's work, *The Shepherd's Hunting* (printed 161*j*), eclogues in which the two poets appear as "Willie" and "Roget" (in later editions "Philarete"). The fourth of these eclogues contains a famous passage in praise of poetry. After his release he was admitted (161j) to Lincoln's Inn, and in the same year he printed privately *Fidelia,* a love elegy, of which there is a unique copy in the Bodleian. Other editions of this book, which contained the lyric "Shall I, wasting in despair," appeared in 1617 and 1619. In 1621 he returned to the satiric vein with *Wither's Motto. Nec habeo, nec careo, nec curo.* Over 30,000 copies of this poem were sold. according to his own account, within a few months. Like his earlier invective, it was said to be libelous, and Wither was again imprisoned, but shortly afterward released without formal trial on the plea that the book had been duly licensed. In 1622 appeared his *Faire-Virtue,* The *Mistress of Phil' Arete.*

Wither began as a moderate in politics and religion, but from this time his Puritan leanings became more and more pronounced, and his later work consists of religious poetry, and of controversial and political tracts. His *Hymnes and Songs of the Church* (1622–23) were issued under a patent (later disallowed) of King James I ordaining that they should be bound up with every copy of the authorized metrical psalms offered for sale. *(See* HYMNS.) Wither was in London during the plague of 1625, and in 1628 published *Britain's Remembrancer,* a voluminous poem on the subject, which he had to print with his own hand in consequence of his quarrel with the Stationers' company. In 1635 he was employed by Henry Taunton, a London publisher. to write English verses illustrative of the allegorical plates of Crispin van Passe, originally designed for Gabriel Rollenhagen's *Nucleus emblematum selectissimorum* (1610–1613). The book was published as a *Collection of Emblemes, Ancient and Moderne,* of which the only perfect copy known is in the British museum. The best of Wither's religious poetry is contained in *Heleluiah: or Britain's Second Remembrancer,* printed in Holland in 1641. Besides hymns proper, the book contains songs of singular beauty. especially the cradle song ("Sleep. baby, sleep, what ails my dear").

Wither had served as captain of horse in 1639 in the expedition of Charles I against the Scottish Covenanters. but three years after the Scottish expedition, at the outbreak of the Great Rebellion, he definitely sided with the parliament. He sold his estate to raise a troop of horse, and was placed by a parliamentary committee in command of Farnham castle. After a few days' occupation he left the place undefended. and marched to London. His own house near Farnham was plundered. and he himself was captured by a troop of Royalist horse, owing his life to the intervention of Sir John Denham on the ground that so long as Wither lived he himself could not be accounted the worst poet in England. After this episode he was promoted to the rank of major. He was present at the siege of Gloucester (1643) and at Naseby (1645). He had been deprived in 1643 of his nominal command, and of his commission as justice of the peace, in consequence of an attack upon Sir Richard Onslow, who was, he maintained, responsible for the Farnham disaster. In the same year parliament made him a grant of £2,000 for the loss of his property, but he apparently never received the full amount. An order was made to settle a yearly income of £150 on Wither, chargeable on Sir John Denham's sequestrated estate: but there is no evidence that he ever received it. A small place given him by the protector was forfeited "by declaring unto him (Cromwell) those truths which he was not willing to hear of." At the Restoration he was arrested, and remained in prison for three years. He died in London on May 2, 1667.

His extant writings, catalogued in Park's *British Bibliographer,* number over a hundred. Sir S. E. Brydges published *The Shepherd's Hunting* (1814), *Fidelia* (1815) and *Fair Virtye* (1818), and a selection appeared in Stanford's *Works of the British Poets,* vol. v (1619). Most of Wither's works were edited in 20 volumes for the Spenser Society (1871–82); a selection was included by Henry Morley in his *Companion Poets* (1891); *Fidelia* and *Fair Virtue* are included in Edward Arber's *English Garner* (vol. iv, 1882; vol. vi, 1883) and an excellent edition of *The Poetry of George Wither* was edited by F. Sidgwick in 1902.

WITHERITE, a mineral consisting of barium carbonate! was named after W. Withering. who (in 1784) recognized it to be chemically distinct from barite. Although barite is the principal source of barium, witherite is a favoured material for the preparation of other barium compounds because of its solubility in common acids. It is used in the casehardening process to introduce carbon into the surface of steel; in sugar refining; in the manufacture of heavy clay products, enameled iron and glass; and as a paint filler.

The formula is $BaCO_3$, and the mineral crystallizes in the orthorhombic system. The crystals are invariably twinned together. giving rise to pseudohexagonal forms; the faces are usually rough and striated horizontally. The mineral is colourless to dull white or grayish. The hardness is 3–3.5; the specific gravity, 4.29. Witherite occurs in low-temperature hydrothermal veins associated with barite and ores of lead and silver. The deposits in Scotland and Northumberland, Eng., have been mined commercially.

(D. L. G.)

WITHERSPOON, JOHN (1723–1794), Scottish-American Presbyterian minister and president of the College of New Jersey (now Princeton university), was born at Gifford, Scot., probably on Feb. 5, 1722 or 1723. He was educated at the Haddington grammar school and the University of Edinburgh (M.A., 1739), where he completed his theological studies in 1743. He was called to the parish of Beith in 1745 and in 1757 became pastor at Paisley. His militant tendencies, which later made him a prominent figure during the American Revolution, manifested themselves at the invasion of the Young Pretender and in his ecclesiastical controversies.

These he waged by sermon, debate, pamphlet and essay, revealing himself as a keen dialectician, an effective satirist and a convincing and entertaining speaker. Among his chief publications of this period are *Ecclesiastical Characteristics* (1753), *Essay on Justification* (1756) and a three-volume collection of his essays and doctrinal sermons (1764).

Witherspoon's popularity as a preacher is shown by his refusal of calls to Dundee, Dublin and Rotterdam; but his acceptance of a second call to the presidency of Princeton in 1768 marked a turning point in his career. Thereafter, although he was received warmly by the American Presbyterian Church and although he took a prominent part in the meetings of the synod and was first moderator of the general assembly which he had advocated, he was more distinguished as an educator and as a statesman than as a clergyman.

He seems to have brought to the struggling little college centred in Nassau hall a vision of its potentialities as a cultural agency as well as a training school for ministers. He opened a grammar school, announced graduate courses, encouraged the undergraduate societies, added Hebrew and French to the curriculum, provided scientific equipment and set out immediately on a quest for more money and more students.

From his arrival he was an enthusiast about America. He encouraged Scottish immigration, and in the dispute with the mother country ranged himself uncompromisingly on the side of the colonists. The loyalism of the Scots Regulators in the Carolinas especially troubled him. He presided over the Somerset county committee of correspondence in 1775–76; was a member of two provincial congresses; and in 1776–79 and 1780–82 he was a member of the Continental Congress.

He was the only clergyman to sign the Declaration of Independence; and in general he played a creditable part in the congressional body both in debate and on committees. He was especially distinguished for the soundness of his financial views, some of which were published later in his *Essay on Money* (1786). He died on his farm, Tusculum, near Princeton, Nov. 15, 1794.

The first edition of Witherspoon's Works was published in four volumes in Philadelphia in 1800 with a biographical account by John Rodgers. A nine-volume edition was published in Edinburgh in 1804–05.

See his *Lectures on Moral Philosophy* (1912), ed. by V. L. Collins, and the biography *President Witherspoon* by the latter, 2 vol. (1925).

WITNESS, in law, a person who is able from his knowledge or experience to make statements relevant to matters of fact in dispute in a court of justice. The relevancy and probative effect of the statements which he makes belong to the law of evidence (*q.v.*). In the present article it is only proposed to deal with matters concerning the position of the witness himself. In England, in the earlier stages of the common law, the jurors seem to have been the witnesses, for they were originally chosen for their knowledge or presumed knowledge of the facts in dispute, and they could (and can) be challenged and excluded from the jury if related to the parties or otherwise likely to show bias.

Competency.—Modern views as to the persons competent to give evidence are very different from those of Roman law and the systems derived from it. In Roman law the testimony of many persons was not admissible without the application of torture, and a large body of possible witnesses was excluded for reasons which have now ceased to be considered expedient, and witnesses were subject to rules which have long become obsolete. Witnesses must be *idonei* or duly qualified. Minors, certain heretics, infamous persons (such as women convicted of adultery), and those interested in the result of the trial were inadmissible. Parents and children could not testify against one another, nor could slaves against their masters, nor those at enmity with the party against whom their evidence was offered. Women and slaves could not act as witnesses to a will. There were also some hard and fast rules as to number. Seven witnesses were necessary for a will, five for a *mancipatio* or manumission, or to determine the question whether a person were free or a slave As under the Mosaic law, two witnesses were generally necessary as a minimum to prove any fact. *Unius responsio testis omnino non nudiatur* are the words of a constitution of Constantine. The evidence of a single witness was simply *semi-plena probatio,* to be supplemented in default of a second witness, by torture or reference to oath. The canon law followed the Roman law as to competence, but extended the disabilities to excommunicated persons and to a layman in a criminal charge against a clerk, unless he were actually the prosecutor. The evidence of a notary was generally equivalent to that of two ordinary witnesses. The evidence of the pope and that of a witness who simply proved baptism or heresy (according to some authorities) are perhaps the only other cases in which canon law dispensed with confirmatory evidence. It is probable that the incompetence of Jews as witnesses in Spain in the 14th and 15th centuries was based on what is termed "want of religion," *i.e.,* heresy or unwillingness to take the Christian oath on the gospels. But in England until their expulsion they were on the status of slaves (*captivi*) of the king, A policy similar to that of the Roman law was followed for centuries in England by excluding the testimony of parties or persons interested, of witnesses for a prisoner, and of infamous persons, such as those who had been attainted or had been vanquished in the trial by battle, or had stood in the pillory. All these were said *vocem non habere.* In the days of trial by battle a party could render a witness against him incompetent by challenging and defeating him in the judicial combat. Women were generally regarded as wholly or partially incompetent. English law had also certain rules as to the number of witnesses necessary. Thus under a statute of 1383 (6 Rich. II. st. 2 c, 5) the number of compurgators necessary to free an accused person from complicity in the peasant revolt was fixed at three or four. Five was the number necessary under the *Liber feudorum* for proving ingratitude to the lord.

In the course of the gradual development of the law of evidence, which is in a sense peculiar to the English system, the fetters of the Roman rules as to witnesses were gradually shaken off. In civil cases all disabilities by interest, relationship, sex or crime have been swept away. The witness need not be *idoneous* in the Roman sense, and objections which in Roman law went to his competence, in English law go to his credibility. The only general test of competency is now understanding. It excludes lunatics, idiots, dotards and children of tender years; a person convicted of perjury is said to be competent if convicted at common law, but incompetent if convicted under the act of Elizabeth. No trial ever takes place now under this act, and on this point the act seems to have been virtually repealed by Lord Denman's act (1843; 6 and 7 Vict. c. 85). The disqualification is not absolute as to lunatics; as to children it is sometimes made to depend on whether they are able to understand the nature of the witness's oath. And in certain cases within the Criminal Law Amendment Act, 1885, and the Prevention of Cruelty to Children Act, 1904, the unsworn evidence of children of tender years is admissible but needs corroboration.

Non-judicial witnesses are those who attest an act of unusual importance, for the due execution of which evidence may afterwards be required. They are either made necessary by law, as the witnesses to marriages and wills, or used by general custom, as the witnesses to deeds. In some cases the attestation has become a mere form, such as the attestation of the lord chancellor to a writ of summons. *(See* WRIT.)

Number.—The rule of English law as to the number of witnesses necessary is expressed in the phrase *testes ponderantur non numerantur.* But there are certain exceptions, all statutory. Two witnesses are necessary to make a will valid; two are required to be present at a marriage and to attest the entry in the marriage register; and in the case of blasphemy, perjury, personation and most forms of treason, two or more witnesses are necessary to justify conviction. Witnesses to bills of sale under the Bills of Sale Act, 1882, and witnesses on a charge of personation at elections, are required to be "credible." And in the case of dishonour of a foreign bill of exchange the evidence of a notary public is required, probably a survival from the law merchant or a concession to Continental practice. A warrant of attorney must be attested by a solicitor, and certain conveyances of property held on charitable uses must be attested by two solicitors. In certain civil cases the evidence of a single witness is not sufficient unless corroborated in some material particular—not necessarily by another witness—*e.g.,* in actions of breach of promise of marriage, or affiliation proceedings and matrimonial causes, or where unsworn evidence of children is admissible. In practice, but not in strict law, the evidence of an accomplice is required to be corroborated.

In criminal cases an accused person could not formerly be sworn as a witness or examined by the court, though he was free to make statements. The origin of this rule is by some traced to the maxim *nemo tenetur prodere seipsum,* by others to the theory that the petty jury were the prisoner's witnesses. Moreover, witnesses for the defence could not be examined on oath in cases of treason and felony until 1702 in England, 1711 in Ireland and 1735 in Scotland The husband or wife of the accused could not be examined on oath as a witness either for the prosecution or the defence except in prosecutions for treason or for personal injuries done by one spouse to the other. This exclusion was in accord with the disqualification of parties to civil causes; but there was a lack of reciprocity, for the prosecutor was a competent witness because the Crown is the nominal prosecutor. The rule had to a certain extent a beneficial effect for the defence, in saving the accused from cross-examination, which in certain periods and in political trials would have ied to abuse. On the abolition of other disqualifications that of the accused was left. This inconsistency led to much legal discussion and to piecemeal and, ultimately, complete change in the law. Between 1872 and 1897 some 26 acts were passed rendering accused persons and their wives or husbands competent (but not in general compellable) witnesses in particular criminal cases; and finally, by the Criminal Evidence Act, 1898, which abrogates the common law rule above, and in practice supersedes, but does not repeal, the particular statutes just mentioned, and does not apply to Ireland, every person charged with an offence, whether solely or jointly, and the wife or husband of such person is rendered a competent witness for the defence, subject to certain specified conditions. For these conditions, and for the rules regulating the attendance, oaths, examination, and privileges of witnesses, *see* EVIDENCE.

The attestation of documents out of courts of justice is ordinarily not on oath; but where the documents have to be proved in court the attesting witnesses are sworn like others, and the only judicial exception is that of witnesses ordered to produce documents (called in Scotland "havers") who are not sworn unless they have to verify the documents produced. Questions as to competence (including questions of the right to affirm instead of swearing or as to the proper form of oath) are settled by examination by the court without oath on what is termed the *voir dire.* The evidences of judicial witnesses is taken *viva voce* at the trial, except in interlocutory proceedings and in certain matters in the chancery division and in bankruptcy courts Where the witness cannot attend the court or is abroad his evidence may be taken in writing by a commissioner delegated by the court, or by a foreign tribunal under letters of request issued by the court in which the cause is pending. The depositions are returned by the delegated authority to the court of trial. Under English law evidence must be taken *viva voce* in a criminal trial, with a few exceptions, *e.g.,* where a witness who has made a deposition before a magistrate at an earlier stage in the case is dead or unable to travel, or in certain cases within the Merchant Shipping Acts, or of offences in India or by Crown officials out of England In Europe *commissions vogatoires* are freely used to obtain written depositions for the purpose of criminal trials, and are allowed to be executed in England.

On charges of treason lists of the witnesses to be called by the Crown must be supplied to the accused. In ordinary indictable cases there is no such obligation, but the names of the witnesses for the Crown are written on the back of the indictment; and where the witnesses have not been examined at the preliminary enquiry it is now established practice to require notice to the accused of their names, and a précis of what they will be called to prove. In Scotland, in all indictable cases, a list of witnesses must be served on the accused (the panel) (1887, c. 35), and the same rule is observed in France. In the United States the same course is adopted where a capital offence is charged.

(W F C.; S L PH)

WITNEY, a market town and urban district in the Banbury parliamentary division of Oxfordshire Eng on the Windrush river, a tributary of the Thames 12 mi N W of Oxford by road Pop (1951) 6 j54 Area a o sq mi Witney, partly due to its position in the Cotswolds (*q v*) where vast numbers of sheep were formerly raised is the seat of an old-established industry in blanket making, and gloves and other noollen goods are also made The great church of St Mary is cruciform with a lofty central tower and spire (Early English) and a Norman porch Among the gray stone buildings are the grammar school (founded in 1663) the butter cross (1683) and the old blanket hall (1; 21).

The manor of Witney was held by the see of Winchester before the Conquest In the middle of the 18th century it was leased by the bishop of Winchester to the duke of Marlborough Witney was a borough by prescription at least as early as 1278 and sent representatives to parliament fairly regularly from 1311–12 to 1359–60

There is reference to a fulling mill in a charter of King Edgar dated 909. In 1641 the blanket weavers petitioned the crown against vexatious trade regulations; in 1673 the town is described as "driving a good trade for blankets and rugs." In 1710 the blanket weavers obtained a charter making them into a company, consisting of a master. assistants, two wardens and a commonalty.

See J. A. Giles, *History of Witney* (1852); W. J. Monk, *History oj Witney* (1894).

WITOWT or WITOLD (1350–1430), grand-duke of Lithuania, son of Kiejstut, prince of Samogitia, first appears prominently in 1382, when the Teutonic Order set him up as a candidate for the throne of Lithuania in opposition to his cousin Jagiello (see WLADISLAUS), who had treacherously murdered Witowt's father and seized his estates. Witowt, however, convinced himself that the German knights were far more dangerous than his Lithuanian rival; he accepted pacific overtures from Jagiello and became his ally. When Jagiello ascended the throne of Poland as Wladislaus II. in 1386, Witowt was at first content with the principality of Grodno; but jealousy of Skirgiello, one of Jagiello's brothers, to whom Jagiello committed the government of Lithuania, induced Witowt to ally himself once more with the Teutonic Order (treaty of Konigsberg, May 24, 1390). He strengthened his position by giving his daughter Sophia in marriage to Vasily, grand-duke of Muscovy; but he never felt secure beneath the wing of the Teutonic Order, and when Jagiello removed Skirgiello from the government of Lithuania and offered it to Witowt, the compact of Ostrow (5th of August 1392) settled all differences between them.

Nevertheless, subsequent attempts on the part of Poland to subordinate Lithuania drove Witowt for the third time into the arms of the Order, and by the treaty of Salin in 1398, Witowt, who now styled himself *Supremus* Dux *Lithuaniae,* ceded his ancestral province of Samogitia to the knights, and formed an alliance with them for the conquest and partition of Pskov and Great Novgorod. He nourished the grandiose idea of driving out the hordes of Tamerlane, freeing all Russia from the Tatar yoke, and proclaiming himself emperor of the North and East. This dream of empire was dissipated by his terrible defeat on the Lower Dnieper by the Tatars on Aug. 12, 1399. He was now convinced that the true policy of Lithuania was the closest possible alliance with Poland A union between the two countries was effected at Vilna on Jan. 18, 1401, and was confirmed and extended by subsequent treaties. Witowt was to reign over Lithuania as an independent grand-duke, but the two states were to be indissolubly united by a common policy. The result was a whole series of wars with the Teutonic Order. which now acknowledged Swidrygiello, another brother of Jagiello, as grand-duke of Lithuania; and though Swidrygiello was defeated and driven out by Witowt. the Order retained possession of Samogitia. and their barbarous methods of "converting" the wretched inhabitants finally induced Witowt to rescue his fellow-countrymen at any cost from the tender mercies of the knights.

In the beginning of 1409 Witowt concluded a treaty with Jagiello at Novogrudok for the purpose, and on July 19, 1410, the combined Polish-Lithuanian forces. reinforced by Hussite auxiliaries. crossed the Prussian border. The rival forces encountered at Grünewald. or Tannenberg, and there on July 14 or 15, 1410, was fought one of the decisive battles of the world, for the Teutonic Knights suffered a crushing blow from which they never recovered. After this battle Poland-Lithuania began to be regarded in the west as a great power, and Witowt stood in high favour with the Roman curia. In 1429 Witowt revived his claim to a kingly crown, and Jagiello reluctantly consented to his cousin's coronation; but before it could be accomplished Witowt died at Troki, on Oct. 27, 1430. (R. N. B.)

WITT, CORNELIS DE (1623–1672), Dutch statesman, brother of Johan de Witt, with whose policies he was closely associated, was born at Dordrecht in 1623. He became an alderman of that town in 1648. After the victory of the so-called States party and the death of William II of Orange in 1650 he was able, because of the ascendancy of his brother, the grand pensionary, to acquire much power, being appointed governor of the Land of Putten. As alderman and later as burgomaster (1666 and 1667) of Dordrecht, he became a deputy to the states of Holland, in which capacity he accompanied De Ruyter on his famous expedition against Chatham in 1667 and took part in the great naval fight against the united English and French fleets at Southwold bay in 1672. Compelled by illness to leave the fleet, De Witt found on his return to Dordrecht that the Orange party was in the ascendant and that he and his brother were being vehemently criticized. For an account of his subsequent imprisonment, trial and death, see WITT, JOHAN DE. (E. H. K.)

WITT, JOHAN DE (1625–1672), Dutch statesman who was grand pensionary of Holland from 1653 to 1672, was born at Dordrecht on Sept. 24, 1625, of one of the ruling families of the urban patriciate. His father, Jacob, six times burgomaster of Dordrecht and for many years one of the town's representatives in the states of Holland, mas a strenuous adherent of the so-called States party (see HOLLAND: History).

In 1650 Johan was appointed pensionary of Dordrecht, which made him the leader of the town's deputation to the states of Holland at the time when the states came into conflict with the youthful prince of Orange, William II, over the question of the disbanding of troops. William, who found himself supported by the army and by some of the other provinces, seized six of the leaders of the States party and imprisoned them in Loevestein castle; among these was Jacob de Witt. The sudden death of William II in Nov. 1650 led to a reaction. He left only a posthumous child, afterward William III of Orange, and the principles of the states triumphed.

It was his father's position which gave Johan his opportunity, but his own eloquence, wisdom and business ability caused him to be appointed grand pensionary of Holland on July 23, 1653, at 28. He was re-elected in 1658, 1663 and 1668 and held office until just before his death in 1672. His first years of office were among his most difficult because the first Anglo-Dutch war (see DUTCH WARS) had taken the Dutch unprepared and made them suffer severely through the loss of their carrying trade. Yet the peace concluded in 1654, although advantageous to England, was a compromise. The peace treaty included a secret article by which the province of Holland pledged itself never to appoint in future a stadholder or a captain general. This act of exclusion was aimed at the young prince of Orange. De Witt, although he himself favoured the exclusion, resigned himself only reluctantly to declaring it on the occasion of the Anglo-Dutch peace treaty and at the request of Cromwell.

The policy of De R'itt after the peace of 1654 was mainly successful. He restored the public finances and extended Dutch commercial supremacy in the East Indies. In 1658–60 he sustained Denmark against Sweden. Relations with England, however, remained strained. The restoration of King Charles II did not alter. the situation (although the act of exclusion was rescinded) and war broke out again in 1665. The grand pensionary went to sea with the fleet and inspired all by his calmness in danger, energy in action and inflexible strength of will. It mas due quite as much to De Witt's organizing ability and diplomacy as to De Ruyter's brilliant seamanship that the treaty of Breda (July 1667) was so honourable to the United Provinces. In the same year De Witt made the states of Holland promulgate the Eternal edict which abolished the function of stadholder of Holland and declared the functions of stadholder of any province and captain general to be incompatible.

In 1668 De Witt was forced by the diplomacy of Charles II to sign with England and Sweden the Triple alliance which checked Louis XIV's attempt to take possession of the Spanish Netherlands for France. He rightly foresaw that this would make the French king an enemy of the Dutch. Louis managed to detach Charles from the Dutch, and in 1672 France and England declared war on the United Provinces. Louis himself headed the splendid French army which invaded the republic and conquered the larger part of the country. This was the signal for the Orangist party to overthrow De Witt and his supporters. Johan's brother Cornelis was arrested (July 24) on an improbable charge of conspiring against the prince of Orange.

On Aug. 4, Johan de Witt resigned the post of grand pensionary. Cornelis was put to the torture and, on Aug. 20, sentenced to deprivation of his offices and banishment. On the same day Johan went to visit him in the Gevangenpoort at The Hague. A vast crowd. hearing this, collected outside and finally burst in, seized the two brothers and tore them to pieces. William III, who had become stadholder of Holland in July, made no move to have the mob dispersed or the murderers punished.

There are editions of Johan de Witt's correspondence by R. Fruin and others, 4 vol. (1906-13) and 2 vol. (1919-22).

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WITTE, SERGE JULIEVICH, COUNT (1849–1915), Russian statesman, was born at Tiflis. He entered the service of the Odessa State railway in 1877 and facilitated the transport of troops to Turkey in 1877–78. He became general traffic manager of the South-Western railway of Russia and member of an imperial commission to study railway construction and management. Vishnegradski, minister of finance, recognized his ability and made him head of the railway department in the finance ministry. In 1892 he was promoted to minister of ways of communication, and in 1893 he succeeded Vishnegradski.

Witte was an ardent disciple of Friedrich List and sought to develop home industries by means of moderate protection and the introduction of foreign capital for industrial purposes. At the same time he succeeded by drastic measures in putting a stop to the great fluctuations in the value of the paper currency and in resuming specie payments. The rapid extension of the railway system was also largely due to his energy and financial ingenuity. In foreign policy he extended Russian influence in northern China and Persia. Witte struggled for what he considered the liberation of his country from the economic bondage of foreign nations. During his ten years' tenure of the finance ministry he nearly doubled the revenues of the empire, but he made for himself a host of enemies. He was transferred, therefore. in 1903 from the influential post of finance minister to the ornamental position of president of the committee of ministers.

The disasters of the war with Japan, and the rising tide of revolutionary agitation, compelled the government to think of appeasing popular discontent by granting administrative reforms, and the reform projects were revised and amended by the body over which Witte presided. But the Witte reforms were obstructed by the other departments, especially by the police. Naturally the influence of a strong man made itself felt, and the president became virtually prime minister; but he did not advance very far in this legislative work, and later he was transformed into a diplomatist and sent to Portsmouth, N.H., U.S., in Aug. 1905, to negotiate terms of peace with the Japanese delegates. In these negotiations he showed great energy and decision, and contributed largely to bringing about the peace. On his return to St. Petersburg he had to deal. as president of the first ministry under the new constitutional regime, with a very difficult political situation (see RUSSIA: *History)*; he was no longer able to obtain support, and early in 1906 he was dismissed. His last service to the emperor had been to raise a large loan in France which made the government practically independent of the Duma. He died at St. Petersburg on March 12, 1915.

WITTELSBACH, the name of an important German family, taken from the castle of Wittelsbach, which formerly stood near Aichach on the Paar in Bavaria. In 1124, Otto V. count of Scheyern (d. 115j). moved the residence of his family to Wittelsbach, and called himself by this name. His descendants bore simply the title of counts of Scheyern until about 1116. when the emperor Henry V recognized Count Otto V as count palatine in Bavaria. His son, Count Otto VI, who succeeded his father in 11jj, accompanied the German king Frederick I to Italy in 1154, where he distinguished himself by his courage, and later rendered valuable assistance to Frederick in Germany. When Henry the Lion, duke of Saxony and Bavaria, was placed under the imperial ban in 1180, Otto's services were rewarded by the investiture of the dukedom of Bavaria at Altenburg. Bavaria was ruled by the Wittelsbachs from that time onward until the revolution of 1918, and the history of the house is closely connected with the history of Bavaria (*q* v.). The ancestral castle of Wittelsbach was destroyed in 1208.

In 1329 the most important of various divisions of the Wittelsbach lands took place. By the treaty of Pavia in that year, Louis IV. German king, formerly duke of Bavaria, granted the Palatinate of the Rhine and the upper Palatinate of Bavaria to his brother's sons. Rudolph II (d. 1353) and Rupert I. Rupert, who from 1353 to 1390 was sole ruler, gained the electoral dignity for the Palatinate of the Rhine in 1356 by a grant of some lands in upper Bavaria to the emperor Charles IV. It had been exercised from the division of 1329 by both branches in turn. The descendants of Louis IV retained the rest of Bavaria, but made several divisions of their territory, the most important of which mas in 1392, when the branches of Ingoldstadt. Munich and Landshut were founded. These were reunited under Albert IV. duke of Bavaria-Munich (1447–1508), and the upper Palatinate was added to them in 1628. Albert's descendants ruled over a united Bavaria, until the death of Duke Maximilian III in 1777, when it passed to the elector palatine Charles Theodore. The Palatinate of the Rhine. after the death of Rupert I in 1390, passed to his nephew. Rupert II, and in 1398 to his son, Rupert III, who was German king from 1400 to 1410. On his death it was divided into four branches. Three of these had died out by 1559, and their possessions were inherited by the fourth. or Simmern, line, among whom the Palatinate (*q v*) was again divided.

In 1742, after the extinction of the two senior lines of this family. the Sulzbach branch became the senior line, and its head, the elector Charles Theodore, inherited Bavaria in 1777. He died in 1799, and Maximilian Joseph, the head of the Zweibrucken branch. inherited Bavaria and the Palatinate. He took the title of king as Maximilian I. The Wittelsbachs gave three kings to Germany, Louis IV, Rupert and Charles VII. Members of the family were also margraves of Brandenburg from 1323 to 1373, and kings of Sweden from 1654 to 1718

WITTENBERG, a town in Halle district, Ger., on the Elbe, 59 mi. S.W. of Berlin. Pop. (1950) 49 852.

Wittenberg is mentioned as early as 1180. It mas the capital of the little duchy of Saxe-Wittenberg, the rulers of which afterward became electors of Saxony. The Capitulation of Wittenberg (1547) is the name given to the treaty by which John Frederick the Magnanimous was compelled to resign the electoral dignity and most of his territory to the Albertine branch of the Saxon family. It was occupied by the French in 1806, and refortified in 1813 by command of Napoleon; but in 1814 it was stormed by the Prussians. Its defenses were dismantled in 1873.

Part of the Augustinian monastery in which Luther dwelled has been fitted up as a Luther museum. The Augusteum was built in 1564–83 on the site of the monastery The Schlosskirche, to the doors of which Luther nailed his famous 95 theses in 1517, dates from 1439–99; it was, however, seriously damaged by fire during the bombardment of 1760, was practically rebuilt, and has since been restored. The old wooden doors, burned in 1760, were replaced in 1858 by bronze doors, bearing the Latin text of the theses. In the interior of the church are the tombs of Luther and Melanchthon. The parish church, in which Luther often preached, was built in the 14th century, but has been much altered. The University of Wittenberg, founded in 1502, was merged in the University of Halle in 181j Luther was appointed professor of philosophy there in 1508; and the new university rapidly acquired a considerable reputation from its connection with the early Reformers. In opposition to the strict Lutheran orthodoxy of Jena it represented the more moderate doctrines of Melanchthon The ancient electoral palace is another of the buildings that suffered severely in 1760; it now contains archives. Melanchthon's house and the house of Lucas Cranach the elder (1472–1jj3) who mas burgomaster of Wittenberg. are also pointed out. The spot. outside the Elster gate, where Luther publicly burned the papal bull in 1520, is marked by an oak tree.

WITTGENSTEIN, LUDWIG (JOSEF JOHANN) (1889–1951), the philosopher whose work was a major factor in the rise of the several schools of logical positivism, linguistic analysis and semantics in the second quarter of the 20th century, was born in Vienna on April 26, 1889; his family was of Jewish descent Wittgenstein studied engineering at Berlin and at Manchester and, from 1912, logic and philosophy at Cambridge. He fought in the Austrian army in World War I and was a prisoner in Italy from 1918 to 1919. After working as a schoolmaster in lower Austria (1920–26) and as an architect in Vienna (1926–28), he returned to Cambridge in 1929, becoming Ph.D. in the same year. Subsequently he was fellow of Trinity college (1930–36), lecturer (1930–35) and professor of philosophy (1939–47). In 1938 he became a naturalized British subject. He died in Cambridge on April 29, 1951.

The only book that Wittgenstein published in his lifetime was the *Tractatus logico-philosophicus* (German original, 1921; German-English parallel text. 1922). Posthumous publications include *Philosophische Untersuchungen* (Eng. trans.. *Philosophical Investigations,* 1953) and *Bemerkungen über die Grundlagen der Mathematik* (Eng. trans., *Remarks on the Foundations of Mathematics,* 1956). He wrote in a simple. nontechnical and occasionally aphoristic prose of high stylistic merits.

In his *Tractatus* Wittgenstein taught that the world consists of "things" (simples) which are configurated to "atomic facts." Things in the world are represented by names in language. In the "elementary proposition" names are configurated to a "picture" of a possible state of affairs. Language, thus, is a picture of reality. Significant propositions, which are not elementary, are "truth-functions" of elementary propositions. Among truth-functions a singular position is held by tautologies. Tautologies are true, regardless of the truth or falsehood of elementary propositions. All truth which is a priori or logical, as distinct from experiential or factual, is, according to the *Tractatus,* tautological truth. hfetaphysical and ethical propositions in Wittgenstein's view, cannot be expressed in language. Philosophy is none of the sciences. It is an activity, the objective of which is to make us see what cannot be said—the limits of language—through clearly displaying the logical grammar of propositions.

The *Tractatus* profoundly affected logical positivism (*q.v.*) The idea that all meaningful propositions are truth-functions of elementary propositions which stand in a picturing relation to reality was interpreted by the logical positivists as requiring the dependence of meaning upon verifiability through sense experience. This interpretation, however, has no ground in Wittgenstein's work.

Later. Wittgenstein's thought underwent great changes. But the problem of language remained central in his work. In *Phzlosophical Investigations* he studies "language games" or simplified linguistic situations in which the actual working of language is perspicuously displayed. When a great variety of such language games is presented, it becomes clear that there is no general form of proposition or "essence" of symbolism. The mutual interrelatedness of the various language games, mhich together constitute all the variety of linguistic usage, is a family resemblance. Any member of the family resembles some other member But there is no single pervading feature marking them all as members of the same family.

The family character mhich belongs to the concept of language is also true of other concepts, such as "name," "meaning," "number," "proof" and "consciousness," in the nature or essence of which philosophy has traditionally been interested. The moral taught by the study of language games, in which such concepts are used, is thus that the philosopher's quest for essences is an uneasiness of the mind that originates from a misunderstanding of our ordinary use of words and can be allayed by a perspicuous presentation of the linguistic situation. In his later work, moreover, Wittgenstein regards philosophy as a logical clarification of thought through a "critique of language," not as a theory about the foundations of knowledge or the nature of reality.

Much of what has become known under the names of "analytic," "linguistic" or "semantic" philosophy is inspired by Wittgenstein's teaching at Cambridge in the 1930s and 1940s or by his published work. Wittgenstein tended, however, to repudiate the results of his influence and was probably justified in thinking that his ideas were usually misunderstood and distorted even by those who professed to be his disciples.

See G. H von Wright, "Ludwig Wittgenstein, a Biographical Sketch," *Philosophical Review,* 64 527–545 (Oct. 1955). (*G.* H. v. W)

WITU, formerly a rebel state on the east African coast opposite Lamu Island and stretching from Kipini (2° 30' S.) to Manda bay (2° S.). It was founded in 1856 by Ahmed Fumo Luti, nicknamed Simba ("the Lion"). who was nominally a subject of the sultan of Zanzibar. In 1885 the German government in its anxiety to forestall British expansion in east Africa induced Ahmed to accept German protection. In 1890, however, the protectorate was transferred to Britain as a result of the Anglo-German agreement of that year. The administration was undertaken by the Imperial British East Africa company, but after continuous trouble between the company and Ahmed's successors the protectorate was placed under sovereignty of the sultan of Zanzibar. In 1895 Witu came directly under the control of the British foreign office and now forms part of the Lamu district of Kenya colony. The construction of the Uganda railway in the late 1890s drew away many people, and this, together with the abolition of slavery, and, in 1907, of the status of slavery, caused much of the area to revert to bush. (K. I.)

WITZ, KONRAD (*c.* 1400–*c.* 1445), painter, active in Basel, one of the first masters of modern realism and one of the first landscape painters, but a painter of the monumental not the narrative Dutch style, was born *c.* 1400 in Rottweil. Wiirttemberg. In 1435 he acquired citizenship of Basel, having entered the painters' guild in 1434. The panels for three altars have been preserved: the Heilsspiegelaltar (Mirror of Salvation altar; Basel, Berlin, Dijon). in which he created thickset, monumental figures; the altar from Geneva cathedral (museum), dated 1444, where in the course of illustrating Peter's draught of fishes he presented a wide landscape of Lake Geneva; and some panels of the Virgin (Basel, Xurnberg, Strasbourg) as well as small pictures (Berlin, Naples). In these late works he prepared the way for the perspective drawing of modern art.

See W. Uberwasser, *Konrad Witz* (1938) ; J. Gantner, *Konrad Witz* (1942). (A. SE.)

WIVALLIUS, LARS (1605–1669), Swedish poet and adventurer, whose lyrics show a feeling for the beauties of nature new to Swedish poetry, was born at Wivalla in 1605. He studied at Uppsala and in 1625 left Sweden to travel in Germany, France, Italy and England. Frequently posing as a nobleman, he swindled his way across Europe, being imprisoned for a time in Nürnberg. Back in Sweden (1629), by false pretenses he succeeded in marrying the daughter of a nobleman, but was found out and again imprisoned. In 1634 he mas deported to Kajaneborg, northern Finland, where he spent seven years of severe hardship. Subsequently he became an advocate in Stockholm, where he died on April 6, 1669.

Unscrupulous and antisocial, in his youth Wivallius was full of gaiety. Of his many ballads. written mainly in prison, the best are those inspired by longing for freedom (for example, "Ack libertas," an ode to liberty) and love of nature, in which, with grace and feeling, he sings of the creatures of field and forest, of May rain and of wanderings under the stars.

Wivallius' collected works were published, with a life, by H. Schiick, 2 vol. (1893–95).

See S. Ek, *Studier i Wivalliusvisornas kronologi* (1921) and *Lars Wioallius oisdiktning* (1930). (*S.* H. L.)

WIVELISCOMBE, a small market town in the Taunton parliamentary division of Somerset, Eng., 11 mi. W.N.W. of Taunton by road. Pop. (1951) 1,218. An urban district from 1894 to 1933, it is now a parish in the rural district of Wellington. Remains of prehistoric earthworks exist in the hills near the town and several hoards of Roman coins have been found. The town is probably Saxon in origin and for centuries was a manor and an occasional residence of the bishops of Bath and Wells. A centre of the west country cloth industry until the 19th century, the town became principally an agricultural and brewing centre. The church, completely rebuilt in 1829, is a remarkably interesting structure. (T. J. HT.)

WLADISLAUS (WLADISLAW), the name of four kings of Poland and two Polish kings of Hungary[1].

WLADISLAUS I. (1260–1333), king of Poland, called Lokietek, or "Span-long," from his diminutive stature, was the re-creator of the Polish realm, which at the end of the 13th century had split up into 14 independent principalities, and become an easy prey to her neighbours, Bohemia, Lithuania and the Teutonic Order. In 1296 the gentry of Great Poland elected Wladislaus, then prince of Cujavia, to reign over them; but later changing their minds, placed themselves under the protection of Wenceslaus, king of Bohemia, who was crowned at Gnesen in 1300. Wladislaus obtained the support of Pope Boniface VIII., and on the death of Wenceslaus in 1305 Wladislaus succeeded in uniting beneath his sway the principalities of Little and Great Poland. He had a long struggle with the towns and the prelates headed by Muskata, bishop of Cracow. He managed to suppress the magistrates of Cracow, but had to invoke the aid of the Teutonic Order to save Danzig from the margraves of Brandenburg; whereupon the Order not only proceeded to treat Danzig as a conquered city, but claimed possession of the whole of Pomerania. Wladislaus appealed to Pope John XXII. (1317) and ultimately (Feb. 9, 1321) obtained locally a judgment with costs against the Order, which however, appealed to Rome and got the judgment reversed. The result was a six years' war (1327–33) between Poland and the Order, in which all the princes of Central Europe took part, Hungary and Lithuania siding with Wladislaus, and Bohemia, Masovia and Silesia with the Order. It was early on Sept. 27, 1332, that Wladislaus, with his Hungarian allies, inflicted upon the knights their first serious reverse, at Plowce. In March 1333 he died. He had laid the foundations of a strong Polish monarchy, and with the consent of the pope revived the royal dignity, being crowned king of Poland at Cracow on Jan. 20, 1320.

See Max Perlbach, *Preussisch-polnische Studien zur Geschichte des Mittelalters* (Halle, 1886); Julius A. G. von Pflugk-Harttung, *Der deutsche Orden im Kampfe Ludwigs des Bayern mit der Kurie* (1900).

WLADISLAUS II., JAGIELLO (1350–1434), king of Poland, was one of the 12 sons of Olgierd, grand-duke of Lithuania, whom he succeeded in 1377. From the first Jagiello was involved in disputes with the Teutonic Order, and with his uncle, Kiejstut, who ruled Samogitia independently. By the Treaty of Dawidyszek (June 1, 1380) he contracted an alliance with the knights, and two years later, enticed Kiejstut and his consort to Krewo and there treacherously murdered them (Aug. 15, 1382). This foul deed naturally drove Witowt (*q.v.*), the son of Kiejstut, into alliance with the Order. But the two soon made common cause against the knights and invaded Prussian territory. In search of allies, Wladislaus in 1384 offered his hand to Jadwiga, the young queen of Poland, on condition they shared the Polish crown. Jadwiga renounced her previous fiancé, William of Austria. Jagiello was elected king of Poland as Wladislaus II.; on Feb. 15, 1386, he adopted the Catholic faith, and on Feb. 18 he married Jadwiga. He at once proceeded to convert Lithuania to his new faith. At Vilna, on Feb. 17, 1387, a stately concourse of nobles and prelates, headed by the king, proceeded to the grove of secular oaks beneath which stood the statue of Perkunos and other idols, and in the presence of an immense multitude hewed down the oaks, destroyed the idols, extinguished the sacred fire and elevated the cross on the desecrated heathen altars, 30,000 Lithuanians receiving Christian baptism. A Catholic hierarchy was immediately set up. Ruthenia with its capital Lemberg was persuaded to acknowledge the dominion of Poland; and there on Sept. 27, 1387, the hospodars of Walachia and Moldavia submitted voluntarily to Polish suzerainty.

[1]In Hungarian history the Polish Wladislaus (Mag. Ulászló) is distinguished from the Hungarian Ladislaus (László). They are reckoned separately for purposes of numbering. Besides the Wladislaus kings of Poland, there were three earlier dukes of this name: Wladislaus I. (d. 1102), Wladislaus II. (of Cracow, d. 1163) and Wladislaus III., duke of Great Poland and Cracow (d. 1231). By some historians these are included in the numbering of the Polish sovereigns, King Wladislaus I. being thus IV. and so on.

The knights endeavoured to re-establish their position by sowing dissensions between Poland and Lithuania. In this for a time they succeeded (see WITOWT); but in 1401 Jagiello recognized Witowt as independent grand-duke of Lithuania (union of Vilna, Jan. 18, 1401), and their union was cemented in the battle of Grünewald, which shook the fabric of the Order to its foundations.

Jagiello was married four times. At the dying request of the childless Jadwiga he espoused a Styrian lady, Maria Cillei, who bore him a daughter, also called Jadwiga. His third wife, Elizabeth Grabowska, died without issue, and in 1422 Jagiello married Sonia, princess of Vyazma, a Russian lady rechristened Sophia, who bore him two sons, Wladislaus and Casimir, both of whom ultimately succeeded him. Jagiello died at Grodko near Lemberg in 1434. During his reign Poland had risen to the rank of a great power, a position she was to retain for nearly 200 years.

WLADISLAUS III. (1424–1444), king of Poland and Hungary, the eldest son of Wladislaus II., Jagiello, by his fourth wife, Sophia of Vyazma, was born at Cracow, Oct. 31, 1424, succeeding to the throne in his tenth year. He had a turbulent minority; but Poland was wisely controlled by Zbigniew Olesnicki, while Wladislaus himself defeated the arch-traitor Spytek of Melztyn at Grotnik on May 4, 1439. On the sudden death of the emperor Albert, who was also king of Bohemia and Hungary, the Hungarians elected Wladislaus king, and he was crowned at Buda in July 1440. For three years, however, he had to fight against the partisans of the widowed Empress Elizabeth, till Pope Eugenius IV. mediated between them to enable Wladislaus to lead a crusade against the Turks. At the head of 40,000 men, mostly Magyars, and with Hunyadi commanding under him, Wladislaus made a glorious campaign in the Balkans in 1443, and by the Peace of Szeged (July 1, 1444), the Sultan Murad II., engaged to surrender Serbia, Albania and whatever territory the Ottomans had ever conquered from Hungary, including 24 fortresses, besides paying an indemnity of 100,000 florins in gold. After swearing to observe the treaty, however, Wladislaus broke it two days later in the name of religion, and invaded the Balkans a second time, losing his life and more than a fourth of his army at Varna on Nov. 10, 1444. (See also POLAND.)

WLADISLAUS IV. (1595–1648), king of Poland, son of Sigismund III., king of Poland, and Anne of Austria, succeeded his father on the throne in 1632. He had already served with distinction under Zolkiewski in the Muscovite campaigns of 1610–12, and under Chodkiewicz in 1617–18; and his first official act was to march against the Muscovites, who had declared war against Poland immediately after Sigismund's death, forcing the Muscovite general, after bloody engagements (Aug. 7–22, 1632), to raise the siege of Smolensk and surrender (March 1, 1634). Wladislaus then concluded peace (May 28), conceding the title of tsar to Michael Romanov, who renounced all his claims upon Livonia, Estonia and Courland, besides paying a war indemnity of 200,000 rubles. Wladislaus then marched to Lemberg, and under threat of invasion the Porte offered terms, which were accepted in October, whereby each Power engaged to keep its borderers, the Cossacks and Tatars, in order, and divide between them the suzerainty of Moldavia and Walachia, the sultan binding himself always to place philo-Polish hospodars on those thrones. In the following year the long-pending differences with Sweden were settled, very much to the advantage of Poland, by the truce of Stumdorf (Sept. 12, 1635). Thus externally Poland was everywhere triumphant. Internally, however, things were in their usual deplorable state owing to the suspicion, jealousy and parsimony of the estates. When Danzig rebelled openly against dues lawfully imposed by the king, and a Danish admiral broke the blockade and almost destroyed the flotilla Wladislaus had sent against the rebellious city, the *Sejm* connived at the destruction of the national navy and the depletion of the treasury, "lest warships should make the crown too powerful." For some years after this humiliation, Wladislaus sank into a sort of apathy; but the birth of his son Sigismund (by his first wife, Cecilia Renata of Austria, in 1640) gave him fresh hopes and energy. With the aim of bringing about a royalist reaction, he founded the Order of the Immaculate Conception, consisting of 72 young noblemen who swore a special oath of allegiance to the Crown, and were to form the nucleus of a patriotic movement antagonistic to the constant usurpations of the diet. After the *Sejm* had frustrated this attempt. Wladislaus, assisted by the grand hetman of the Crown, Stanislaw Koniecpolski, tried to use the Cossacks, who were deeply attached to him, to chastise the *szlachta,* at the same time forcing a war with Turkey, which would make his military genius indispensable to the republic. Simultaneously Wladislaus contracted an offensive and defensive alliance with Venice against the Porte, a treaty directly contrary, indeed, to the *pacta conventa* he had sworn to observe. The ill-prepared enterprise fell through; and the king. worn out, disillusioned and broken-hearted at the death of his son (by his second wife, Marie Ludwika of Angoulême, Wladislaus had no issue), died at Merecz on May 20, 1648.

See W. Czermak, *The Plans of the Turkish Wars of Wladislaus IV.* (Pol.) (Cracow, 1895); V. V. Volk-Karachevsky, *The Struggle of Poland with the Cossacks* (Rus.) (Kiev, 1899); *Letters and other Writings of Wladislaus IV.* (Pol.) (Cracow, 1845).

WLOCLAWEK, a town of Poland in Bydgoszcz province. Pop. (1931) 56.277; (1946) 48,126; (1950) 51.800. Situated on the left bank of the Vistula about 100 mi. below Warsaw, Wloclawek has always been an important city, being the capital of the Wloclawski district and the seat of one of the ancient Catholic bishoprics.

The medieval cathedral, built in the Vistula Gothic style, still exists. The region suffered much in the 14th century from the invasions of the Teutonic Knights. The diocese of the bishops included all eastern Pomerania.

Germany occupied the town in 1939 but it was returned to Poland in 1945.

WLODIMIERZ-WOLYNSKI (VLADIMIR-VOLYNSKI), formerly a town of Poland, it was incorporated in the Ckrainian Soviet Socialist Republic, U.S.S.R., after World War II. The town is the ancient capital of Volhynia, but it soon declined in importance on the rise of Luck and other towns. Near the town are the ruins of a church supposed to have been built by Vladimir, grand prince of Kiev, in 973. It became the capital of the independent princes of Volhynia.

Its name was Latinized as Lodomeria by the Austrians when they occupied it. It was occupied by the U.S.S.R. in 1939, by Germany in 1941.

WOBURN, a city of Middlesex county. in northeastern Massachusetts. C.S., is 10 mi. N.W. of Boston and within the Boston standard metropolitan statistical area. Set off from Charlestown (*q.v.*) and incorporated as a town in 1642, Woburn was chartered as a city in 1888.

Woburn's historical attractions include the old burial ground. which includes the graves of the ancestors of four presidents (Cleveland, Harrison. Pierce and Garfield), and a number of colonial houses. among which are the birthplace of Sir Benjamin Thompson (*q.v.*, also known as Count von Rumford) (erected 1714) and the Baldwin mansion (1661), home of Laommi Baldwin, the engineer. The latter, popularly remembered as the originator of the Baldwin apple, was largely responsible for the old Middlesex canal (built 1803; its dried up channels are still traceable), which gave impetus to the town's economic development.

The principal modern manufactures include pharmaceutical. chemical and photographic supplies, leather goods and processed foods.

For comparative population figures *see* table in MASSACHUSETTS: *Population.* (L. G. H.)

WODEHOUSE, PELHAM GRENVILLE (1881–), English author of humorous novels whose works are signed P. G. Wodehouse, was born in Guildford, Eng., on Oct. 15, 1881. He was educated at Dulwich college. London, and in 1903 began to write a humour column for the *London Globe.* He also published books for children, including *The Pothunters* (1902) and *A Prefect's Uncle* (1903), a collection of short stories.

He first won wide recognition with his humorous series of Psmith stories, including the novels *Psmith in the City* (1910), *Psmith, Journalist* (1915) and *Leave It to Psmith* (1923; later rewritten as a play nith Ian Hay, 1930).

Wodehouse became well known as the creator of the character Jeeves, a gentleman's gentleman aho deftly extricates his young master from various difficulties. The obsequious but competent valet appears in many novels; among the titles are *The Inimitable Jeeves* (1924), *Very Good, Jeeves* (1930), *The Return of Jeeves* (1954) and *Bertie Woostev Sees It Through* (19jj). Other characters were introduced in *Ukridge* (1924) (Stanley Featherstone Ukridge); *Meet Mr. Mulliner* (short stories, 1927); and *Blandings Castle* (1935) (Lord Emsworth and others).

Critical opinion on the value of Wodehouse's contributions as a humorist nas divided, but a popular demand for his books continued year after year. A prolific author, he also wrote plays and lyrics for musical comedies, many of which were produced in the United States. With Guy Bolton, who often collaborated with him, Wodehouse published *Bring on the Girls!* ("the improbable story of our life in musical comedy, with pictures to prove it") in 1953. His stories are characterized by intricate plots dealing nith common foibles and complex situations and often by incongruous anticlimaxes.

Wodehouse lived in both the United States and France for many years and during World War II nas interned by Germany. He later settled in Remsenburg. N.Y. His *Perfornting Flea: a Self-Portrait in Letters* was published in 1953 and *America, I Like You* in 1956.

WODEN, a deity of the Anglo-Saxons, the name being the Anglo-Saxon counterpart of the Scandinavian Odin (*q.v.*). In German he mas Wodan or Wuotan. Information is lacking as to how far the character and adventures attributed to Odin were known to other Teutonic peoples. Clearly, however, the god was credited nith special skill in magic, both in England and Germany, and was also represented as the dispenser of victory. By the Romans he nas early identified with Mercurius; "Wednesday" (Woden's day) is *dies Mercurii.*

WOFFINGTON, MARGARET (PEG) (1714?–1760), Irish actress, was born at Dublin, of poor parents, on Oct. 18, probably in 1714. As a child of ten she played Polly Peachum in a Lilliputian presentation of *The Beggar's Opera,* and danced and acted in Dublin theatres until 1740, when her success as Sir Harry Wildair in *The Constant Couple* secured her a London engagement. In this, and as Sylvia in George Farquhar's *The Recruiting Officer,* she had a great success. being unapproachable in "breeches parts." Also among her best impersonations were the elegant women of fashion, like Lady Betty Modish and Lady Townley. Her morals were notoriously sketchy, but her heart was warm. She built and endowed almshouses at Teddington, nhere she lived after her retirement in 17j7. She died there on March 28, 1760.

See Austin Dobson's introduction to Charles Reade's novel *Peg Woffington* (London, 1899), and Augustin Daly's *Woffington: a Trzbute to the Actress and the Woman* (Philadelphia, 1888). (W. A. DN.)

WÖHLER, FRIEDRICH (1800–1882), German chemist, nas born at Eschersheim, near Frankfurt-am-Main, on July 31, 1800 In 1820 he entered Marburg university, and next year removed to Heidelberg, where he worked in Leopold Gmelin's (1788–1853) laboratory. Gmelin advised him not to attend the lectures in chemistry, because for him they would be a waste of time. Intending to practise as a physician. he took his degree in medicine and surgery (1823) but was persuaded by Gmelin to devote himself to chemistry. He studied in Jons Jakob Berzelius' laboratory at Stockholm for a year. and there began a lifelong friendship with the Swedish chemist. Their correspondence was published in 1901. He then taught in the technical schools of Berlin (1825–31) and Cassel (1831–36). In 1836 he was appointed to the chair of chemistry in the medical faculty at Göttingen. He brought the department to a high rank, and many prominent chemist5 from all over the world were trained there. An imposing statue was unveiled in 1890. This professorship he held until his death on Sept. 23, 1882, although he had retired from active teaching long before.

In 1827 Wohler first obtained metallic aluminum by heating the chloride with potassium, and he prepared many of the salts from the metal. In the following year he isolated beryllium by the same method. His great contribution to the development of chemistry was the synthesis of the natural product urea (*q.v.*) in 1828. This aided greatly in the overthrow of the vitalistic doctrine, which distinguished organic from inorganic materials. He worked with Justus von Liebig (*q.v.*) in a number of important investigations.

One of the earliest was the investigation, published in 1830, which proved the polymerism of cyanic and cyanuric acid. The most famous was their study on the oil of bitter almonds (benzaldehyde) and the radicle benzoyl (1832), which Berzelius said could be regarded as the dawn of a new day. The investigation of uric acid (1837) was likewise of fundamental importance in the history of organic chemistry.

The correspondence of these lifelong friends was published in 1888 by A. W. Hofmann (*q.v.*). Most of Wohler's work, however, lay in the field of inorganic chemistry. He isolated boron and silicon and prepared silicon nitride and hydride. He prepared phosphorus by the modern method, discovered calcium carbide and showed that it could be used to prepare acetylene. He showed the analogy between the compounds of carbon and silicon. He discovered quinone, hydroquinone and quinhydrone. He just missed the discovery, of vanadium and niobium. His studies touched practically every known element. He also obtained pure titanium and showed the similarity between this element and silicon and carbon.

The Royal society's *Catalogue* enumerates 276 separate memoirs written by Wöhler apart from 43 in which he collaborated with others. (R. E. O.)

WOHLGEMUTH (WOLGEMUT), **MICHAEL** (MICHEL) (1434–1519), the leading painter of Niirnberg in the late 15th century, is best remembered as the master of Albrecht Diirer (1486–90), who later painted his portrait (1516; Munich). After an obscure early period he laid the foundations of his modest fortunes by marrying (1472) Barbara, widow of the Niirnberg painter Hans Pleydenwurff, and in the next 40 years produced a series of large altarpieces, rich with carving and gilding, as well as portraits and book illustrations.

The altarpiece of St. Jacob, Straubing, is attributed to the beginning of this activity (*c.* 1475–76), and those of the Marienkirche. Zwickau (1476–79), the Stiftskirche, Feuchtwangen (1484), the Heiligkreuzkirche, Niirnberg (1486), and of Schwabach church (1506–08) are all documented products of his workshop.

With his stepson Wilhelm Pleydenwurff, Wohlgemuth completed the designs for the 650 woodcuts of Hartmann Schedel's *Weltchronik* in 1492 and the woodcuts of *Schatzbehalter der wahren Reichtümer des Heils* (1491); several other books of the period are evidently theirs.

No powerful, artistic personality emerges from these works. As a painter, Wohlgemuth was a competent technician, adapting current Flemish styles to local taste, but his search for expression leads often to insipidity or violence. His designs for woodcut extended the range of that medium, but were rapidly surpassed by Diirer and others. (D. KG.)

WOJCIECHOWSKI, STANISLAW (1869–1953), second president of the Polish republic, was born on March 1, 1869, at Kalisz, then a city of Russian Poland.

While a student at Warsaw university, he took part in the Polish Socialist movement which was also a struggle for Polish independence. Arrested in 1891 he was released the following year and went to Paris, where he was again arrested in 1893. Set free, he went to London where he helped to print the Polish Socialist periodical *Przedświt* (The Dawn). At that time Wojciechowski and Josef Pilsudski were friends. Meanwhile, Wojciechowski studied the co-operative system. On returning to Poland (1906), he devoted himself chiefly to developing co-operative societies.

During World War I he saw Germany as Poland's main enemy. In 1915 he went to Moscow where in 1917 he was elected president of the Council of Polish Parties' union. He returned to Warsaw in 1918. From Jan. 17, 1919 to July 24, 1920, he served as minister of the interior in three successive cabinets. Elected to the *sejm* (chamber of deputies) as a member of the Polish Peasant party in Nov. 1922, he was chosen to succeed the assassinated Gabriel Narutowicz as president of the republic on Dec. 20, 1922.

Wojciechowski and Marshal Pilsudski were henceforth friends no more. the former supporting parliamentary government, while the latter recommended a more authoritarian regime. In May 1926 Pilsudski staged a successful *coup d'état* and on May 14 Wojciechowski resigned. He took no further part in politics. He died at Golabki, near Warsaw, on April 9, 1953.

WOKING, a town and urban district in the Woking parliamentary division of Surrey, Eng., 25 mi. S.W. of London by road, in the valley of the Wey, amid extensive heathlands and pine woods. Pop. (1951) 47.596. Area 24.5 sq.mi. The parish church has an original Norman door. The Shah Jehan mosque. built in 1889, is the headquarters of the Muslim Society in Great Britain. Woking's development as a residential area dates from 1838 when the railway connected it with London; the Basingstoke canal also runs through the district. In 1885 Woking crematorium was built—the first in England. Besides numerous nursery gardens there are printing, rubber and packing works.

WOLCOT, JOHN (1738–1819), English satirist and poet, known under the pseudonym of PETER PINDAR, was baptized at Dodbrooke. Devonshire, on May 9, 1738. He was apprenticed to his uncle. John Wolcot, a surgeon at Fowey, and he took his degree of M.D. at Aberdeen in 1767. In 1769 he was ordained, and went to Jamaica with Sir William Trelawny, the governor. In 1772 he became incumbent of Vere, Jamaica, but on the death of his patron (1772) he returned to England, and settled as a physician at Truro. In 1781 Wolcot went to London, and took with him the young Cornish artist. John Opie, whose talents in painting he had been the first to recognize. He soon achieved fame by a succession of pungent satires on George III. Two of Wolcot's happiest satires on the "farmer king" depicted the royal survey of Whitbread's brewery and the king's naive wonder how the apples got into the dumplings. He had a broad sense of humour, a keen eye for the ridiculous and great felicity of imagery and expression. Some of his serious pieces—his rendering of Thomas Warton's epigram on *Sleep* and his *Lord Gregory*, for example—reveal an unexpected fund of genuine tenderness. He died at Latham Place, Somers Town, London, on Jan. 14, 1819, and was buried near Samuel Butler, the author of *Hudibras*, in St. Paul's, Covent Garden.

Polwhele, the Cornish historian, was well acquainted with Wolcot in his early life, and the best account of his residence in the west is found in vol. i of Polwhele's *Traditions* and in Polwhele's *Biographical Sketches*, vol. ii. Cyrus Redding was a frequent visitor at the old man's house, and has described Wolcot's later days in his *Past Celebrities*, vol. i, and his *Fifty Years' Recollections*, vol. i and ii.

WOLCOTT, ROGER (1679–1767), American administrator, was born in Windsor, Conn., Jan. 4. 1679, the son of Simon Wolcott (d. 1687). He was a grandson of Henry Wolcott (1578–1655), who emigrated to New England in 1628; assisted John Mason and others to found Windsor, Conn., in 1635; and was a member of the first general assembly of Connecticut in 1637 and of the house of magistrates from 1643 to his death. (Henry Wolcott the younger [d. 1680] was one of the patentees of Connecticut under the charter of 1662.) Roger Wolcott was a member of the Connecticut general assembly in 1709, one of the bench of justices in 1710, commissary of the Connecticut forces in the expedition of 1711 against Canada, a member of the council in 1714, judge of the county court in 1721 and of the superior court in 1732 and deputy governor and chief justice of the superior court in 1741. He was second in command to Sir William Pepperrell. with rank of major general in the expedition (1745) against Louisbourg, and was governor of Connecticut in 1751–54. He died in what is now East Windsor on May 17, 1767.

He wrote *Poetical Meditations* (1725), an epic on *The Agency of the Honourable John Winthrop in the Court of King Charles the Second* (printed in vol. iv, series 1, *Collections* of Massachusetts Historical society). His *Journal at the Siege of Louisbourg* is printed in pp. 131–161 of vol. i (1860) of the *Collections* of the Connecticut Historical society.

His son OLIVER WOLCOTT (1726–97) was graduated from Yale in 1747 and studied medicine with his brother Alexander (1712–95). In 1751 he was made sheriff of the newly established Litchfield county and practised law in Litchfield He was a member of the council in 1774–86 and of the Continental Congress in 1775–76, 1778 and 1780–84, and a commissioner of Indian affairs for the northern department in 1775. During the War of Independence he was active in raising militia in Connecticut. He was one of the signers of the Declaration of Independence; commanded Connecticut militia that helped to defend New York city in Aug. 1776; in 1777 organized more Connecticut volunteers and took part in the campaign against Gen. John Burgoyne; and in 1779 commanded the militia during the British invasion of Connecticut. In 1784. as one of the commissioners of Indian affairs for the northern department, he negotiated the treaty of Ft. Stanwix (Oct. 22) settling the boundaries of the Six Nations. In 1786–96 he was lieutenant governor of Connecticut, and in Nov. 1787 mas a member of the Connecticut convention which ratified the federal constitution. He became governor in 1796 upon the death (Jan. 1j) of Samuel Huntington, and served until his death on Dec. 1, 1797.

His son Oliver wrote a sketch of him in Sanderson's *Biography of the Signers of the Declaration of Independence* (Philadelphia, 1820–27).

Oliver's son, OLIVER WOLCOTT, JR. (1760–1833), was graduated from Yale in 1778. studied law in Litchfield and was admitted to the bar in 1781. With Oliver Ellsworth he was appointed (May 1784) a commissioner to adjust the claims of Connecticut against the United States. He mas controller of public accounts of Connecticut and auditor of the federal treasury. In June 1791 he became controller of the treasury, and in Feb. 1795 succeeded Alexander Hamilton as secretary of the treasury. At the end of 1800 he resigned after a bitter attack by the press. He re-entered politics as a leader of the "Toleration Republicans." and in 1817 presided over the state convention which adopted a new constitution, and in the same year was elected governor, serving until 1827. He died in New York city, June 1, 1833.

His grandson George Gibbs (1815–73) in 1846 edited *Memoirs of the Administration of Washington and John Adams . . . From the Papers of Oliver Wolcott, Secretary of the Treasury*. Wolcott write *British Influence on the Affairs of the United States Proved and Explained* (1804).

WOLF, FRIEDRICH AUGUST (1759–1824), German philologist and critic, was born on Feb. 1;. 1759, at Hainrode in the province of Hanover. He was educated at Nordhausen grammar school and Gottingen university. There he chose philology as his faculty. which then had no existence, and succeeded in carrying his point. He was dissatisfied with Heyne's treatment of Homer. and the two fell out. Later his edition of the *Symposium* obtained for hirn a chair at Halle. The moment was a critical one in the history of education. The literary impulse of the Renaissance was almost spent; scholarship had become dry and trivial. A new school, that of Locke and Rousseau, sought to make teaching more modern and more human, but at the sacrifice of mental discipline and scientific aim. Wolf was eager to throw himself into the contest on the side of antiquity. In Halle (1783–1807), by the force of his will and the enlightened aid of the ministers of Frederick the Great, he was able to carry out his long-cherished ideas and found the science of philology.

During his time at Halle Wolf published his commentary on the *Leptines* of Demosthenes (1789) and a little later the celebrated *Prolegomena* to Homer (1795). This book, the work with which his name is chiefly associated, was thrown off in comparative haste to meet an immediate need. It has all the merits of a great piece of oral teaching — command of method, suggestiveness, breadth of view. From it originated the great Homeric controversy and Wolf's main points, oral tradition, deliberate revision after reduction to writing and plurality of authorship, are still the crucial questions. The French invasion swept away the university, and the rest of his life was spent at Berlin, where he had another professorship. His most finished work, the *Davstellung der Altertumswissenschaft,* though published *at* Berlin (1807), belongs essentially to the Halle time. At length his health gave may. He was advised to try the south of France. He got as far as Marseilles, and died there on Aug. 8. 1824.

Mark Pattison wrote an admirable sketch of Wolf's life and work in the *North British Review* (June 1865), reproduced in his *Essays* (1889); *see* also J.E Sandys, *Hist. of Class Schol*, iii, pp 51–60 (1908). Wolf's *Kleine Schriften* mere edited *by* G. Bernhardy (Halle, 1869) Works not included are the *Prolegomena*, the *Letters to Heyne* (1797), the commentary on the *Leptines* (Halle, 1789) and a translation of the *Clouds* of Aristophanes (1811).

WOLF, HUGO (1860–1903), Austrian composer of songs, was born at Windischgraz in Styria, the son of a leather merchant from whom he inherited his musical talent and received his first instruction. He did not get on well at school. nor at the Vienna conservatory to nhich he nent in 187j and which he left under a cloud in 1877; he made enemies in the musical world of Vienna, which was not, hen-ever, a difficult thing to do in the foolish partisan warfare then raging over Liszt, Wagner and the "music of the future." and he ended his days in a madhouse. On the other side of the account are to be set the story of his friendships, the genius of his compositions and the enthusiasm generated by the combination of these two together that resulted in the establishment. during his lifetime. of Wolf societies (Hugo-Wolf-Verein) for the propagation of his music in Berlin, in Vienna and in other cities.

In 1878 he fell in love and had his first burst of inspired creative activity — he spoke of these eruptions as "days of Lodi." Resemblance to Schumann is to be found not only in this conjunction of events but in the music of the early songs. In 1884 he became music critic of the *Wiener Salonblatt.* The juvenilia composed between these dates include a string quartet in D minor, a symphonic poem, *Penthesilea,* some choral as well as solo settings of Nikolaus Lenau and Goethe. During his four years as a critic he attacked Brahms and the conservatives and supported Wagner, whom he idolized as man and artist. Wagner's artistic tenets became Wolf's own creed and were applied, with the necessary modifications, to song writing. In 1888 he published the 53 *Mörike Lieder* and a group of 20 songs to poems of Joseph von Eichendorff. Under this same creative impulse he began his settings of Goethe, of which there are 51 in all. After a brief interval the *Spanisches Liederbuch* of 44 songs followed, from poems translated by Paul Heyse and Emanuel Geibel. Then came some lean years before the discovery of a libretto for an opera, such as he had long desired to write, set free the flood of creation once more *Der Corregidor* mas composed during 1895. In 1896 he published the second part of the *Italienisches Liederbuch* of Heyse, the first part having been completed in 1891. Work on a second opera was broken off in 1897 by his first bout of insanity. After a year there was a recovery but no further production — his last songs were three settings of Michelangelo in 1897—and in 1898 he became permanently insane for the remaining five years of his life.

Apart from the delightful *Italienische Serenade,* which exists in two forms, for string quartet and chamber orchestra, Wolf's fame depends entirely on his songs, of nhich the chief characteristic is the subtle interplay of words and music. He insisted that they were songs for voice and piano — the piano part was not an accompaniment — although he actually scored a number of them for orchestra subsequently. All song writers. certainly the German *Lieder* uriters, may be placed on a scale which has pure poetry and pure music for its logical extremities. Wolf's place is near the literary end—so much so that his method and influence have been described by one critic in the phrase "the Poetic Supremacy Act, 1887." It is not only that he is punctilious about verbal rhythm and vocal inflections, it is a delicacy of psychological insight which makes a song by Wolf a reincarnation of the poem in another medium Wolf's songs do not sing themselves with the melodic spontaneity of Schubert or Brahms. composers nearer to the musical end of the musicopoetic scale, but they represent the most complete integration of the two arts ever achieved.

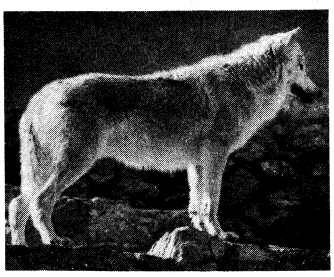
A few of his songs have achieved popularity; among these "Verborgenheit," "Anakreons Grab" and "Der Rattenfaenger" may be instanced.

See lives by *E.* Decsey (3rd–6th ed , Berlin, 1919); Ernest Newman (London, 1907); Frank Walker (London, 1951; New York, 1952) (F. S H)

WOLF, MAX (MAXIMILLIAN FRANZ JOSEPH CORNELIUS) (1863–1932), German astronomer whose survey of the Milky Way showed its true structure for the first time, was born at Heidelberg on June 21, 1863. Educated at Heidelberg university, where he attained distinction as a mathematician. he was given the position of *Privatdocent* in the university in 1890 and in 1893 was appointed to a special professorship in astrophysics and made director of the new observatory at Konigstuhl, near Heidelberg. In 1902 he was elected to the chair of astronomy in Heidelberg university, a position. together with the directorship of the observatory, which he retained until his death in Heidelberg on Oct. 3. 1932. Wolf was an observational astronomer of the first rank and was especially active in the application of photography to the discovery of asteroids, spectroscopy and photography of nebulae both galactic and extragalactic, and the application of the stereocomparator to the discovery of stars with large proper motion. (O. J. E.)

WOLF, the typical wild species of the dog family. The gray or timber wolf. *Canis lupus,* is the commonest and most aidespread species. Excluding certain domestic breeds of dogs, it is the largest living canid. A large northern male may measure 7 ft. in length including the bushy, 2-ft tail. Females are smaller than males; southern races. smaller than northern. The fur is dense, long and soft and, although usually gray, may be brown. reddish, black or almost white. The gray wolf is a powerful animal with a broad head, robust limbs, large feet and deep but narrow chest. Once gray wolves were widely distributed over North America and Eurasia. In North America they are still common from Alaska through northern Canada to the northern plains states, making rare appearances in the Rockies. They are extinct in the British Isles and, except for occasional wanderers in the winter, are not found in west-central Europe. They may occur as far south as India.

The gray wolf is a savage and fearless predator quite capable of bringing down an elk, bison or horse. Wolves usually hunt in small groups, rarely in large packs, catching larger prey—deer, caribou, bighorn, moose—by a chase during which they display both speed and endurance. Nonetheless, their diet consists mainly of small animals such as rodents, rabbits and hares. Wolves are prodigious eaters and when ample food is available will gorge themselves. They will return to an old kill to eat even after it has become putrid although fresh meat is preferred. Wolves perform an important function of controlling the numbers of large herbivores and removing the old, maimed and unhealthy individuals which are most easily caught. Unfortunately they display a liking for domestic livestock and have thus earned persecution by man. They are much hunted and trapped, and survivors become exceedingly elusive and wary. Gray wolves are truly nilderness animals and inhabit both open and timbered areas. Near human habitation they tend to stay in dense timber and thickets.



R VAN NOSTRAND FROM THE NATIONAL AUDUBON SOCIETY

NORTH AMERICAN TIMBER OR GRAY WOLF (CANIS LUPUS)

Gray wolves mature sexually in two or three years and until then, and often thereafter. remain with the family group. Wolves often mate for life. Breeding occurs between December and April and 4 to 14 pups are born 63 days later. The female prefers to appropriate the den of another animal—fox or woodchuck—enlarging it as necessary. The usual site is a bank or rocky crevice that affords a good view and sunny exposure. Members of a family group are friendly to each other but rarely accept an interloper; more often he is driven off or killed. All members of the group solicitously care for the young.

The red wolf, C. niger, of the southeastern United States, is a smaller species and may be tawny, reddish or black. Structurally it resembles the coyote The Antarctic wolf (Dusicyon) is a foxlike canid from the Falkland Islands; the maned wolf is a South American canid of the genus *Chrysocyon;* the aardwolf of Africa (Proteles) is a relative of the hyena; the Tasmanian wolf is a marsupial.

The largest known wolf, the now extinct dire wolf, seems to have been common in western North America during the Pleistocene period; its body length was about 6 ft.

See Stanley P. Young and Edward A. Goldman, *The Wolves of North America* (1944) (K R. KN)

WOLFDIETRICH, German hero of romance. The tale of Wolfdietrich is connected with the Merovingian princes, Theodoric and Theodebert, son and grandson of Clovis; hut in the Middle High German poems of Ortnit and *Wolfdietrich* in the *Heldenbuch* (*q.v.*) Wolfdietrich appears as the son of Hugdietrich, emperor of Constantinople. He was repudiated by his father, who mistakenly believed him to be illegitimate, and was brought up by the emperor's faithful retainer, Berchtung von Meran. After Hugdietrich's death Wolfdietrich was driven from his inheritance by his own brothers. Berchtung and his 16 sons stood by Wolfdietrich. 6 being slain and the other 10 imprisoned. After a long exile in Lombardy at the court of King Ortnit (q v.), the hero returned to liberate his friends and regain his kingdom. Wolfdietrich's exile and return suggested a parallel with the history of Dietrich von Bern (*q* v.), with whom he was indeed often actually identified. Among the exploits of Wolfdietrich was the slaughter of the dragon which had slain Ortnit. He thus took the place of Hardheri, the original hero of this feat. The myth attached itself to the family of Clovis, around which epic tradition rapidly gathered. Some critics believe Hugdietrich to be the epic counterpart of Theodoric (Dietrich: the name might be a Latinized form of Hugo Theodericus), eldest son of Clovis. Wolfdietrich represents his son Theodebert (d. 548), whose succession was disputed by his uncles. But father and son are merged by a process of epic fusion, so that Wolfdietrich appears to be the counterpart sometimes of Theodoric and sometimes of Theodebert.

The story of how Hugdietrich won his bride Hildburg, daughter of the king of Salonika, forms in one manuscript version a separate introduction to the Wolfdietrich romance.

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WOLFE, CHARLES (1791–1823), Irish poet, son of Theobald Wolfe of Blackhall. County Kildare, was born on Dec. 14, 1791. He was educated at English schools and at Trinity college, Dublin. where he matriculated in 1809 and graduated in 1814. He was ordained priest in 1817, and obtained the curacy of Ballyclog, County Tyrone, which he shortly exchanged for that of Donoughmore in the same county. He died at Cork on Feb. 21, 1823, in his 32nd year. Wolfe is remembered solely by his stirring stanzas on the "Burial of Sir John Moore." written in 1816 in the rooms of Samuel O'Sullivan, a college friend, and printed in the *Newry Telegraph.*

WOLFE, JAMES (1727–1759), mas born at Westerham, Kent. Eng. on Jan. 2. 1727. He nas the elder son of Lieut. Col. Edward Wolfe. an experienced soldier, nho afterward rose to the rank of lieutenant general. and of Henrietta, daughter of Edward Thompson, of Long Marston, Yorkshire. He received his brief education at private schools. the first at Westerham, the second at Greenwich. From his earliest years he was determined to be a soldier, despite his weak health, which just prevented him from sailing as a volunteer with the ill-fated Cartagena expedition of 1740. In 1741 he received a commission in the marines. but, having transferred into the line. he was sent to Flanders in the spring of 1742 as an ensign in the 12th foot. Until the close of the War of the Austrian Succession, he was continuously on active service, being present at the battles of Dettingen. Falkirk, Culloden and Laffeldt, uhere he was wounded. His zeal, intelligence and gallantry won him the regard of his superiors, notably the duke of Cumberland. In 1743 he was appointed adjutant of the 12th; next year he received a captain's commission in the 4th; in 1745 and 1747 he served as brigade major; while in Scotland he was aide-de-camp to General Hawley.

In 1749 Wolfe, with the rank of major, was appointed acting commander of the 20th foot, whose lieutenant colonel he became in the following year. He was with this regiment for eight years, during which it was stationed at several towns in Scotland and, from 1753, at various places in the south of England.

In 1757 Wolfe was appointed quartermaster general in Ireland, but before entering upon his duties he was chosen by Pitt for the same position in the expedition against Rochefort. Though the enterprise failed utterly, Pitt and the English public had substantial grounds for their belief that it would have succeeded if plans for landing suggested by Wolfe had been acted upon by the commanders in chief. Wolfe was consequently selected to serve as brigadier under Amherst in the force which was to attempt the capture of Cape Breton and Quebec in 1758. At the siege of Louisburg he played a conspicuous and brilliant part.

Meanwhile, Wolfe had been made colonel of the 67th, but soon after his return home Pitt gave him the command of the expedition which was to renew the attempt to take Quebec. He was to have the local rank of major general, and, though technically under Amherst, to enjoy full discretion in his conduct of operations. Leaving England in Feb. 1759, Wolfe mustered his troops, rather more than 9,000 in number, at Louisburg; and thanks to the marvellous seamanship and the unselfish co-operation of Admiral Saunders, they arrived without mishap before Quebec in the last week of June. Wolfe's first intention was to land above, though near, the town, so as to attack the weak fortifications from the plains of Abraham; but the plan was abandoned, probably because of the misgivings of Saunders. The British, however, seized the heights on the south shore of the St. Lawrence, opposite Quebec, which they were thus able to bombard, and established a camp at the mouth of the Montmorency river, between which and the city Montcalm had entrenched nearly all his army. Perplexed by Montcalm's deliberate inactivity, Wolfe, on July 31, made an ill-conceived, unsuccessful and costly assault on the French lines. Wolfe, at this crisis, felt it his duty to consult his three brigadiers. When they counseled a landing to the west of Quebec, he readily concurred, and in a few days more than 3,000 men were transferred to ships above the town. Instead, however, of landing above Quebec, he resolved to take a force downstream and disembark it secretly at the Anse du Foulon, a cove only 1½ mi. from the city. This operation he successfully carried out in the early hours of Sept. 13. Montcalm was constrained to make a precipitate attack, and the British musketry decided the issue in a few minutes. Wolfe, however, was mortally wounded by a musket ball, and died after the French gave way.

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WOLFE, THOMAS CLAYTON (1900–1938), U.S. novelist, was born on Oct. 3, 1900, at Asheville, N.C., the locale of much of his best writing. His father, William Oliver Wolfe, the "Old Gant" of his novels, was a stonecutter of Pennsylvania descent, while his mother, Julia Elizabeth Westall Wolfe, the "Eliza" of the early novels, came from a family prominent in Appalachian North Carolina affairs. Educated privately, he entered the University of North Carolina; Chapel Hill, in 1916, where he became interested in the theatre and wrote and acted in several one-act plays. In the fall of 1920 he enrolled in George Pierce Baker's 47 Workshop at Harvard university, intending to become a playwright, and studied for several years with Baker, John Livingston Lowes and others. Several of his plays were produced at Harvard, including "Welcome to Our City" (1923). It was there, too, that he began the play known as *Mannerhouse* (published 1948), which was never produced during his lifetime.

In 1923 Wolfe left Harvard for New York city where, except for trips to Europe and elsewhere, he resided until his death. Still intending to be a playwright, he earned a livelihood by teaching at the Washington Square college of New York university, described in several of his novels. It was in 1926, while abroad, that he began work on the novel that eventually became *Look Homeward, Angel* (1929), in which he recounted the growth of an autobiographical protagonist, "Eugene Gant," in the mountain town of Altamont. During the late 1920s he was the close associate of the theatrical designer Aline Bernstein, who appears as "Esther Jack" in his last two novels.

After publication of *Look Homeward, Angel,* Wolfe resigned his teaching position to devote full time to his writing. Not for six years, however, did he produce another book. In 1935 appeared *Of Time and the River*, perhaps the most turbulent of his books, and a collection of shorter pieces, *From Death to Morning.* The events of those years are described in his memoir, *The Story of a Novel* (1936).

Wolfe did not publish another novel during his lifetime, though when he died in Baltimore, Md., on Sept. 15, 1938, he left a prodigious quantity of manuscript, from which were extracted two more novels, *The Web and the Rock* (1939) and *You Can't Go Home Again* (1940), and a collection of shorter pieces and chapters of an uncompleted novel, *The Hills Beyond* (1941). Wolfe's *Letters to His Mother* (1943) were also published, as well as his *Selected Letters* (1956).

Gifted as he was with the faculty of almost total recall, Wolfe's fiction is characterized by an intense consciousness of scene and place, together with what is often an extraordinary lyrical power. Though he denied it, his fiction was almost literally autobiographical. Indeed, publication of his first novel caused a great furor in Asheville. Subsequent books depicted the struggles of a young writer to become established in the metropolis, and his first experiences with literary fame. Always intensely conscious of time and memory, Wolfe in his best work drew on his early environment and family memories to produce fiction rich, in his own words, "in space and color and in time." Though his later books contain episodes and sequences of great vividness and interest, they are too often uncontrolled in their form, and his most successful novel is probably his first, *Look Homeward, Angel,* which bids fair to become an American classic.

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WOLFENBÜTTEL, a town of Germany, in the *Land* of Lower Saxony, situated on both banks of the Oker, 7 mi. S. of Brunswick on the railway to Harzburg. Pop. (1950) 34,401. The library is rich in Bibles and books of the early Reformation period, and contains some fragments of the Gothic Bible of Ulfilas.

A castle is said to have been founded on the site of Wolfenbüttel by a margrave of Meissen about 1046. When this began in 1267 to be the residence of the early Brunswick or Wolfenbüttel line of counts, a town gradually grew up around it. The town passed into possession of the Brunswick-Wolfenbüttel family in 1671 and for nearly 100 years was the ducal capital.

WOLFF (less correctly **Wolf**), **CHRISTIAN** (1679–1754), German philosopher and mathematician, the son of a tanner, was born at Breslau on Jan. 24, 1679. At the University of Jena he studied first mathematics and physics, to which he soon added philosophy. In 1703 he qualified as *Privatdozent* (official but unpaid lecturer) in the University of Leipzig, where he lectured till 1706, when he became professor of mathematics and natural philosophy at Halle through the influence of Leibniz, of whose philosophy his own system is a modification. In Halle Wolff limited himself at first to mathematics, but presently added physics, and eventually all the main philosophical disciplines. But the claims which Wolff advanced on behalf of the philosophic reason (*see* Rationalism) appeared impious to his theological colleagues. Halle was the headquarters of Pietism, which, after a long struggle against Lutheran dogmatism. had itself assumed the characteristics of a new orthodoxy. Wolff's professed ideal was to base theological truths on evidence of mathematical certitude, and strife with the Pietists broke out openly in 1721 when Wolff. on the occasion of laying down the office of prorector, delivered an oration "On the Practical Philosophy of the Chinese" (Eng. trans.: 1750), in which he instanced the moral precepts of Confucius as evidence of the power of human reason to attain by its own efforts to moral truth. For ten years' Wolff was subjected to attack, until in a fit of exasperation he appealed to the court for protection. His enemies, however, told Frederick William I that. if Wolff's determinism were recognized, no soldier who deserted could be punished. since he would only have acted as it was predetermined that he should. Wolff was at once deprived of office and ordered to leave Prussia on pain of death. He crossed over into Saxony, where the landgrave of Hesse received him with every mark of distinction, and the circumstances of his expulsion drew universal attention to his teaching at Marburg, where he was now established. Over zoo books and pamphlets appeared lor or against Wolff's doctrine before 1737, not reckoning the systematic treatises of Wolff and his followers. One of the first acts of Frederick the Great was to recall Wolff (1740) to Halle. In 1743 he became chancellor of the university, and in 1745 he received the title of *Freiherr* from the elector of Bavaria. But his matter was no longer fresh. he had outlived his power of attracting students. and his classrooms remained empty. He died on April 9, 1754.

Wolff's most important works are as follows: *Anfangsgründe aller mathematischen Wissenschaften* (1710; in Latin. *Elementa matheseos universae,* 1713–15); *Vernünftige Gedanken von den Kräften des menschlichen Verstandes* (1712; Eng. trans.. 1770); *Vern. Ged. von Gott, der Welt und der Seele des Menschen* (1719); *Vern. Ged. von der Menschen Thun und Lassen* (1720); *Vern. Gcd. von dem gesellschaftlichen Leben der Menschen* (1; 21); *Vern. Ged. von den Wirkungen der Natur* (1723); *Vern. Ged. von den Absichten der natürlichen Dinge* (1724): *Vern. Ged. von dem Gebrauche der Theile in Menschen, Thieren und Pflanzen* (1725) (the last seven may be described briefly as treatises on logic, metaphysics, moral philosophy. political philosophy. theoretical physics, teleology, physiology); *Philosophia rationalis, size logica* (1728); *Philosophia prima, sive Ontologia* (1729); *Cosmologia generalis* (1731); *Psychologia empirica* (1732); *Psychologia rationalis* (1734); *Theologia naturalis* (1736–37); *Philosophia practica universalis* (1738–39); *Jus naturae* and *Jus Gentium* (1740–49); *Philosophia moralis* (1750–53). His *Kleine philosophische Schriften* have been collected and edited by G. F. Hagen (1736–40).

In addition to Wolff's autobiography (*Eigene Lebensbeschreibung*, ed. by H. Wuttke. 1841) and the usual histories of philosophy, *see* C. G. Ludovici, *Ausführlicher Entwurf einer vollständigen Historie der Wolff'schen Philosophia* (1736–38); J. Deschamps, *Cours abrégé de la philosophie wolffienne* (1743); F. W. Kluge, *Christian won Wolff der Philosoph* (1831); W. Arnsperger, *Christian Wolffs Verhältnis zu Leibniz* (1897); H. Pichler, *Über Christian Wolffs Ontologie* (Leipzig, 1910); H. Ostertag. *Der philosophische Gchalt des Wolff-Manteuffelschen Briefwechsels* (Leipzig, 1910).

WOLF-FERRARI, ERMANNO (1876–1948). Italian composer. was born at Venice on Jan. 12. 1876. his father being a distinguished German painter and his mother an Italian. He studied with Joseph Rheinberger at Munich, and on his return to Venice brought out his oratorio La *Sulamite*. He then went to Germany and revised his early opera *Cinderella* for production at Bremen in 1902. This was followed by *Le donne curiose* and *I quattro rusteghi* (1906), both of which were performed at Munich. His first great success came with *Il segreto di Susanna*, ***a*** one-act comedy. first given at Munich in 1909. Still more popular was *The Jewels of the Madonna* (Berlin, 1911), which gave him an international reputation. He also wrote a chamber symphony *Rispetti* for soprano. op. 11. and a pianoforte quintet (1920). From 1y02 to 1y12 Wolf-Ferrari was director of the Liceo Benedetto Marcello in Venice. He died on Jan. 21, 1948, in Venice.

WOLF FISH (SEA WOLF, SEA CAT) (*Anarrhichas*), a marine fish, the largest of the blenny group (*see* BLENNY). The body is long, subcylindrical in front, compressed in the tail region, smooth and slippery, with rudimentary scales embedded in the skin. An even dorsal fin exten is the whole length of the back and a similar fin from the vent to the caudal fin, as in blennies. The pectorals are large and rounded, the pelvic fins entirely absent. Both jaws are armed in front with strong conical teeth, and on the sides with two series of large molars, a double band of similar molars occupying the middle of the palate. By these teeth the wolf fish is able to crush the hard shells of the crustaceans and mollusks on which it feeds.

The wolf fish probably does not deserve the character of ferocity often attributed to it.

Wolf fish inhabit the northern seas of both hemispheres, one (*A. lupus*) being common on the coasts of Scandinavia and northern Britain and two in the seas around Iceland and Greenland. Two others occur in corresponding latitudes in the North Pacific. They attain a length of over 6 ft. and in the north are esteemed as food, both fresh and preserved.

WOLFRAMITE or WOLFRAM, the chief ore of the metal tungsten, which is used as a constituent of high-speed and other special steels, as well as certain nonferrous alloys; for the filaments of electric lamps; and for various other technical uses, often as sodium tungstate. Tungsten carbide is widely used in metal-working tools and. in place of tungsten steel alloys. as cutting edges and points of wear in machinery.

Wolframite is commonly associated with tin ore in lodes and veins in and around granites. This form occurs in Cornwall; northwest Spain and north Portugal; Saxony; lower Burma; the Malay peninsula; and Queensland and Tasmania in Australia. In the United States the largest production comes from Colorado, Idaho and North Carolina.

Wolframite consists of an isomorphous mixture in varying proportions of the tungstates of iron and manganese, $FeWO_4$ and $MnWO_4$. Varieties with dominant iron are often called ferberite, with dominant manganese. hiibnerite, but since iron and manganese have nearly the same atomic weight the percentage of tungsten trioxide (WO_3), about 76%, shows little variation and the difference is not of commercial importance. Wolframite crystallizes in the monoclinic system. usually in prismatic forms. and there is a perfect cleavage. The colour is brown to black. with a sub-metallic to metallic lustre, especially on cleavage faces. Hardness is 5 to j.j and density 7.0 to 7.j. For material on the mining and processing of wolframite and for bibliography *see* TUNGSTEN.

(CL. F.)

WOLFRAM VON ESCHENBACH (*fl.* early 13th century), one of the greatest medieval German poets. He belonged to a Bavarian family of the lower nobility and apparently served a succession of Franconian lords: Abenberg, Wildenberg and Wertheim are among the places he names in his works. and he also knew the court of Hermann of Thuringia at the famous castle of the Wartburg. It is not known exactly when he died. but since in his epic poem *Willehalm* he laments the death of Hermann of Thuringia (1217). and since *Willehalm* was followed by *Titurel*, his last work. he may be assumed to have died shortly after 1220.

The corpus of Wolfram's literary work. as it has come down to us. consists of eight lyric poems (five of them *Tagelieder*, or "dawn songs"), the epics *Parzival* and *Willehalm* (the latter unfinished) and short fragments of a further epic. the so-called *Titurel*, which elaborates the story of Parzival and Sigune in book iii of *Parzival*. The dawn songs are a natural complement to Wolfram's epic art in that the scenes they describe are like "stills" from an epic narrative. experienced and depicted as intense dramatic moments in a broad span of human action; the intensity and originality of Wolfram's imagination are, indeed, almost too great for the medium of medieval lyric poetry.

Parzival, probably written between 1200 and 1210, is one of the great literary works of the middle ages, distinguished alike by elevation of purpose and moral tone, and by power of poetic inspiration. The problem of the sources of the work is still unsolved. for although much of the story corresponds to Chrétien de Troyes' *Perceval* (*c.* 1180), Chrétien's poem is unfinished and also lacks the Gahmuret sequence at the beginning of Wolfram's work. The content of *Parzival*, books i and ii and books xiii to xvi, must therefore derive from another, as yet unknown source; Chrétien's is. in any case, not the first French version of the story of the Holy Grail, while Wolfram's acknowledgments in his poem to an unidentified and possibly quite fictitious Provençal poet called Kyot (Guiot) have only led to further inconclusive speculation. All that can be said with certainty is that *Parzival* is based on Chrétien together with other romance sources, and that at the same time it contains much material invented, or at least completely transformed. by Wolfram.

The cycles of action in this vast work (it totals about 25.000 lines) revolve around three points of attraction: the Grail, Parzival and King Arthur. The Grail motif is of Christian origin, and is widely treated in medieval French literature from about 1176 onward; the story of Parzival, "the guileless fool," who through his innocence and artlessness reaches a goal denied to wiser men and becomes king of the Grail, goes back to a popular fairy tale motif; from the Celtic background of Arthurian legend stems the ideal of chivalric virtue, together with the adventures of Gamain, Arthur's nephew, to which books viii to xiii of *Parzival* are predominantly devoted.

In the *Bildungsroman* of Parzival's career Wolfram presents his ideal picture of spiritual education and development. Where Hartmann von Aue extols the virtues of moderation in human conduct, and Gottfried von Strassburg proclaims the satisfaction of worldly happiness, Wolfram preaches the moral gospel of otherworldly values and leads from the empirical and the temporal to the ideal and the divine. The kaleidoscope of Parzival's adventures, with their culmination in the temple of the Grail, is a symbol of chivalric life at its highest, in which the demands of the world and of God are brought together in a single ethico-religious principle. In a nider context the story is an allegory of man's history—his innocent happiness as a child in God, his estrangement from his divine home through the enticements of the world, and his return to God after his reconciliation of the warring claims of the flesh and the spirit. The profundity of Wolfram's theme is matched by his language, which, in all his epics, is rhetorical and complex; his trains of thought. too, are often original to the point of obscurity. *(See* also GRAIL, *THE* HOLY; PERCEVAL)

Willehalm, written after *Parzival,* is a religious epic based on a *chanson de geste* entitled *La bataille d'Aliscans,* and tells the history of the famous crusader William of Toulouse. It is nritten for the edification of Christian knights, and sets before them an example both of religious devotion and of worldly honour.

Wolfram's influence on later poets was profound, and he joins Hartmann von Aue and Gottfried von Strassburg in the great triumvirate of Middle High German epic poets.

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WOLLASTON, WILLIAM (1659–1724), English moralist whose ethical doctrine of "conformity to the truth" in several ways foreshadows philosophical views current in the 20th century, was born at Coton-Clanford on March 26, 1659, of an old Staffordshire family. Having studied at Sidney Sussex college. Cambridge, from 1674 to 1681, he took a post as a schoolteacher in Birmingham in 1682 and was subsequently ordained priest. In 1688, however, he inherited the greater part of the family fortune from his cousin William Wollaston of Shenton (Leicestershire). This enabled him to set up house in London, to marry (1689) and to devote the rest of his life to scholarship and to philosophy. He died on Oct. 29, 1724.

Wollaston was affable to his few intimates and believed strongly in private charity, but suffered from headaches and lived a secluded life. He had 11 children. some of whom died in infancy. He wrote much, but destroyed many of his manuscripts, apparently from fastidiousness of taste. He published a verse paraphrase of part of Ecclesiastes in 1690 and had a Latin grammar privately printed in 1703. His major work, *The Religion of Nature Delineated,* of which a few copies were circulated in 1722 ("as a *private monument* of one that meant well"), was published in 1724. An autobiographical memoir that he had composed in 1709 was printed by J. Nichols. *History and Antiquities of the County of Leicester,* iv, part 2 (London, 1811).

The Religion of Nature Delineated, which is remarkable for its literary elegance, is divided into nine sections. In the first, Wollaston propounds his fundamental maxim *"That whoever acts as if things were so, or nof so, doth by his acts declare, that they are so, or not so"* and makes "the formal ratio of moral good and evil . . . to consist in a conformity of men's acts to the truth." "Truth is but conformity to nature." which is tolerated. if not wholly approved, by God, so that to reject it is rebellion against God. To distinguish between acts of greater or lesser immorality, a principle of degree is introduced, whereby such acts are assessed according to the "importance" or the number of truths violated. Sec. ii deals with hedonism: "The way to happiness and the practice of truth incur the one into the other." Sec. iii puts forward a rationalist theory of knowledge of the truth and defines natural religion as "The pursuit of happiness by the practice of truth and reason." Sec. iv contains a pragmatic dismissal of arguments about free will: if me doubt our capacity to act conformably to the truth, "the short way of knowing this certainly is to try." Sec. v–viii comprise a statement of the usual arguments of theism; an account of miracles as effects of divine providence; a demonstration of the necessity of a future state because God is reasonable; a defense of oral and public prayer, not for God but *"upon our own account* and to make our adorations as compleat as we are able" (language is held to be almost indispensable to thought) ; and an exposition of the natural law in terms of conformity to truth, with particular reference to political and social organization and to family life. Sec. ix deals with the individual soul as "the subject or *supposition* of self-consciousness," nonmaterial and immortal; it is "their different degrees and habits of reasonableness or unreasonableness" that determine the station that souls will find in the future world.

Wollaston's natural religion is theistic but not necessarily Christian; it was sometimes ignorantly confused with Thomas Woolston's deism. His ethical system was attacked, notably by Jeremy Bentham, as reducing all immorality to telling a lie. It can be maintained, however, that he related virtue to truthtelling rather by way of analogy than by strict identification.

See Clifford G. Thompson, *The Ethics of William Wollaston* (Boston, 1922).

WOLLASTON, WILLIAM HYDE (1766–1828). English chemist and natural philosopher who proved the identity of frictional and voltaic electricity and made other important discoveries, was born at East Dereham. Norfolk, Aug. 6, 1766. Wollaston was educated at Charterhouse, and afterward at Caius college, Cambridge. He received his medical degree in 1793 and practised for several years. He was elected a fellow of the Royal society in 1793 and became its secretary in 1804, serving until 1816. He died in London Dec. 22, 1828.

Most of Wollaston's original work deals more or less directly with chemical subjects, but diverges on all sides into other specialties. In chemistry he discovered *(c.* 1804) how to work platinum on a practical scale and he made a fortune of about £30,000 from his secret process.

Wollaston was the first to detect the metals palladium and rhodium *(qq.v.)* in crude platinum (1804–05). In 1808 he discovered instances of multiple proportions among the alkali oxalates, sulfates and carbonates. Anticipating Jacobus van't Hoff and Joseph Le Bel, he predicted the necessity of acquiring a three-dimensional geometrical conception of the relative arrangement of the elementary atoms. He discovered cystine (1810). In 1809 he proved the elementary character of columbium (niobium) and titanium. In 1801 he gave experimental proof of the identity of frictional and voltaic electricity.

In optics he was the first (1802) to observe dark (Fraunhofer) lines in the solar spectrum. He described the reflecting goniometer in 1809 which permitted measurement of the angle formed by rays of light reflected from crystal facets allowing angles of even minute crystals to be measured accurately. The camera lucida

(1807) greatly aided microscopists and others who had to make accurate drawings of very small objects.

He provided microscopists with the "Wollaston doublet." and applied concavo-convex lenses to the purposes of the oculist. His cryophorus was described in 1813 in a paper "On a Method of Freezing at a Distance."

In 1821, after Hans C. Oersted (17jj–1851) had shown that a magnetic needle is deflected by an electric current. Wollaston unsuccessfully attempted to transform that deflection into a continuous rotation. When Michael Faraday (*q.v.*) who overheard a portion of his conversation with Humphry Davy on the subject. was subsequently more successful, Wollaston asserted his own priority, which Farraday would not admit.

He was a member of the royal commission which opposed adoption of the decimal system of weights and measures (1819). He proposed the imperial gallon measure adopted by parliament in 1824. He endowed the fund in the Geological Society of London from the proceeds of which is granted the Wollaston prize. The mineral wollastonite (*q.v.*) was named after him.

An appreciative essay on Wollaston will be found in George Wilson. *Religio Chemici* (1862). *See* also *E.* Ferguson, *Journal of Chemical Education* (1941). (R. E. O.; X.)

WOLLASTONITE, a mineral named after William Hyde Wollaston and consisting of calcium silicate, is used in many ceramic products, including floor and wall tiles. electrical insulators and porcelain fixtures, in welding rod coatings and as a paint extender.

Wollastonite is mined in Essex county, New York. It commonly occurs as white tablets. short prismatic crystals or cleavable masses in metamorphosed limestones. The formula is $CaSiO_3$, and it crystallizes in the triclinic system. Three cleavage traces in the zone perpendicular to the b axis (one perfect, one less perfect and one poor), forming angles approximately 84° and 32°, are commonly present and serve to distinguish wollastonite from similar-appearing white pyroxenes and amphiboles.

Wollastonite commonly occurs with other calcium-containing silicates such as diopside (a pyroxene), tremolite (an amphibole). garnet and epidote and is thought to represent the reaction of calcite with quartz:

$$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$$

This reaction is sensitive to temperature and carbon dioxide pressure and occurs at 450° C. at one atmosphere carbon dioxide pressure with the temperature increasing with increasing gas pres-, sure. Therefore, ii the gas pressure can be estimated, the formation of wollastonite could serve as a temperature indicator and vice versa.

The crystal structure of wollastonite adopts the single chain structure of the pyroxenes but with a different arrangement for the relative positions of the unshared oxygen atoms between the SiO_4 tetrahedra (see PYROXENE). Because of an over-all similarity to the pyroxenes, considerable amounts of iron. magnesium and manganese can be taken into solid solution in the mineral.

A monoclinic modification of wollastonite called parawollastonite has almost identical physical properties and geologic occurrence. The two minerals have been found to occur together in limestone inclusions in volcanic rocks at Monte Somma, Italy. Wollastonite float from Riverside county. California. is used as an ornamental stone because of its resemblance to driftwood.

(G. W. DEV.)

WOLLIN or WOLIN, an island formerly in the Prussian province of Pomerania and after World War II in Szczecin province. Pol.. the more easterly of the islands at the mouth of the Oder which separate the Stettinisches Haff from the Baltic sea. It is divided from the mainland on the east by the Dievenow channel. and from Usedom on the west by the Sn-ine. It has an area of 95 sq.mi. Heath and sand alternate with swamps, lakes and forest on its surface. which is flat except for low hills in the southwest. Cattle rearing and fishing are the chief resources of the inhabitants. Some of the villages are summer bathing resorts. Wollin (Wolin), the only town. is situated on the Dievenow, and carries on the industries of a small seaport. Pop. (1950) 1,361.

Near the modern town once stood the ancient and opulent Wendish city of Wolin or Jumne. called Julin by the Danes, and Winetha or Vineta (*i.e.*, Wendish town) by the Germans. The Northmen made a settlement there about 970, and built a fortress on the "silver hill." called Jomsburg. which is often mentioned in the sagas. The stronghold of Jomsburg was destroyed in 1098 by King hfagnus Barfod of Norway. This is probably the origin of the legend that Vineta was overthrown by a storm or earthquake and overwhelmed by the sea. Some submarine granite rocks near Damerow in Usedom are still popularly regarded as its ruins. The town of Wollin became in 1140 the seat of the Pomeranian bishopric. which was transferred to Kammin about 1170. Wollin was burned by Canute VI of Denmark in 1183. and was taken by the Swedes in 1630 and 1759 and by the Brandenburgers in 1659 and 1675.

WOLLONGONG, industrial city in New South Wales, Austr. Greater Wollongong (pop.: 1954, 90.852) extends from Waterfall in the north to Macquarie rivulet in the south and includes numerous ton-nships. Tectonic and erosional processes have produced a narrow strip of lowlands backed by steep and often precipitous scarp. Wollongong is in the centre of the most productive part of the Bulli coal measures, and coal seams outcrop all along the coastal plains and hillsides. The lowlands with their mild and equable climate, hilly terrain, fertile soils and favourable position made this one of the earliest and leading dairying districts of Australia. Industry has made rapid inroads into the agricultural areas. particularly since 1926 when the steel industry was established. Other industries produce rolled sheet steel. galvanized iron. copper. brass and other nonferrous tubes, copper wire and strand. aerial cables and covered wires, sulfuric acid and superphosphate, bricks and machinery. The shipping harbour. formed by a breakwater, is at Port Kembla and accommodates interstate and overseas vessels.

WOLSELEY, GARNET JOSEPH WOLSELEY, 1ST VISCOUNT (1833–1913), British field marshal and a decisive figure in the creation of the modern British army, was born at Golden Bridge. County Dublin. on June 4. 1833. Educated at a Dublin day school. he was commissioned in the 12th foot in March 1852, and was transferred to the 80th foot, with which he served in the second Burmese War. Promoted lieutenant and invalided home, he exchanged into the 90th light infantry, then in Dublin. and went on service with it to the Crimea. After the fall of Sevastopol, Wolseley was employed on the quartermaster general's staff and was there given an insight he never forgot into the total inadequacy of the British army's supply services. After home duty in 1856–57, he went with the 90th again to join the punitive expedition to China, but his transport "Transit" foundered off Sumatra. The rescued troops, beached at Singapore, were sent at once to Calcutta to help cope with the Indian mutiny. Wolseley served under Sir Colin Campbell at Lucknow (Nov. 1857), at the Alambagh with Sir James Outram—one of his heroes, along with C. G. ("Chinese", Gordon and Robert E. Lee—and ultimately in March 1858 at the final siege and capture of Lucknow. He was then appointed deputy assistant quartermaster general, in the place of Sir Frederick Roberts, another celebrated soldier of the late Victorian era, on Sir Hope Grant's staff. In that position he saw out the entire Indian campaign. By 1859 Wolseley was a lieutenant colonel, having served in four campaigns, been four times wounded and nine times mentioned in dispatches. When Grant took command of the British troops in the Anglo-French expedition to China in 1560. Wolseley was again his deputy assistant quartermaster general. In 1861 he was appointed assistant quartermaster general in Canada, becoming deputy quartermaster general six years later. In Canada he wrote his *Narrative* of the *War With China* in *1860*, reorganized the Canadian militia, studied past and present military tactics and put together his The Soldier's Pocket-Book for Field Service, published in 1869 and revised five times subsequently; modern Field Service *Regulations* still derive much from Wolseley's vade mecum. In 1870 he commanded an expedition that marched 1,188 mi. to the Red river to put down Louis Riel's rebellion (see CANADA: The First Riel Rebellion).

Appointed knight commander of St. Michael and St. George and companion of the Bath, he became assistant adjutant general at the war office in May 1871 and worked with Edward Cardwell to further army reform, so beginning what was to be a 30 years' war of his own on the British military system, "bow-and-arrow generals" and the commander in chief, the duke oi Cambridge. In 1873 he commanded a punitive expedition into Ashanti and, having chosen a staff "ring" that included H. E. Wood, R. H. Buller (*qq.v.*), G. P. Colley, F. B. Maurice and Henry Brackenbury, with their aid and 2,500 white troops completed in two months a successful tropical campaign, culminating (Feb. 4, 1874) with the burning of the Ashanti capital, Kumasi. Ashanti made Wolseley famous: he was W. S..Gilbert's "modern major-general" in *The Pirates of Penzance*, and Henry Labouchère, in an article in the *Daily News* in 1875, called him "the long arm of the British empire." Parliament voted him £25,000, he was appointed knight commander of the Bath and knight grand cross of St. Michael and St. George and promoted major general at the age oi 40. After a term as inspector general of auxiliary forces at home. he left to go to Natal as governor and general commanding. This was a political post in which he was neither happy nor remarkably skilled. He was the first high commissioner in Cyprus in 1878, but returned to South Africa in 1879 to take over from Lord Chelmsford. who had mishandled the Zulu War, and from Sir Bartle Frere (*q.v.*), whose actions as high commissioner had divided Lord Beaconsfield's cabinet. Wolseley settled Zulu affairs for a time and went to the Transvaal where he reorganized the administration and assured everyone that British rule was there to stay. Home again in May 1880. he was appointed quartermaster general.

In 1882 he became adjutant general. somewhat to the queen's dismay. That August he took command of the army corps that was sent to Egypt to put down Ahmed Arabi's nationalist rising. Wolseley seized the Suez canal—thus alarming the powers and setting on foot negotiations that led to the convention of 1888—and after a well-planned campaign defeated Arabi at Tel-el-Kebir (Sept. 13). Promoted to general, granted £30,000 and created a baron, Wolseley was back in Cairo by Sept. 1884, commanding the expedition to relieve Gordon in the Sudan. His force reached Khartoum on Jan. 28, 1885, two days after Cordon's death. The expedition was withdrawn and Wolseley, now a viscount, returned to the war office as adjutant general. There he founded the intelligence department, encouraged the staff college and suggested (in vain) that both a ministry of defense and a general staff should be created: "war is a serious business which has to be prepared for."

After commanding in Ireland (1890–94), Wolseley was promoted to field marshal, and became commander in chief in 1895 The powers of the office were now limited by the secretary of state; Wolseley described himself as "vice-chairman of a debating society." but saw to it that there was an efficientmobilization of the army in 1899 for South African service. He resirned his office to Lord Roberts in 1901.

Wolseley died'at Menton, France, on March 25, 1913, and was buried in St. Paul's cathedral, London. His unwearying efforts to make the British army an effirient instrument remain his best monument.

See Sir George Arthur, *Life and Letters of Lord and Lady Wolseley* (London, 1912); Sir F. Maurice and Sir George Arthur, *Life of Lord Wolseley* (London. New York, 1924). (A. P. T.)

WOLSEY, *THOMAS* (*c.* 1473–1530), English cardinal and statesman, was the son of Robert Wolsey of Ipswich and his wife Joan. He was educated at Magdalen college. Oxford. According to his servant, George Cavendish. he took his B.A. at the age of 15; but his earliest appearance in the records is in 1498. when he mas ordained priest and became junior bursar of the college. of which he was already a fellow. The next year he was senior bursar. and the story goes that he had to resign this office in 1joo for spending college revenues without proper authority on completing the great tower. He was also master of Magdalen college school. There he had charge of three sons of Thomas Grey. 1st marquess of Dorset. who in 1500 presented him to the rectory of Limington in Somerset. At Limington, Cavendish tells us. the sheriff; Sir Xmias Paulet. once put him in the stocks. Wolsey taking his revenge long afterward by confining Paulet to his chambers in the Middle Temple. In 1501 Wolsey obtained a dispensation to hold two other livings and also became chaplain to Archbishop Deane. In 1503 he became chaplain to Sir Richard Nanfan, deputy lieutenant of Calais, who recommended Wolsey to Henry VII. The king made Wolsey his own chaplain and also employed him on minor diplomatic missions to Scotland and the Netherlands. Although the story of his accomplishing a mission to Flanders and back in three days is inaccurate, he did impress the king by his ability and was rewarded by further ecclesiastical preferments, culminating in the deanery of Lincoln.

Henry VII's death momentarily clouded Wolsey's prospects. But in Nov. 1509 he mas appointed âlmoner to Henry VIII and by 1511, though still holding no other office in the state, he had become one of the young king's most influential counselors. Against the pacific advice of Archbishop Warham and Bishop Foxe (*qq.v.*), he encouraged Henry to join the pope's "holy league" against France, and the war which followed gave him the chance to prove his extraordinary organizing ability. The campaign of 1512 was a failure, but after the victories over the French at the battle of the Spurs and over the Scots at Flodden in 1513, he arranged the "perpetual peace" of 1514 and the marriage of Henry's sister Mary to Louis XII of France. His own immediate rewards were the bishoprics of Lincoln and Tournai and then (Sept. 1514) the archbishopric of York. Next year he became involved in the quarrels between the clergy and the house of commons about an act of 1512, due for renewal in 1515, which denied benefit of clergy to men in minor orders who committed murder. In 1514 the pope had declared that laymen had no jurisdiction over churchmen, and the clergy therefore prepared to fight its renewal. The situation was exacerbated by the case of Richard Hunne, a London citizen who was found hanged while imprisoned by the bishop of London on a charge of heresy and of whose murder the bishop's chancellor was accused. The bishop appealed to Wolsey to intervene with the king; Henry. meanwhile. was persuaded that the pope's pronouncement infringed his rights and he took the part of Henry Standish. a Franciscan friar whose public defense oi the action of the court and of the 1512 act led to his being summoned before convocation. As a result. convocation was declared guilty of praemunire (*q.v.*). and Wolsey, on behalf of the church. made a partial submission to the king. With Warham and Foxe he begged the king not to let parliament meddle with the liberties of the church and at the same time he pressed the pope to appoint him legate *a latere* with commission to reform the particular abuses of which the commons complained. The pope did make him a cardinal (Sept. 1515), but would not yet grant the legatine commission. Henry. however, at length dissolved parliament and on the same day (Dec. 22) appointed Wolsey lord chancellor.

It was as chancellor that Wolsey made his greatest mark on English history. As chancellor he presided over the public sessions in the Star Chamber at which the king's council normally exercised its jurisdiction in semicriminal causes. That jurisdiction had been less vigorously exercised in the early years of Henry VIII's reign and a weakening in the enforcement of law and order had been the result. Wolsey now used it for all it was worth. By it. as the chronicler Edward Hall says. "he punished lords. knights, and men of all sorts for riots, bearing, and maintenance in their countries, so that the poor men lived quietly." The young marquess of Dorset. the earls of Northumberland and Surrey and many knights. sheriffs and royal accountants were thus taught what Wolsey called "the new law of the star chamber." His activity there was also extended to deal with perjury. forgery, fraud, slander. enclosures. food prices and supplies and any other potential causes of disorder and breach of the peace. In this way he helped to enforce law and order and to reassert the authority of the central government. The persistency and vigour with which he used this jurisdiction also did much to give the sessions of the council in the Star Chamber the appearance of a regular and distinct court (see STAR CHAMBER). A similar result followed from the vigour with which Wolsey wielded the equity jurisdiction in civil suits between subject and subject that in the 15th century had devolved upon the chancellor (*see* ENGLISH LAW: *The* Growth *of Equity*). He also showed himself sympathetic to the poor. drawing to himself, after Foxe's retirement in 1516, that jurisdiction in their suits which hitherto had been associated rather with the lord privy seal and various councilors acting as masters of requests than with the chancellor. However, the growing popularity of these jurisdictions with suitors and Wolsey's own growing preoccupation with foreign affairs caused him to delegate more and more of this judicial work. Many of the commissions that he issued were temporary appointments of particular persons to deal with individual cases. Others. however, were of a more general and lasting character. such as the 1517 commission to hear and determine piracy cases. which prepared the way lor the establishment of separate admiralty courts; the four commissions of c. 1518 for poor men's causes. which emerged in the 1530s as the court of requests (*q.v.*); the delegation from the Star Chamber in 152j of northern and Welsh cases to the resuscitated local councils at York and Ludlow; and the final, short-lived delegation of chancery cases to commissioners in June 1529. These more general commissions helped further to hasten the evolution of these various aspects of conciliar jurisdiction into separate courts, operating as normal parts of the machinery for the administration of justice.

Meanwhile, Wolsey had obtained by his diplomacy a position in the church matching his position in the state. After failing in 1515–16 to organize effective resistance to the invasion of Italy by the new king Francis I of France. he managed to play a leading part in the general pacification of 1j18. As his reward he at last extorted from the papacy his own appointment as legate a *latere*. At first he had to share his commission with Cardinal Campeggio, and its scope was limited to the preparations for a crusade against the Turks. But a-hen Campeggio returned the next year to Rome, Wolsey retained his own commission. and by taking advantage of papal necessities he was able to get its scope and duration repeatedly extended until in 1524 he became legate a *latere* for life and with unusually wide powers. He thus gained an ecclesiastical authority overriding that of Archbishop Warham and a supremacy, under the pope. over the church in England parallel to the preeminence which as chancellor he already possessed, under the king. in the state. Here, too. he asserted his authority n-ith unusual vigour, though the confusion between his actions as legate and as chancellor encouraged chancery to encroach upon the jurisdiction of the ecclesiastical courts just as it did upon the courts of common law. Yet. despite this plenitude of power, Wolsey did very little to reform the abuses in the church which had already provoked the anger of the commons. He did dissolve certain monastic houses and use their endowments for his new college—later Christ Church—at Oxford and his new grammar school at Ipswich. But he himself was almost the pattern of a worldly prelate. loving pomp and display. lavish in dress, extravagant in entertainment. He was, too, a shameless pluralist and absentee. He held. besides his see of York. the rich abbey of St. Albans and the bishoprics first of Bath and Wells. then of Durham and finally of Winchester. His own morals were lax. and he endowed his son before he was 18 with a deanery. four archdeaconeries, five prebends and a chancellorship. He thus added considerably to the mass of ecclesiastical abuse for whose reform he pretended that his legatine powers were required. At the same time. by overriding the local ecclesiastical jurisdictions and privileges in virtue of the legatine authority that Rome had granted him. he helped to n-eaken the English clergy's affection toward papal power. And the concentration of so much secular and spiritual jurisdiction in the single hands of the chancellor-legate made acceptance of the royal supremacy all the easier in the 1530s. Wolsey, indeed, "as legate a *latere* of the pope rode papal jurisdiction in England to its death" (A. F. Pollard; see *Bibliography*).

The chief reason for Wolsey's failure to reform the church in England. and for his increasing delegation of secular jurisdiction. was probahly that from 1519 onward he became more and more absorbed in foreign affairs. Here he was much less his own master. For his power, great as it was, all depended upon royal favour, and Henry VIII, though he might leave the routine of administration and justice to his chancellor, always took a lively interest in and asserted an increasing control over foreign policy. It is not therefore easy to assess Wolsey's work in this field, though it is clear that he sought to make his own profit by persuading the king's allies to secure his own election as pope—a hope twice disappointed (1522 and 1523) because of the failure of the emperor Charles V to perform his promises. Nevertheless, it was his share in foreign policy that first made Wolsey generally hated and that finally lost him the king's confidence. It was he who extracted the forced loans of 1522 to finance the campaigns in northern France. It was he who tried in vain to browbeat the commons into granting £800,000 in 1523 and who was most blamed for the "amicable grant" of £500,000 from the laiety which Henry demanded in 1525 to help to destroy France and which brought the country to the verge of rebellion. Yet all this failed either to regain England's lost lands in France or to hold Charles V—even after his great victory over the French at Pavia (1525)—loyal to the English alliance (concluded by the treaty of Windsor, 1522) and to his promise to marry Henry's only daughter Mary.

Charles's repudiation of Mary brought to the fore the question of the succession to the throne and, very soon. the problem of Henry VIII's "divorce" from Catherine of Aragon. To secure the necessary papal authorization of the divorce was no easy matter, for since Pavia (and more still after the sack of Rome by the imperial army in 1527) Pope Clement VII mas virtually in the power of Catherine's nephew, the emperor. Wolsey was thus driven to expedients more and more desperate. In Xug. 1527 he concluded an unpopular French alliance and in 1528 began a brief but still more unpopular war with the emperor in order to remove the pope from Charles's clutches. For a time French arms prospered in Italy and Clement's concessions matched their progress. But his legate Campeggio. to whom at one point he gave full powers to settle the case, had hardly set out for England when the tide turned.

The French defeat in Italy, completed in 1529, compelled the pope to come to terms with Charles V (the peace of Cambrai, Aug. 1529j. and in July Campeggio was recalled.

Thereafter. Wolsey's fall was certain. He had long ago gained the hatred of rhe nobility; he had lost the support of the clergy: he had alienated the rest of the nation by his taxation. Now he had failed the king in a matter of vital and personal concern and through Anne Boleyn his enemies had ready access to Henry's ear. for Wolsey had advocated Henry's remarriage, not to Anne, but to a French princess. On Oct. 9. 1529, he was indicted for praemunire in the king's bench and. although he was allowed to keep the archbishopric of York and a yearly pension of 1,000 marks from the see of Winchester. he had to surrender all his other offices and preferments. Early in the next month parliament met, and a bill of attainder passed the lords but was rejected in the commons—probably with the king's good will, for he n-as not yet prepared to break the cardinal utterly. Wolsey himself had not yet lost all hope of regaining the royal favour and soon entered into dangerous secret correspondence with the French and imperial ambassadors and with Rome. He stayed near London until April 1530 when, under pressure from the council. he journeyed slowly north to visit for the first time the province of which he had been archbishop for nearly 1j years. At length, however, his intention to be publicly enthroned at York on Nov. j and his summoning of the northern convocation to meet him there seem to have alarmed the king. who had become aware that he was corresponding with foreign powers. So, on Nov. 4, 1530, he was arrested at Cawood and carried back toward London. On the way he died at Leicester abbey (Nov. 29), where he was buried.

See George Cavendish, *Life of Cardinal Wolsey*, 2 vol., ed. by S. W. Singer (London, 1815; first printed 1541). The best modern account is A. F. Pollard, *Wolsey*, new ed. (London. New York, 1953).

(R. B. Wm.)

WOLVERHAMPTON, a municipal and county borough, Staffordshire, Eng., 13 mi. N.W. of Birmingham by road. Pop. (1961) 150,385. Area 11.3 sq.mi. It stands on a sandstone hill at the northwestern edge of the group of great manufacturing towns extending to Birmingham. but there are residential suburbs to the west. where the country is well wooded. The town's original interests ti-ere mainly agricultural. but with the development of the South Staffordshire coal and ironstone deposits it rapidly became known for its metal manufactures. There are enormous iron and steel foundries and the town manufactures a wide range of goods, including railway cars and road vehicles, locks (for which it was famous in 1751), tools, bicycles, enamel and galvanized ware, rubber tires! artificial silk, chemicals, paints and varnishes. The church of St. Peter, dedicated in 994 and several times rebuilt, is a fine cruciform building with some 13th-century work. A grammar school, founded in 1512–15 by Sir Stephen Jermyns, occupies modern buildings (1875). There are a bluecoat school (1710), a college of art and a technical college.

The town of Wolverhampton (Handone, Wolvernehamptone, Wollernehampton) grew up round the church of St. Mary. probably founded in 996 by Wulfruna, who endowed it with extensive lands. which are enumerated in Domesday. In 1204 John granted the manor of Wolverhampton to the church, and at the Reformation it was held by the dean of the collegiate body; in 1553 Edward VI granted the college and manor to Dudley, duke of Northumberland, but Mary refounded the college and restored its property. Henry III (12j8) granted the Wednesday market. which is still held, and a fair for eight days, beginning on June 29. In 1848 the borough was incorporated and became a county borough in 1888. It was first represented in parliament in 1832, sending two members; from 1885 to 1948 it sent three after which it sent two. The boundaries of the borough were extended in 1927 and 1933.

WOLVERINE: see GLUTTON.

WOLVERTON, an urban district of Buckinghamshire, Eng., in the Buckingham parliamentary division, 11 mi. S.E. of Buckingham by road. Pop. (1951) 13,421. Area 7.3 sq.mi. Its modern growth was the result of the establishment of carriage works by the railway company. The technical college (1926) is important. There are large printing works.

WOMBAT, the typical representative of the marsupial family Vombatidae (see MARSUPIALIA). All the teeth are of continuous growth, having persistent pulps. The incisors are large and chisel-like. as in rodents. The body is broad and depressed. the neck short, the head large and flat, the eyes small and the tail vestigial. The limbs are equal, stout and short. The feet have broad, naked soles; the forefeet have five toes, each with a long nail. The hind feet have a short nailless first toe; the second, third and fourth toes partially united by skin, the fifth distinct and shorter; these four with long nails. The wombat of Tasmania (*Vombatus ursinus*) and the similar but larger *V. platyrhinus* of southern Australia belong to the typical group of the genus. with short ears, coarse fur and naked muzzle. On the other hand, in the hairy-nosed wombat (*Lasiorhinus latifrons*) of South Australia, the fur is silky. the ears more pointed, and the muzzle hairy.


BROAD-NOSED WOMBAT (VOMBATUS PLATYRHINUS), AUSTRALIA

In form and action wombats resemble small bears, having a similar shuffling walk, but they are shorter in the legs and have broader backs. They live on the ground, or in burrows or holes among rocks, and feed on grass. roots and other vegetable substances. They sleep during the day but wander forth at night in search of food. They are shy and gentle, though they bite strongly when provoked. The prevailing colour is brownish gray. The large wombat of the mainland is variable in colour, some individuals being pale yellowish brown, others dark gray and some black. The length of the head and body is about 3 ft. Fossil wombats. some of larger size than any now existing. have been found in the Pleistocene of Australia.

WOMBWELL, an urban district in the Dearne Valley parliamentary division of the West Riding of Yorkshire, Eng., 42 mi. S.W. of York by road. Pop. (1951) 18.837. Area 6 sq.mi. The population is employed chiefly in the extensive collieries, but there are also engineering works and glass manufacture. Wombwell is mentioned in Domesday Book as Wamballa and the district now includes the villages of Jump, Hemingfield and Broomhill. The Roman Catholic church of St. Michael was opened in 1953. Margaret Wombwell (d. 1776) of Wombwell hall (traditionally associated with the kings of Northumbria) married Anthony St. Leger after whom the race (founded *1776* at Doncaster, *12* mi. E.) was named.

WOMEN, DISEASES OF: see GYNAECOLOGY.

WOMEN, EDUCATION OF. The 19th and 20th centuries brought a revolution in the status and education of women, first sweeping Europe and the United States. then the orient, and reversing ancient judgments of women's aptitudes.

Factors of Change. — Hebraic-Christian ethics elevated woman morally. The Renaissance gave upper-class women Greek and Latin classics. The Reformation stressed reading the Bible in the vernacular, and joined with rising nationalism to prepare the way for universal basic education. The technological revolution displaced age-old domestic crafts with factory production, took women outside their four malls and gave them cash instead of "keep." A rising middle class, growing affluent through commerce and industry. gave daughters an education of accomplishments, and occasionally something more substantial.

In the 19th century, seminary, college and university provided pragmatic proof that girls, like boys, could master the known and explore the unknown. New sciences. notably biology, psychology, anthropology and a naturalistic philosophy of education, shed fresh light on likenesses and differences of male and female, but offered no confirmation of the alleged inferiority of women. Political liberalism, resting on a naturalistic premise, opened the way to participation in government. World wars and ensuing revolutions augmented changes already in progress, broadened the scope and accelerated the tempo.

Early Cultures. — The original source of woman's restricted sphere of activity and dependence lay in her biological function and a less agile. smaller and weaker body. Bound by a shorter tether, she shared the labour of primitive societies. but hers was near at hand while man's took him far afield. The societies of the great river valleys of the east and those of the Mediterranean exhibit, similarly, a differentiation of roles of men and women; but, although women of the lower orders laboured as had their primitive sisters. wealth and class structures and functions facilitated a degree of seclusion and subjection of upper-class women which generally left them without significant labour or public function. Such women had little education, save that befitting their narrowed sphere; being unlettered, they seemed to have inferior minds. When man began to philosophize, he explained the inferiority of woman: "A woman without ability is normal," said the Chinese. Hindus considered "infidelity, violence, deceit, envy. extreme avarice. a total want of good qualities, with impurity" the natural faults of woman. Aristotle saw women's virtue in obeying, being less complete. less courageous, weaker, more impulsive than men. There were exceptions — a few educated women in China. India, Greece, Rome; *e.g.,* Lady Tsao, Rama, Aspasia, Cornelia. In theory, too. views differed. Plato thought some women could be philosophers; he admitted a few to his academy. Musonius and Seneca believed women talented. even for philosophy. But learning opened no office or respected profession to women.

Christian Influence. — Christianity credited women with souls equal, in the sight of God. to those of men. The full benefit of this moral status was long deferred, however, for Christian ascetics waged war against worldly aesthetic, intellectual and physical culture, and for maximum discipline of the soul fled to monastery and nunnery. The restricted education of girls was described by St. Jerome. Although limited, and though one must leave normal life to win it. nunneries opened for women (*e.g.,* Hilda of Whitby, Hrosvitha, Elizabeth of Schönau) a path to letters: and administrative posts as abbesses. England had about 140 nunneries in the late middle ages, exclusive of "double houses." But nuns were only a small fraction of the female population, and came chiefly from the upper classes. Lower-class women carried on the world's work with men. High social status, in Europe as elsewhere, kept women from the world of labour. Cathedral school and university, the highest institutions of the middle ages, led to the supreme profession, theology — closed to women. Had not St. Paul advised women to be silent in church?

The Classical Revival. — The "New Life," of which Dante was spokesman and forerunner, brought learning from the cloister to the court, broadened its range and gave it worldly character and colour. Women of courtly circles. profiting from the change, drank from classic springs. as witness Ginevra Nogarola, Isotta, Lady Jane Grey. Vittorino da Feltre. Guarino da Verona. Roger Ascham taught gentlewomen of the world. Erasrnus of Rotterdam ridiculed the ignorant abbot who argued that "books destroy women's brains . . . it is not safe for a woman to know Latin." Juan Luis Vives wrote *The Instruction of a Christian Woman*, and Sir Thomas Elyot, *The Defence of Good Women.* Richard Mulcaster advocated education for girls, but not in grammar schools or universities. But theory outran practice: German *Gymnasien,* English public schools, French *lycées* and American Latin grammar schools did not fulfil the promise of early humanists. These schools became subservient to universities which. save for a few in Italy and Spain where women taught. did not admit women. Not till college and university broadened their scope and became fully identified with secular life did women generally find a place in them.

Developments in England and on the Continent.—Reaction set in after the 16th century, but the idea of girls' education was kept alive by C. B. Barksdale's *Learned Maid* (1659), a translation of a work by Anna van Schurman, Bathsua Makin's *Essay to Revive the Antient Education of Gentlewomen* (1673). Mary Astell's *A Serious Pi-oposal to the Ladies* (1694), Daniel Defoe's essay on *An Academy for Women* (1698). More significant were Mary Wollstonecraft's *A Vindication of the Rights of Woman* (1792), Erasmus Darwin's *Plan for the Conduct of Female Education in Boarding Schools* (1797), Hannah More's *Strictures on the Modern System of Female Education* (1799), Emily Shirreff's *Intellectual Education* (1858), Emily Davies' *The Higher Education of Women* (1866) and John Stuart Mill's *On the Subjection of Women* (1869).

This literature reflected a keen concern for the education of girls, a critical appraisal of errors. Education was filtering down to daughters of the middle class. By the mid-18th century many boarding schools for young ladies, in London and other cities, offered chiefly accomplishments. A century later a royal commission (1864) found that lack of "organization," "thoroughness," "attention to rudiments," too much "slovenliness" and "showy superficiality" characterized girls' schools.

Remedies were urged, The Kational Union for Improving the Education of Women of All Classes, promoted by Lady Stanley of Alderley, Emily Shirreff, Mary Gurney and Mrs. William Grey, was founded in 1871. The Girls' Public Day School company (1872) sought to give girls an education equal to that of boys in public schools. The first school opened at Chelsea in 1873; by 1900 there were 33. Collegiate education also gained attention.

Amelia Murray sought to promote courses in "all branches of female learning." a project encouraged by F. D. Maurice and others at King's college, London. which culminated in Queen's college, 1848. Bedford college followed in 1849. These were scarcely better than secondary schools. Cambridge admitted girls to local examinations. Girton (Hitchin), opened in 1869, thanks to Emily Davies. and Newnham (1871) were recognized as colleges in the university in 1948. Women at British universities (1948–49) numbered 20,005; men. 80,996.

In France the education of girls lagged behind that of boys, as in England. Louis XIV founded St, Cyr (1686) for daughters of nobles. Madame de blaintenon, François Fénelon. Alfred Nettement and Madame Albertine Kecker de Saussure represent trends of French thought on girls' education. Napoleon, wanting "women who believe . . . not women who reason." provided at Écouen (1807) education of daughters and sisters of Legion of Honor men and at St. Denis (1809) for daughters of higher officers. Convents held a prominent place in French girls' education. A commission (1844) investigated private girls' schools, but with slight effect. Jules Simon judged girls' education "futile and incomplete." Following Jean Victor Duruy's suggestion (1867), an Association for Girls' Secondary Courses was formed. By 1887 there mere 69 courses. A law, passed in 1880 despite clerical opposition, provided secondary schools for girls. The first *lycée* opened at Montpellier in 1881. The Higher Normal school at Sèvres (1881) prepared women for secondary school positions. The Collège de Sèvigné (Paris, 1880) opened university work to women. There were 3.830 women at French universities in 1910; in 1950 they constituted 35% of the enrolment.

In Germany, following Luther, Hamburg (1526) and Brunswick (1528, 1534) provided elementary schools for girls. Ursulines and Hieronymians were active in Catholic localities. The late 18th century saw the opening of secondary schools, Elizabeth school at Berlin (1748), Frankfurt-on-Main (1749), a *Töchterschule* at Breslau (1767) and at Dessau (1786). Following a reform movement (1865). an official rescript (1894) established a curriculum for *höhere Mädchenschulen.* Private efforts at Berlin and Karlsruhe prepared girls for the *Abitur* in 1893; Leipzig followed in 1894. Victoria lyceum. Humboldt academy and *Realkurse* under the scientific *Zentralverein,* Berlin, also prepared women for this examination, giving entrance to universities. There were 4,057 regular women students by 1914; 8,761 in 1923. After World Wat II, women constituted a fourth to a third of university students.

The United States: Origins—Though colonial New England generally excluded girls from town schools, their entrance being considered "improper and inconsistent," dame schools received them. A few towns specifically admitted girls. The 18th century saw a change. Boston provided for both sexes in 1789. In the central colonies churches generally gave elementary education to both sexes. Latin grammar schools were not for girls. Private schools developed in the 18th century, however, notably in Philadelphia. New York city and Boston. Their proprietors, men and women, taught whatever anyone, male or female, wanted to learn. Most of them taught girls accomplishments; others, venturing upon solid subjects, gained public esteem. John Poor's school (Philadelphia), offering reading, writing, arithmetic, English grammar, composition, rhetoric and geography, was chartered on Jan. 9, 1792. The Ursuline convent. New Orleans, La. (1727), a Moravian school (1742)—later Bethlehem seminary, Bethlehem, Pa. (1749)—Linden Hall, Lititz. Pa. (1794), Leicester academy, Leicester, Mass. (1784), Westford academy. Westford, Mass. (1793) and Westtown Boarding school, Westtown, Pa. (1799)—the last three admitting both sexes—gained renown: Public high schools began (Worcester, Mass., 1824) the slow process of making secondary education free; an end not widely realized till after 1870. By 1900 girls in public high schools numbered 317,146; boys 224,584. Girls totalled 3,327,000, slightly less than boys, in 1950.

Collegiate Education of Women.—From 1825 to 1875 many efforts were made to found women's colleges. Certain better seminaries—Troy Female seminary, Troy, N.Y., founded by Emma Willard (1821), Mount Holyoke. South Hadley, Mass., begun by Mary Lyon (1837), and Milwaukee Female seminary (later Milwaukee-Downer college), Milwaukee, Wis. (1851)—later became colleges. Georgia Female college, Macon, Ga. (1839), Mary Sharp, Winchester, Tenn. (1851), Elmira, Elmira, N.Y. (1855), and Vassar, Poughkeepsie, N.Y. (1865), laid serious claim to collegiate rank. Elmira and Vassar fully merited the name; only Vassar had generous support. When Smith college, Northampton, Mass., and Wellesley college, Wellesley, Mass., opened (1875), success of collegiate experiments was established. Coeducation began on the college level at Oberlin college, Oberlin. O., where women entered college courses in 1837. Antioch college, Yellow Springs, O. (1852), gave women equal opportunities with men "in the same studies, and classes, and by the same instructors." Women were to be teachers as well as students. In state universities coeducation was the rule initially or soon became so. The State University of Iowa, Iowa City (1856), was coeducational. The University of Wisconsin, Madison (1850), proposed a normal department, opened to women and men, first attended by women in 1860; collegiate coeducation was realized after 1872. The University of Michigan, Ann Arbor, admitted women in 1870. Forty years after Oberlin opened, 8,141 women were in coeducational institutions, 2,519 doing college work. Affiliated colleges—H. Sophie Newcomb, New Orleans, La. (1887), Barnard, New York city (1889), the Women's college (later Pembroke), Providence. R.I. (1891), Radcliffe, Cambridge, Mass. (1894), Jackson, Medford, Mass. (1910), associated with Tulane, Columbia, Brown, Harvard and Tufts, respectively—did not significantly alter the pattern of women's education; but they gave women certain facilities and the services of faculties previously denied them. By 1900 there were 26,728 women college students, 8,104 graduates; in 1950, 103,217 women graduates and 328,841 men.

Fear had been felt that women were too weak to stand the strain of serious mental labour. College and seminary demonstrated that they could master Euclid, Greek and Latin without losing their health or their minds. Another fear—college for women would mean race suicide, they would not marry or, if they did, would not have children—was soon laid. Thorough study showed marriage and fecundity were conditioned by wealth and social status rather than by classics and mathematics.

Professional Education.—Entrance to higher professions was as difficult as getting into college—or more so. Teaching was the first profession to admit women. Women were too weak to handle discipline, it was said; and they were, as long as schools were ruled by the rod. But the common schools demanded more teachers, and women were the readiest source. From seminaries, then from normal schools (a private experiment, 1823, and state institution, 1839), women went rapidly into a profession, highly praised, poorly paid. Women in teacher-preparatory schools (1900) numbered 42,290; men, 21,112. In 1950 there were 96,906 women and 116,321 men in teachers colleges, excluding summer schools.

Entrance to medicine, law and theology was more difficult than teaching. If one could get training, medical societies, bar associations, churches and the public were hostile to women practitioners. In medicine a minor step was taken in Philadelphia (1765) when William Shippen, Jr., gave lectures on midwifery "to women who had virtue enough to own their ignorance." Almost a century later Elizabeth Blackwell sought in vain to enter first-class medical schools. Accepted, finally, at Geneva college, Geneva, N.Y. (1847), she took a degree (1849) and finished her medical preparation abroad.

As old institutions refused admission, special schools for women developed. Encouraged by friendly doctors and the Female Medical society, lectures began (1848) in Boston at the New England Female Medical college (1852) which later became part of Boston university. The Female Medical College of Pennsylvania, Philadelphia, incorporated March 11, 1850, was the first institution so recognized in the United States. Progress was slow. Women studying medicine (1891) numbered 1,302; men, 18,514. In 1950 women won 584 M.D. degrees, men, 5,028; in medical sciences there were 729 and 2,495 degrees, respectively.

The law offered many obstacles, since training was generally in private offices. Growth of law schools benefited women. Lemma Barkaloo studied law in Washington university, St. Louis, Mo., in 1869. Ada Kepley received a degree from Union Law college, Chicago, in 1870. The University of Pennsylvania, Philadelphia, admitted women in 1881. Law schools almost doubled from 1870 to 1890; by 1900 there were 94, with 151 women and 12,365 men; in 1920 there were 19,821 men, 1,171 women. In 1950 women won 421 degrees in law; men, 13,891. After a strenuous fight Myra Bradwell won the right to practise when Illinois (1872) forbade disbarment from any profession, other than military, on grounds of sex. Bella Lockwood, admitted to the supreme court of the District of Columbia (1873), was refused admission to the United States court of claims and the United States supreme court. Finally, a bill (1879) enabled women to practise before the highest tribunal.

Postgraduate study met little opposition. Graduate schools, being new, generally welcomed both sexes, though a belief prevailed that women, while they could master the known, would not be capable of original investigation. By 1900 women in graduate departments numbered 1,-982, men. 4,883; in 1950, there were 65,047 and 172,161, respectively.

Recent Developments.—Having found that women could master traditional college studies, a concern arose as to what the higher education of women really should be. Do traditional studies suffice? Causes of the query lay in economic pressures, specialization dictated by scientific and technological development and decline of faith in the mental discipline once credited to Greek, Latin, mathematics and science. Some women's colleges sought to hold fast to the ancient disciplines; most of them, however, revealed the influence of vocational demands. Two, Sarah Lawrence college, Bronxville, N.Y. (1928), and Bennington college, Bennington, Vt. (1932), broke boldly with tradition, giving first place to development of persons according to interests and needs—an application of John Dewey's philosophy.

Great progress has been made in many lands in the past generation, but education is still less accessible to women than to men, except in primary schools. Fifty nations (1952) had about equal numbers of girls and boys in primary schools. The proportion of girls to boys in secondary schools in 43 lands ranged from less than 10% (Egypt and Honduras) to more than 50% in Chile, Denmark, Finland, Scotland, Sweden and the United States. In 47 countries the proportion of women to. men in higher education ranged from 0% (Cambodia and Saudi Arabia), 1.08% (Honduras), 2.73% (Persia), 4.79% (India), 6.45% (Egypt), to 43.82% (Panamá), 40.70% (Scotland) and 40% (Poland). Women constituted 30% of the enrolment in the United States: The Soviet Union had 44% women in universities (1926); 57% in 1941.

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WOMEN, LEGAL POSITION OF. This article describes, as well as the present legal position of women, something of the process whereby the rights of men and women have tended to become equal in British and United States law.

GREAT BRITAIN

Only in comparatively modern times did the women of Great Britain emerge from a complex of legal disabilities within which they had remained for long centuries. The three main landmarks of their modern emancipation were the Married Women's Property act of 1882; their admission to the parliamentary electorate by the Representation of the People act of 1918 (see WOMEN'S SUFFRAGE); and the Sex Disqualification (Removal) act of 1919, which opened public functions and many professions hitherto closed to them.

The Norman Conquest placed England as a conquered land under a feudal law more oppressive and thorough than that of other northern or western European nations. Reaching the lower ranks, feudalism clothed even the humblest husband with "more than the authority of a feudal lord," and merged the wife's existence completely in that of her husband. Whatever property rights the pre-Conquest wife had possessed disappeared; and, as marriage was indissoluble, not until a woman became a widow did she come into her sole remaining property right, her dower. This was rather the creation of the church than of the common law.

Right of Women to the Crown.—After 1066 the regnal position of women monarchs was ill-defined. The attempt of Henry I to leave the crown to his only surviving child, Matilda, resulted in a civil war of uncertain issue. The matter was not set at rest until a statute of the first year of Mary Tudor's reign declared a woman to be as capable as a man of full regnal power. Thereafter four other female sovereigns ascended the throne, enjoying equal regnal rights. But female succession to the crown is not yet in full parallelism with male, for the senior son of any issue surviving the sovereign succeeds in preference to a daughter, although she be his senior by birth.

Women Peers, Privy Councillors and officers of State.—Although certain women of rank were summoned to the Saxon witenagemot, the Norman era ushered in a state of things whereby peerages were conferred usually upon males. Often the peerage as a dignity was expressed to be heritable by women. But its enjoyment did not connote any obligation upon the crown to summon the woman peer to "seat, voice and place" in the house of lords; *i.e.*, when that house was summoned in the full parliamentary sense. King John at a meeting in the Temple summoned among others certain *abbatissae*, and Edward III summoned about 11 women peers to a gathering before undertaking a fresh war. Until 1870 a woman peer possessed at any rate a theoretical right to nominate a deputy to represent her peerage. Lady Rhondda in 1922 raised the issue directly by petitioning for "seat, voice and place" in the house of lords, and her petition was heard by a committee of privileges. Unfortunately, the petition was based upon the Sex Disqualification (Removal) act, 1919, which proved too frail a legal foundation for the claim. However, under the Life Peerages act, 1958, life peeresses might be created and would be entitled to sit in the house of lords. The queen created the first four such peeresses on July 24, 1958.

The privy council has functioned under varying nomenclature since the earliest days, and the idea of excluding women as such apparently never arose, the only question being what women, if any, were important enough.

In the reign of George V it became necessary to swear in Margaret Bondfield as a member, on her nomination as minister of labour, for the cabinet is historically and technically a subcommittee of the whole privy council. Later Edith Summerskill and Florence Horsbrugh similarly achieved privy councillorship as cabinet ministers. Queen Mary, consort of George V, had already been sworn of his privy council.

Public office was often inherited by women. and if their lands were associated with public office, the woman holder had either to perform the duties of such office or provide for their fulfilment. For instance, Ela, countess of Salisbury, in the reign of John held the earldom of Salisbury together with the government of the castle of Sarum and also inherited the sheriffdom of the county of Wiltshire. Nicolaa de la Haye, wife of Gerard de Camville, was sheriff of Lincoln under John.

But under the Stuart dynasty opportunities open to women became fewer, and Mary Astell in 1694 was protesting. in her work *A Serious Proposal to the Ladies,* that the decline in the higher education of women underlay their diminished general position—"since there are no accounts in history of so many great women in any one age as are between 1500 and 1600." She therefore proposed the foundation of an institution for the better education of women. Nothing resulted.

In 1792 Mary Wollstonecraft pleaded in her *Vindication of the Rights of Woman:* "Let us consider women in the grand light of human creatures, who in common with men, are placed on this earth to unfold their faculties." She asked for their parliamentary representation. Again, little resulted.

Progress had to be made upon three parallel paths—the right to property, the right to political enfranchisement and the right to enter all professions, trades and callings.

The Right to Hold Property.—The demand for property rights for wives, entirely disallowed by the common-law concept of coverture, proceeded concurrently with the demand for parliamentary suffrage. It is perhaps more logical to consider property first because it is hard to see how even the later peaceful propaganda for the vote could have been financed by moneyless wives. Furthermore, the property act of 1882 antedated the franchise act of 1918 by 36 years.

It must always be remembered that the women of the aristocracy and the moneyed mercantile classes received protection from the chancery courts. This process began to rise into importance about the time of Henry VIII.

Property began to be held to the "use" of another than the original owner, and the fruits arising from its ownership had to be paid to a beneficiary who became in equity the owner, while the bare legal estate was held by a trustee or trustees, who passed on to the equitable owner whatever profits arose.

But the ordinary wife who was simply a woman of the people had normally no lands or money safely settled upon her and therefore no equitable rights protected by the court of chancery. Except in the City of London a married woman had not even the right to money she earned by her own labour inside or outside the matrimonial home. A husband could, if he liked, collect the profits arising from his wife's literary work or, from a theatrical manager, her remuneration as an actress; and in poorer classes the profits made by the mangle, the sewing machine or the charing done in the house of another could be collected by the husband, and without the wife's having any recourse to them if that husband drank or gambled them away and left her and her children starving. Even if his conduct had forced her to leave the matrimonial home or he had deserted her, the legal payment made by the employer was the one he made to the husband, and if he risked paying first to the wife who had earned the money, her receipt would not protect him'in law if the husband sued.

When parliament in 1857 first set up a court empowered to grant dissolutions of marriage and judicial separations. the 1857 Matrimonial Causes act did at least secure to the deserted or separated wife the right to her own earnings. The ordinary wife still living with her husband was not so protected. The Married Women's Property act of 1870 took that necessary step.

The vital section of the 1870 act is s. xi which runs: "A married woman may maintain an action in her own name for the recovery of any wages, earnings, money, and property by this Act declared to be her separate property, or of any property belonging to her before marriage . . . and she shall have in her own name the same remedies, both civil and criminal, against all persons whomsoever for the protection and security of such wages, earnings, money and property purchased or obtained by means thereof for her own use, as if such wages, earnings. money, chattels, and property belonged to her as an unmarried woman; and in any indictment or other proceeding it shall be sufficient to allege such wages, earnings, money, chattels and property to be her property."

The Married Women's Property Act (1870) Amendment act, 1874. dealt mainly with points of detail and extended considerable and no doubt necessary protection to husbands with regard to their wives' prenuptial debts. torts, assets, etc.

The Married Women's Property act of 1882 operated from Jan. 1, 1883. and enacted that: "A married woman shall in accordance with the provisions of this Act be capable of acquiring, holding and disposing by will of any real or personal property as her separate property in the same manner as if she were a feme sole (spinster or widow) without the intervention of any trustee." It was also provided that a married woman "shall be capable of entering into and rendering herself liable in respect of and to the extent of her separate property on any contract" (i, s. 2). By a further Married Women's Property act of 1893 it was enacted that "every contract hereafter entered into by a married woman otherwise than as an agent . . . shall bind all separate property which she may at that time or thereafter be possessed of or entitled to." The 1893 act came into force on Dec. 5, 1893. It will be observed that the tone of these various enactments sounds rather minatory than emancipatory. The freedom to own and to contract at once added liability to wives. Suffice it to say that without such liabilities no sane person would enter into contract with the wife exempt as such from the necessary burdens of the law. All these rights were granted in the U.S. in 1848.

Women in Parliament and Other Public Offices.—A special statute to render possible the election of women members of parliament was necessary. The Qualification of Women act, 1919, was therefore enacted and proclaimed that "a woman shall not be disqualified by sex or marriage from being elected to or voting as a member of the Commons House of Parliament." The first woman to be elected to the British house of commons was the Countess Markiewicz, an Irish lady, who did not sit; but the next one elected, the Viscountess Astor, became the first woman to serve fully as an active member of parliament.

Membership of various bodies associated with local government, *e.g.,* school boards, boards of guardians, etc., began to be opened to women in the reign of Victoria. But they had not been appointed (normally) for centuries as justices of the peace, nor upon the police force, nor indeed in various other public capacities until the passage of the Sex Disqualification (Removal) act, 1919. Women were under the same statute made liable to jury service.

Right to Practise in the Professions.—The inns of court had refused at least three women applicants, and the Law society had obtained a queen's bench judgment protecting the solicitors' profession from their entry. It was therefore thought advisable to enact a generally qualifying statute, viz., the Sex Disqualification (Removal) act, 1919, throwing open the exercise of all professions. The chief ones immediately attained were the legal profession in both branches; *i.e.,* barristers and solicitors; chartered (and other) accountancy; veterinary surgery; and certain other perhaps rather unexpected callings such as marine engineering. One very important reservation was made by order in council promulgated under the Sex Disqualification (Removal) act, 1919, namely that the diplomatic and consular services and certain higher civil service appointments were reserved to men. However. in 1946 a special commission appointed to consider this matter duly reported favourably and the barrier was removed. In the diplomatic and consular services up to 1953 about 16 women had been appointed to some of the higher positions, although not the highest of all.

King George V created certain Canadian women barristers silks, the first two being H. A. Kinnear (later Judge Kinnear) and M. P. Hyndman. In 1941 George VI gave silk to Frances E. Moran of the Southern Irish bar. In 1948 he created M. H. Kidd of the Scottish bar a silk and in 1949 similarly honoured Helena Normanton and Rose Heilbron, both of the English bar.

Nationality of Married Women.—By an act of 1844 alien women who married British subjects automatically acquired British nationality. This in some cases led to abuses in connection with prostitution, as undesirable foreign women obtained easy entry. Instead of dealing with that, parliament by the Naturalization act of 1870 deprived of her British nationality any British woman who married a man of foreign nationality. During World War I difficulties arose. British-born women technically aliens became subject to vexatious regulations—sometimes even to internment. In took 34 years of hard work for British women to obtain remedial legislation which took shape as the British Nationality of Women act, 1948.

By this act a British woman received the right to retain British nationality on marriage to a foreigner, and the act conferred automatic restoration of British nationality to those who had lost it. It also ended the right of alien women to acquire automatic British nationality when marrying British subjects. Such a woman must now make application to the secretary of state for home affairs for registration and must take an oath of allegiance to the British crown.

Testacy and Intestacy of Married Women.—The Married Women's Property act of 1882 confirmed and extended such rights as wives had formerly enjoyed. The Law Reform (Married Women and Tortfeasors') act, 1935, consolidated and completed sex equality by empowering a married woman to dispose by will of all her property, real or personal, as if she were a feme sole; and such will disposes of all property to which she was entitled or held at the date of her decease.

The liability of the male under the Law of Intestate (Succession) act of 1953 has been equated absolutely with that of the female; and by that act reforms have been made almost revolutionary in effect. Considering the small amount left in fact by the average British subject, in the majority of cases the surviving spouse will stand to benefit far more under an intestacy than when a normal will has been made; and the issue of the marriage will benefit *pro tanto* far less.

The widow or widower will take the chattels and the first £5,000 of the total estate. After that, further pecuniary benefits to a spouse are balanceable against the various provisions made by the act for children, brothers and sisters and surviving parents or grandparents. The surviving spouse has the first option of purchasing the matrimonial residence at its market value and also may commute a life income for its actuarial value. The act also enlarges reliefs obtainable by dependants deprived of support, etc., under unjust mills.

Criminal Law and Women.—Two vestiges of the old common-law theory of the merger of the wife's person in that of her husband still modify criminal law. One is that, as a conspiracy still needs at least two persons, a joint plan by husband and wife to commit a crime is not indictable as a conspiracy; and the tendency is for the wife to escape through that loophole. This legal fiction is however not deemed to hold good in the case of treason. The other instance is that if a wife commits a crime in the presence of her husband she may raise the defense that she in fact committed the crime under his marital coercion.

A wife cannot be charged with harbouring a husband after he has committed a crime, *i.e.,* as an accessory after the fact, for she is not compelled to "discover" his crimes.

Formerly, as husbands by marriage *ipso facto* acquired the total property of a wife (other than any protected by equity) he had to pay any damages awarded by the courts to the person aggrieved by any tort committed by the wife. By the Law Reform (Married Women and Tortfeasors) act, 1935. husbands were released from the onerous liability of paying for the torts of wives who were living with them.

Husbands and wives who are living together cannot proceed against each other in tort.

Rights of Women to Dissolution of Marriage.—Prior to the Matrimonial Causes act, 1857, the church exercised general control over marriage, effectuating it validly, or per contra pronouncing as to questions of invalidity. Broadly speaking, pre-Reformation doctrine as to invalid marriages prevailed, and those purported marriages which had never under ecclesiastical law been real marriages were annulled by one or other of the ecclesiastical courts of the country. Such courts could also grant separations "from bed and board"—which did not confer upon either separated party any right to remarry a third person, as would a decree of annulment.

After the Reformation, parliament took power to grant parliamentary divorces, which were *a vinculo, i* e., from the matrimonial bond itself, and did entitle the former spouses to remarry if they so desired. But the great difficulty and expense of these limited them in effect to the aristocracy and even so they were indeed few in number. It is believed that not one was in fact granted to a wife. The normal preliminary was a civil action brought by the husband against the male adulterer for criminal conversation. The wife being no party to the action had no right of representation at the trial, so her reputation could easily enough be demolished by perjured testimony. The Matrimonial Causes act, 1857, boldly transferred the whole processes of dissolution of marriage to a lay tribunal by setting up a division of the high court empowered to annul marriages, grant judicial separations and dissolve the actual bond of marriage, or, in popular phraseology: grant divorces.

Substantially, the ground upon which a husband could obtain a divorce was the adultery of the wife. Substantially, the grounds upon which a wife could obtain dissolution were much graver—certainly more onerous, for a husband's adultery alone did not suffice. There had to be in addition incest or bigamy coupled with the adultery; or grave cruelty; or causeless desertion of her against her will for more than two years; or the commission of sodomy; or an act of bestiality. Separation orders were granted more easily and could include orders protecting the deserted wife's earnings, which she might receive and expend without control by her separated husband.

One serious inequality of ground operated against the husband. Although: as above, the mife could proceed against a husband who had committed sodomy or bestiality, the husband was granted no redress—not even a judicial separation—against a wife addicted to unnatural sexual practices with other women, a male disability still forming part of matrimonial law. But a husband was empowered to claim damages from the male corespondent to the petition, while the wife was granted no parallel right..

A presumption of law underlay and complicated the whole process of matrimonial litigation, namely, that the husband's domicile was and is automatically the wife's domicile, in other words that her only forum of jurisdiction was whatever forum was the husband's, whether his original one or one that he had newly acquired. If, therefore, a husband had legally and finally settled in some land which did not grant divorces as part of its law, no matter how bad his conduct the wife lost her right to launch any matrimonial litigation against him.

The Matrimonial Causes act, 1923, took one step in equalizing the position of women by making it possible for a wife to obtain a divorce upon the sole ground of her husband's adultery, to which cruelty or desertion no longer had to be coupled. The Matrimonial Causes act of 1937 as consolidated in the Matrimonial Causes act, 1950, effected great changes. It made separate grounds of the following acts so that a husband or wife could obtain a decree of divorce for adultery, cruelty, desertion or insanity, proved strictly by five years' detention in an institution for the treatment of insanity. The inequality as to unnatural sexual conduct described above was left untouched. So was the inequality as to damages.

This act provided some other useful remedies for certain sad states of affairs; *e.g.,* after a total disappearance of one spouse from the other without any news for seven years a petition might be presented asking for a presumption of death and for dissolution of the marriage, and this once granted, the petitioner could remarry without fearing any legal proceedings for bigamy and could contract a further legal marriage after decree absolute. A marriage can now be annulled if a woman at the time of its celebration has concealed her pregnancy by a man other than her husband.

A novelty in English law was introduced in the 1937 act. whereby the subject was deprived of recourse to the courts for a period of three years after the celebration of the marriage unless the petitioner could obtain a preliminary decision from the court on the ground that the other spouse had been guilty of exceptionally depraved conduct or on the ground of exceptional hardship; upon this decision leave to proceed for dissolution could be granted. The difficulty as to domicile was left untouched by this act. Whatever criticisms may fairly be made upon its provisions, there has been a large increase in the number of decrees of absolute dissolution of marriage since its enactment. There have been some useful modifications of the presumption of domicile since the 1937 act, notably one of 1948. which enabled aggrieved wartime wives to obtain decrees more readily.

The whole matrimonial law was to some extent codified by the Matrimonial Causes act, 1950. There remains outstanding, however, a grave complex of all that has happened to the matrimonial jurisdiction of the summary courts. Discrepancies of various natures have arisen, making probable the necessity for codification to assimilate and embody these two sometimes conflicting systems of law.

Married Women's Rights in Connection With Children.—Under the old common law the father alone was the parent of his child, subject to an overriding presumption that the sovereign was *parens patriae.* A father could transfer even a tiny infant from its mother's arms to the care of a mistress if he chose. or to anyone else, and the mother had no right to any information as to the child's whereabouts and might not go to see it nithout the father's permission. Children were sometimes most callously used to force a wife to submit to a husband's will.

The first mother to protest publicly against this kind of thing was Caroline Norton whose unremitting work led to the first step to help the mother, namely an Access to Children bill in 1838 Under this a mother could petition the chancellor for an order giving her access to her own children upon filing an affidavit to prove that she was of unblemished moral conduct.

Further provisions as to access were made under the various Matrimonial Causes acts but the mother as such was mainly helped by the Guardianship of Infants act, 1925. Its governing principle is that the welfare of the infant is paramount—a principle which enables the court to review the whole set of circumstances affecting the child—money. maintenance, religious differences of parents, quarrels concerning education. training, residence, morals, cruelty and everything else. Proceedings usually begin in a magistrate's court and appeals are determinable in the chancery division of the high court. Apart from the paramountcy of the infant's welfare, the parents are placed in this act upon a footing of presumed equality. so that the reign of tyranny of the father has ceased.

In the case of the dissolution of a marriage where there is issue of the marriage under the age of 16. the court usually considers what order to make as to the custody of such children. The making of an order giving custody to one parent frequently connotes the desirability of granting access to the other parent. The great principles now applied are that primarily the party who is not morally guilty has the greater probability of obtaining custody, but that other considerations may outweigh that prima-facie preferability. For instance it would be most improbable that the court would take away even from a guilty mother the custody of a very young child still needing constant maternal care. The prospect of consigning a child to the care of a corespondent stepfather is not altogether enticing although it is a course that often has to be tacitly sanctioned for practical reasons. At 16. the boy or girl can make an individual decision where to reside; *i.e.,* with either or neither aarent.

The court makes suitable orders for maintaining children in accordance with the possibilities of the case. Such maintenance orders are a constant feature of the matrimonial jurisdiction of the magistrates' courts. Obedience to such can be ordered on pain of imprisonment.

Nomenclature of Married Women.—By the act of marriage a woman *ipso facto* acquires the right to assume and bear her husband's surname. but she is not thereby under any obligation to do so. That marriage itself does not operate to change her surname is proved by the fact that she signs the register after the ceremony still in her maiden name. In Scotland the assumption and use of a husband's surname does not operate to extinguish and determine the maiden surname and in criminal indictments a married woman will be cited by both surnames (X or Y) and even upon wives' tombstones the use of the maiden surname is frequent. In England there is apparently a cesser of the maiden surname if the husband's surname is assumed. There is nothing in law to prevent a wife who so desires, a widow or a divorcee from resuming a maiden surname. A divorced woman may continue to bear the matrimonial surname if she so desires.

English courts have no jurisdiction over surnames until and unless the question arises in a definite context; *e.g.,* as under a will or settlement. Husbands frequently assume or add wives' surnames. The children of a marriage can use the surname of father or mother or both as they choose, with the sole exception that it is not legal for anyone to assume a surname for the purpose of effecting fraud or crime. Special rules and customs govern usage as to surnames in titled classes.

One frequent present-day usage is, however, most undesirable from the legal point of view, namely the use by a wife of her own surname in certain circumstances; *e.g.,* in a trade or profession, alternating with the use of her husband's surname socially. The use of a surname is to ensure identification of a given personality and a wavering between the two surnames makes this a fluid and unsettled matter. For example it makes a dubious document of a passport. Clauses frequently occur in wills and settlements requiring a husband to assume the names and arms of the wife's family in order to govern a bequest or demise of property. Before settling the relevant documents it is highly desirable to ascertain the view of the husband concerned upon this matter as he cannot be compelled to assume these against his own will however desirable a testator or settler may feel to be the perpetuation of an old and honoured patronymic. This lam is gathered from a series of case law reports extending over many centuries.

The Law in Scotland and Northern Ireland.—The main legal difference between the women of Northern Ireland and those of England and Scotland has hitherto been that divorce in Northern Ireland was until the Matrimonial Causes act, 1939, obtainable only by the difficult and expensive process of parliamentary legislation; under this act the law on divorce has been assimilated to that of England.

The tendency of English and Scots law has been for them broadly speaking to approximate although it must be remembered always that Scotland has its own legal system *(see* SCOTS LAW) while English law has developed differently and mainly internally. Vast inroads have been made in recent years on English common law but it still covers an immense field in the national life.

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UNITED STATES

When the United States acquired its independence. the prevailing body of jurisprudence governing the political, economic and social status of women was the common law of England at the time of separation. Under that law women enjoyed very little in the way of legally enforceable rights. In the political sphere, they were not permitted to vote, to hold public office, to serve on juries or to act in other public capacities. In the economic realm, they were limited in the range of employment in which they were permitted to engage. Married women were under disabilities to enter into independent contracts and in their own right to hold and dispose of property. In the words of Blackstone, "The husband and wife are one and that one is the husband." Socially, married women were amenable to the discipline of the male head of the household.

With the common-law disabilities, as one might expect, were coupled certain common-law protections consistent with the view of women as "the weaker sex." For example, where a wife committed a crime in the presence of her husband, there was a conclusive presumption that she was under coercion.

The strong tendency throughout the history of the United States has been toward a gradual disappearance of both the disabilities endured and the protections enjoyed by the American woman of 1776. The process has been one of ceaseless effort on the part of determined and ambitious groups of women who have worked with great energy and enthusiasm toward the goal of equal treatment under law.

Since most of the states adopted the common law, either through direct inclusion in their new constitutions of articles to that effect or through judicial interpretation, the evolution in the legal position of women has necessarily taken place through a state-by-state fight for corrective legislation and constitutional amendment.

Right of Women to Vote.—In the United States, as in England, there was a long and at times bitter controversy concerning the right of suffrage for women. *(See* WOMEN'S SUFFRAGE.) The right of women to vote was firmly established, however, by the adoption in 1920 of the 19th amendment to the constitution of the United States. This amendment provided that "The right of the citizens of the United States to vote shall not be denied or abridged by the United States or by any State on account of sex."

Right to **Hold Office.**—Women hold the most exalted public offices. They have been governors of several states, members of the United States senate and house of representatives, members of the president's cabinet and judges in both the federal courts and the courts of many of the states. Indeed there is no legal obstacle to the election of a woman as president or vice-president of the United States. The last substantial limitation on the right of women to hold office was the provision in the constitution of Oklahoma barring women from such offices as governor, lieutenant governor and attorney general. This provision was repealed in 1942. By statute until 1943 women were barred from holding positions as employees of the state legislature in Wisconsin. Since the repeal of these provisions the right of women to hold public office in the United States has been unlimited.

Right of Married Women To **Own** Property and **Make** Contracts.—Through constitutional amendment and appropriate statutory enactments in the several states the common-law disabilities of married women with regard to the independent ownership of property largely disappeared, and in this area American married women came to enjoy substantially the same rights as their husbands.

With regard to the rights of women in property acquired during marriage, however, there is a split of authority. It should be remembered that while the 13 original states were created from British territory, many of the states which subsequently became members of the union were created from land which had never been under the rule of Great Britain. It is not surprising, then, that some of those states carved from the territories in which the civil rather than common-law tradition prevailed should have adopted some of the aspects of their parent systems of jurisprudence.

An example of this variation from the common-law norm is seen in the states of Arizona. California. Idaho, Louisiana, New Mexico, Nevada, Texas and Washington, which have adopted the institution of community property.

"The general principle underlying the system of community property is that all property acquired during mamage by the industry and labor of either the husband or the wife or both, together with the produce and increase thereof, belongs beneficially to both during the continuance of the marriage relation" (41 C.J.S., Husband and Wife, sec. 462). The obvious effect of this system is to create a partnership relation between husband and wife as to property acquired after marriage. There is a great volume of legislation by which this institution has been modified and adapted to modern conditions. In community property states the property of married persons is divided into: (1) The separate property of the wife; (2) the separate property of the husband; (3) the community property in which both spouses have certain defined rights.

Generally speaking, each spouse has ownership of and control over his or her separate estate. In the several community property states there are substantial differences in the relative rights of husband and wife as to this joint estate known as the community property. In general, both husband and wife have beneficial interests in such property. The husband's rights, however, are active while those of the wife are passive. The wife's interest remains in abeyance until the termination of this relationship. As a result of this general principle the husband has the general management and control of the community property. He may lease, mortgage or sell it subject to the obligation that he must not defraud the wife in her interests. Of course, the proceeds of such lease, mortgage or sale will continue to be community property. Either spouse may dispose by will of his or her interest in the community property.

It will be seen that there is a substantial difference between the rights of husband and wife in the community property states and those in which the institution does not exist. On the one hand, the system favours the wife because it recognizes marriage as a quasi partnership in which the wife has an equal beneficial interest although she has not the same power of disposition. On the other hand, the husband is recognized as the head and master of the community property with the attendant rights to manage and dispose of such property, having due regard to the interests of the wife. There has been much discussion as to the origin of this system. On this subject it has been said:

"The origin of the community property system has never been satisfactorily determined. . . . It apparently was not derived from Roman law. Intermediately it has been certainly traced to the laws of France and Spain. . . . It was unknown to the common law" (31 C.J.S., Husband and Wife, Community Property, sec. 1073).

It was said by Chief Justice Edward White on this subject in the case of *Garrozi* v. *Dastas,* 204 U.S. 64–78:

"We need not consider whether the community was derived from the Roman law, from an express provision of the early Saxon law, or from the ancient customary law of the Continent. For, however derived, the very foundation of the community and its efficacious existence depend on the power of the husband, during the marriage. over the community, and his right, in the absence of fraud or express legislative restriction, to deal with the community and its assets as the owner thereof. The purpose of the community, as expounded from the earliest times, whilst securing to the wife on the dissolution of the marriage an equal portion of the net results of the common industry, common economy and common sacrifice, was yet, as a matter of necessity, during the existence of the community, not to render the community inept and valueless to both parties by weakening the marital power of the husband as to his expenditures and contracts, so as to cause him to be a mere limited and consequently inefficient agent."

He goes on to say:

"The rights of the wife are dormant during the marriage, because the husband is charged to watch over and conduct the affairs of the conjugal society. But this right, which is inert, as long as the husband is at the head of the affairs of the community, becomes active when the marital authority ceases to exist. The wife is like a silent partner, whose rights arise and reveal themselves when the partnership ceases." (Troplong. *Contrat de Mariage, id,* p. 79)

Jury Service.—After the suffrage battle had been won one of the most intensive women's rights campaigns centred around the right to serve on juries. This campaign was largely successful, and by the 1950s women had become eligible for jury service in all but a few states, located chiefly in the southeastern section of the country. In some of the states which amended their constitutions or statutes to provide for women jurors, however, their service is made optional.

Civil Professions. — In all the states there has been legislation permitting women to engage in civil professions and occupations.

Legal Position Under the Criminal Law. — There is no longer the conclusive presumption that a crime committed by a married woman in the presence of her husband or under his compulsion is coercion. There remained. however, a presumption of coercion by him in cases where a wife commits a crime in her husband's presence. The burden of proof is then on the prosecution to prove the absence of coercion. This presumption, however, does not apply in cases of the most serious crimes such as murder or treason. Moreover. the presumption can always be rebutted by evidence. If it can be proved that the crime was committed independently by the wife and that as a matter of fact there was no coercion, she can be convicted alone upon an offense committed in the presence of her husband.

Divorce and Custody of Children. — The changes in these areas by statute in the United States have been substantially the same as those occurring in the United Kingdom. Absolute divorce is recognized in all the states, and the right of the wife to divorce admitted, although there are in some states discriminations as to the grounds for divorce, the law being more favourable to the husband than to the wife.

Also the rigorous rule of the common law which gave absolute control and custody of the children to the father has been very largely abolished. In most of the states the law provides that in these matters of custody and control regard must be had only to the welfare of the child; the right of neither parent is paramount. The courts will consider all the circumstances and will make such decree as will best serve the interests of the child.

Legal Status as **Employees.**—Women in the United States are generally accorded the full benefits of labour legislation. They are permitted to join unions and along with male workers are protected by law in the exercise of the rights and privileges of such membership. They enjoy also the protections of fair labour standards legislation, minimum wage laws, unemployment insurance, workmen's compensation, old-age and survivors insurance, union and industrial pension plans and the full range of whatever legislation controls in general the relationship between employer and employee.

In addition to sharing with men the protection and benefits of laws and regulations adopted for the benefit of workers at large, women in the United States have traditionally been protected further by statutes which limit the hours during mhich they may work in certain industries and at certain occupations. by statutes establishing minimum wages without corresponding regulations as to men and laws regulating working conditions, rest periods and the like.

These statutes, usually supported as protections necessary to prevent the exploitation of women, have been attacked by women's rights groups as discriminatory and harmful to the progress of women in industry. These groups point out that by a legal requirement of preferential treatment for women workers legislators have made it less likely that women will be hired. Some have gone so far as to suggest that the motive behind such legislation is as often the consideration of eliminating competition as it is an honest concern over the welfare of women.

This point of view was adopted by the supreme court of the United States in *Adkins* v. *Children's Hospital*, 261 U.S. 52j (1922), a case arising in the District of Columbia and involving a statute establishing a minimum legal wage for women. Justice George Sutherland, speaking for the court, said:

"But the ancient inequality of the sexes otherwise than physical, as suggested in the Muller case (p. 421) has continued with diminishing intensity. In view of the great — not to say revolutionary — changes which have taken place since that utterance, in the contractual. political and civil status of women, culminating in the 19th Amendment, it is not unreasonable to say that these differences have now come almost if not quite to the vanishing point. In this aspect of the matter, while the physical differences must be recognized in appropriate cases, and as legislation fixing hours or conditions of work may properly take them into account, we cannot accept the doctrine that women of mature age, *sui juris*, require or may be subjected to restrictions upon their liberty of contract mhich could not lawfully be imposed in the case of men under similar circumstances. To do so would be to ignore all the implications to be drawn from the present-day trend of legislation, as well as that of common thought and usage, by which woman is accorded emancipation from the old doctrine that she must be given special protection or be subjected to special restraint in her contractual and civil relationships" (id. p. 554).

The Xdkins case (above), though bitterly criticized at the time as a restrictive view of the power of society to protect its weaker members from exploitation and though reversed in terms in 1937 by *West Coast Hotel Company* v. *Parish*, 300 U.S.279, was later hailed by leaders in the women's rights movement as a major step in the direction of true equality of the sexes.

Equal Rights Amendment. — Although women's rights groups were still active in the 1950s in support of state legislation designed to further their goal of complete equality under the law, the major energies of such groups were now concentrated on the adoption of a proposed amendment to the constitution of the United States. This proposed amendment, popularly referred to as the "Equal Rights amendment," reads:

(Article

Section 1. Equality of rights under the law shall not be denied or abridged by the United States or by any State on account of sex. Congress and the several states shall have power, within their respective jurisdictions, to enforce this article by appropriate legislation.

Sections 2 and 3 provide for mode of ratification and time of taking effect.

A similar proposal, before every congress from 1923, had reached a vote only once, in the senate in July 1946. At that time the vote was 38 in favour and 35 against, a majority of those voting but short of the two-thirds vote required on a proposed amendment to the constitution. (G. G. B.; J. D. Ls.)

WOMEN'S CLUBS, GENERAL FEDERATION OF. The General Federation of Women's Clubs is a national (U.S.) and international organization to promote interest in education, philanthropy. public welfare. moral values and the arts. It is open to any women's club or organization which requires no sectarian or political test for membership and which, in its concepts. conforms to state and national laws. The membership of the General Federation of Women's Clubs in the 1950s was approximately 11,000,000, but exact figures are difficult to give because of overlapping. Approximately half these members were in the United States, with 815,000 women paying per capita dues and providing the main financial support of the organization. Other members belonged to affiliated organizations in the United States or to organizations in 39 other countries.

The G.F.W.C. was organized and a constitution adopted on April 24, 1890, after a preliminary meeting of women's clubs held in New York city in 1889. It was incorporated under the laws of New Jersey in 1895, and a charter was granted by congress in 1901. Officers are elected by delegates from member clubs at a biennial convention. At intervening conventions and annual meetings of the board of directors, organizational policy is established. Before action is taken on controversial issues, the General federation makes every effort to disseminate information on both sides.

The work of the General federation is carried on through departments arid subdivisions of these departments. Department and division chairmen are appointed by the G.F.W.C. president. Club membership is contacted through the official organ, *The Celteral Federation Clubwoman* magazine, printed programs, bulletins issued by department and division chairmen and periodic communications from the president to club leaders.

WOMEN'S RELIGIOUS ORDERS. The history of the part played by dedicated women in the life of prayer and charitable works in the Western Church is one of continuous development and expansion from the simplest beginnings to a multiplicity of world-wide organizations. The life of vowed virginity or widowhood, often accompanied by charitable work, is as old as Christianity and is assumed as familiar, in some churches at least, by St. Paul who gives explicit approval. These women, pledged to a life of chastity and prayer, were early recognized as a "state" by the church; they were numerous in the centuries before Constantine I, as can be seen from allusions and inscriptions, and from the writings of Tertullian and St. Cyprian; they were bound by a private vow of chastity, but a subsequent change of mind in favour of marriage was for long not regarded as deserving of ecclesiastical censure, and there is no clear evidence of community life. A change took place when Christianity became the official religion of the Roman empire, and the subsequent history of religious women may, for convenience's sake, be divided into four periods: from the rise of monasticism to the 11th century; from the 11th century to the Reformation; from the Reformation to the French Revolution; and since the Revolution.

ROMAN CATHOLIC ORDERS

4th to 11th Centuries.— When, early in the 4th century, monasticism became common in Egypt and Syria, communities of women and women anchorites were also found, though in smaller numbers than the monks. The message of the desert gradually made its way among women of the west, and small groups were formed privately; perhaps the first instance in higher society is that of the noble Roman ladies Marcella, Paula and Eustochium in their retreat on the Aventine directed by St. Jerome and in their following him to the east, where they were established at Bethlehem c. 386. A few decades later, St. Augustine of Hippo was directing a community of women, for whom he wrote the letter of instruction that became known as his rule.

Thenceforth. wherever monks were found there were almost always houses of religious women or nuns with similar customs and practices; the bestowal of the veil and the consecration of a virgin by the bishop became normal features in the ceremony of reception in many regions. and the beautiful rite of consecration, still practised in certain older orders, takes shape first in the Gelasian sacramentary (6th century). Scholastica, sister of St. Benedict of Nursia, lived as a nun near Monte Cassino, and the rule of St. Benedict has been followed by women from the earliest times (for the rule, see BENEDICT, SAINT).

All the communities of women in the early middle ages lived a life of liturgical prayer, reading and work, such as spinning and weaving, retired from the world and under vow, though not necessarily strictly enclosed. Meanwhile, in cities and towns the practice of private dedication to a life of virginity continued, and persons so dedicated often assisted the clergy in various works of charity and mercy. When Christianity spread to Brittany and the British Isles, communities of women soon appeared, and an original departure was made with the so-called "double" monasteries of Gaul, Ireland and England. These seem to have arisen first in Gaul In Ireland they were family or clan establishments. Their distinguishing feature was the supremacy of the abbess, who governed two communities of men and of women, even when the latter were strictly enclosed. Many of the most celebrated early English monasteries were of this kind, such as Ely. Minster in Thanet and, above all. Whitby. The abbesses were often royal or noble ladies, such as St. Etheldreda at Ely, St. Mildred at Thanet and St. Hilda at Whitby, who exercised an influence on the life of their time which has no later parallel.

Generally speaking, however, by the 10th and 11th centuries the only type of nunnery was Benedictine, either Cluniac or independent, recruited principally from the landed class. Domestic work was done by servants; there was as yet no class of "lay sisters." and the nuns, often highly cultured, followed exactly the life of the monks.

11th Century to the Reformation.— From the middle of the 11th century the multiplication of new orders of men was followed in almost every case, often after a time lag of 20 years or so, by a corresponding sisterhood. Thus there were, and still are, houses of Camaldolese and Carthusian nuns. The Cistercians, though reluctant, were at last compelled to admit houses of nuns to affiliation. and St. Norbert founded a Premonstratensian nunnery as early as 1121. With the multiplication of nunneries the need for spiritual direction became pressing, and several orders were founded with a small quota of priests to act as chaplains, confessors and administrators to the nuns. Among these were the strict French order of Fontevrault (1100) and the English order of St. Gilbert of Sempringham (c. 1089–1189). with its four tiers of nuns, lay sisters, canons and lay brethren. The Gilbertines flourished in northeast England, but never spread outside Britain. It was in this period that women began to stand out as examples and expounders of the mystical life, among the earliest and most celebrated being the German Benedictines Hildegarde, Mechtild and the two Gertrudes.

When the friars came, both St. Dominic and St. Francis founded "second orders" of nuns, and later women of the "third order" living in the world grouped themselves in communities under vow. The Franciscan nuns, with St. Clare of Assisi as their first abbess, became the Poor Clares, an austere, strictly enclosed body with an illustrious history; in 1417 St. Colette established a reformed branch, the Colettines, which still exists (see FRANCISCANS: Second Order). The Dominican nuns, founded by St. Dominic at Prouille in the south of France, spread rapidly to Italy and south Germany. where their convents were distinguished by an intense mystical life inspired by the teaching of Meister Eckhart and J. Tauler (see DOMINICANS: Second Order). In Italy St. Catherine of Siena was a Dominican tertiary. Later, St. Bridget of Sweden composed a rule for an order of nuns, directed by a group of priests. who came to be known as Brigittines (*q.v.*) and flourished in Scandinavia and Germany, with a celebrated abbey (Syon), founded in 1415 by Henry V of England. Throughout this period the Augustinian canonesses, another 12th-century creation. continued to make fresh foundations. Nuns, however. were never as numerous as men religious in the middle ages, and the law of enclosure, though often disregarded in practice, prevented the establishment of what were later called the "active" orders. Finally. mention must be made of the numerous individuals who, with a bishop's permission, were enclosed as anchoresses in small houses alongside a church or chapel; a celebrated English instance is provided by the mystic Juliana of Norwich.

From the Reformation to the French Revolution.— The nuns shared the fate of the monks in the countries of northern Europe in the mid-16th century. In the world of the Counter-Reformation the most important name is that of St. Teresa, who in 1562 initiated a "discalced" (barefooted) branch of the Carmelite order at Avila in Castile (see CARMELITES). St. Teresa at the same time provided a body of ascetical and mystical doctrine which, completed by that of her ally St. John of the Cross. has been accepted as the classical exposition of the contemplative life. The Teresan reform was carried to Belgium by Anne of Jesus and to France (1604) by Mme.Acarie.

Meanwhile, the success of the Jesuits inspired admirers to imitate their methods with an active, unenclosed order of women. Among these was the Englishwoman Mary Ward, a pioneer whose work, misunderstood and thwarted by authority, nevertheless lived on and throve, particularly in central Europe, as a great and populous educational institute. that of the Englische *Fräulein* (founded 1609). In time, a small group returned to England (York, 1686) and thence, in the 19th century, as the Institute of the Blessed Virgin Mary, spread throughout Canada and the United States.

A similar aim inspired St. Francis of Sales and his disciple St. Jane Frances de Chantal in their foundation of Annecy (1618) of the Order of the Visitation to care for the sick and poor. but here once again the sisterhood reverted to type and became an enclosed, quasi-contemplative order, of which St. Margaret Mary Alacoque was a member.

It was reserved to St. Vincent de Paul and his associate St. Louise de Marillac to provide the institute, unenclosed and devoted to active work, toward which others had been groping. The Sisters of Charity, dedicated to nursing the poor in hospitals, and later to the teaching of children, came to being in 1614 (see CHARITY OF ST. VINCENT DE PAUL, SISTERS OF). Meanwhile, an older order, that of the Ursulines, founded at Brescia in 1535 by St. Angela Merici for the religious education of girls, but subsequently standardized as an enclosed order by St. Charles Borromeo. entered upon a great vogue in France and Germany; led to Quebec by Marie de l'Incarnation. Ursulines formed the first community of women in North America (see URSULINES).

The 18th century, though it showed few new enterprises, was one of prosperity for the religious orders of women, both contemplative and active, in France and throughout the German-speaking lands.

Since **the** French **Revolution.- he** women religious, though notably more faithful to their vocation than the men, shared in the general debacle of the French Revolution and Napoleonic conquests. They shared also. indeed they led. the remarkable revival that followed, especially in France. and it is noteworthy that several of the most influential of the new orders were founded by those who had heard their call during the decades of stress and apparent desolation in the church.

Of the multitudinous organizations that came into being almost yearly, only a few can be mentioned. Pre-eminent among them was the Society of the Sacred Heart, founded in 1800 by St Madeleine Sophie Barat (*q* v.) and formally recognized in 1840. Akin in spirit to the Jesuits, though without formal connection these nuns, in this also like the Jesuits, have been associated with Catholic higher education all over the world, and entered the United States (Louisiana) under Blessed Philippine Duchesne (*q v*).

The Sisters of Mercy were founded in Dublin in 1827 by Catharine McAuley (*q v.*) for the practice of works of mercy toward poor women and children

The contemporary Sisters of Our Lady of Charity of the Good Shepherd. founded at Angers in 1833 by St Marie Euphrasia Pelletier (as an offshoot of the Sisters of Our Lady of Charity of the Refuge. founded by St. John Eudes in 1641) for the rescue and protection of fallen and penitent women has been distinguished by a union of selfless devotion with many of the features of a Carmelite vocation.

The Little Sisters of the Poor (*q.v.*), originating in Brittany in 1840, are pledged to the succour of the destitute and aged, for whom they beg alms. The religious of Perpetual Adoration of the Blessed Sacrament (Rome, 1867) and those of Marie Reparatrice (Paris 1854) are enclosed nuns maintaining ceaseless prayer in the presence of Christ in the exposed Host for the conversion of sinners and in reparation for the world's ingratitude toward the Redeemer Two world-wide orders are English in origin: the Society of the Holy Child Jesus, founded at Derby by the American Cornelia Connelly (*q.v*) for the higher education of girls, with a head house at Mayfield (Sussex); and the Poor Servants of the Mother of God founded in 1868 by Mother Magdalen Taylor with the help of Lady Georgiana Fullerton, who also introduced the Sisters of Charity to England

Alongside these new orders, the older bodies enjoyed an equally impressive growth, and many of them spread overseas into the British and French possesrions and into North and South America. The Carmelite nuns in particular, always an elite of hidden fervour, after 50 years of expansion in France in the 20th century made foundations far and wide, from Iceland to Australia. from Africa and China to India and Peru, and gave to the church, among other mistresses of the spiritual life St Teresa of the Child Jesus and Elizaheth of the Trinity The Dominican nuns are equally numerous In Europe and America the Passionist nuns in their two branches, contemplative and teaching the Redemptorist nuns (contemplative) and the Servites (teaching) are widely spread. Finally. almost all the active orders of men, and in particular the missionary congregations and societies. have associated with themselves sisterhoods following a similar or auxiliary vocation.

Nevertheless. many of the orders are undoubtedly passing through something of a crisis in the rapidly changing conditions of the 20th century. The nuns, in common with the male religious and indeed with many who are neither members of religious orders nor priests. have been exiled from the countries of eastern Europe and from China and other parts of the east, and have felt the consequences of the colonial recession of England, France and the Netherlands in several continents of the world. At the same time, the world-wide emancipation of women and their entry into every kind of employment and society, while removing many unnecessary conventions and disabilities from the lives of the active orders, equally have brought problems of formal and spiritual discipline into prominence. The Holy See has encouraged many institutes of women to adapt their clothing and some of their customs to the practical needs of the modern world. and to take part in some interests previously deemed unsuitable. but it cannot be said that a final equilibrium has been reached between the demands of modern times and the inviolable principles of the life of Christian perfection. On the other hand, the attractions and economic independence offered to women by the modern world have undoubtedly led, since World War II, to a slackening of recruitment; this is particularly noticeable in the class of lay sisters, upon whom the majority of the orders depend for the maintenance and service of their houses and active works.

Yet the nuns have shown remarkable flexibility in adapting themselves to modern skills and techniques as teachers, medical women, nurses and social workers. The world population of religious women far exceeds that of medieval Christendom, and in the spheres of nursing. education and social welfare they have filled a distinguished and often a pioneering role both among the western nations and among backward and primitive peoples in the mission field. Every social class has taken its part in all the varieties of vocation. Several of the modern orders have had as foundress one who began life in domestic service or unskilled lahour, while on the other hand no reader of religious history can fail to be impressed by the long list of names of women. sprung from the noblest and most ancient families of Europe, who have dedicated their lives to contemplative austerity or to the service of the sick and distressed in the cities of Europe and America or in the mission fields of Asia and Africa. (M. D. K.)

PROTESTANT ORDERS

Anglican. — The revival of religious communities for women throughout the Anglican Communion. and in the first place in the Church of England itself was one of the most remarkable consequences of the 19th-century Oxford Movement. From the time of the Reformation, when all the communities of women mere dissolved at the same time as those of men, until 1845, there were no communities either of contemplative nuns or of active sisters within the Church of England. At various times during the 17th and 18th centuries tentative proposals were made for the foundation of "a Protestant nunnery." but it was only after the teaching of E. B Pusey. J. Keble and J. H. Newman that such communities actually came into being

The first community, the Sisterhood of the Holy Cross, was founded in London at Park Village. near Regents park, in 1845. In the following ten years the Society of the Most Holy Trinity at Devonport (1848). the Community of St. Mary the Virgin at Wantage Berkshire (1848), the Community of St. John the Baptist at Clewer near Windsor (1851; both near Oxford), the Community of All Saints, London Colney. Hertfordshire (1851) and the Society of St Margaret at East Grinstead, Sussex (1855) were founded. Notable among later 19th-century foundations are the Community of the Holy Name, Malvern Link. Worcestershire (1865), the Sisters of Bethany, London (1866), the Sisters of the Church. London (1570) and the Community of the Epiphany, Truro (1883). This movement grew up spontaneously in response to pressing practical needs and to the desire to lead a dedicated life. Almost all of the sisterhoods combined an active life (teaching. nursing. helping in parishes, etc.) with a life of prayer and worship. They based their manner of life fairly closely on Roman Catholic patterns and made use of the breviary offices in English. along with, or in place of the services of the Book of Common Prayer.

Communities of women during the 19th century were much more numerous than communities of men, a fact which may be related to the beginning of the emancipation of women. Anglican sisters were among those who accompanied Florence Nightingale to the Crimea, and took part in the work of raising the standards and status of the nursing profession. Similarly, in various forms of social and educational work the Anglican sisterhoods offered opportunities of service, which were not easily to be found in mid-19th century England. But the religious motive predominated in the revival.

Many English sisterhoods opened branch houses abroad, and in many provinces of the Anglican Communion independent communities were founded. For example, in the United States the oldest surviving sisterhood is the Community of St. Mary at Peekskill. N.Y. (1865); in Canada there is the Sisterhood of St. John the Divine (1884) at Willowdale, Ont., and in Australia the Community of the Holy Name (1886) at Melbourne.

During the 20th century, the foundation of new communities has continued, though at a slower rate. A number of enclosed communities of contemplative nuns have been established, both in England and in the United States; *e.g.*, the Sisters of the Love of God (1907) at Oxford, the Benedictine nuns at West Malling in Kent (1916) and the Poor Clares of Reparation and Adoration, Mount Sinai, Long Island. N.Y. (1922). A flourishing active community is the Order of the Holy Paraclete at Whitby, Yorkshire (1917).

The sisterhoods at first had to fight against a greal deal of misunderstanding and suspicion, which occasionally flared up in acts of open hostility Neither public opinion nor the authorities of the church was prepared for this sudden revival within the Church of England. and for some time the sisterhoods' relations nith the bishops were difficult. By the end of the 19th century however, this situation was altering; in 1890 the English convocations gave recognition to the sisterhoods and the bishops began to acknowledge the sisters' right to bind themselves to their calling by life vows. In 1935 an advisory council was established in the provinces of Canterbury and York. which advises both bishops and communities on matters of importance and supervises the formation of new communities.

Most of the Anglican sisterhoods are small; the most numerous contains about 300 members. But by the pioneering character of their works and by the quality of their liturgical and spiritual lives, they have exercised a considerable influence on the development of Anglicanism.

Other Protestant Churches. — During the 19th century a parallel movement took place on the continent of Europe, in the development of deaconess orders. Beginning at Kaiserswerth in 1836 under the inspiration of Theodor Fliedner, they spread rapidly, especially in Lutheran and Pietist circles However, the deaconess orders do not fully correspond with religious communities in the traditional sense. They lay more stress on the works to be done than on the life of the community, and their members do not take life vows (See also DEACONESS.)

It was not until the mid-20th century, and particularly after World War II. that a tendency appeared in the Protestant churches of Europe toward the recovery of the full life of prayer and worship in religious communities. Considerable communities of women have been established in both the Lutheran and the Reformed traditions. Prominent among them are the Oekumenische Marienschwesternschaft at Darmstadt, the Christus Bruderschaft at Selbitz (which includes both men and women) and the community at Grandchamp in Switzerland, which is closely linked with the parallel community at Taizé near Cluny in France. Other smaller communities of women exist in France, Germany and Scandinavia.

As in the Church of England in the 19th century, so on the continent of Europe in the 20th century the revival of forms of life unknown since the Reformation is carried on not without difficulty and hesitation. The development undoubtedly forms one strand in the much larger movement of liturgical and theological renewal and of ever-growing concern for Christian unity.

See also MONASTICISM; ORDERS AND CONGREGATIONS. RELIGIOUS. (A MACD A)

WOMEN'S SERVICES, MILITARY. Since World War I women have played an increasingly important role in the military services of all major powers. They have been enrolled as regular members of the various land, sea and air forces, have been issued distinctive uniforms and have been made eligible for all the rights and privileges of their male colleagues. In most countries women have not been trained for combat but have been employed in non-combat assignments suited to their abilities and have thus freed men for combat duty. For women as nurses with the armed forces, see NURSING; for women's uniforms, see UNIFORMS.

UNITED STATES

Many reports tell of women serving in the United States armed forces in the tradition of Molly Pitcher (*q.v.*) during the American Revolution. but none appears to be well confirmed. The truth seems to be that throughout the 18th and 19th centuries women served with the armed forces only in a civilian status as nurses, laundresses, cooks. clerks, etc. In 1901, following the Spanish-American War, congress opened a new chapter by establishing the Army Nurse corps to solve some of the problems encountered earlier in maintaining an organization of civilian female nurses within a military organization. The U.S. Navy Nurse corps was created in 1908. During World War I the U.S. navy and marine corps. in spite of grave doubts as to the legality of the move, recruited nearly 13.000 women as yeomen, the first women to be admitted to full military rank and status in the U.S. services.

Women in the Army. — The Women's Army corps (WAC), originally created as the Women's Army Auxiliary corps on May 14, 1942, became a part of the army of the United States on July 1, 1943. Mrs. Oveta Culp Hobby was named first director with rank equivalent to that of colonel — the first U.S. woman to hold such rank.

The basic WAC military training program was similar to that given for the first six weeks to men, except that it was not of a combat nature. After training, members were assigned to non-combat military duties in which women were found to be as adept as men. Many of these duties, such as typing. had civilian counterparts, whereas others required special military training. In some instances women were trained in the use of weapons so they could qualify for specific duties such as that of disbursing officer. At peak strength of about 100.000 (6.600 officers and 93.000 enlisted women), members of the WAC mere serving at more than 400 installations in the United States and in all theatres of military operntion. Women were subject to all army regulations and shared all privileges; they were also entitled to benefits under the Soldier's and Sailor's Relief act and the G.I Rill of Rights and were eligible for National Service life insurance. After World War II the WAC was greatly reduced in strength but was made a permanent part of the U S army when the Women's Armed Services Integration act was passed in June 1948. During the Korean war (1950–53) the strength of the WAC rose to more than 14 000, then declined to about 8,000.

Women in the Navy. — The women's reserve of the U S. naval reserve known as the WAVES (Women Accepted for Volunteer Emergency Service), was established on July 30, 1942 Its members had the same military status as male officers or enlisted men but until 1944 they were restricted by law to service in continental United States, Alaska and Hawaii. Mildred H. McAfee (later Mrs. Douglas Horton) was sworn in as first director on Aug. 3, 1942. serving as lieutenant commander and later captain until Feb. 1946 Peak strength of personnel was reached shortly after V-J day in Sept. 1945. with 8,000 officers and 78.000 enlisted women on active duty in the United States and Hawaii. At that time the WAVES comprised 18% of the total naval personnel assigned to shore establishments in the U.S. They released 50,500 men for duty afloat or overseas and took over 27,000 other jobs in the expanded naval shore establishment.

The largest group of enlisted women were seamen; they filled a variety of billets ranging from general office workers to film projectionists and chauffeurs. Thirty-eight ratings were open to enlisted women, with about 14,500 WAVES serving as yeomen. Others included storekeepers, telegraphers, electrician's mates, cooks, bakers and printers. After World War II the WAVES became an integral part of the U.S. navy when the Women's Armed Services Integration act was passed in 1948.

Women Marines. — The women's reserve of the U.S. marine corps mas set up on Feb. 13. 1943, with an announced quota of 1,000 officers and 18,000 enlisted women—a quota which was reached in June 1944. At the surrender of Japan, personnel numbered 831 officers and 17,714 enlisted women. The reserve helped in the training. processing and supply of combat units and in camp administration. Col. Ruth Cheney Streeter, the first director, continued in active service until Dec. 7. 1945. After passage of the 1948 act mentioned above, women continued to serve in the marine corps both as regulars and reservists.

Women in the Coast Guard.—On Nov. 23, 1942, congress approved formation of the women's reserve of the U.S. coast guard. This reserve came to be known as the SPARS, derived from the coast guard motto. *Semper Paratus*.

Women in the Air Force.—During World War II, when the air force was part of the army, women in the air force were members of the WAC. A few women pilots were enlisted in the Women's Auxiliary Ferrying squadron (WAFS) under Nancy Harkness Love. or in the group headed by Jacqueline Cochran known as Women Auxiliary Service pilots (WASP). In June 1948; less than a year after establishment of the U.S. air force as an independent service, the WAF (Women in the Air Force) was created as an integral part of the air force. Single women between the ages of 18 and 34 were accepted for enlistment in the WAF and performed a wide range of noncombat duties during World War II and the Korean war.

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GREAT BRITAIN AND COMMONWEALTH COUNTRIES

Aside from nursing, the first British service to be formed for women was the Women's Army Auxiliary corps in 1917. followed by the Women's Royal Naval service and the Women's Royal Air Force. all of which were disbanded by 1921.

World War 11.—Before war broke out in Europe in Sept. 1939, Great Britain had revived the women's services on the same basis as those of World War I. but the women's army and air force organizations were renamed the Auxiliary Territorial service and the Women's Auxiliary air force, respectively. Members were uniformed and had their own code of discipline which was administered on the same lines as the navy. army and air force but was founded on a voluntary code incorporated in terms of enrollment rather than on any legal sanction. In peacetime the members' services were voluntary and unpaid. although they were clothed at the public expense and received grants to defray expenses. At the outbreak of war. however, they were enrolled for full-time service: they were paid, but were not trained to carry arms.

In the majority of commonwealth countries women joined voluntary organizations to serve the armed forces after the outbreak of war. but it was not until after the fall of France in 1940 that they were organized on the same lines as the women's services of Great Britain which. at the same time. were greatly expanded. The naval services retained their voluntary status. hut those of the army and the air force were made liable to a modified form of military law and their officers were granted a special form of emergency commission. The next significant change that took place was in Canada in 1942, when members of the Canadian women's army corps were made subject to the Army act in the same way as men (but with certain special provisions). The women's auxiliary air force was reorganized on the same lines and renamed the Royal Canadian air force (women's division).

The original purpose of women's military services was to replace men in certain nonoperational units in their native country. As the war progressed. women were introduced as plotters into the operation rooms of all three services, into many signal units and into intelligence work. The number of trades in which they were employed rose to three figures. One-third of the women in the British army served with antiaircraft command where they operated the instruments controlling the guns. With the exception of Australia, women were liable for service overseas and most of them were sent to the middle east; eventually Australia found it necessary to appeal for volunteers to serve in New Guinea. At their greatest strength the three British services alone reached a peak of nearly 500 000; those of the commonwealth brought the total up to nearly 600,000.

Great Britain After World War 11.—On Feh. 1. 1949, the British women's services were included in the permanent establishments of the navy. army and air force and were also included in the reserve and auxiliary services. Once again the titles of the army and air force services were changed, becoming the Women's Royal Army corps and the Women's Royal Air Force. They were not trained to carry arms.

Although not subject to the Naval Discipline act of 1922. the Women's Royal Naval service (W.R.N.S.) is an integral part of the naval organization and has its own similar disciplinary code. Its members serve in naval shore establishments in the United Kingdom, in Malta and with the North Atlantic Treaty organization in Oslo Norway, and in Germany. Their duties range from radio and air mechanics, range assessors. plotters, meteorologists and cinema operators to cooks and stewards.

The Women's Royal Army corps is a corps of the regular army, commanded and administered by its own officers who hold regular commissions. The other ranks are enlisted. Although generally organized in separate units, there are some mixed operational establishments with a male commanding officer and a female second-in-command who is responsible for the women's discipline. Most of the women serve in domestic categories but there are some highly skilled trades of which the experimental assistants gunnery (equivalent to the range assessors of the W.R N.S.) call for the highest standard of education. A high percentage of the total strength serves overseas in every command in which British troops are included.

Officers of the Women's Royal Air Force (W.R.A.F.) hold regular commissions in the air force; the other ranks are enlisted. They are in every sense integrated with the Royal Air Force (R.A.F.) and there is no separate force within a force, no independent W.R.A.F. chain of command. All officers and enlisted personnel belong to one or another of the R.A.F. branches or trades with which they work throughout their service. They work either on the ground or in the air; it has been proved that they can be employed in 18 out of the 22 trades. Although the normal administrative channels are the same for men and women. W.R.A.F. officers are often asked to undertake certain welfare and administrative duties in addition to their normal work. The bulk of the women serve at home, but some go overseas.

The British Commonwealth After World War 11.—After the women's services of Great Britain came into line with those of Canada, few differences existed between the two countries. In Australia and New Zealand. although they were established on a peacetime basis. they still sought recognition as permanent services at the beginning of the 1960s. Their officers! including those of the Women's Royal Australian Naval service. are given only short service commissions. Members of the W.R.A.A.C. and W.R.A.A.F. are governed by regulations made under the provisions of the Army and Air Force acts, which operate in the same way as did those of the Eritish services during World War 11.

The women's army corps (India) was disbanded when India and Pakistan gained independence in 1947. After that time, Pakistan formed a women's national guard and a women's naval reserve to train women for employment in an emergency. Other part-time services included a small but active unit in Singapore which formed part of a mixed antiaircraft regiment of the Singapore defense force. The Hong Kong women's army corps. also on a part-time basis, trained under active service conditions with the Royal Hong Kong defense force.

OTHER COUNTRIES

Before World War 11.—In the Scandinavian countries part-time military service for women was based originally on the Finnish *Lottekorps*, named after Lotte the heroine of an 18th-century saga. It provided financial support for the militia by raising money through entertainments. bazaars and other means. A different type of military service for women existed principally in

Communist countries. It was integrated with the armed forces and looked for its early traditions to the women of the Russian Revolution who fought side by side with their menfolk in the defense of Petrograd in 1917. At the outbreak of war in 1939, the Soviet Union had no women's services but in that year passed a conscription law that provided for the inclusion of women in the armed forces in peace and war. Certain specialists and technicians were made liable for registration and conscription in an emergency. Although plans were drawn up for a German corps of women in 1918, the war ended before they could be implemented.

During World War 11.—Women who remained in the occupied countries of Europe played their part in resistance movements, while those who had taken refuge in Great Britain were organized as part of the contingents of foreign nationals formed on the same lines as the British services. by whom they were clothed and trained. When the U.S.S.R. was invaded by Germany in 1941 the women who were liable for conscription were called up for duty behind the lines. As the Germans overran thousands of miles of their homeland, many volunteered and were accepted for fighting at the front. In this way women served with the Russian armies in two capacities: all were trained to carry arms but the conscripts mere not called upon to use them except for guard duty in rear areas; a woman in a fighting unit, on the other hand. lived and fought along with the men and was treated as one of them. No aomen's service was planned by Nazi Germany, which relegated women to a subordinate position.

After World War 11.—In Communist countries, the employment of women generally followed the Soviet pattern. Women were armed and included in fighting units, although in the U S S R. and China they generally carried out only administrative duties. There was no conscription for full-time service. but boys and girls in China received the same military training in schools. Afterward the girls served in the reserves where their training was kept up to date by attending camp and, they were liable to serve in an emergency. A few women were known to hold the rank of major general, unlike those of Great Britain where ordinarily the highest rank held was that of brigadier. As examples of forces employing women in roles after the Russian pattern, such irregular armies as the Freedom Fighters of Tibet and rebel forces in Latin America may perhaps be mentioned.

The only full-time women's service in Europe was that of France. It was under the discipline of and closely integrated with the army and the air force; there were no separate units or senior officers; all ranks usually lived out of barracks. except with the army of occupation in Germany, and were not accepted by the men with whom they worked in the same way as in the British commonwealth. Of the part-time women's services in Europe. the Finnish *Lottekorps* was disbanded under one of the clauses of the Finnish treaty with Russia in 1944, but after 1945 similar organizations were established in Norway. Denmark and the Netherlands There were no women's services in the Federal Republic of Germany.

The only Asian country outside the commonwealth in which a women's corps existed was that of Thailand where the army was modeled after that of the United States. In the middle east, Israel became the first country in the world to conscript women in peacetime. Women were included in the army where they were employed largely as instructors in the Hebrew language, but they also carried arms; one-third of the militia on which the defense of the country depends was made up of women.

Another country known to have introduced women into its regular forces is Turkey. In 1955 women were permitted for the first time to enter the sea, land and air mar schools as officer cadets. Some were commissioned in 1957 and they carried out the normal duties of their rank. It was intended to enlist other ranks as soon as there were sufficient women officers to command them.

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WOMEN'S SUFFRAGE. In England women's suffrage was first mooted by Mary Wollstonecraft in her work *A Vindication of the Rights of Woman* (1792) and was first revived—but also quelled—in the Chartist movement of the 1840s; but independently it was again raised by Richard Cobden, by Disraeli (perhaps not too seriously), by Joseph Hume, M.P., and with a permanent and magnificent devotion by Jacob Bright, M.P. R. M. Pankhurst followed them in Manchester, where the first women's suffrage committee was formed in 186j. Its honorary secretary was Elizabeth Wolstoneholme Elmy, a woman who had already rendered splendid service to the Married Women's Property committee. On Mrs. Elmy's removal from Manchester, Lydia Becker succeeded her as salaried secretary. She earnestly desired that agitation for further reform concerning married women's property should be abandoned in favour of concentration on suffrage alone. Pankhurst and Jacob Bright successfully opposed a plan which would have necessitated wives fighting the suffrage campaign without control of their own money.

Meanwhile, a later-formed London Suffrage committee had been stirred by the election of John Stuart Mill to parliament in 1865 to collect 1,449 signatures to a petition which Mill presented to parliament in 1867. In 1868 a general election took place, in which Mill lost his seat. In 1869 he published his famous work *On the Subjection of Women.* Societies were organized in many large towns, and parliament in the next decade received petitions containing in all 2,953,563 signatures.

The long succeeding years saw the gradual deterioration of the parliamentary position, evidenced by the loss of every suffrage bill brought forward; this resulted from the steady hostility of Gladstone, alternating with the insincere lip service of Disraeli; nor did either statesman care to affront the implacable enmity of Queen Victoria to the women's movement. It was a political deterioration which ran parallel with the increasing determination of Englishwomen to attain their enfranchisement.

In 1867 a Reform bill giving increased rights to male voters had reached the statute book, and the women's societies determined to ascertain whether it enfranchised them or not. Two test cases were brought before the court of common pleas, viz., *Chorlton* v. *Lings* (1866) and *Chorlton* v. *Kessler,* Sir William Bovill, the lord chief justice, presiding. He contemptuously ignored all former mediaeval precedents showing that women anciently exercised voting rights when county members were elected and decided against the principle of women's suffrage in the first (Lings) case and harshly refused to hear the second case (Kessler) at all, although Pankhurst, with Sir John D. Coleridge, Q.C. (afterward lord chief justice), had been briefed to argue the case. Pankhurst drafted a Women's Disabilities Removal bill and Jacob Bright introduced it; but Gladstone insisted on its defeat. In 1871 Bright again introduced it, but again Gladstone implacably opposed. Bright lost his seat and Lydia Becker passed the bill over to a member of parliament named Forsyth. She also concurred in his addition to it of a clause excluding wives from the suffrage, to which the disheartened Manchester committee gloomily assented, and the London one more readily. This bill was lost—happily.

The Married Women's Property bill drafted by Pankhurst became law in 1882. Pankhurst stood as candidate for Manchester in 1883, Lydia Becker and her suffrage organization refusing their support, but for various other reasons he was defeated. Dissension in the suffrage camp on wives' votes was practically endemic, and under Lydia Becker's secretaryship the newly formed Society for Women's Suffrage continued to back the principle of enfranchising widows and spinsters only. Consequently there was a secession. Mrs. W. Elmy, Josephine Butler, Pankhurst, Jacob Bright, Mrs. Pankhurst, Ursula Bright and others of the original suffrage pioneers formed the new Women's Franchise league. This organization soon received considerable support and adopted Pankhurst's original Disabilities bill. However the Local Government act of 1894 dealt a deathblow to the exclusion of wives, for under it they received the local franchise. The passage of this act resulted largely from the effortsof the Women's Franchise league. The act closed that gap within suffragist ranks.

In 1892 J. Keir Hardie was elected to parliament and the women's cause gained one of its doughtiest and noblest warriors, almost solitary for many years but later on joined by Philip Snowden and George Lansbury.

In 1884 the suffragists had high hopes of inclusion in the Reform bill of that year, but Gladstone again ensured their defeat. A period of frustration ensued.

In 1897 the various suffrage societies united into one National Union of Women's Suffrage Societies under the presidency of Millicent Garrett (Mrs. Henry) Fawcett, who introduced much more coherence, harmony and good organization. Women owe her a great debt.

In 1898 occurred the death of the veteran pioneer Pankhurst, but his widow, Emmeline Pankhurst, carried on his work and in 1903 started the Women's Social and Political union in Manchester. In 1904 her daughter Christabel graduated with honours in law. Her training made her see that the old N.U.W.S.S. policy of adding together the number of private members' declarations of support and then presenting private members' hills would never achieve success but that enfranchisement could only follow the coming into power of a cabinet resolved upon women's suffrage as a policy of the government. A general election was due for 1906 and it was therefore vital to ascertain what would be the policy of the Liberals if returned to power—as in fact they were. These different policies—counting heads or demanding cabinet policy—proved the true watershed between the W.S.P.U. and the N.U.W.S.S.

The match which ignited the flame of so-called "militancy" was touched off in 1905 at a Manchester Liberal meeting, addressed by Sir Edward Grey, whose purpose was to declare the official Liberal policy if that party returned to power. Christabel Pankhurst and Annie Renney rose to put a question upon the future government's policy. The two were seized by stewards, their arms were twisted, they were kicked down the gallery stairs and were thrown outside. There, in attempting to address the crowd, they were arrested for obstruction. Next day they were fined but chose the alternative—to serve a prison sentence. This aroused attention all over the country and indeed in the world.

After the return of the Liberals in 1906 the succeeding years saw the defeat of seven suffrage bills. Concurrently, acute militancy in the form of women's reprisals by damage to property constantly increased in gravity. The women militants mere sent to prison and continued their protests there by hunger-striking. Forcible feeding brought some of them near death. Under the "Cat and Mouse" act, as the Prisoners (Temporary Discharge for Ill-Health) act was called, they were (sometimes several times) released and then rearrested when just well enough to resume imprisonment. At the same time the militants consistently opposed every government candidate at every by-election. often aiding defeat. Public support grew in volume and sums aggregating hundreds of thousands of pounds were contributed. Public demonstrations, exhibitions and processions were carried out by both W.S.P.U. and N.U.W.S.S., and the Women's Freedom league organized many useful protests unaccompanied by violence. such as picketing of every exit of the house of commons for weeks. In 1913 one militant, Emily Davidson. gave her life by throwing herself before the horses in the Derby race.

In 1913 also came the nadir of parliamentary process. H. H. Asquith. the prime minister. had launched a reform bill to give more votes to men and announced that it would be open to women's suffrage amendments. When tabled, the speaker ruled that such amendment altered the character of the original bill too profoundly for it to proceed. It mas abandoned, and the suffragettes and even suffragists were aroused to fury. In Aug. 1914 World War I supervened and the S.U.R.S.S. and the W.S.P.U. alike devoted their efforts solely to aiding the national cause.

By the midst of 1918 when victory was in sight David Lloyd George. the premier who had superseded Asquith. announced the formation of a speaker's all-party conference to settle the principles of a new reform bill. Women's suffrage formed one recommendation, and in the resulting Representation of the People act, 1918, married women. women householders and women university graduates of 30 and over received the franchise. An act to enable women to sit in the house of commons was enacted shortly afterward. In 1928 the age of women electors was lowered to 21 to place the woman voter on an equality with male voters.

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THE UNITED STATES

During the colonial period, the vote was very closely restricted to the members of certain specified churches and to those vhose names nere on the tax list. nhile in some cases a slight educational requirement was made. Women, even though qualified, were almost universally excluded.

After the Revolutionary War when the convention met in Philadelphia to draft the constitution. no question aroused such vehement discussion as that of the suffrage. It was so long continued that finally the only solution possible was to omit the subject from the national constitution and leave each state free to make its own qualifications for voting.

Meanwhile women were receiving the rudiments of an education and slowly acquiring a voice in public affairs. By 1832 the anti-slavery question was becoming acute. Women were intensely interested and were developing so much power as public speakers that the question of allowing them on its platform had divided the Anti-Slavery association, the Garrison-Phillips branch standing by Lucretia Mott and her contemporaries. Among these were the Quakers who always had recognized the equal rights of women. In later years Elizabeth Cady Stanton. of Revolutionary ancestry. joined the antislavery forces and she and Lucretia Mott decided that the rights of women as well as those of the Negro slave needed redressing. In July 1848, at a Friends' Yearly Meeting in western New York. they issued a call for the first woman's rights convention in history. It met in Seneca Falls. Mrs. Stanton's home, on July 19, and after a two-day session adjourned to Rochester.

This may be regarded as the beginning of the movement for women's suffrage in the United States. It received wide publicity in the New *York Tribune* under Horace Greeley and was followed in 1850 by a convention in Worcester, Mass., under the auspices of Lucy Stone and a distinguished group of eastern suffragists. The movement, however, still lacked the dynamic force which was to put it into effective action. This was soon supplied by Susan B. Anthony. In 1851 she first met Mrs. Stanton and the friendship began which remained unbroken for more than 50 years. Miss Anthony attended her first women's rights convention in Syracuse, N.Y., in 1852, her last in Baltimore, Md., in 1906, one month before her death.

At first no way of extending suffrage was known except through amendments to state constitutions, which required the consent of a majority of the male voters. The first attempt was made in Kansas in 1867, immediately after the close of the Civil War. An amendment was submitted at the same time to enfranchise the newly liberated male slaves. who had flocked into that state. Both were defeated but the latter received a much larger vote in its favour. All the states had the word "white" in the suffrage clause of their constitutions, and legislatures in a number of them submitted amendments to take it out. They were defeated and it was evident that some other method must be found if the Negro men were to vote. which the Republican party was very desirous that they should do. A measure was decided on that had not been attempted since the early days of the republic, the submission of an amendment to the national constitution.

As soon as this intention was announced Miss Anthony and some of the women's suffrage leaders demanded that the proposed amendment should enfranchise not only Negroes but all women as well. Most of the men who had been the strongest advocates of women's suffrage opposed this demand and they were supported by some of the women who feared that it would imperil the success of the amendment. Women were not included in this 14th amendment and, later, when a 15th was found necessary to strengthen it, they were also excluded.

The women's suffrage leaders, however, perceived a new method, which did not seem so utterly hopeless as amending the constitution of every state by consent of a majority of the voters. In New York city in 1869, at the close of the May anniversary of the Equal Rights association, which had been formed soon after the war to protect the Negro men, a National Woman Suffrage association was organized. Representatives from 19 states uere present and its object was declared by resolution to be to secure the ballot for women by a 16th amendment to the federal constitution. Mrs Stanton was elected president and Miss Anthony chairman of the executive committee. This organization held a national convention every year thereafter for 50 years and went before committees of every congress asking for the amendment. Its leaders soon learned that pressure from the states on their representatives in the congress would be absolutely necessary and, therefore, began to organize women in the states to mork on the legislatures until every state was so organized In the autumn of 1869 another distinguished group. headed by Lucy Stone, organized a national association called the American, solely for this purpose. In 1890 the tuo organizations united under the name of National American, which worked for both objects for almost 30 years. After the deaths of Mrs. Stanton, Miss Anthony and their contemporaries. their work was continued by Anna Howard Shaw and Mrs Carrie Chapman Catt, who headed an organization eventually increased to many thousands. Individual states began to yield and enfranchise their women and each one increased the members of congress elected partly by women, nho were thus obliged to vote for an amendment to the national constitution. The revenues increased annually. $120,000 being subscribed in 1919 to the work of the National association, exclusive of the amounts raised by the various states for their own work.

It was found that legislatures could give women the vote for presidential electors and in some states the municipal and various forms of local franchise. Those of Arkansas and Texas gave the primary suffrage. equivalent to a full vote. Meanwhile campaigns were being vigorously conducted to persuade the legislatures to submit to the voters amendments to the state constitutions conferring the full suffrage in state affairs. This was accomplished in New York in 1917 and was the greatest victory yet achieved. By 1918 women had thus acquired equal suffrage with men in 15 states, offering the only instance in the world where the voters themselves gave the franchise to women.

Meanwhile other national associations had been formed The Federal association was organized in 1892. The Rev. Olympia Brown was president for 17 years and many prominent men and women were members. Its object was the passage of a law by the congress authorizing women to vote for members of the lower house, which would have been constitutional. The College Equal Suffrage league was organized in 1908 with M. Cary Thomas. president of Bryn Mawr college, at its head during the nine years of its existence, and it co-operated with the National American association. This was true also of the Friends' (Quakers') association. Mississippi Valley conferences were organized in 1912 and Southern Women's conferences the following year, which did effective work in their sections as auxiliaries of the National American. A Congressional union was formed in Washington in the spring of 1913 to support the work of the association's congressional committee, but in December it became an independent organization with headquarters in Washington and Alice Paul as its head. Its object was a federal amendment, which it attempted to secure by aggressive methods never before employed in the United States. At the time of the national Republican convention in 1916 it adopted the name National Woman's party. In 1911 a National Men's League for Woman Suffrage was organized.

World War I, and the part taken therein by U.S. women, broke down the barriers of the opposition. All the political parties were committed to their enfranchisement, but there was still enough opposition in congress to delay the final vote of both houses to submit the amendment to the legislatures until June 1919. The task then remained of securing the ratification of three-fourths of the legislatures in time for the women to vote at the presidential election of Nov. 1920. Most of them had adjourned and this would have to be done by special sessions. It was accomplished and the last certificate, that of Tennessee, was delivered to Secretary of State Bainbridge Colby at 4 o'clock in the morning on Aug. 26, 1920. At 9 o'clock he issued the official proclamation that the 19th amendment having been duly ratified by 36 state legislatures "has become valid to all intents and purposes as a part of the Constitution of the United States." It reads as follows: "The right of citizens of the United States to vote shall not be denied or abridged by the United States or by any State on account of sex."

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WŎNSAN (Japanese pronunciation, *Gensan)*, a city and seaport of Democratic People's Republic of Korea (North Korea), the capital of Kangwon province. is on the Sea of Japan about 80 mi. E. of the North Korean capital of P'yŏngyang. Protected by two promontories and by islands. Wŏnsan has the best natural harbour along the east coast of Korea. It was opened as a commercial port in 1891. The major railroad for northeastern Korea led inland from Wdnsan southwest to Seoul. Branch lines were later built north and south along the coast and, in the 1940s. a line to the west connected this region with P'yŏngyang. As it became a focal point for an important railroad network, railroad workshops and transshipment yards were developed. During Japanese control (1910–1945) oil refining and distribution plants based on imports were built. largely with foreign capital, and a considerable fishing fleet was based there. Oil refineries, port facilities and urban centres were heavily damaged through aerial attacks during the Korean War. Industry has been rehabilitated somewhat. The estimated population (1958) is 200.000. (S. McC.)

WOOD, ANTHONY À (1632–1695), English antiquarian and historian of Oxford, whose *Athenae Oxonienses* is a valuable source of biographical information, was born on Dec. 17, 1632, in Merton street. Oxford. He spent his life within a stone's throw of Merton college, where he matriculated and in the chapel of which he was buried, but he was never a fellow of the college. Inspired by Sir William Dugdale's *Warwickshire* (1656). Wood devoted his life to collecting and publishing the "antiquities" of the city, the university and the colleges of Oxford. His mork on the city did not appear in his lifetime; but, assisted by John Fell, dean of Christ Church, he published his account of the university, *Historia et antiquitates universitatis Oxoniensis*, at the university press in two large folios in 1674. Wood then turned (with financial assistance from his patron Ralph Sheldon and the help of materials supplied by John Aubrey [*q.v.*] and others) to the compilation of a vast biographical dictionary of Oxford writers and ecclesiastics. which appeared (also in two folio volumes) in 1691–92, under the title *Athenae Oxonienses*. Apart from antiquarian excursions, mainly in the neighbourhood of Oxford. Wood lived the life of a recluse, devoting all his time and his resources to research. He never married. He was deaf, bitter and suspicious, and quarreled with his family: his patrons and the fellows of his college. His biographical sketches contain many spiteful criticisms of his contemporaries, which reflect his own bitterness and that of his correspondents, and one such passage (supplied him by Aubrey), accusing the 1st Lord Clarendon of corruption, led to his prosecution for libel in the vice-chancellor's court at Oxford. Wood was convicted, mulcted in costs and expelled from the university. an experience which still further embittered his attitude toward his Oxford contemporaries. He died at Oxford on Nov. 29, 1695.

Wood left to the Ashmolean library a vast collection of papers, mainly in manuscript, including, besides correspondence, an autobiography and diaries. His manuscripts have proved a gold mine for subsequent historians of Oxford, and they afford a uniquely detailed and human picture of university life in the second half of the 17th century. Wood's place in Oxford historiography was not long left vacant: a few weeks after his death there took place the matriculation of Thomas Hearne (*q.v.*), whose voluminous *Collections* continue over the first quarter of the 18th century that day-to-day chronicle of university happenings which Wood provided for an earlier generation.

The English text of Wood's *History and Antiquities* was edited by John Gutch in two volumes (1786–90) and a scholarly edition of his *Athenae* was published by Philip Bliss, four volumes (1813–20). His autobiography and diaries were admirably edited for the Oxford Historical society in five volumes by Andrew Clark (1891–1900) under the title *The Life and Times of Anthony Wood*. (J. SP.)

WOOD, GRANT (1892–1942), U.S. painter, one of the major exponents of the midwestern regionalism that flourished in U.S. art during the 1930s, was born Feb. 13, 1892, on a farm near Anamosa, Ia., on which his Quaker grandfather had been a pioneer settler in the 1860s. When Wood was ten his father died. and the family moved to Cedar Rapids, Ia. Even before this he had begun sketching with charcoal. After graduating from high school he studied for a summer under Ernest Batchelder at the Minneapolis School of Design and Handicraft. In 1913 he went to Chicago where he worked with jewelry at the Kalo silversmith shop and attended night classes at the Art institute. During World War I he did camouflage work in the army; following the war he taught art at a Cedar Rapids junior high school. In 1920 he went abroad for the summer and in 1923 spent a year at the Académie Julian in Paris. On his return to Iowa. David Turner, a mortician, gave him a garage for a studio and living quarters, becoming his first major patron.

In 1928 when Wood was commissioned to do a stained-glass window for the Cedar Rapids Memorial building of the American Legion, he went to Munich to seek craftsmen to assist him. While there he became fascinated by the work of the Flemish primitives, especially that of Hans Memling, and by the portraiture of Hans Holbein and Albrecht Diirer. He also admired the meticulously realistic peasant types of Wilhelm Leibl and the work of his contemporary Otto Dix. Wood's manner changed from his earlier pseudo-Impressionist style to the clean-cut realism generally associated with his name. A portrait of his mother, "Woman With Plants" (1929), did not attract attention, but in 1930 his "American Gothic" caused a sensation when it was exhibited in Chicago. The hard. cold realism of the technique displayed in this painting and the honest, direct, earthy quality of the subject were unusual in U.S. art. Iowa farmers, however, thinking that they were being ridiculed, were incensed. Actually Wood had used as models his sister Nan and his dentist. B. H. McKeeby, portraying them as a farmer-preacher and his daughter in front of their 19th-century Gothic revival farmhouse. symbols of the sober. hard-working and dependable people who were the backbone of the U.S.

Thus the trend toward regionalism, the American scene of the 1930s associated with the paintings of Wood. John Steuart Curry and Thomas Hart Benton, was set in motion. Wood's success increased. and his paintings mere eagerly sought. "Daughters of Revolution" caused a furor because of its biting satire. It was interpreted as a plea for democracy, a stab at smugness. In 1934 Wood was made assistant professor of fine arts at the University of Iowa. Iowa City, and busied himself with painting. lithography and teaching. He died in Iowa City, Feb. 12, 1942.

See Darrell Garwood, *Artist in Iowa; a Life of Grant Wood* (1944). (F. A. Sw.)

WOOD, MRS. HENRY (née ELLEN PRICE) (1814–1887), English novelist. was born at Worcester on Jan. 17, 1814. She married Henry Wood in 1836. and after her marriage lived for the most part in France. In 1860 she wrote a temperance tale, *Danesbury House*. Her first great success was made with *East Lynne* (1861) which was translated into several languages and was dramatized. Other novels followed. She became proprietor and editor of the *Argosy* magazine in 1867. She died on Feb. 20, 1887.

WOOD, SIR HENRY EVELYN (1838–1919), British field marshal whose organizing capacity led to notable improvements in British army administration, was born at Cressing. Essex, on Feb. 9, 1838. Educated at Marlborough, he entered the Royal Navy in 1852. Serving with the naval brigade at Inkerman, he discovered he preferred land warfare and transferred to the army. With the 17th Lancers, Wood served in the Indian mutiny and there gained his Victoria cross. There followed a succession of staff appointments in which his reputation grew. An intimate of Garnet Joseph Wolseley (*q.v.*) and a member of his staff "ring," his planning contributed much to the success of Wolseley's Ashanti campaign in 1873–74. Again with Wolseley in 1879 in Zululand, Wood greatly distinguished himself and was appointed knight commander of the Bath. After Sir George Colley's defeat and death at Majuba Hill. he negotiated with Gen. P. J. Joubert for the withdrawal of British forces from the Transvaal (March 21, 1881); this work was rewarded by his appointment as knight grand cross of St Michael and St. George.

After becoming major general and commanding at Chatham, Wood from Aug. 1882 served again with Wolseley; this time in Egypt, where he commanded a brigade and stayed to become first British sirdar of the Egyptian army. Returning to England in 1886, he thereafter served at home and when appointed to the senior command at Aldershot in 1889 put into practice Wolseley's theories of training and efficiency. Wood became quartermaster general in 1893, adjutant general in 1897, and reorganized the entire transport system of the army, equipping it in 1899 for speedy mobilization. In 1903 he was promoted field marshal. In retirement he put all his energies into the organization of Lord Haldane's territorial forces, not beloved at the war office. He died on Dec. 2. 1919. He wrote several books, including his autobiography. *From Midshipman to Field Marshal*. (A. P. T.)

WOOD, SIR HENRY JOSEPH (1869–1944), British conductor, was born in London on March 3, 1869. He received his first music lessons from his mother, and when he was ten acted as deputy organist at St. Mary's, Aldermanbury. In 1886 he went to the Royal Academy of Music where he studied composition, and by 1888 had written songs, light opera and cantatas. His first experience as conductor came in 1889, when he toured with the Rousbey company, and in 1890 he was engaged to rehearse Sir Arthur Sullivan's *Ivanhoe*, later becoming assistant conductor at the Savoy theatre. After several important appointments, including a tour with the Carl Rosa company (1891), a season of Italian opera in London, and the English *première* of Tschaikovsky's *Eugen Onegin* (1892), he was engaged in 1895 by Robert Newman to conduct a series of Promenade concerts at the Queen's hall. These proved so successful that they became an annual event, being continued in 1927 under the management of the British Broadcasting corporation. After the destruction of the Queen's hall during World War II they were moved to the Royal Albert hall. Wood also conducted at many festivals, both in England and abroad, acquiring a high international reputation. He was knighted in 1911. In 1938 he published his autobiography, *My Life of Music*.

WOOD, JOHN (1704–1754), British architect. known as Wood of Bath because his work established the 18th-century character of the city, was the son of George Wood, also an architect of Bath. After working in London as one of the principal builders on the Cavendish-Harley estate, he returned to Bath in 1727 and set about transforming the city. applying to the design of streets and groups of houses principles first tried out by other architects in the West End of London. His designs in Bath include Queen's square; Prior park, built for Ralph Allen; the Circus; and the royal crescent, designed by himself, but built under the direction of his son. The Bristol (1740–43) and Liverpool (1748–55) exchanges were also designed by Wood, and he restored Llandaff cathedral in Wales. His best work is, however, to be seen in Bath. He died on May 23, 1754. Many of his designs were carried out after his death by his son John (d. 1782), who also, in addition to many groups of houses, built the hot bath and the royal private baths. (Ms. W.; X)

WOOD, LEONARD (1860–1927), U S. soldier, was born at Winchester. N H , Oct 9, 1860. He graduated from the Harvard medical school in 1884. was appointed acting assistant surgeon, U.S army. in 1885, becoming assistant surgeon with the rank of first lieutenant in 1886, when he was assigned to Captain

Lawton's expedition against the Apaches in the southwest, resulting in the capture of Geronimo. For distinguished services he was awarded the medal of honour. In 1891 he was promoted captain and full surgeon, and later, while stationed in Washington, D.C., became the close friend of Theodore Roosevelt, then assistant secretary of the navy. On the outbreak of the Spanish-American War in 1898 Wood was commissioned colonel U.S. 1st volunteer cavalry (the famous Rough Riders) with Roosevelt as lieutenant colonel. For conduct at Las Guasimas and San Juan hill. Wood was promoted brigadier general, July 1898, and in December major general of volunteers. He was military governor of Cuba from 1899 to 1902, when the Cuban republic was established. He was appointed brigadier general U.S.A., Feb. 1901. In 1903 he was sent to the Philippines and appointed governor of the Moro province, being promoted major general in that year. In 1908 he returned to the U.S. as commander of the eastern department. In 1910 he was appointed chief of staff. U.S.A., serving until 1914, when he was again given command of the eastern department. General Wood as early as 1908 had urged preparedness. He was largely responsible for the establishment of a summer camp at Plattsburg for training civilian officers, which was taken as a model for other camps of the kind after the entrance of the U.S. into World War I. Just before the entrance of the U.S. into the war in 1917 he was assigned to the southeastern division but was later transferred to Camp Funston, where he trained the 89th division, N.A., the 10th division of the regular army and other troops. In 1919 he was put in command of the central department, with headquarters at Chicago. In 1920 he was a candidate for the presidential nomination at the Republican national convention. Warren G. Harding, a "dark horse," was nominated on the 10th ballot, with 692½ votes to 156 for General Wood. In 1921 General Wood was sent at the head of the Wood-Forbes mission to the Philippine Islands. Prior to leaving he was appointed head of the University of Pennsylvania, but did not assume charge because of the president's desire that he remain in the Philippines as governor general, a position which he held from Oct. 1921 until his death in Boston on Aug. 7, 1927. Wood was the author of lectures, *The Military Obligation of Citizenship* (1915).

WOOD, NICHOLAS (1795–1865), English mining engineer and pioneer in mine accident prevention, was born at Sourmires. County Durham, on April 4, 1795. He was trained as a viewer at the Killingworth colliery, where he became iriendly with the engineer George Stephenson (*q.v.*) and shared in the experiments that led to the modern locomotive and the first saiety lamp. Wood soon achieved prominence as both a mining engineer and geologist, and eventually became a colliery owner. Greater output and an increasing number of accidents, particularly the explosion at St. Hilda's colliery in 1839 with 50 fatalities. emphasized the need for inspection. Wood strongly supported introducing legislation to this end. and the first Inspection act became law in 1852. A society ior the prevention of accidents was formed, as he had urged, in 1852 as the North of England Institute of Mining Engineers, under his presidency. To this Institute he contributed many papers on safety lamps, ventilation. conveyance underground, sinking and mine explosions. Wood strenuously advocated, but without success, the establishment of courses of instruction in mining technology. He died in London on Dec. 19, 1865. (C. W. D.)

WOOD, ROBERT WILLIAMS (1868–1955), U.S. physicist who specialized in physical optics, was born May 2, 1868, in Concord, Mass. He graduated from Harvard in 1891 and later studied at Johns Hopkins university, Baltimore, Md., and the universities of Chicago and Berlin. From 1901 until his death he was at Johns Hopkins as professor and later research professor of experimental physics. In physical optics he made numerous fundamental discoveries in the fields of resonance radiation, fluorescence, absorption spectra and Raman spectra. The various improvements he introduced in the rule of diffraction gratings, *e.g.*, ruling of echelet gratings, and in other spectrometric methods opened entirely new possibilities for astrophysicists. Wood also made important contributions to the fields of supersonics and biophysics. His publications include *Physical Optics* (1905; new editions, 1911. 1934) and *Researches in Physical Optics* (2 vol.; 1913–19). His *How to Tell the Birds From the Flowers*, a book of nonsense verses with illustrations by the author, was first published in 1917 and went through many editions. Wood died Aug. 11, 1955, in Amityville, N.Y.

See William Seabrook, *Doctor Wood* (1941), which includes a bibliography of his scientific publications.

WOOD, botanically, the complex vascular tissue of plants called xylem, but more popularly, the hard fibrous xylem of shrubs and trees. In all plants more highly organized than mosses. wood runs continuously from the finest rootlets, through the stem and into the leaves and flowers of their equivalents. Wood performs two functions in the plant's life: first, it serves for the transport of water and contained salts, absorbed by the roots, to parts where this "raw sap" is needed and especially to the leaves; second, it gives mechanical strength to the plant.

In palms and bamboos the wood of the leaves is stringlike in form and is confined to the nerves or veins; from these the strings extend into the trunk or stem. where they descend but join one another at intervals thus producing a basketlike or loose luffalike complex, uhich is embedded in the general mass of tissue composing the rest of the trunk. Thus it is this linked netlike complex of woody strings that corresponds to the solid mass of wood.

Wood that has attained only slight thickness and accordingly cannot be termed timber is nevertheless utilized, for instance in the form of thin branches and twigs to make besoms and baskets. Even when wood attains greater thickness it is not always timber. since there are some woods so soft, light in weight, and weak that they have little or no value as structural material upon which there is a demand for strength; such wood supplies means of flotation for fishing nets and buoys, and insulation, while the lightest of all are pithlike and are the materials of which sun helmets are composed. *See* also TIMBER. (P. GM.)

WOOD ALCOHOL: *see* **METHYL** ALCOHOL.

WOODARD, NATHANIEL (1811–1891), Anglican priest and iounder of the Woodard schools, was born at Basildon, Essex, on March 21, 1811. After being educated privately. he graduated at Oxford in 1840 and was ordained priest in 1842. Woodard was not an outstanding scholar, but he possessed a genius for organization and for attracting funds for his foundations. He was impressed by the lack of good schools for the middle classes which combined Anglican teaching with the advantages of public schoql education at a moderate cost To supply this need he iounded the Corporation of St. Mary and St. Nicolas in 1848 and based his future foundations on regional centres. His first schools were St Nicolas, Lancing. for the upper middle class, St. John's, Hurstpierpoint. for the middle and St. Saviour's, Ardingly. for the lower middle class. These were followed by a number of boys' and girls' schools in different parts of the country. At his death at Henfield, Sussex, on April 25, 1891. his schemes were not completed. In the second half of the 20th century there were 18 Woodard schools and one associated school. In 1870 Woodard was appointed canon residentiary of Manchester. His tomb is in the chapel of Lancing college.

See Sir John L. Otter, *Nathaniel Woodard* (1925); K. E. Kirk, *The Story of the Woodard Schools* (1952). (S. J. C.)

WOODBINE, a plant name applied in North America to the Virginia creeper (*q.v*) and in England to the honeysuckle (*q.v.*).

WOODBRIDGE, an urban district in the Sudbury and Woodbridge parliamentary division of Suffolk, Eng., 8 mi. N.E. of Ipswich on the tidal River Deben. Pop. (1961) 5,927. Area 1.7 sq mi. Woodbridge is an old agricultural market town with nursery gardens and boatbuilding yards (since the 14th century). The annual horse show has developed from Lady fair. King Edgar gave the manor to the monks of Ely in 970. In 1564 a school was built on the site of the 12th-century Augustinian priory. Woodbridge school was originally the Seckford grammar school (1662), named after Thomas Seckford who built the shire hall (*c.* 1570) and almshouses. Across the river is Sutton Hoo, where excavations in 1938–39 yielded the ship burial of a Saxon chieftain.

WOOD CARVING, the process in which mood is shaped for aesthetic or decorative purposes with cutting tools held in the hand. The term includes sculpture, in relief or in the round, as well as the embellishment of furniture or architecture. (See also WOODCUTS AND WOOD ENGRAVING.)

I. PRIMITIVE

The greater part of primitive sculpture is in wood, since it is both plentiful in most of the regions inhabited by primitives and easily worked with tools made of natural materials (see SCULPTURE: *Primitive* Peoples). Because of its deterioration when exposed to the elements, few wooden pieces remain in good condition in their native environment for more than half a century.

Since wood in its natural state is a living substance, it had a special meaning in animistic cultures. The Iroquois Indians carved their dance masks from living trees in order that the indwelling spiritual force of the tree might be retained. The Maori of New Zealand conducted rituals of propitiation to the forest spirits before felling a tree, and never burned or even brushed away the chips while working, believing that they still were part of the spirit of the tree.

Wood carving tools were most often made of stone. The greenstone of New Zealand, for example, can be worked to an edge that is as effective as an iron tool. Shell was also used, and the teeth of some animals were found hard enough to cut stone. Stone adzes were used first to chop out the general form. and sometimes to finish the carvings, as in those of the northwest coast area of North America, where the adze marks were left in a regular pattern on the surface. African work was usually finished to a smooth surface with knives of stone or iron, polished with sand or sharkskin and rubbed with palm oil. Iron tools were made by the Bushongo tribes of the central Congo, who carved numerous wooden objects such as stools, neck rests, drums, bowls and boxes, and decorated them with their traditional designs. Some of the most intricate carvings were made with shell and stone tools, however, such as the New Ireland funerary figures which have deep undercuttings and lacy perforations, and the ceremonial paddles of the Austral Islands which are completely covered with minute and extremely precise geometric designs. However, the huge totem poles of British Columbia, some as high as 60 ft., were made with the metal tools of the white man.

In general, primitive carvers were not professional artists. In many societies all the men carved, as in the Marquesas Islands, and the most skillful were chosen to execute the ritual objects. Exceptions existed, as among the Maori of New Zealand, where the sculptors of ceremonial boards for the community houses were specialists, and also among the Bushongo of Africa, where the sculptors became members of the royal court. Little is known of the training of carvers in primitive societies. The Maori master sculptor was a craftsman-priest called the tohunga. who instructed his pupils in both the technique of carving and the proper magic rituals that were necessary in order to ensure good work. Sculptors among the Bushongo took apprentices, but in many other societies carving was learned simply by watching and practising.

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II. ORIENTAL

Indian and Ceylonese.—Since all Indian architecture was once wood, it may be said that both the structural and carved elements of many ancient stone temples are reflections of early design in woodwork, Even in regions where stone abounds, domestic architecture remains nooden in the 20th century. The earliest example of the joiner's art is the wooden screen of the chaitya (Buddhist sanctuary) at Karli (*c.* 120 A.D.) and the wooden umbrella of its stupa, carved with concentric floral designs. The fragments of carved panels and a wooden pillar from Kashmir Smats in the British museum are the wooden counterparts of Gandhara sculpture. The most elaborate examples of later wood carving are architectural ornaments of buildings in Ceylon, south India, Gujurat. Kathiawar, Nepal and the Himalayan regions. Especially notable are the paneled doors used from the Punjab to south India, including early examples preserved at Ajmer. Balconies and window panes received a particularly rich surface decoration in western India. Perforated windows with floral designs were universally used. Some lattices with geometric patterns of Arabic character are found in northern India. Notable also are the paneled pine ceilings of Kashmir. Some distinction was achieved by the Singhalese artisans working at Kandy as late as the 19th century. A rather interesting Indo-Portuguese style of ornament is found on the chests carved in the 17th century.

Burmese.—Burmese wooden architecture undoubtedly reflects the magnificence of earlier temples and palaces. The flamboyant carving of the crockets and the immense teak columns of the monasteries of Mandalay and Amarapura are especially remarkable for their exuberance and floridity of style.

Siamese and **Indochinese.**—The nature of early wood carving in Siam (Thailand) and Indochina can best be studied in the decoration of stone monuments from the 6th to the 13th century, which reproduce lost originals in wood. In more modern periods the process was reversed, and wood carvers as late as the 20th century drew their inspiration from the forms of early stone carving at Angkor. For a time in the 17th and 18th centuries there was an imitation in Siam of the styles of Louis XIV and XVI.

Javanese.—Wood carving of a barbaric richness and fantasy survives in Java and Bali, not only in sculpture but in the ornamentation of litters, panels and musical instruments. This is a traditional design composed of indigenous, Chinese and Indian elements.

Central Asia.—The countless fragments of sculptured panels, architecture and furniture recovered in the excavations of sites in central Asia, dating from the 2nd to the 10th century A.D., reveal designs of mixed Classical. Indian and Chinese origin.

Chinese.—Wood carving is undoubtedly a craft of great antiquity in China. The earliest examples are lacquered fragments of the Chou dynasty (1122–249 B.C.) from Changsha. Wood carving for architectural decoration continued throughout the classical periods, although little prior to the Ming period has survived. Ceiling beams and supporting pillars are integrally carved with a profusion of ornament. generally in floral and geometric patterns. Also favoured for architectural carving were the monster masks or *t'ao-t'ieh,* the eight trigrams, as well as auspicious symbols appropriate to Buddhist. Taoist and Confucian usage. The carving on the furniture is generally restricted to the key or fret pattern. Chinese wood carving invariably reveals a laborious, even mechanical, execution. and especially in later periods it is evident that the virtuosity and intricacy of the performance is the only measure of artistic merit. Railings in houses and temples are frequently decorated with fretnork designs in the familiar key pattern. which found its way into the Chippendale style in Europe. Among the more imaginative and ornate examples of Chinese wood carving are the often very elaborate designs for window grills or lattices nhich comprise a very diversified traditional grammar of ornament. including emblems of happiness. abundance and longevity. Although these techniques are known only in examples of the Ming period (1368–1644), they are of great antiquity. (*See* CHINESE SCULPTURE.)

Japanese.—The earliest examples of Japanese wood carving are the phoenix and music-making angels adorning the canopy in the Kondo of Horyuji at Nara. These examples already display the delicacy of design and exquisite feeling for the medium, characterizing the Japanese wood carver's art in all periods. Preserved in the Shosoin, the imperial treasure house at Nara, are many wooden masks worn by dancers at the dedication of the Great Buddha of Todaiji in A.D. 752. These masks for the *gigaku* dance have the realism and vitality of the sculpture of the Tempyo or Nara period (710–794) in a grotesque vein. The wooden masks used in *bugaku,* a dance originally imported from China, are smaller and less fantastic than the gigaku masks. Some of the best examples were carved during the Kamakura period (1185–1392) and have something of the hardness, worldliness and exaggerated realism of the style of this time. The no masks, all carved in wood, first came into existence in the 16th century. They are more abstract and expressionless than earlier masks because the wearer himself gave them expression through his performance. (See MASKS.)

Whereas in the early periods wood carving was largely restricted to the decoration of temples and Buddhist paraphernalia. in the 16th century it came to be employed for ornamenting the mansions of the shoguns. Splendid examples may be seen at Kitano Jinja and Nishi Hongwanji in Kyoto. In the 17th century the mausoleums of the Tokugawa shoguns at Shiba. Tokyo and Nikko were richly decorated with carving both outside and inside. In domestic architecture the wood carver was generally restricted to the *ramma,* the vertical panel in the partition mall above the screens separating one room from another. Many of these wood carvings were conceived as pictures and, in some cases, they uere designed by famous artists. Although these panels are for the most part two-dimensional. the carving often assumes a really sculptural, three-dimensional character. The finest examples date from the Momoyama period (1568–1615). (*See* JAPANESE SCULPTURE.)

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III. EUROPEAN AND AMERICAN

While the finest examples of mood carving in Europe are those associated with the ecclesiastical buildings of the medieval and renaissance periods. house embellishment also was not uncommon. But. in general. the churches have survived better. Besides the great buildings, decorative wood carving was common on furniture — chairs and chests. for example — and many small domestic articles were so ornamented This small woodenware, known as treen. included bowls for kitchen and dining room use, salts. nutcrackers, cups, tankards and chalices. stamps and molds, spoons. pipe cases and tobacco boxes, busks, chessmen, candlesticks and, in southern Europe. stirrups.

The figure carving in the round that decorated the churches of ancient days nas made with the intention of covering the wood with paint and gold. The traces of such painting still remain on much of the carving. Most of the paint disappeared so long ago. however, that it became the custom for other carvers to copy the figures as they saw them without decoration. The result is that they are often seen in such poor light that their lines or features cannot be properly distinguished. Wood has a way of disappearing into the shadow if the lighting is not strong enough, but the moment it is covered with gold and paint it reappears in all its details, even in a dark recess. Stalls or other church fittings which were liable to rubbing were never painted. (E. S D)

Such meagre fragments of woodnork as have come donn from the 11th and 12th centuries tend to show that the woodworker was following the stonenorker, who was paramount until about the 15th century. From that time onward it was the woodworker who became predominant. By that time he had found that wood should be treated in quite a different manner from stone, and, inspired by new ideas and nen motives, he invented new methods for the construction and embellishment of his work The wood carver, then. no longer followed the patterns and designs of the stone carver, but made them for himself in a manner to suit the material and tools he uorked with and in fact began to influence the stoneworkers in such a way as sometimes to divert them from their intrinsic principles.

Early Period. — The earliest extant examples of wood carving are Scandinavian remnants dating from the 9th and 10th centuries. They are carved framings of doorways made of thick planks of pinewood. The carving is in low relief. and it is always kept up to the surface of the material out of which it is made. The designs are of interlacing stems sometimes foliated, and often terminating in a monster's head. Invariably the space which is decorated is so much filled with pattern as to leave scarcely any ground showing.

Of the Norman period in England only a few isolated pieces remain. and these are only enriched with a row of molded arches, as in the tomb at Pitchford church, Shropshire. which has also a shield carved in oak in each arch of the arcaded side of the tomb. supporting the carved nood effigy of Sir John Pitchford. It may be conjectured that the characteristic feature of Norman wood carving was the rounded surface of most of the foliated forms, which appear to have avoided hollows. The leaves were often a series of lobes with a V-shaped sinking round the edge. Even in the moldings. beads or rounds preponderated over hollows, and in the grotesque beaked heads carved on the arches to many a doorway the surface treatment is generally a series of ribs or small rolls, rather than a succession of hollows or V cuts as in Byzantine ornament.

Gothic. — Of the Early English period, which began at the end of the 12th century, there is not a great deal of wood carving remaining, though there is sufficient to tell what it was like, even in elaborate wark, as in the stalls at Winchester cathedral. These however were executed at the very end of the 13th century. They are carved with the utmost care and skillfulness but the work follows the idiosyncrasies of the stonemason and carver, inasmuch as it is cut out of solid blocks of oak and the forms and designs are identical with that of stonework. Some of the designs for foliage follow the typical Early English forms, while others might be taken for the work of the next great divisional period of architecture which followed. The niiserere seat from the Priory church at Christchurch, Hampshire, is a good example of early English carving. Others may be found in Henry VII's chapel at Westminster, and at Exeter.

In the traditional carvings of the 13th century the curves of the foliage are very simple. The leaves start from a fairly thick stem which is generally cut very square in section. The variations of this form of foliage are wonderful and beautiful in the extreme. The building where this form of carving may best be studied in England is Wells cathedral. Toward the end of the 13th century the woodworkers were coming into greater prominence. There is an example of a groined roof with carved bosses at the junction of the ribs at Warmington, Northamptonshire, and of carved roof beams at Bradfield, Berkshire; and Rochester cathedral has a lean-to roof with molded beams.

Decorated Style. — The next phase is known in England as the Decorated style. It extended through the first three quarters of the 14th century. during which carving had more than one character. At first there was a tendency to follow more closely naturalistic forms. though treating them conventionally. but this is rather more apparent in the stone carver's work than in the wood carver's. This faithful portraying of natural forms does not appear to have lasted for more than 10 to 20 years. What succeeded was a very conventional and exaggerated treatment of the surface of foliage applied indiscriminately to leaves of every description.

The 15th Century.—The 15th century was productive of the finest quality and of the largest amount of decorative Gothic woodwork that the world has ever seen. Although there was a distinct style pervading the whole period, there was more variety in expressing it than had been the case in any of the previous developments in architecture. This period of work, known as the Perpendicular style. began in the last quarter of the 14th century and continued until the middle of the 16th century, after which it was practised in a debased form for another 100 years.

There was no difference in the style of building between domestic and ecclesiastical edifices, save that many houses were constructed of timber. Screens, pulpits and font covers were invariably prepared with gesso and sometimes minute decoration added to the faces of the buttresses, as at Southwold, and then gilded, and sprays of flowers painted on the broad hollows. The beadings were picked out with a chevron, or a twist of two or more colours like a barber's pole. The corner posts generally received a greater or less degree of carved ornamentation.

The most noticeable features of the work of this period are that carving became flatter; tracery was built up of several boards as one order was superimposed upon another and not cut out of one thick piece of oak as had formerly been done. In the emblems of SS. John and Matthew in the Victoria and Albert museum, London, the work is applied and a broad simple treatment is the outstanding characteristic of these vigorous carvings. In the latter half of the 15th century some of the carved foliage was composed almost entirely of hollows divided by a V cut to represent the stem of the leaf, or by a softly carved raised stem. The edges of the leaves were kept up and the serrations were produced by a vertical cut with a gouge at right angles to the edge of the leaf and a hollow cut with the same tool on the edge of the leaf, getting deeper until the chip fell out as the cut met the first incision. The inner edge of these gouge cuts formed the centre stems of the serrations. In a poppyhead at Walpole St. Peter, Norfolk. the carver's expression is very different from what it was when every serration was elaborately carved with a swelling in the middle and a hollow round it. One type of leaf which was invented, for there is nothing in nature like it, was that in which the corners of the leaf ended in a tightly rolled ball, as in the left-hand leaf on the miserere seat in Ripon cathedral, Yorkshire, on which Samson is shown carrying away the gates of Gaza.

The wealth of pattern and fanciful design in crestings, strings, bosses, tracery, poppyheads, bench ends, etc., is wonderful, and the rendering of fables and biblical stories in the miserere seats inimitable. The curves of tracery are never mechanical but are drawn freely, and great care was taken to get a breadth of effect. The hollows of the tracery are very flat, and not like the cast-iron effect produced by some revivalists who make the section of the hollow almost a quarter of a circle. In a few of the East Anglican churches an effect of great richness was produced by carving the back of the top rail of each bench with a simple band of ornament, as in Dennington church. Suffolk.

An extraordinary development took place at this period in the erection of timber roofs. The skill and imagination of the carpenter together with the conception of the figure and foliage carvers produced a wealth of grand architectural effects that has never been surpassed. The roof of Westminster hall, for example, will forever be a wonder for its construction and magnitude.

There is a great deal of beautiful oak carving of this period to be seen in France, Germany and Flanders. In St. Paul's church at Abbeville, France, there is a beautiful reredos which is Flemish in character, illustrating the lacelike effect so often found in French carvings. Perhaps the most striking piece of work on account of its vast amount. its completeness and its elaboration is the stalls at Amiens cathedral. which were begun in 1508 and completed in 1522. One characteristic feature of French Gothic tracery carving is that the section is often but little more than a chamfer, and when there is a double order it is often made by dividing the chamfer by a square incision. In German work the tendency was for the designs to be more intricate and to contain less breadth and freedom in the carving. Most of this work is very much undercut and the chief aim appears to have been definition of outline and strong shadows.

At the end of the 15th century Renaissance influence began to make its appearance. and although the structural parts of woodwork remained purely Gothic in design, it was in the carvings that the innovation first made its presence known. The four oak panels dated 1540 of Beauvais cathedral. Beauvais. France: indicate the effect the new style was beginning to have on the carver. The suggestion is that carvers were introduced from Flanders, with which there was constant intercourse in connection with the trade in wool, and it was from this source that the splendid traditions of the Gothic period were undermined. When the fashion for this new form of art took hold of the popular imagination, the end of Gothic was not far off; although tradition born of centuries is hard to kill: it was not quite dead until the middle of the 16th century. (L. A. T.; E. S. D.)

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The Renaissance.—With the passing of the Gothic the symbolism that inspired the wood carver gave place to ornament almost devoid of ideas. Under the influence of the builders it functioned to give expression to proportion and structural design, and to convey something of the joy of life in those effects with which man delights to surround himself. When symbolism or aesthetic understanding is not guiding the decorative instinct, manipulative skill becomes easily a snare. hence. the styles of decoration which have arisen throughout Europe since the Renaissance have provoked a constant struggle between sincerity and technical dexterity. Especially has this been the case nith wood carving.

The wood carving of the Renaissance was chiefly in walnut, and is best understood if it be realized that the structural design of the woodwork was reminiscent of building and that structural features such as pilasters, capitals, etc., were employed decoratively. Further. the Renaissance being in essence the revival of classic motifs, familiarized by ancient examples in marble, which material was especially understood in Italy, it is not surprising that much of the work lacks a distinctive woodlike effect. Nevertheless the release from the domination of the middle ages with their limited symbolism brought a freedom and vitality into design that made the Italian carving the inspiration of the greater part of Europe for many centuries. and the inventiveness and opulence displayed have been rarely equaled elsewhere. Its motifs, taken freely from nature and treated naturalistically to an extent unknown in the classic prototypes on which the Renaissance was founded. were combined with arabesques, woven into designs by means of sinuous and scroll movements, and modeled to produce to the utmost a play of light and shade.

Toward the end of the 15th century, France felt the inspiration of the Renaissance. It was there welcomed avidly by the carvers, who had had the Gothic insight to a degree never attained by the Italians. Perhaps the highest beauty achieved by the Renaissance was in the admixture of the new details and Gothic structure so common in France, suggesting that it is during transitional periods in art that man is most vital and creative. French artisans understood the treatment of wood and although sometimes overlavish and small in detail. their technique was easy and unsophisticated, and in the designs of the best examples provision was made freely for surfaces broad enough to display the grain and beauty of the wood. Characteristic of the period are the doors of St. Maclou, Rouen, which are attributed to Jean Goujon, and if this work be compared with much of the stonenork of the time it would appear that stone nas influenced by wood.

The work of nearly the whole of Europe was gradually influenced by Italy either directly or through an intervening country. The influence nas too vital to incite mere reproduction, even had the means existed to make this possible, so that, except where the craftsman was imported, the expression of Renaissance ideas in each country had its distinctive idiom. The Plateresque of Spain was noteworthy for the exceptional profusion of small surface detail, sometimes of great refinement. In Germany, the Netherlands and England, Renaissance carving was associated with the development of strapwork, in some examples of which it scrolls vigorously while in others groups of fruit. grotesque masks and figures sculptured in high relief enrich it. At a later date the Baroque carving of large figures was in Germany remarkable for its skill and in Italy for its unrestrained application to its architectural setting.

Of great interest to the wood carver as further examples of his art when uncontrolled by architectural considerations are a number of the pulpits of Belgium. That by Henri Verbruggen. 1699, in St. Gudule. Brussels, is the most extravagant of the school.

The Eighteenth Century.— The most radical change in style after the Renaissance was the so-called Rococo of the reigns of Louis XIV and XV. It reflected the artificiality and extravagance of its time and was distinguished by its arrangements of "C" scrolls and attenuated foliage for structural as well as decorative purposes, and for the substitution of richly ornamented broken curved movements for straight horizontal lines. Its draftsmanship was superb, and for effect it relied upon the perfect technique of its some\\-hat fantastic designs.

The inception of the 18th century in England was singularly remarkable for the fertility of its designers and carvers. Grinling Gibbons fashioned wood with a freedom and delicacy unprecedented. His work has provoked controversy as to the suitability of wood for masses of fruit and flowers in such high relief and so freely undercut. The preservation of his work, in spite of the ravages of the woodworm, has permitted a later judgment that justifies the apparent liberties he took with his material and his freedom from the shackles of tradition; the variety of his designs and his sense of decoration proclaim him a great artist and craftsman. His most restrained work and probably his best was done in association with Sir Christopher Wren for the choir of St. Paul's cathedral, London.

In Italy and Germany the character of the French Rococo style was often interpreted with a crudeness that almost amounted to a burlesque; and only in England, notably in the hands of Chippendale, were its suggestions controlled by refinement and discretion. The swing of the pendulum led to the production of the ornament of Louis XVI in France. Biedermeier in Germany and the Adam brothers in England. These styles were a return to more severe classic ideals. and the enrichments involved the repetition of small patterns and motifs that had been exhausted in the past.

The United States.— In America during the late 18th and early 19th centuries there developed a handsome style of wood carving decoration associated with the architecture of the period. This was best exemplified by William Rush of Philadelphia, Samuel McIntire of Salem. Mass.. and John and Simeon Skillin of Boston. This carving consisted of sheaves of wheat, urns, medallions of classical scenes, and swags for mantels, doorways, stairways, panels. etc., based on classical motifs; as well as figures in the round for gardens and eagles to decorate public buildings. Some of the finest carving of this period was that done for ships' quarter galleries, transoms, trail boards and, best of all, the graceful figureheads and billetheads.

Decline of Wood Carving.— After the end of the 18th century, wood carving all over Europe and America was almost confined to the reproduction of the styles of the past without any regard for nationality or the expression of individuality. *L'art nouveau* of France toward the close of the 19th century had its repercussions elsewhere, but passed away rapidly because its tones were untrue to material, its wood carving conveying the impression of metal or modeled clay. The carver worked with the architect and furniture designer, and the tendencies of modern Europe influencing these in the direction of simplicity of structure and effect, his art languished.

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IV. 20TH CENTURY

Europe.— The first half of the 20th century witnessed a considerable revival in Europe of the use of wood as a material for sculpture. Among the most important artists in this medium were Aristide Maillol (1861–1944), French; Jean (Hans) Arp (1887–), born in Strasbourg; and Constantin Brancusi (1876–1957), a Rumanian who spent most of his life in Paris. Maillol carved simplified. well-rounded figures of young girls. Arp carved abstract forms in wood. Brancusi also did abstract forms, many of them mounted on pedestals that were often as interesting in form and shape as the sculpture they supported. Brancusi was largely responsible for the renaissance of sculpture in wood and exercised great influence on artists of the 20th century. Ossip Zadkine (1890–), another sculptor of importance who worked in wood, was born in Smolensk, Russia, and lived in Paris. A German artist; Ernst Barlach (1870–1938), did a large part of his work in wood, much of it to be seen in the churches of his native land. He remained more under the Gothic influence than many of his contemporaries.

Working in England, Henry Moore (1898–) exerted a great influence on the younger sculptors of both Europe and America. His statues were often large, more than life-size, reclining figures, semiabstract or abstract forms suggested by the human body. At times Moore treated these forms by cutting holes through the wood, or adding strings, with effective results. He made use of many different types of wood—elm, lignum vitae, walnut, beech, ebony and boxwood. Another English sculptor, Barbara Hepworth (1903–), also used wood as a medium.

United States.— In the United States the art of wood carving was very much at a standstill about 1900, in spite of the earlier popular tradition exemplified in the beautiful ship figureheads. the wooden Indians used to advertise cigar stores and the wood figures and decorations often found in barrooms. Most of these had disappeared by the mid-20th century, except those which found a safe, important place in museums and private collections. This popular art was by no means exclusively American, even the wooden Indian being imported from England in the early 18th century.

For many years Robert Laurent (1890–) did wood sculpture exclusively, using mostly walnut and mahogany. An exhibition of his works in 1915 received important recognition. Another artist to exhibit wood carving at this time was Charles E. Prendergast (1868–1948), who carved reliefs. which he covered with gesso and then painted and gilded. William Zorach (1887–), who began his career as a painter, also exhibited wood carvings both in relief and in the round. Among his early pieces were interesting figures of his daughter and his son, done in 1921. Both Laurent and Zorach as instructors at the Art Student's league in New York city inspired many of their students to use wood as a medium and to exhibit their work. At one time Alexander Calder (1898–), later famous as a constructor of mobiles, carved figures of acrobats and animals in wood.

Among others who worked to a great extent in wood were Chaim Gross. Concetta Scaravaglione, Oronzio Maldarelli, Milton Hebald, John Rood. Raoul Hague and Carl Milles.

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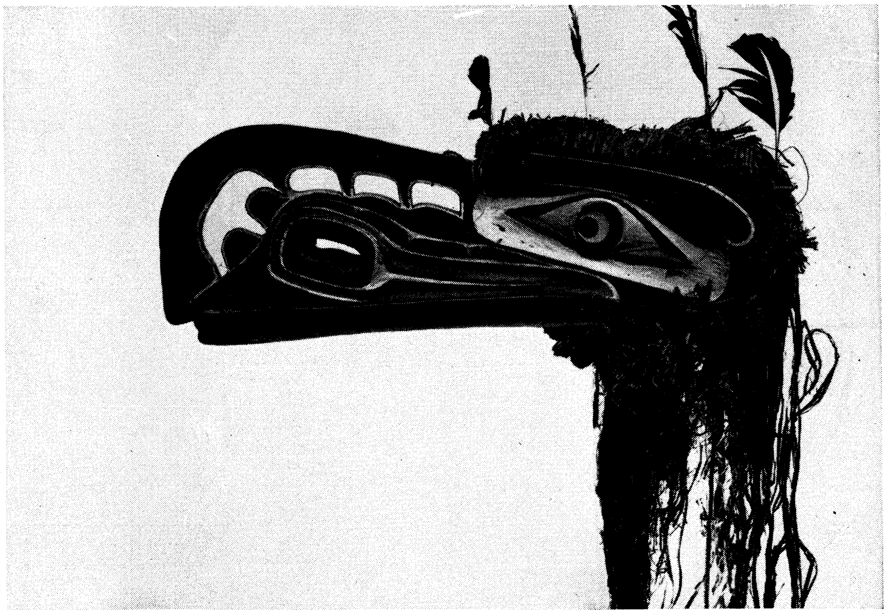
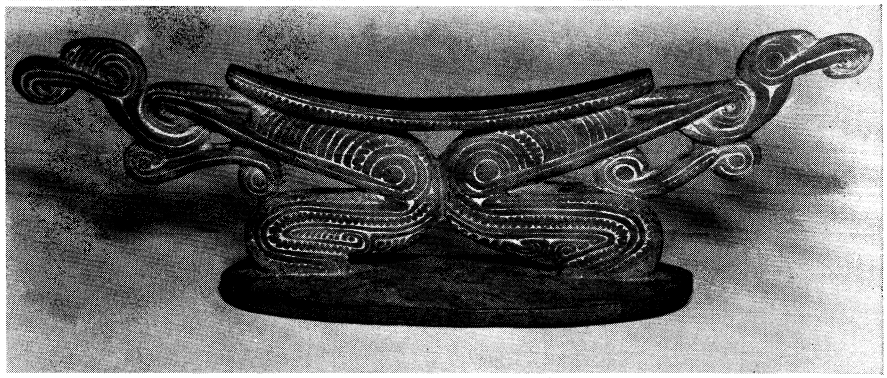
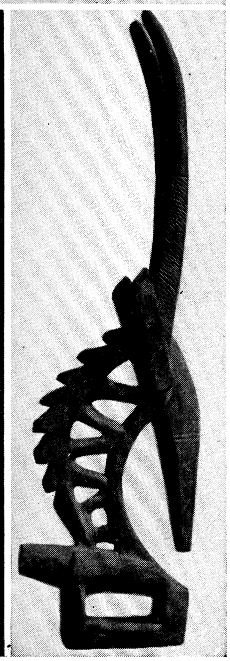
V. TECHNIQUE

The experienced artist will start with a solid block of wood, not necessarily squared off. often without any preconceived plan or idea, which develops as he works from the shape and grain of the material. The sculptor grasps his ideas as he cuts. This is the most exciting way, and the most successful, of doing wood sculpture. It is the most alive. For the inexperienced. however, it is not recommended. Without a sketch, in clay or plasticine, or a drawing, he would feel lost. Nearly all beginners need a model that they can follow.

Choice of Woods.— Most artists prefer hard and semihard woods, black walnut, lignum vitae, chestnut. teak, elm, ebony,







BY COURTESY OF (TOP LEFT, M. H. DE YOUNG MEMORIAL MUSEUM SAN FRANCISCO. (TOP RIGHT) THE PORTLAND ART ASSOC., (CENTRE RIGHT, BOTTOM LEFT) ROYAL ONTARIO MUSEUM OF ARCHAEOLOGY, TORONTO. (BOTTOM CENTRE) THE TRUSTEES OF THE BRITISH MUSEUM

CARVINGS BY PRIMITIVE PEOPLES

Top left: Painted carving used in funerary ceremonial. Height 41 in. New Ireland Island, Bismarck archipelago

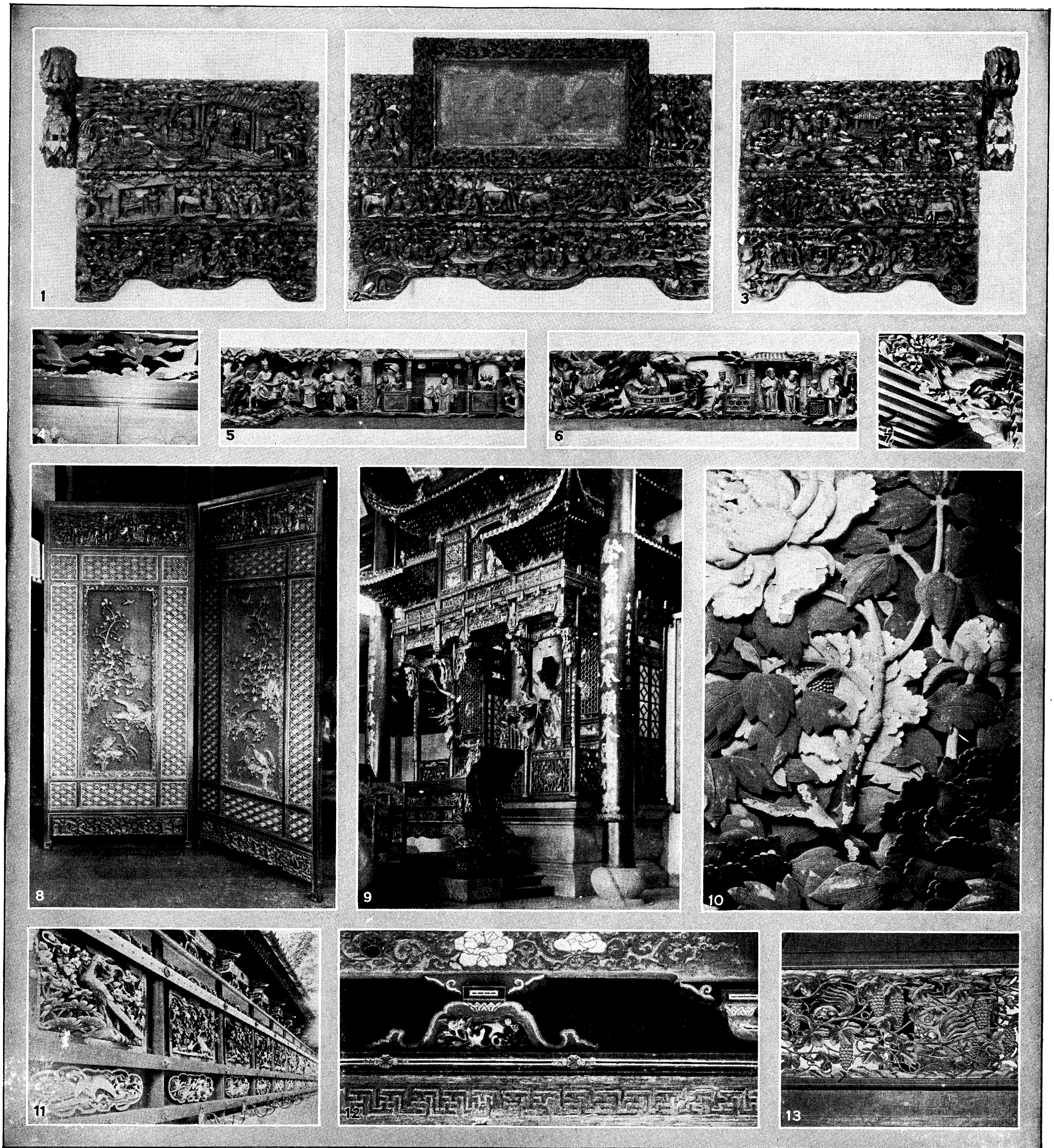
Top right: Dance mask representing a mythological monster. Movable jaw. Length 31 in. Kwakiutl, British Columbia

Centre right: Neck rest with frigate bird design. Massim area, eastern New Guinea

Bottom left: Neck rest used as a pillow. Baluba, southern Congo area

Bottom centre: Ceremonial cup carved with weaving design. Bushongo, Belgian Congo

Bottom right: Antelope head piece worn in a fertility dance. Bambara, Sudan



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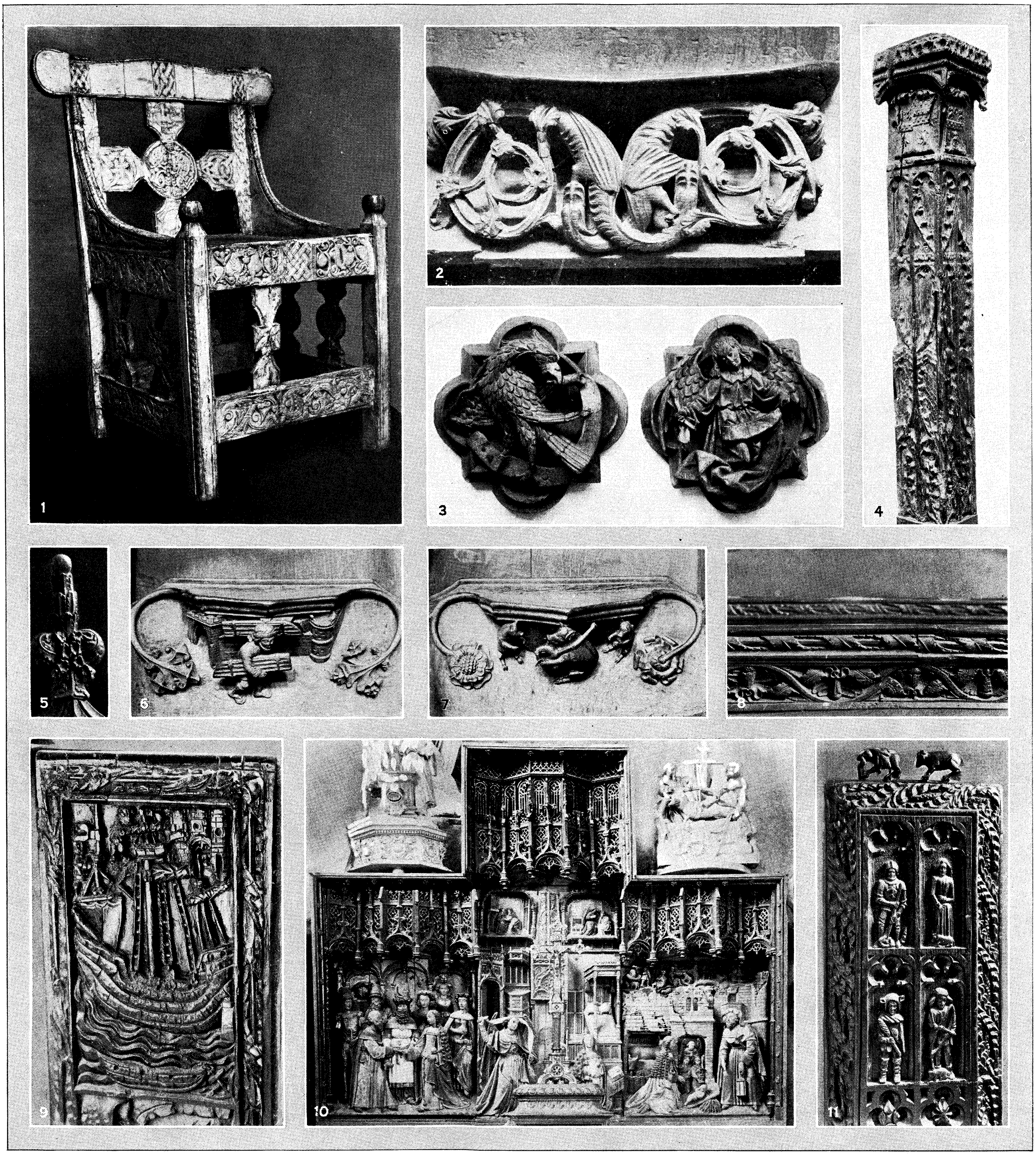
EXAMPLES OF FAR EASTERN WOOD CARVING

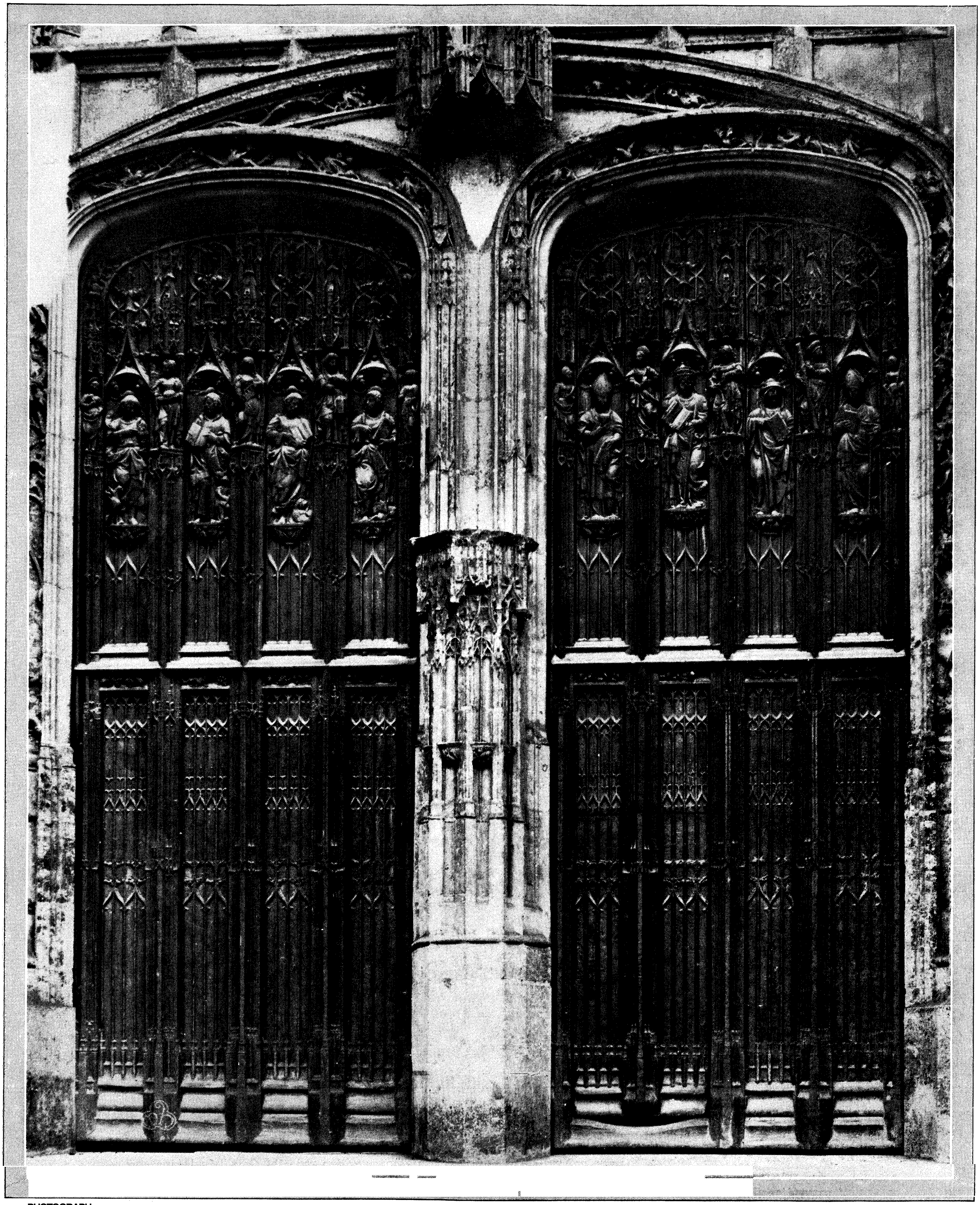
1, 2, 3. Chinese shop front
4. Carved ramma in the crane room of the Nishi Hongwanji, Kyoto
5, 6. Carved beam from a Chinese house
7. Wood carving under the eave of Kitano Jinsha, Kyoto
8. Chinese screen with carving
9. A Chinese temple
10. Wood carving on the famous gateway (Yōmeimon) of the Nikko Shrine, Japan
11. Wood carving on the wall of the Nikko Shrine
12. Sleeping cat at the Nikko Shrine carved by the left-handed Jingoro
13. Carved ramma in the wave room of the Nishi Hongwanji, Kyoto



BY COURTESY OF (1, 3, 4) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, LONDON, (2) THE VICAR OF CHRIST CHURCH PRIORY, (6) THE DEAN OF RIPON; PHOTOGRAPHS, (7, 9, 11) COPR. B. C. CLAYTON

GOTHIC WOOD CARVING

1. Chair of the 9th or 10th century, from Tydalen, Norway, an example of the earliest type of extant wood carving
2. Miserere seat of conventionalized foliage with writhing dragons, from the Priory church of Christ Church, Hampshire, early 13th century. The miserere or misericord, a projection on the under side of a hinged stall seat for giving support to a standing person, afforded a rich field to the ingenuity of the Gothic carver
3. Emblems of St. John and St. Matthew, 15th century applied carving
4. Corner post from a house in Bury St. Edmunds, ornamented with tracery and the family arms; 2nd quarter of the 16th century
5. Fleur-de-lis poppy-head, or finial of a bench end, Walpole St. Peter, Norfolk, 15th century
6. Miserere seat in Ripon cathedral, Yorkshire, 1490, showing Samson carrying away the gates of Gaza. As in the case with most Old Testament subjects employed by the mediaeval wood carver, the story is symbolical of events in the New Testament, Samson representing Christ rising from the tomb
7. Pigs and bagpipes, a miserere seat in Ripon cathedral, 1493, one of many satires in wood directed against minstrelsy
8. Pew railing from Dennington church, Suffolk, late 15th century
9. Square "ship" bench end, church of East Budleigh, Devonshire, 1537
10. Reredos in St. Paul's church at Abbeville, France, showing the lace. like effect characteristic of French carving
11. Square bench end from the church of Combe-in-Teignhead, Devonshire, carved with niched figures representing Sts. George, Agnes, Genest (in fool's cap and bells) and Hubert, 15th or 16th century



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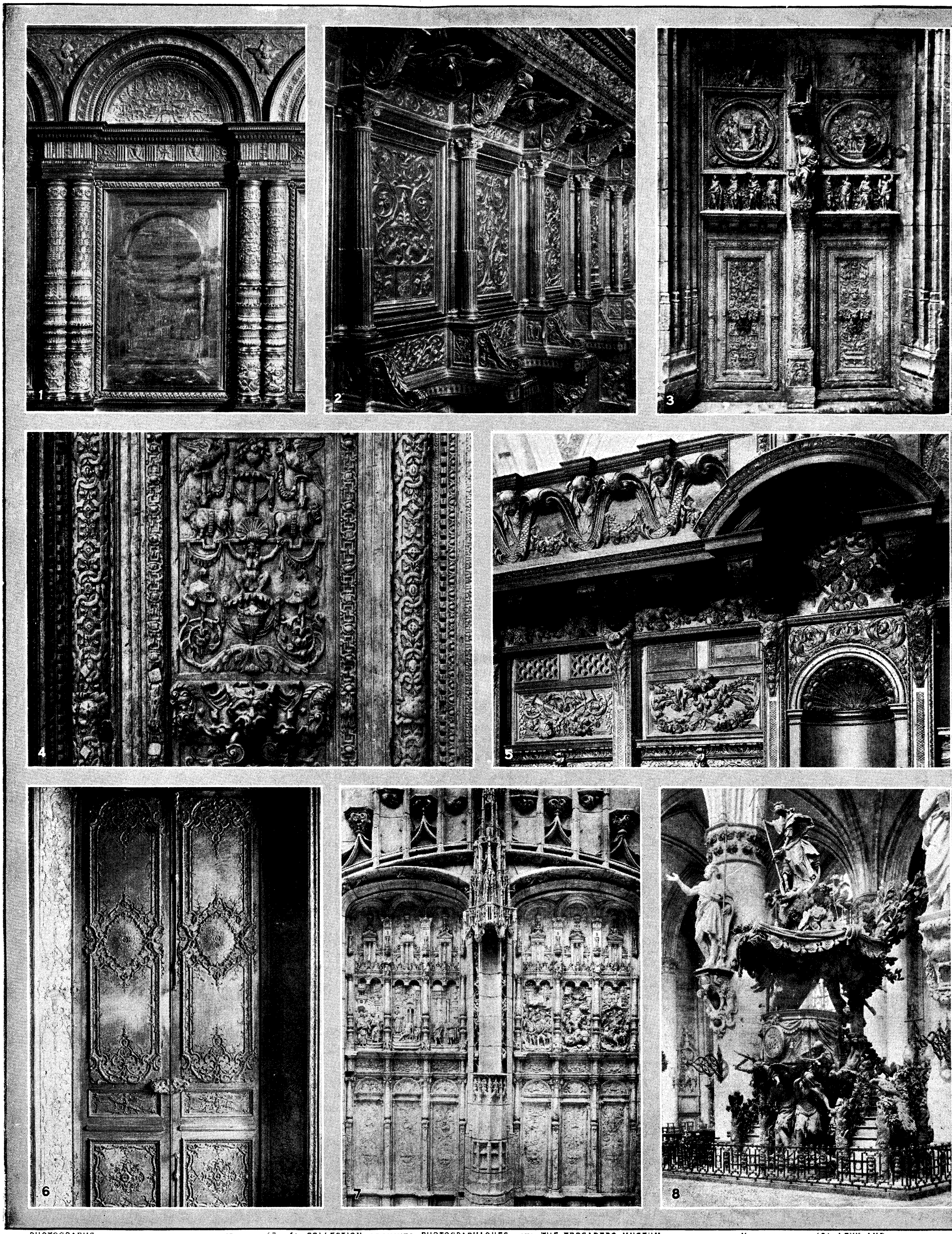
EXAMPLES OF GOTHIC CARVING

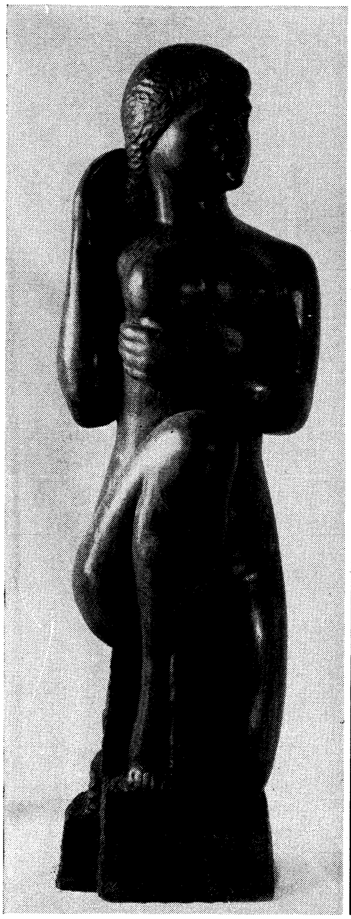
Carved wood portal of Beauvais Cathedral, Beauvais, France. Most of the foliage carving is expressed by use of the gouge (composed of broad hollows). Photograph shows the delicate lace-like effect often found in French carving

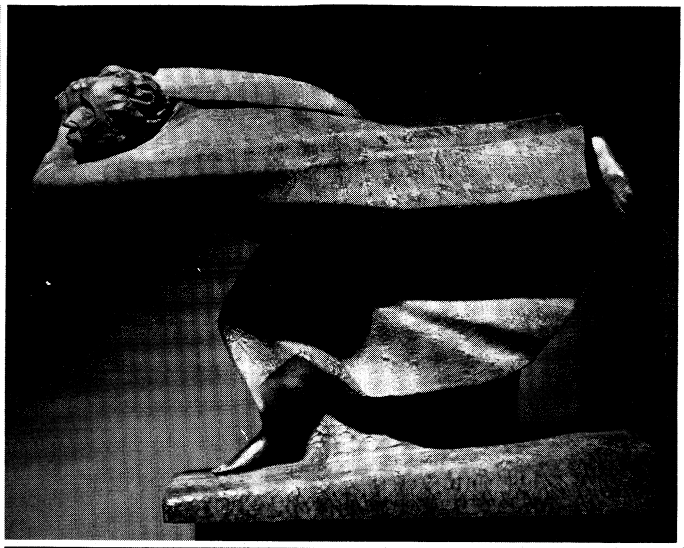


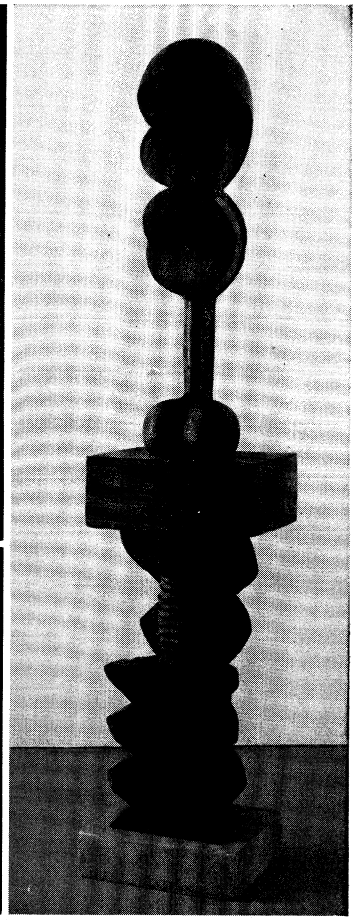
PHOTOGRAPHS, (1) ALINARI, (2) ANDERSON (3, 4) COLLECTION ARCHIVES PHOTOGRAPHIQUES, (7) THE TROCADERO MUSEUM, PARIS COPR. H. BONNAIRE, (8) LEVY AND NEURDEIN: FROM (5) "GRINLING GIBBONS AND HIS COMPEERS" (JOHN TIRANTI AND COMPANY), (6) "LE CHÂTEAU DE RAMBOUILLET" (ARMAND GUÉRINET)

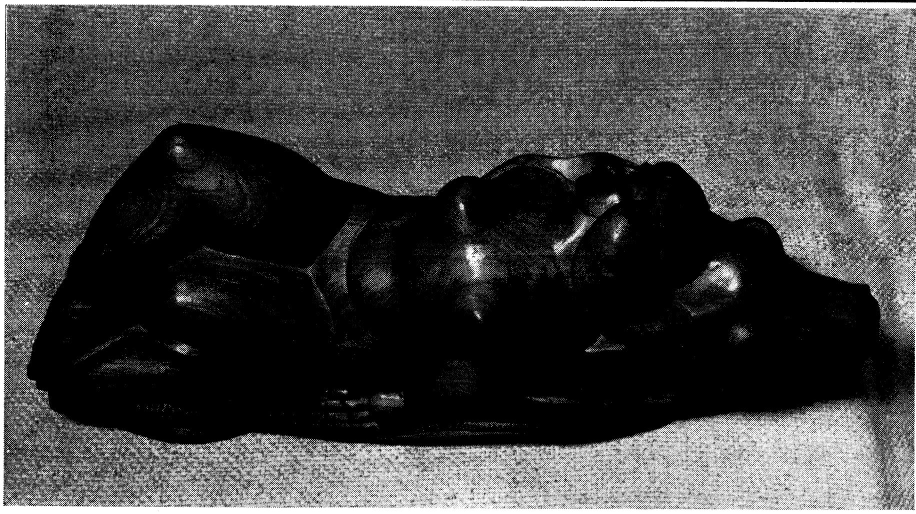
EXAMPLES OF EUROPEAN WOOD CARVING

1. Choir stalls (1499), Church of Sta Maria in Organo, Verona. 2. Choir stalls (1535), Church of S. Pietro dei Cassinensi, Perugia. 3, 4. North transept door, Church of St. Maclou, Rouen. 5. Stalls north side, Mayor's seat (1697), by Grinling Gibbons (1648–1720). In St. Paul's cathedral, London. 6. Door of the boudoir of Marie Antoinette, Château de Rambouillet. 7. Sixteenth century panels in Beauvais cathedral. 8. Pulpit by Fredrik F. Verbruggen (1655–1724), Church of Ste Gudule, Brussels









BY COURTESY OF (TOP LEFT) WILLIAM ZORACH, (BOTTOM LEFT) ROBERT LAURENT, (BOTTOM RIGHT) ORONZIO MALDARELLI, (TOP RIGHT) THE SOLOMON R. GUGGENHEIM MUSEUM; PHOTOGRAPH. (CENTRE) ANDREAS FEININGER © TIME. INC.

CARVINGS OF THE 20TH CENTURY

Top left: "Bathing Girl" by William Zorach (1887–), U.S. Carved in Borneo mahogany

Centre: View from the side (above) and detail of the head from the front (below) of "The Avenger" by Ernst Barlach (1870–1938), German From the Herman Schulman collection

Top right: "Adam and Eve" by Constantin Brancusi (1876–1957), Rumanian. Construction of carved chestnut, limestone and old oak

Bottom *left:* "Europa" by Robert Laurent (1890–), U.S. Carved in teak. In the collection of the Norton gallery, Palm Beach, Fla.

Bottom right: "Companions," a composition in two figures by Oronzio Maldarelli (1892–), U.S. Carved in rock maple

English oak or mahogany, all of which are fairly easy to obtain. The beginner will do well to practise on softer woods, yellow pine or white wood, which have good grains and are easy to cut.

Tools.—.Approximately two dozen carving tools are sufficient for the sculptor in wood; most useful are the straight chisels and gouges, varying in size from one-eighth of an inch to an inch or more according to the type and size of the work to be done. The tools should be sharpened every day after the day's work is done. using carborundum stones both smooth and rough, or Washita or Arkansas stones. The outside of the tool, which comes against the wood and has the longest bevel, is rubbed against the stone; when it has been sufficiently honed it can be rubbed on a piece of pig's hide to obtain a fine finish. The inside of the gouges should be rubbed on a very fine stone—a slip, either straight or round edge—to remove any steel burr that may have remained after the tool has been sharpened on the long beveled edge. The handles of chisels should be octagonal, for these provide a firmer grip for the hand than the smooth, round ones.

A necessary addition to the collection of carving tools are the wood files of various types, half-rounds (both large and small) and the regular wood rasps of the type made only in Europe.

On large pieces and with hard woods, the use of a mallet is necessary, the size and weight varying from 12 ounces to 3 pounds, depending on the individual and the type of work to be done. The best mallets are of lignum vitae and of hickory. After the work is blocked in, and the sculptor is close to the finished shape and surface, he may apply pressure only with the palm of the hand that is not holding the chisel. Working thus he has better control. and the palm of the hand soon gets hardened. The workman. at this point, may hold the lower part of the handle and a good part of the tool itself with one hand and with the other take a good grip on the handle. thus getting good control and more power and minimizing the danger of cutting himself. The experienced workman always cuts away from himself.

Finishing **Woods.**—One of the most satisfactory ways of finishing a wood carving is by using several coats of paste or liquid wax, well rubbed in. Some artists prefer to stain the raw wood, any color such as mahogany or walnut, and then apply the wax. Shellac or linseed oil may also be used as a first coat.

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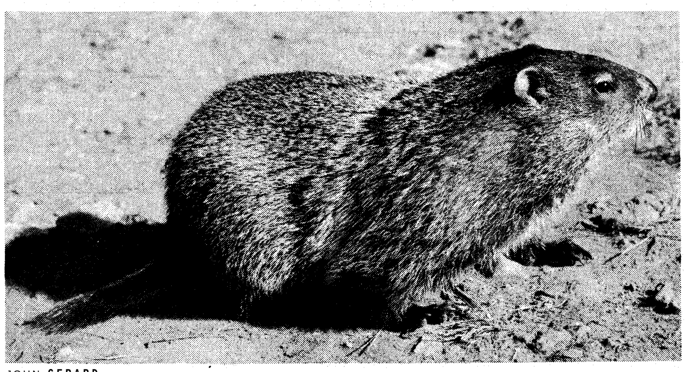
WOODCHUCK (*Marmota monax*), a large heavy-bodied burrowing rodent of the squirrel family (Sciuridae); it is also called ground hog. "Woodchuck" is also applied less often to the other species of North American marmots. They range from Alaska over Canada and the eastern United States. A large woodchuck measures about 22 in, long including a 6-in. tail. The body colour is reddish brown; the feet are almost black. Woodchucks inhabit the edges of meadows and forests and they prefer the rocky sites.

The den is usually dug in a hedge row, under a ledge of rock or in an open meadow, and has several chambers and galleries.



JOHN GERARD

WOODCHUCK (MARMOTA MONAX)

Mating takes place in the spring, shortly after the animals emerge from hibernation. At this time the males wander widely in search of a female and fight each other in the defense of their individual territories.

The two to nine young are born four weeks after mating. The male and female may live together in the spring but at other times are usually solitary. The young are playful but soon grow into slow, lumbering, methodical adults.

Woodchucks are active usually only during the day. When emerging to feed, they pause near the burrow entrance for a thorough inspection of their surroundings and often give vent to a piercing whistle. They eat green plant material and occasionally resort to cultivated crops, causing considerable damage. They may be controlled by fumigation of the burrows or poisoned bait. Woodchucks hibernate in a true torpor for as long as eight months each year.

See also GROUND-HOG DAY; MARMOT. (K. R. KN.)

WOODCOCK, a succulent game bird, in the family Scolopacidae, highly prized by sportsmen and epicures, famous for its erratic, whistling flight. It is chunky, short in neck and leg, and lives in wooded bottomlands and wet uplands. The sensitive, movable tip of the long bill is used to punch "borings" and probe for earthworms in moist earth. One American bird, weighing six ounces, ate half a pound of worms in 24 hours.

Large eyes are set high forward in the large head, and the bird is usually crepuscular or nocturnal. During bright daylight it sits close in brush, where its mottled brown plumage conceals it against dead leaves or nest. Three blackish bands across the pale buff rear-crown distinguish woodcocks from' snipe.

JOHN MARKHAM

EUROPEAN WOODCOCK (SCOLOPAX RUSTICOLA)

The sky dance is a remarkable courtship flight. With loud cries, usually at dawn, the male spirals over a wide area, high into the air, and zigzags back to earth.

Four buff eggs, blotched with brown. are laid—February to May in America. March to August in Europe—in a slight hollow in the ground, and incubated for 21 days. Downy young are carried in flight to the feeding ground. or removed from danger, between the mother's thighs. Reluctant to leave the nest, the mother feigns injury to mislead intruders.

The American woodcock (*Philohela minor*), 11 in. long, breeds from Nova Scotia to Florida, and Manitoba to Louisiana and Colorado, wintering in the southern half of its range. The European species (*Scolopax rusticola*). 14 in. long. breeds from Ireland to Japan, from the Arctic circle to the Azores and Canaries, Pyrenees, Alps and Himalayas; it winters in North Africa, Ceylon and southern China, and occurs occasionally from Labrador to Virginia.

A smaller, darker species (*S. saturata*) is found in the mountains of Sumatra, Java and New Guinea, while local species occur in the Celebes (*S. celebensis*) and on Obi in the Moluccas (*S. rochussenii*). (G. F. Ss.)

WOODCRAFT. Woodcraft is the knowledge of the wilderness conditions which enables one to enjoy and supply oneself with the crude necessities and comforts of life in unsettled and uninhabited areas, be it forest or prairie, mountain or swamp, lakeland or desert.

Primitive' man has always had to deal with nature in order to exist. However, it took centuries to bring knowledge of woodcraft to a point where it embraced comforts as well as necessities. The particulars of woodcraft vary with each country and area, but the requisites are always the same, good eyesight and hearing, good judgment and patience.

The first white settlers of North America learned much from the Indians who were masters of woodcraft. Life itself was a matter of woodcraft to the Indian, as it still is to many savage and semisavage people in Africa, South America. and the South Pacific islands.

One versed in woodcraft will have sufficient knowledge of mechanics and craftsmanship to enable him to improvise tools, weapons, shelters and clothing; to make rafts and to construct canoes of birch bark or skins. He will know the value of fire. and what can be done with it. For the dry wood or bark which is needed for his fire he will break dry branches from trees rather than use those found on the ground, or he will look for it in hollow logs or trees. He knows that resinous woods produce smoke while dry, non-resinous woods usually do not. For a quick fire the woodsman will use soft woods such as poplar or pine; for a hot fire such hard woods as oak, hickory or maple; and on his night fire he will use green logs since they will burn slower and keep a fire longer than dry logs. In rainy weather he often carries enough dry wood or birch bark in his pack to start a fire: and he dries out wood at each fire to carry with him to his next stopping place and he always carries extra matches in a waterproof match box. The woodsman never builds a fire without first clearing away all brush and inflammable matter to prevent a forest or grass fire and he always kills his fire before leaving it.

Woodcraft is the knowledge of where to find water fit to drink. The old timer knows that springs can often be found in low places or at the bases of hills and that they are as a rule safe to drink from, as are also swift-flowing streams away from human habitation. Many a woodsman in swampy country quenches his thirst by cutting off grapevines and drinking the sap as it drips from the ends. The desert prospector. on the other hand. will when necessary drink the water that is found in certain cactus: he will never drink alkali water or salty water, and when in doubt he knows that 10 or 15 minutes of boiling will make any but salt or alkali water fit for drinking or cooking.

The woodsman knows which berries and wild fruits are edible and will not eat those he knows nothing about. He knows that fresh greens are a necessary addition to a meat. diet, and that he can eat young stalks of milkweed: burdock and Solomon's-seal when they are boiled. He will eat roots of bulrushes also. when boiled, and young shoots of dandelion, dock, sorrel, wild mustard and watercress without cooking. He knows how to build caches of stone or poles to keep his food and belongings out of the reach of wild animals,. The expert in woodcraft knows how to read signs—that is, he can tell by telltale marks what animals have passed along a trail. He knows the marks left on trees by bear claws, raccoon or squirrel claws. and deer horns. He knows the footprints of animals and birds, and he can tell that a bit of fur on the bark of a tree or tn·ig has come from a bear or a deer, or a feather from a partridge or a blue jay.

He knows how to make cord and rope of basswood, elm: or cedar bark, strong enough to lash things together when nails are lacking. He is able to build a rainproof lean-to shelter with a few poles and a blanket or some brush. Here, in the reflected heat of a fire built a few feet from its open side, he can be comfortably warm in cold weather. The woodsman knows too that it is warmer sleeping on fir branches or dry grass on the ground than a raised platform or cot under which cold draughts circulate.

The true woodsman is seldom lost. If he hasn't the faculty of knowing directions at all times, he does know that moss usually grows thicker on the north side of a tree. providing the tree is not in a damp shady spot or in a densely wooded place. He can also, by chopping into the sides of a tree. find by careful observation which side has the thickest bark; this side, he knows, is north, but he must check on several trees. He also knows that the two stars at the end of the bowl farthest away from the handle in the Great Dipper point upward to the north star.

Woodcraft then, may be said to he a match of wits with nature, an attempt to be one jump ahead of it or at least to meet it on even terms. (W. B. HT.)

WOODCUT AND WOOD ENGRAVING are terms conventionally applied to pictorial designs printed from wood blocks cut by hand. The most usual method in earlier times was first to draw or trace the design on a specially prepared wood block. and then to cut away with the knife the surrounding parts of the wood surface between the lines so that the block. when inked and pressed on to paper, produced a print of the drawing in black line on a white ground. During the latter half of the 18th century, in Europe, it gradually became the practice to engrave the design on the wood block with an engraving tool, or burin, leaving the main surface of the block at its original level, so that the impression produced a picture in white line on a black ground. The former method is correctly described as woodcut. the latter as wood engraving. Both are essentially "relief" processes, since the parts to receive the printer's ink are left in relief.

HISTORY

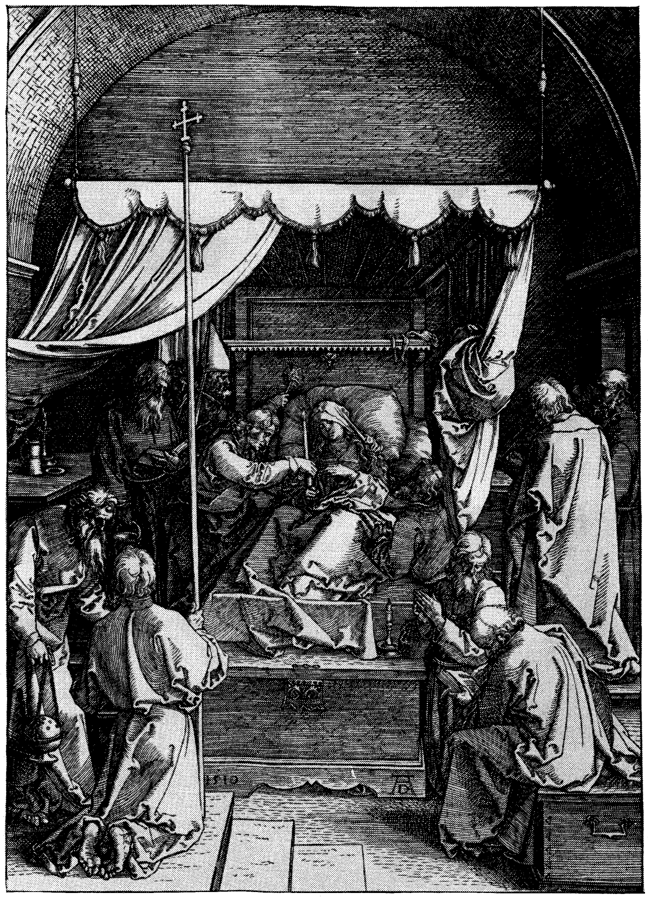
Early History of Woodcut.—The art of woodcut was practiced in the Orient much earlier than in Europe. In China it arose out of the use of a wooden stamp to make decorative. ideographic and symbolic impressions in clay or wax. From this very ancient art came block printing, and the paper used for this was available in China at least by the early 2nd century A.D. Woodcut was brought to Japan from China in the wake of Buddhism in the 6th century A.D. and subsequently nurtured into a national art of great originality and splendour (see JAPANESE PAINTING AND PRINTS: *Wood-block Prints*).

In Europe the earliest printing from wood blocks was done on textiles: and pictorial designs printed in this way are known from the beginning of the 14th century. But the main development of the art of woodcut in the west hegan only when enough paper, which had been introduced into Spain from the east as early as the 11th century, began to be manufactured in France and Germany toward the end of the 14th century. The most primitive cuts, such as the "Christ before Herod" in the British museum, were probably made about 1400 or soon afterward. about 25 years before' the earliest line engraving; they have thick outlines and little or no shading, yet they often show a simple grandeur of design reminiscent of the figures in stained glass, and are sometimes more in accord with modern taste than the elaborate productions of a century later. The earliest credible date which occurs on any woodcut is 1323, on a "St. Christopher" of German origin in the John Rylands library at Rlanchester; but even there it is not quite certain that the cut was executed in that year, and in any case several undated examples seem to be somewhat earlier in style. National loyalties have led to disputes between French and German scholars as to the localization of the earliest woodcuts. But it is at least certain that the art developed most extensively in south Germany; and some very beautiful religious cuts. intended no doubt for domestic veneration in poorer houses. or to be sold to pilgrims. were produced in Bavaria and also in Austria and Bohemia, from the second or third decades of the 15th century. It seems likely also that playing cards were printed from wood blocks at this same early date, though no surviving examples can be dated before 1450.

Book Illustration and Block Books.—The art of woodcut was greatly encouraged by the invention of printing from movable type in the mid-15th century. After 1460 woodcut illustrations became more and more popular in Germany and the Netherlands; and a decade or so later also in Italy. where toward the end of the century some of the most beautiful illustrated books were produced in Florence and Venice. It is tempting to suppose that the immediate predecessors of these illustrated books. in which woodcuts were combined with text printed from movable type, were the so-called block books, such as the Apocalypse, the *Biblia Pauperum* and the *Ars Moriendi,* which were woodcut picture books, generally religious. with a short text. Both text and illustrations were cut by hand on the same block and printed as a page. Historically; however, this may not be exactly the case; for it is at least doubtful whether any of the editions of the fen· surviving block books, which are predominantly Netherlandish in origin, can be dated before the earliest illustrated books printed from movable type; most of them definitely belong to a period alter 1460. On the whole it seems likely that the block-book method developed independently about the mid-15th century, as a means of giving religious instruction to the illiterate, and then was gradually abandoned as literacy increased and a much less laborious method of providing the text became more and more popular.

Above: "The Buxheirn St. Christopher," earliest dated woodcut in Europe, 1423, now in the John Rylands library, Manchester

Above: Frontispiece to Breydenbach's "Itinerary to the Holy Sepulchre," Mainz, Ger., 1486



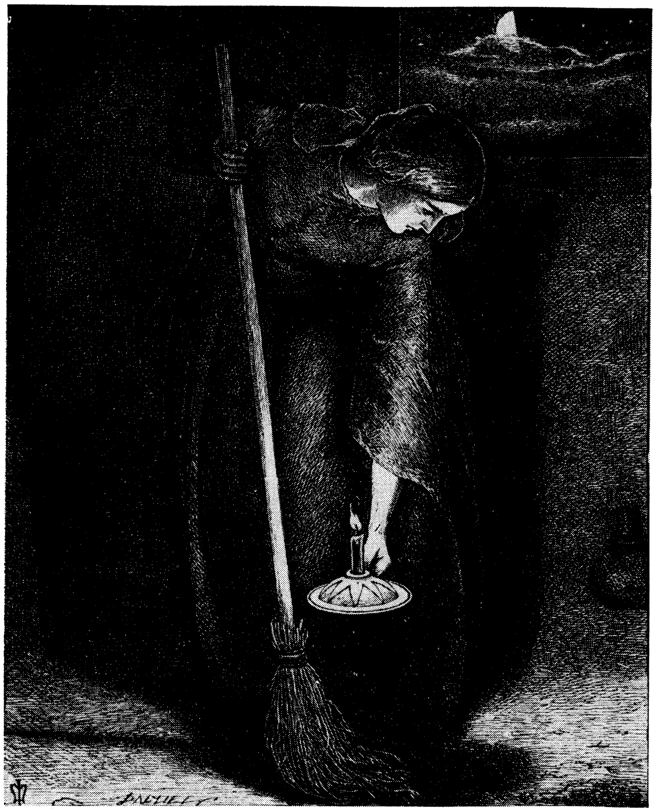
Right: "Death of the Virgin," woodcut by Albrecht Durer, 1510

BY COURTESY OF (TOP LEFT) AMERICAN INSTITUTE OF GRAPHIC ARTS, (BOTTOM LEFT. BOTTOM RIGHT) THE TRUSTEES OF THE BRITISH MUSEUM; PHOTOGRAPHS, (TOP RIGHT) BROWN BROTHERS, (BOTTOM CENTRE) ARTISTS ILLUSTRATORS, LTD.

Below: Florentine woodcut book illustration, late 15th century

Below: "The Noblewoman" from the "Dance of Death" series by Hans Holbein, the younger (1497–1543)

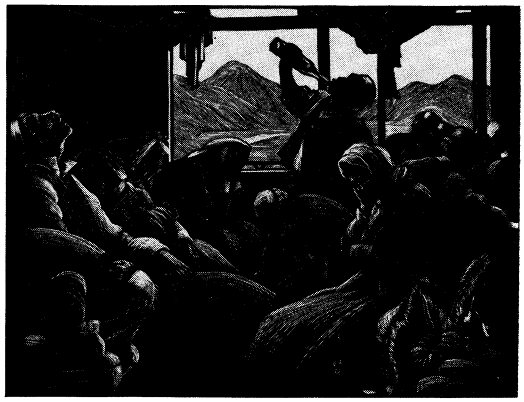
WOODCUT AND WOOD ENGRAVING



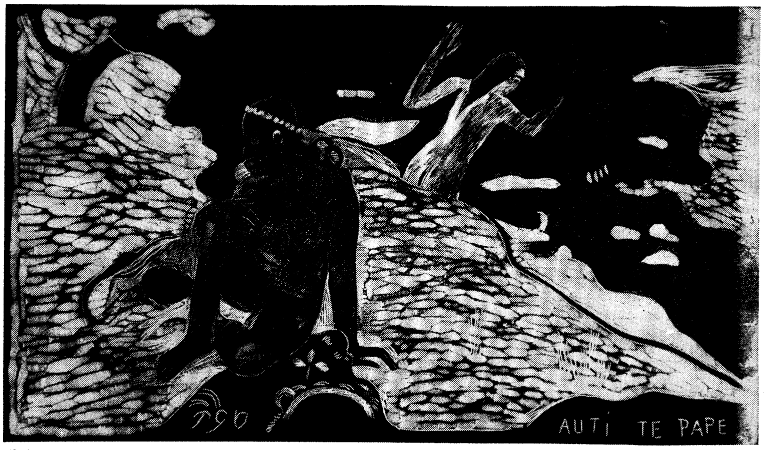
"Parable of the Lost Piece of Silver," engraving by Edward and George Dalziel (after J. E. Millais); English, 19th century

"The Kiss" woodcut by Edvard Munch (1863–1944), Norwegian

Engraving of an owl from *History of British Birds* by Thomas Bewick (1753–1828), English



"Dawn in the Train," engraving by Clare Leighton (1899–), English



"Women by the River," woodcut by Paul Gauguin (1848–1903); French 19th century

The "Pastorals," two of the wood engravings by William Blake (1757–1827) for Thornton's edition of Virgil

WOODCUTS AND WOOD ENGRAVINGS FROM THE LATE 18TH TO THE 20TH CENTURY

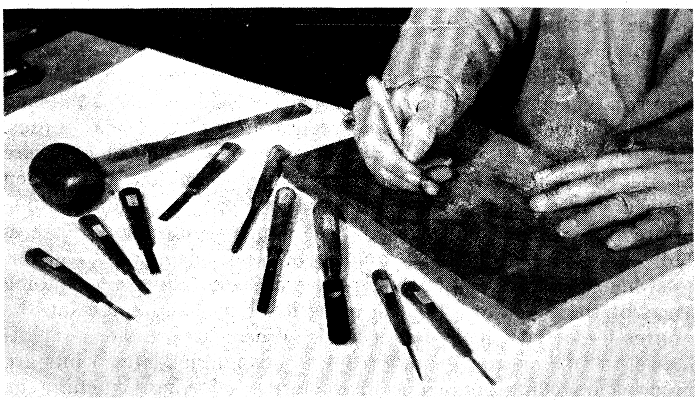
BY COURTESY OF (TOP LEFT, CENTRE RIGHT, BOTTOM RIGHT) MUSEUM OF FINE ARTS, BOSTON (TOP RIGHT, BOTTOM LEFT) THE ART INSTITUTE OF CHICAGO

The 16th Century.—The height of achievement in the art of the black-line woodcut was reached in Germany during the time of Albrecht Durer (1471–1528) and his followers in the first half of the 16th century. Apart from its value for book illustration, the woodcut was quickly recognized as a cheap method of propagating religious and political ideas among a much wider public than could otherwise be reached; the Reformation, for instance, inspired both at Wittenberg in the school of Lucas Cranach and at Niirnberg in the remoter following of Durer. a number of anticlerical prints, often crude and scurrilous, the equivalent of the modern newspaper cartoon. The exquisite designs of Durer himself (which are for the most part sincerely religious), of Hans Holbein the Younger in his famous "Dance of Death," and of other artists at Nurnberg, Augsburg and elsewhere, were cut on the block in the utmost detail by professional block cutters, some of whose names are recorded. The prints may be regarded as perfect facsimiles of the pen drawings which the artists themselves drew on the prepared block. In the Netherlands too, at this time, to some extent under Durer's influence, fine woodcuts were produced by Lucas van Leyden and others; while in north Italy are found cuts after important designs by Titian, and original designs in this medium by such artists as Jacopo de' Barbari and Domenico Campagnola. But it was in Germany that the art flourished. The emperor Maximilian I gave it great encouragement by planning extensive woodcut publications in his own honour: the "Triumphal Arch of Maximilian," largely designed by Durer, the "Triumphal Procession," chiefly by Hans Burgkmair, the "Great Triumphal Car," by Durer, and other illustrated books and series of woodcuts by various artists. Many of the original blocks for these have survived in Vienna. Other blocks of Durer's woodcuts are to be seen in the British museum and elsewhere. In the Basle print room there is a series of blocks with early illustrations by Durer for the comedies of Terence; some of the designs are merely drawn on the block and not yet cut, and some are completely cut and ready for printing.

The book in question was, of course, never published, but these and other surviving blocks give a clear insight into the procedure.

Change of Method to Wood Engraving in White Line.—After the mid-16th century the art of woodcut greatly declined in importance by comparison with line engraving and during the 17th century the attractive prints of Hendrik Goltzius and Jan Lievens in Holland were among the few original works in this medium. Nor were reproductive woodcuts, such as those of Christoffel Jegher after Rubens, any commoner. This situation persisted until the end of the 18th century, when the English engraver, Thomas Bewick of Newcastle, in his charming cuts of birds. animals and country subjects, was chiefly responsible for re-establishing the art by the development of a new method. Since most (though not quite all) of the earlier woodcuts were designed to print in black line on a white ground, which involved the cutting away of a large part of the block surface, the plank of the wood (cut in the direction of the grain) was used, and the cutting was done with a knife. The disadvzntage of this method is that since the plank is relatively soft, and the linens are isolated in relief, they tend to lose their sharpness, and eventually to break, in the process of repeated printing; this can be observed in late impressions of woodcuts of Durer's time. From Bewick onward, the hard end of the wood (cut across the grain) was generally used. and the design was engraved with a burin, so that most of it appears, when printed, in white line against a black background. Bewick was the chief popularizer of the white-line style, and in this he was followed by his contemporary, William Blake, in his small but beautiful illustrations for Thornton's Virgil.

In France it was not long before wood engraving, introduced by English engravers, superseded line engraving, etching and lithography as the most popular medium for book illustration. With facility and fidelity, the French engravers were able to render designs that were little short of the intentions of artists having the most personal and individual styles. What is known today as the "romantic illustrated book" emerged with its hundreds of wood-engraved vignettes, so delightfully placed and printed in the text These were books which were both deluxe editions and books for frequent reading and enjoyment. In 1835, the first of them made its appearance: the famous *Gil Blas*, published by Paulin, with about 800 cuts after the drawings of Jean Gigoux. This was folloned by a long train of handsome and readable volumes to which many notable artists, among them P. Gustave Doré, Tony Johannot, Paul Gavarni, Henri Monnier, Jean Meissonier, made lavish contributions.



CORRECT POSITION OF THE KNIFE FOR CUTTING ON THE FLAT SIDE OF A PLANK BLOCK. ON THE TABLE ARE VARIOUS SHAPED GOUGES AND FLAT CHISELS USED FOR REMOVING LARGE OR SMALL AREAS OF WOOD

Outstanding among them are Curmer's edition (1838) of *Paul et Virginie* (the masterpiece of the period), Balzac's *Les Contes drolatiques* (1855) with Doré's finest work. La *Grande Ville* (1842) and the numerous volumes which perpetuate the strange imagination of Grandville who has been claimed as an ancestor by the surrealists.

The first American woodcut—and also the first book illustration—by a known block cutter, was a portrait of Richard Mather by John Foster which must have been done about 1670, but a national school of engraving did not begin to form until Alexander Anderson, inspired by Bewick in the 1790s, began to engrave on wood. The medium proved to be one for which the Americans had a special flair and brilliant abilities. From about 20 professional wood engravers in the United States in 1838. the number increased to around 400 by 1870. Illustrated magazines, like *The Family Magazine*, *Harper's Monthly* and *Harper's Weekly*, and a great variety of illustrated books, enlisted the talents of prominent artists, among them Winslow Homer, Felix O. C. Darley, John LaFarge, Thomas Moran. Homer Martin. Thomas Nast, and engravers such as William Croome Henry W. Herrick, W. J. Linton, Henry Marsh, as well as a host of others whose technical resourcefulness and invention often obtained amazing results. About 1874 the "new school" appeared. headed by the gifted Timothy Cole. and the Society of American Engravers was formed. A portfolio of norks by 15 of these artists, published by Harper's in 1884, shows their methods brought to such a high degree of skill that not even the mechanical means which appeared about this time and nere soon to replace wood engraving as a reproductive medium can be said to outdo it, for the subtlety and dedication of these last practitioners could have no mechanical counterpart.

In England, for a short time in the mid-19th century. the black-line method was revived, chiefly for reproductive purposes In the 1860s the brothers Dalziel and others engraved admirable facsimiles. in books and periodicals of the pen drawings of the Pre-Raphaelites and of the pictorial reporters of the weekly papers. But there. as in the U.S , in the 1870s, this method of reproduction became obsolete by the introduction of photographic processes, and in spite of a revival of woodcut book illustration at the end of the 19th century (in the Kelmscott and Vale presses in England and in Lucien Pissarro's Eragny press in France), most original nork in black and white during the first half of the 20th century mas confined to engraving in white line Although photomechanical methods had rendered woodcut and nood engraving obsolete as reproductive media, they were to be revived in another realm of the graphic arts; that of the print as an independent .work which accomplishes its aim within itself. Paul Gauguin, during an 18 months' sojourn in France in 1893, following his first Tahitian trip, executed 10 blocks which may be said to have awakened the wood-block media to a new realization of their possibilities. Gauguin's methods were personal and complex. The blocks were of European boxwood which he engraved with fine lines, then gouged out certain portions in varying depths. The two-tone impression. taken from the same block in two different printings (for example: one in black, one in brown), slightly off register, was one of his innovations. Colour was often added by daubing areas of the block and then printing it, or by hand colouring the impression after it had been printed. When he returned to Tahiti he was compelled to use soft native woods and his later prints are much coarser and simpler in character. Following Gauguin, the Norwegian Edvard Munch gave stimulus and energy to what was fast becoming a tradition; he produced strong and haunting compositions. Felix Vallotton. a Swiss artist living in France, brought forth his arresting and amusing subjects in unusual dispositions of black and white. But it was under the influence of Munch that the expressionists of the 20th century employed the medium of the woodcut, sensing its resources so astutely that in many of the prints by Ernst Ludwig Kirchner, Emil Nolde, Christian Rohlfs, there is a return to the essential qualities of wood as a print medium that is the worthy furthering of much earlier traditions. These tendencies have been in key with the great changing movements in all art forms since the late 19th century and—as with painting—there has always been a group that also glorifies the medium by more sober and conservative means. In the 1920s and 1930s both woodcut and wood engraving were very popular: the widely circulated illustrations and block prints of the American. Rockwell Kent; the novels, narrated in woodcuts without text, by the Belgian Franz Masereel, the wood engravings and cuts of Eric Gill. Clare Leighton. Rudolf Ruzicka and Thomas Nason kept the media alive and new for a large public. Neither the woodcut nor wood engraving has lost vigour or its wealth of possibilities and both have strong attractions for young artists who, like the engraver Misch Kohn in the U.S., bring them understanding and technical mastery.

Colour and Chiaroscuro.—Primitive woodcuts in Europe, including book illustrations, were usually coloured by hand and seldom with much care of skill. From the early 16th century (the earliest dated example is by Hans Burgkmair in 1508) the line block was sometimes combined with one or more surface blocks printed in various shades of colour, partly superimposed. This method, which originated in Germany, became popular in the 16th century in Italy. where Ugo da Carpi (*c.* 1455–1523), working from designs by Parmigianino, Raphael and others, was the best known exponent of what is called the chiaroscuro woodcut. The aim of this method was to imitate a drawing in line and wash, and the emphasis was on variety of tone rather than colour. The method, which persisted to some extent through the 17th century, was revived in the 18th, notably in Venice by A. M. Zanetti the elder and the Englishman J. B. Jackson, both of whom published excellent chiaroscuro cuts. generally after drawings or paintings by earlier Italian masters. Experiments with the chiaroscuro medium have been made in the 20th century; but the modern tendency has been mostly in the direction of pure colour-wood-cuts, inspired by the Japanese.

See also Index references under "Woodcut and Wood Engraving" in the Index volume. (J. B. S.; H. Es.)

TECHNICAL PROCESSES

Wood Blocks.—The side grain of soft wood, *e.g.*, cherry, American whitewood, pear. apple or lime. is suitable material for woodcutting. The end grain of boxwood is the only completely satisfactory surface for wood engraving. After seasoning, the blocks are planed level, surfaced and cut to a standard thickness of 0.916 in.; that is to say, they are type high and may be inked and printed with typeset matter. Under ordinary conditions of modern commercial production, however, direct printing from a wood block is rarely, if ever, attempted. Fear that the block will split under pressure obliges the use of electrotypes made from the wood surface.

Transferring the Design.—The design may be drawn directly on the block. or it may be prepared first on paper and then traced through a carbon sheet. If the drawing is direct, it may be made with a soft pencil, lightly used, or with a brush and black paint. If the drawing is traced. the rather slippery wood surface may be made more receptive with a thin coating of either white or black water-colour paint. Some craftsmen, particularly wood engravers, prefer a black surface because, as each stroke of the tool reveals the pale colour of the wood, they can watch the development of their work. Alternatively. the surface of the wood may be sensitized to receive a photographic image of the design. This method is especially helpful when the design is intricate or exacting. Furthermore. since all designs must be made in reverse—in order to print the right way—it is convenient to have the transposal made by the camera.

Woodcutting: Tools.—The tools used by the woodcutter are the knife, gouges, chisel and mallet.

Knife.—The knife is the principal cutting tool for defining all the lines and shapes of a design. There are several kinds, different in size and shape, with little to choose between them in usefulness. The woodcutting knife may be held like a pen, or grasped firmly with the whole fist. The handle, therefore, should be neither too unwieldy nor too slender; the blade should be rigid and fairly short.

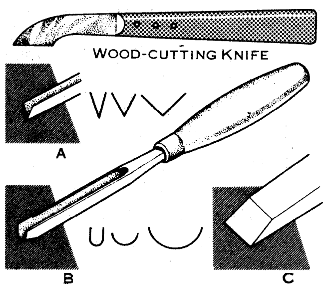


FIG. I.—TOOLS USED FOR WOOD-CUTTING. SHOWING THREE SIZES OF GOUGES: (A) V-GOUGE, (B) U-GOUGE, (C) CHISEL

Gouges.—Gouges are concave metal shafts, V-shaped and U-shaped in section, mounted in wooden handles. They are made in a number of sizes. Their purpose is to cut lines corresponding in width to their own section and to remove superfluous wood. A gouge's efficiency depends on its sharpness. Its cutting edge may be reset on a small sharpening stone, called a V-stone. The sides of the V-stone converge from a curved-back edge to an acute-angled front edge; the former is used for the U-tool, the latter for the V-tool.

Chisel and *Mallet.*—The chisel supports the work of the gouges in leveling down the larger nonprinting areas of the block. Both chisel and gouges may either be pushed by hand, or knocked gently with the wooden mallet.

Cutting technique.—To cut a white line, the knife is drawn toward the body to make two separate incisions. each so inclined toward the other as to cut a V-section in the block. If the incisions are made to meet at either end, the sliver can then be lifted from the surface. Alternatively, the line may be made in one stroke with the V-gouge. The latter method is obviously simpler, but for those parts of a woodcut which demand drawing, as distinct from clearing, the knife is more responsive and versatile.

Wood Engraving: Tools.—The wood engraver's tools are, by name, graver, spitsticker, tint tool. round scauper, square scauper and multiple tool. Each consists of a metal shaft fixed in a wooden handle. As a general rule, the depth of the tool's incision determines the width of the line that it makes. Yet wood engraving is a comparatively shallow process. The wood is hard; if the tool is buried too deep, it will stall. Therefore, so that it may be moved close and nearly parallel to the block's surface, the shaft of the tool is set at a slight upward angle, and the handle is half rounded with one flat side. Engraving tools must be kept very sharp. The edge of a blunt tool can be restored by laying its face absolutely flat on the surface of a hard Arkansas oil stone, and grinding it gently in a few drops of light oil.

Grazer.—The graver is sometimes known as the solid burin. It has a rhombic section, varying from narrow to square, and is made in a number of weights. Its acute point enters the wood very readily. The engraver can use it for a line of uniform width by sustaining a constant dcpth of cutting, or for a line of variable thickness by raising or lowering the angle of entry. A rich variety of stipples and textures may be made with the graver, but it is primarily a tool for straight lines.

Spitsticker.—The spitsticker is a tool for curved lines. In section, it is flat at the top with curved sides which meet keelwise at a point. Like the graver, it is made in several sizes, and the width of its line depends on the depth of its intrusion into the wood.

Tint Tool.—The thickness of the line made by the tint tool depends on the size of the tool; it is made in a number of widths. It has straight sides which converge gradually to a square cutting edge. As its name implies, its function is to lay tints composed of even lines.

Scaupers.—Scaupers, also called scorpers or scoopers, are clearing tools for lowering the surface of unwanted areas of wood. The sides of the round scauper converge to a curved base; the square scauper has straight sides and a square base. Each is made in a numher of widths. A wide size of round scauper is used for dealing with large areas, a narrow size for more delicate clearances around contours and between lines. The square scauper can be used to level off the ruts made by the round scauper, and it has a unique capacity of clearing right angles and corners in two strokes. A useful auxiliary to the scaupers is a chisel tool, which is simply a carpenter's chisel. set in the same handle as an engraving tool.

Multiple Toal.—&lost engravers agree that the multiple. or threading. tool is the last that should be acquired. Most engravers use it. notwithstanding. to a greater or less extent. Its performance of engraving two. three or more lines at once (according to its size) gives it the suspect character of a mechanica1 aid. Nevertheless. it has beautiful qualities when directed with reserve and discretion. Its unrestrained use tends to promote facile and showy execution.

Engraving Technique.—The way of holding tools may vary a little between one craftsinan and another. but the nature of wood-engraving imposes a certain uniformity. A conventional hold is to tuck the handle. flat side downward, between the crook of the little finger and the palm of the hand; then. with the tips of the other three fingers located on the shaft, the thuinb is advanced almost to the point of the tool. In such a position. pressure. exerted on the handle by the little finger and the palm. and steadied by the thumb's contact with the shaft can be as firm or light as required.

The block is placed on a small, heavy, leather sandbag, circular in plan. with a fiattened top and bottom. The weight of the sandbag makes it a rigid support; its height allows room for the left hand to hold the block and the right hand to manipulate the tool. Straight lines are engraved by pushing the tool into the wood surface and. as the shaft passes over the thumb, contracting the hand until the liinit of the stroke is reached. The point of the tool rests in the furrow while the thumb slides fornard again. and the movement is repeated until, by progressive stages. the line is completed At the end of an engraving stroke. the wood fragment is picked out nith a levering action of the tool. In this movenicnt, there is alnays a risk of cutting or bruising an adjacent area of the block with the heel of the tool; a piece of card, laid between the tool and the block. gives both protection and leverage. Curved lines are engraved by turning the block against the point of the tool. The right hand holds the tool steady. while the left hand controls the prcssure and directs the movement.

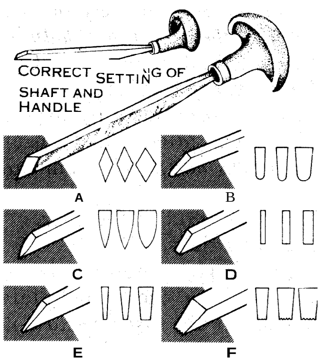


FIG 2—TOOLS USED FOR WOOD ENGRAVING SHOWN TO THE RIGHT OF EACH TOOL ARE THREE VARIETIES OF THE CUT PRODUCEO (A) SOLID BURIN OR GRAVER (B) ROUND SCAUPER. (C) SPITSTICKER (D) SQUARE SCAUPER. (E) TINT TOOL. (F) MULTIPLE TOOL

Printing.—Some craftsmen take prints of their work at an intermediate stage, others prefer to complete their cutting or engraving before inking the block. The ink. a fairly stiff letterpress printing ink, is spread out on a sheet of glass and reduced. by energetic work with a printer's small hand roller. to a silky consistency. Then the roller is passed over the block to cover it with a thin film. A sheet of paper is laid carefully on the inked surface, and a burnisher, or even a teaspoon. is rubbed smoothly all over the back of the sheet until the ink has been transferred evenly from block to paper. Wood blocks may also be printed on a hand press. This ensures an unvarying and desirable uniformity of impressions, but hand printing admits of more direct and sensitive control.

Paper.—For hand printing. Japanese and India papers are suitable; they are available in varied tones, weights and qualities. Printing by press, because it exerts a greater weight and force, allows a wider choice of appropriate papers.

Colour Prints.—The making of a colour print obliges the cutting or engraving of a separate block for each colour. Since the final print is a built-up sequence of impressions from several blocks, co-ordination depends, firstly, on precise fitting of the colour shapes and. secondly, on accurate placing of the paper when takirig each print. The first block to be completed acts as a key. For this purpose. the most pervasive colour in the design is likely to prove the most useful guide for ensuing printings. A wet impression. taken from the first block, is burnished, or offset. onto the uncut face of the second. The second colour may then be plotted in right relation to the first. This method of offsetting is repeated for each colour. The correct lay of the paper is ensured by devising identical register marks on each block. One way is to commit the design to outsize blocks. of equal measurements. and large enough to allow a uniform margin of at least an inch and a half around two adjacent sides of the design. On each block, the level of this marginal space is lowered—to avoid contact with the inking roller—except for a right angle in the top left-hand corner and a line in the top right-hand corner. The line and each arm of the right angle should be about two inches long and of precisely equal width, not less than half an inch. The outer walls of the two shapes are made by the sides of the block; the inner walls should be vertical planes. Then. the paper. provided its edges are square. may be laid on each block in turn. so that its top left-hand corner fits in the right angle, and its top edge lies along the raised line.

In assessing the required number of printings. consideration is given to all the possibilities offered by the overprinting of one colour on another; and. at the same time. because printing inks vary in opacity, the sequence of the impressions is an important decision. The technique of inking and printing is the same as that of the single colour block.

There is another method of printing in colour. appropriate only to woodcuts, which is based on Japanese practice. Instead of printing ink applied with a roller, powder colour, mixed with water and rice flour paste. is painted on the cut surface of each block with a flat brush. To retard absorption. the block is moistened first with a sponge. The impression is made on damped Japanese paper by rubbing the back of the sheet with a baren. a flat. hard pad sheathed in a bamboo leaf. Printing is not limited to fiat colours; differences in tone are effected by varying degrees of pressure. Using means of this sort. the Japanese achieved the most amazing standards of accomplishment in the 18th and 19th centuries. The drawing was made on thin paper by an artist and pasted on the wood. Cutting and printing were carried out by highly specialized craftsmen whose undeviating intention was to make faultless copies of the artist's original.

Nowadays, all the resources of modern photographic reproduction have canceled the need for disguising the colour print in the character of another medium. As a result, contemporary woodcuts and wood engravings. plain or coloured, are deliberately designed in terms of their own characteristic qualities. (F. W. W.-S.)

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WOODFALL, family of printers and journalists. HENRY WOODFALL (d. 1769) was the printer of the *Public Advertiser* and the author of the ballad "Darby and Joan" (first printed in the *Gentleman's Magazine,* March 1735), for which his employer. John Darby, and his employer's wife are said to have been the originals.

HENRY SAMPSON WOODFALL (1739–1805), son of the above. controlled the *Public Advertiser* from 1758–93. The letters of Junius (*q.v.*) appeared in the *Advertiser* during these years.

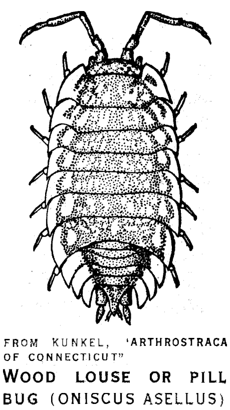
WILLIAM WOODFALL (1746–1803), younger brother of H. S. Woodfall, established in 1789 a daily paper called the *Diary* in which. for the first time, reports of parliamentary debates were published on the morning after they had taken place.

GEORGE WOODFALL (1767–1844), son of H. S. Woodfall, mas an esteemed typographer. He printed a notable edition of the letters of Junius in 1812.

WOODFORD: *see* WANSTEAD AND WOODFORD. England.

WOOD GREEN, a municipal (1933) and parliamentary borough of Middlesex, Eng., 7 mi. N. of St. Paul's cathedral. London. Pop. (1951) 52,228. Area 2.j sq.mi. It is mainly a residential area lying north of Hornsey and west of Tottenham of which borough it formed a part until 1888. It contains most of Alexandra park (154 ac.), with Alexandra palace (opened 1873, burned, reopened 187j) where the British Broadcasting corporation's television station was opened in 1936. the first transmission taking place on Aug. 26, though the B.B.C. had been making television broadcasts since Xug. 22. 1932. Fuller's almshouses, founded in 1592 in Shoreditch. were removed to Wood Green in 1933 and almshouses for fishmongers and printers were opened in 1849 and 1854. In 1609 the New river was constructed, 9 mi. of its course being through Wood Green.

WOOD LOUSE, a name commonly applied to certain terrestrial Isopoda (Crustacea) (*q.v.*), found in damp places, under stones or dead leaves, or among decaying wood. They form the tribe Oniscoidea and are distinguished from all other Isopoda by living on land and breathing air. and by the small size of the antennules and the absence of the mandibular palp. The head bears a pair of sessile compound eyes as well as the minute antennules and the longer antennae. Each of the seven thoracic segments carries a pair of walking legs. The appendages of the abdomen (except the last pair) are flat membranous plates and serve as organs of respiration. In many cases their outer branches have small cavities opening to the outside by slitlike apertures. and giving rise internally to a system of ramifying tubules filled with air somewhat similar to the air tubes or *tracheae* of insects and other air-breathing Arthropods.



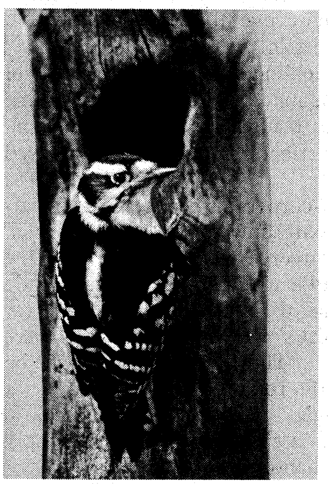
FROM KUNKEL, 'ARTHROSTRACA OF CONNECTICUT'

WOOD LOUSE OR PILL BUG (ONISCUS ASELLUS)

The female wood louse carries her eggs, after they are extruded from the body, in a pouch or "marsupium" which covers the under surface of the thorax and is formed by overlapping, plates attached to the bases of the first five pairs of legs. The young on leaving this pouch are like miniature adults except that they are without the last pair of legs. Some common garden forms, such as *Armadillidium vulgare, Porcellio scaber, Porcellionides pruinosis,* are practically cosmopolitan. often being carried about on introduced plants. (*See* MALACOSTRACA.) (W. T. C.; X.)

WOODPECKER, the name for a group of birds that, with piculets and wrynecks. form the family Picidae. Its relatives are such birds as barbets. honey guides and toucans. There are about 180 species of woodpeckers distributed over most of the world except in the Australian area; they are most numerous in the Americas and in southern Asia.

Typically woodpeckers spend their time climbing up tree trunks and branches. chiselling from the wood their food of insects and wood-boring larvae. These birds' adaptation for climbing include short, strong feet, two toes in front and one or two behind, with sharp, curved claws: and stiffened tail feathers that serve as a prop. For getting at wood-boring insects they have a stout chisel-shaped bill, a tuft of feathers over the nostrils that nould keep chips out of them. and a very long, extensible tongue with barbs near the tip. useful in extracting grubs from their burrows.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE DOWNY WOODPECKER (DRYOBATES PUBESCENS EMEDIANUS) OF NORTH AMERICA SHOWN AT THE ENTRANCE TO ITS NEST

Woodpeckers vary in size from that of a sparrow to that of a crow Their colour pattern is usually bold, including black and white or olive. Often there are areas of red on the head. Their flight is heavy and undulating.

Though most woodpeckers have loud voices and some are noisy, a tattoo beaten out by tapping with the bill on a resonant branch may take the place of a song. Courtship flights and displays are also used at mating time. The nest is usually an excavation chiselled in a tree trunk, in which cavity the pure white eggs are laid without the addition of nest material. The eggs are as few as two in number in some tropical species; elsewhere as many as 8 or 10 are sometimes laid. The young are hatched naked. Both parents share nest duties.

Many species are permanent residents, but some migrate, like the yellow-bellied sapsucker (*Sphyrapicus varius*) that migrates from northern Canada to winter in Central America.

There are a number of woodpeckers with nontypical habits. The green woodpecker (*Picus viridis*) of Europe and the flickers (*Colaptes*) of the Americas feed on insects on the ground, away from trees. and one South American species lives entirely in open country. feeding on the ground and making its nest in holes in banks. The South African ground woodpecker (*Geocolaptes olivaceus*) has similarly forsaken forests for open country.

Not all feed entirely on insects. The red-headed woodpecker (*Melanerpes erythrocephalus*) of the United States feeds much on seeds and grain. The California woodpecker (*Balanosphyra formicivora*) eats acorns and in the autumn stores quantities of them in tree trunks by drilling a little hole for each acorn into which it is fitted. In Central America one of the woodpeckers (*Centurus aurifrons*) commonly eats fruit and berries and punctures oranges, while in the north a sapsucker (*Sphyrapicus*) regularly digs through the bark of living trees to eat the inner layer and drink the sap.

The large, handsome ivory-billed woodpecker (*Campephilus principalis*) of the United States was hovering on the verge of extinction in the 1950s because its habitat, mature stands of timber, were being destroyed.

Woodpeckers are generally beneficial to man, with one exception — their drilling into and weakening electric power-line poles; this is often an important economic loss. (A. L. RD.)

WOOD PULP: *see* PAPER.

WOOD SORREL, the name of various herbs of the genus *Oxalis,* distributed in temperate zones of North and South America, Africa and Eurasia. The petals may be white, pink, yellow or purple. The white-blossomed common wood sorrel or wood shamrock (*Oxalis montana*) is found from Massachusetts to Minnesota. A few species of wood sorrel are cultivated.

See OXALIS.

WOODSTOCK, a municipal borough in Oxfordshire, Eng., in the Banbury parliamentary division, 8 mi. N.W. of Oxford. Pop. (1951) 1,715. The Glyme river divides the town. The church of St. Mary Magdalene is Norman but has later additions.

Woodstock was noted for its leather gloves as long ago as 1580; the industry still flourishes in the district.

Domesday Book describes Woodstock as a royal forest; it was a royal seat from early times and Aethelred is said to have held a council there. Henry I kept a menagerie in the park where lions, camels and a favourite porcupine are said to have been among the animals. The assize of Woodstock is the earliest surviving written law (1184) to preserve "the peace of the king's venison."

Woodstock was the scene of a council held by Henry II in 1163 and of his courtship of Rosamond Clifford ("Fair Rosamond"). Edward the Black Prince. sometimes known as Edward of Woodstock, mas born there in 1330. and there Elizabeth I was imprisoned for six months in the reign of her sister Mary (1554). It was a favourite royal residence until the Civil War, when the manor house was destroyed. After the battle of Blenheim the manor of Roodstock was bestowed in perpetuity on John, duke of Marlborough and Blenheim palace was erected for him by the queen and parliament in consideration of his military services, and especially his decisive victory at Blenheim. The palace was designed by Sir John Vanbrugh in late Renaissance style. On the hill stands a column commemorating the duke.

WOODWARDIA, a genus of rather large ferns of the Polypodiaceae family, commonly called chain fern because the sori occur in chainlike rows parallel to the secondary midribs. Two species are well known in eastern North America: W. areolata, found from Maine to Florida and Texas; and W. *virginica,* found from Nova Scotia to Michigan, Florida and Texas.

See FERN. (J. M. BL.)

WOODWORKING MACHINERY. Wood is man's oldest and one of his most useful natural resources, and from the earliest civilized times, it has been used for shelter. furniture, tools and many of man's other needs. Until the Industrial Revolution, most woodworking was done with hand tools. The fine woodwork on coaches, furniture and the interiors of homes, castles and churches was produced by skilled craftsmen using simple tools. However, during the early part of the 19th century, efforts were made to develop machines that would do the work faster and better. A circular saw had been produced in Holland as early as 1777, and a planing machine was patented in England at about the same time. Subsequently. many types of basic woodworking machines were developed. Wood is an easily worked material and a wide range of versatile machines were designed to shape it into useful products. The basic categories of woodworking machinery are described below.

Sawing Machines. — Sawing machines are used to cut wood into workable sizes. The four commonest types are the circular saw, radial-arm saw, band saw and jig saw.

Circular Saw. — This machine cuts wood with a thin circular blade with teeth around its edge. The machine consists of a base on which an arbor or axle to hold the blade and a table are mounted. The saw blade protrudes through an opening in the table, and the blade can be raised or lowered to make cuts of different depths. Most circular saws are made to hold only one blade at a time, but a few of the larger ones have a double arbor on nhich two blades can be mounted. When one blade is raised ready for use, the other is out of the way. A fence is provided to guide the material as it is fed into the saw and there is a miter gauge against uhich the wood can be held for crosscutting. The circular saw is used to rip (cut with the grain), bevel (cut with either blade or table tilted), crosscut (cut across the grain), miter (cut at an angle) and to make many cuts used in joinery. Circular saws are classified according to the diameter of the blade, ranging in size from a small 8-in. bench saw to the 14- and 16-in. sams used in lumber yards, furniture factories and other woodworking industries.

Radial-Arm Saw. — This machine does the same kind of cutting and uses the same kind of blade as a circular saw, but it is very different in design. In effect it is an inverted circular saw. nith the motor and blade suspended under an arm above the table and so mounted that they can be moved toward or away from the operator. The arm can be turned in a complete circle and the motor and blade can be turned through a complete horizontal circle and tilted in either direction, thus giving the saw three-dimensional movement. For crosscutting, mitering and many other cuts, the material is held firmly on the table while the blade is pulled into it (toward the operator). For ripping, the motor is locked in position and the lumber fed into the revolving blade.

Band Saw. — The band saw has a blade in the form of a continuous metal strip. with teeth along one edge, that runs around two large wheels. Though the band saw is capable of only a few operations, it is important because it can cut curves in any thickness of stock. It can also be used for resawing (cutting boards to thinner widths). Band saws with wheels from 14 to 36 in. in diameter are used for shop work, while larger saws, with wheels 84 in. or more in diameter, are used in saw mills for resawing or for sawing logs into standard sizes. The band saw has an advantage over circular saws in that its thinner blade produces a narrower kerf (the cut made by the saw) and less wood is wasted. Blades for the larger machines used in the lumbering industry may be as wide as 16 in. and as long as 50 ft. On many machines the band saw blade has teeth on both sides. Thus. when a log is mounted on a conveyer or carrier, it can be cut while traveling in either direction past the blade.

Jig Saw. — This machine does the same kind of cutting as the hand coping saw, making inside and outside irregular cuts. The blade is mounted between an overhead support and a driving mechanism that produces a reciprocating movement. The blade passes through an opening in a table upon which the work is manipulated.

Planers or Surfacers. — These are single-purpose machines for smoothing wood to an even thickness. The planer consists of a frame, a bed that can be moved up and down, feed rolls, a feeding mechanism and a cylindrical cutter head holding three or more knives that pare off the excess wood. Models range from the single planer. which smooths one surface of a board at a time, to machines that can finish all four surfaces simultaneously. Planer sizes are indicated by the width of work that can be accommodated, ranging from 18 to 50 in.

Jointers. — The jointer is designed to smooth the surface, edge or end of a board. It does the same work as the hand plane but cuts in a different manner. The jointer consists of a frame holding a front or infeed and a back or outfeed table, the difference in height of the tables governing the depth of cut. It has a round cutter head holding the cutting knives and a fence to guide the stock. The wood is pushed along the tables over the rotating cutter head. Jointers are rated according to the length of the cutting knives, the common sizes ranging from 6 to 24 in.

Shapers. — The shaper is used to cut moldings and the edge designs found on furniture, picture frames. etc. It consists of a table through which protrudes a rotating spindle carrying the cutting blades, which are shaped to produce the desired contour on the work. A vertical guide is provided against which the work is held as it is fed past the cutter. Larger shapers used in the production of moldings may have two or more cutters and are provided with automatic controls that feed material into the machine.

Routers. — Essentially, the router is an inverted shaper, with the cutter spindle suspended over the work table. It is used for such work as shaping the insides of bowls or trays and carving the openings on chair backs.

Lathes. — Long before any other woodworking machines were invented, the lathe was used to turn out cylindrical parts. It combines the power of the motor-driven machine with the skillful use of hand tools. One end of the length of wood to be turned is clamped in a "live" centre. rotated by the motor, while the other is held in a "dead" or nonrotating centre that is adjustable laterally to accommodate the work. A tool rest is provided against which the operator steadies the turning chisel. Lathes are classified according to the length of material they can accommodate, ranging from the 8- or 10- in. models found in home workshops to the 24-in. machines used by patternmakers. For commercial production, automatic lathes have been developed in which the cutting tool is guided by a stylus running against a pattern. (See also LATHE.)

Sanders.—Sanders are used to finish wood surfaces. Some of the common kinds are the belt sander, which has a continuous strip of sandpaper running over two rollers; the disk sander. which uses a piece of sandpaper fastened to a large metal disk; and the spindle sander, a cylindrical spindle around which a piece of sandpaper is fastened.

The drum bed sander is a large production machine used to finish doors, window frames and other large, flat surfaces. This machine looks and operates somewhat like a planer, having two to four large revolving cylinders that sand the stock as it is fed between them.

Mortisers and Tenoners.—A mortiser cuts the square opening for a mortise-and-tenon joint. The hollow-chisel mortiser is the commonest. It has a square chisel, enclosing a revolving bit. clamped to the motor housing. When the chisel and bit are forced into the wood. the bit bores a hole almost as large as the chisel and the sharp edges of the chisel cut out the corners to make a square opening. The hollow-chisel mortiser is made either as an upright or a horizontal machine. The chain-saw mortiser, used in sash and door manufacturing, has a continuous chain saw that cuts a rectangular opening with a rounded bottom.

A tenoner is used in volume production for cutting the tenon that fits into a mortise-and-tenon joint. Tenoners are either single, to cut a tenon on one end of a board at one time, or double, to cut both ends.

Boring Machines.—Boring machines are used to bore the holes for making dowel joints or assembling wood with dowels. The large production boring machines are very similar to the drill press, which in fact serves as a boring machine in small shop work. For industrial uses, the boring machine may be provided with a single boring tool or a gang tool that will bore several holes at the same time. In a small shop, a drill press with a mortising attachment can serve as a mortiser and it also may be provided with accessories to serve as a spindle sander, disk sander, shaper or router.

Multipurpose Machines.—The multipurpose machine is designed for home workshop or school use. It performs many standard woodworking operations. One type, basically a combination drill press and lathe, can be made to perform the functions of a circular saw, band saw, jig saw, jointer, sander, etc., by adding suitable attachments. Another type is basically a radial-arm saw but can also be altered to perform the work of other machines.

Portable Electric Tools.—Portable electric-powered tools are designed for convenience and ease of handling. They permit the machine to be brought to the work. The five commonest are the electric hand saw for straight cutting; the saber or jig saw for cutting irregular shapes; the portable router for making joints and shaping edges, grooves, etc.; the hand drill for boring holes; and the portable sander, of either the pad or belt type.

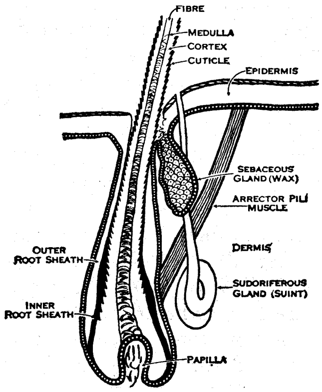
See also MACHINE TOOLS; GRINDING MACHINE; CARPENTRY; JOINERY. (J. L. F.)

WOOF. Another name for weft: *see* WARP AND WEFT.

WOOL. The thick covering or coat of the domestic sheep consists of a mass of specialized fibres called wool. Typically. it is unlike hair in that there are minute overlapping scales or plates extending lengthwise on the surface of the fibre which give it an entangling or felting characteristic. Wool is an outgrowth of the epidermis and is generally believed to represent the evolutionary development of the undercoat of the animal from which domestic sheep were derived. Whether as a vestigial remnant of the past or as a new development associated with certain conditions of environment, some sheep do grow some hair and kemp, particularly in subtropical areas.

Wool fibres, whether short or long, grow in tufts of as many as a dozen fibres. Density of fibre varies widely with the breed and from one part to another of the body of the individual sheep. Merino lambs have been credited with 20,000,000 fibres and the fleece of a full-grown Merino has been estimated to include up to 126,000,000 fibres; an average of about 30,000 to 50,000 per square inch is normal for the Merinos, with other breeds having moderately or sharply lower density.

The wool follicles of the sheep's skin are pits reaching into the dermis, formed by inturning epidermal layers. The follicles appear to be of two sorts, one provided with only the wax gland, the other, primary, with perspiration (suint) gland and *arrector pili* muscle as well as wax gland (see fig.). Growth of the fibre occurs as a continuing process, by multiplication of the soft cells of the papilla at the base of the follicle, which is bathed in a nutritive medium. It is the flow of this fluid which is much affected by the health of the sheep—by drought and poor forage, as well as disease.



FROM HIRSCH MUNZ THE AUSTRALIAN WOOL INDUSTRY BY COURTESY OF ANGUS AND ROBERTSON, LTD

DIAGRAM OF A WOOL FOLLICLE AND ITS ASSOCIATED GLANDS

Defective functioning of this process results in weak areas in the wool fibre, called in the trade "tender wool." The differentiation of the cells into the wool protein (keratin) of the cuticle and cortex occurs perhaps one-third of the distance above the base of the follicle, from which point the wool fibre is no longer living and growing. Wax and perspiration salts are added near the exit.

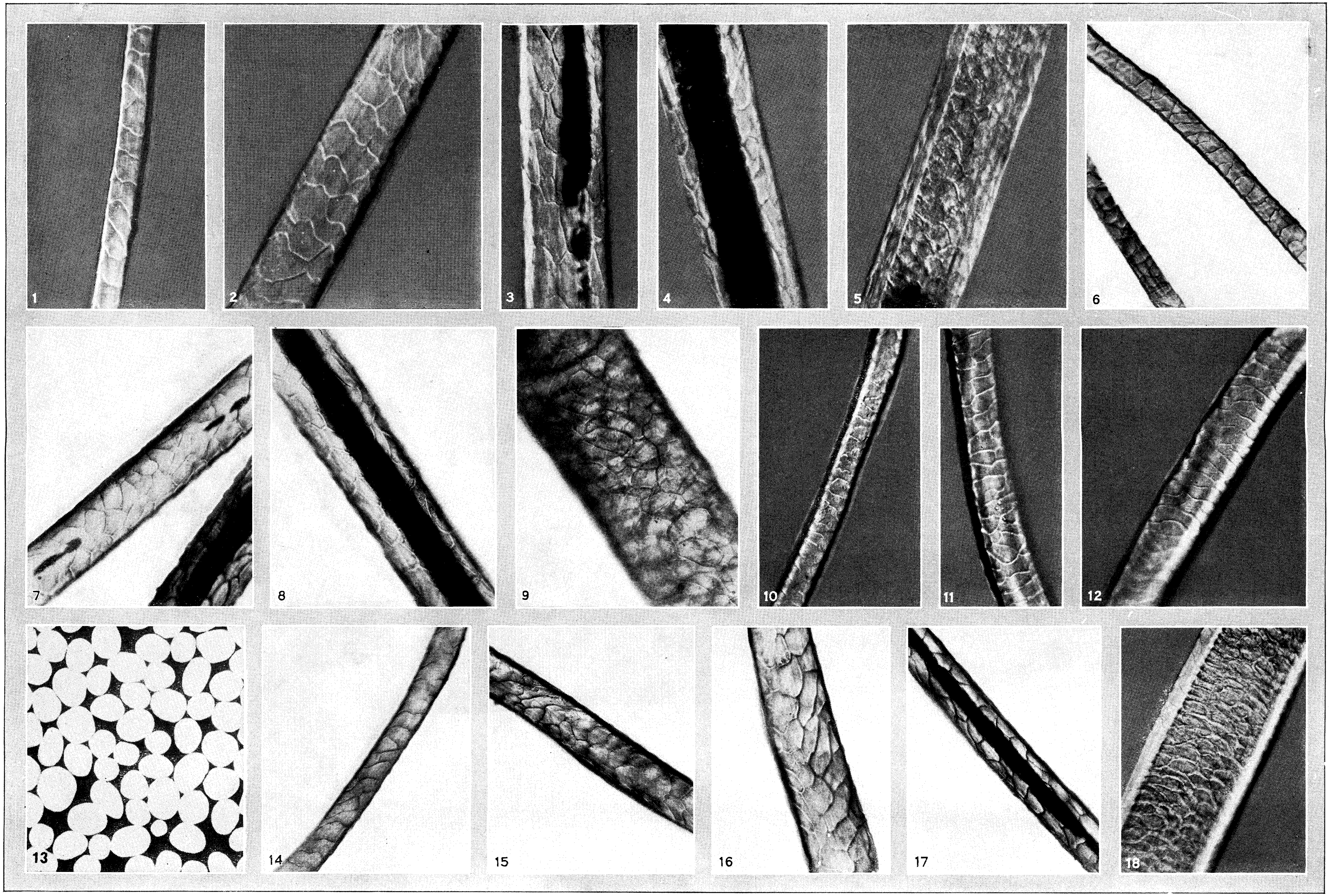
Grease wool, the form in which practically'all wool is marketed initially, is mostly obtained by clipping or cutting the coat or fleece of fibres from the live animal. Smaller amounts, called pulled wool, or sometimes skin or dead wool, are obtained from the skins or pelts of dead sheep. Such raw or grease wool contains perspiration or suint salts, which together with varying amounts of natural grease are sometimes referred to as yolk, plus wool fibres of one or more types and foreign material or dirt of varying sorts and amounts. all of which constitute a total of one-third to two-thirds but average about one-half of the total weight of the unprocessed fleece. It is the raw wool of history and commerce.

Characteristics.—Natural colour of wool varies from the prevailing white through gray, fawn, yellow and brown to black. Wool fibres, usually slightly elliptical, have an average diameter ranging between 8 and 60 μ or from more than $\frac{1}{400}$ in. to less than $\frac{1}{2,000}$ in. The range is associated largely with the breed of sheep but there may be considerable variability within the same fleece. Length of fibre, which depends not only on the kind of sheep but also on the time during which the fibre has been allowed to grow. ranges from a fraction of an inch to many inches. On occasions when sheep have missed shearing for two or three years, a wool growth of more than 40 in. has been recorded in crossbreds. The following are the average yearly growths of the more important breeds of sheep:

Black-faced	10" to 18"	Southdown	3" to 4"
Lincoln	12" to 18"	Clothing Merino	$1\frac{1}{2}$" to 3"
Romney	6" to 8"	Combing Merino	$2\frac{1}{2}$" to 5"
Shropshire	4" to 6"		

The first year's growth of wool, sheared from what are termed hog or teg sheep, is usually somewhat longer than indicated above, because the lambs are born from February to April and the shearing does not take place until the following May or June. Hog wool reveals itself in its pointed fibre tips.

In terms of structural arrangement, most of the finer wool fibres are described as nonmedullated continuous fibres; *i.e.*, solid fibres made up only of cuticle and cortex. However, some other types consisting of three layers, cuticle, cortex and medulla (pith), do occur, as well as mixed types—part medullated, part nonmedullated. In addition, there may be kemps, periodically shed fibres believed to be relics of the former outer coat. They are coarse and straight. often white and shiny, and mostly sharply pointed, consisting of an outer cuticle and an inner medulla of loosely packed cells. The crimp or wave of wool fibre varies generally with the average fineness from about 6 per inch in crossbred wool



BY COURTESY OF (1-12, 14-18) JANET BLYTH (13) U.S.D.A.

MAGNIFIED WOOLEN FIBRES

Top panel (1–5): typical fibres taken from Lincoln sheep. Both continuous and intermittent medullated fibres are seen

Second panel (6–9): wool fibres from the Swaledale (improved Blackface Scotch sheep) showing external structure of the kemp. Actual scale structure approaches Merino fibre

Third panel (10–13): there are no medullated fibres in this wool from a Southdown sheep, the best of the fine British breeds. (13) is a cross-section of Merino wool fibres

Bottom panel (14–18): demi-lustre class fibres taken from a Romney Marsh sheep, the wool of which makes good felting. Clearly defined external structure is probably dominant factor with reference to this quality

to about 24 crimps per inch in the very finest Merino fibres Apparently it is related to the period of the rotation or curl of the major axis of the ellipse as the fibre issues from the follicle. The overlapping scales of the cuticle point toward the outer tip of the fibre.

Some other important physical characteristics of wool are its lightness (a specific gravity of 1.3), and its resilience or springiness, which is related to its elasticity. It can be extended as much as 30% for short periods without permanent deformation, a factor which is important in its use for higher grade clothing. It is a poor conductor of electricity and will hold a charge of static electricity under some conditions. It is a warm fibre because its fabrics enclose much insulating air. Some wools have lustre. Severe drying fatigues the fibre by damaging the protein in some fashion.

Chemically, wool keratin is an animal protein not unlike hair, feathers and horn. A chemical analysis of wool shows that it is composed of five elements in the following approximate percentages: carbon, 50%; hydrogen, 7%; nitrogen, 17%; oxygen, 21%; and sulphur, 3%–4%. This last is rather unusual—wool is rich in the sulphur-containing amino acid cystine. Apparently the amino acids are arranged in chain bundles of large molecules, called polypeptide chains. In one subtype of keratin, these chains apparently take a folded form, whereas the other subtype is built from the same chains pulled into straightened forms. There is evidence of two types of linkage of these chains. The cystine or disulphide one may be altered by some chemical reagents, with consequent alteration or destruction of the physical structure of the fibre. The other or salt linkages can be readily broken, a fact which is utilized to advantage in some stages of processing. If wool is burned, it largely resolves itself into ammonia gas of characteristic odour.

Wool **in** History.—The use of wool for human clothing reaches far back into antiquity, if not indeed into prehistory. Its outstanding properties of resilience, wrinkle resistance, hygroscopic quality, felting property and low heat conductivity long ago gave it a high usefulness not only for human clothing, but for blankets, upholstery, floor coverings, etc. Though in general there was less need for the warming qualities of wool in the Mediterranean and near eastern regions than in northwestern Europe, such records as exist testify to the high esteem in which it was held. Witness the name Babylonia which some interpret as meaning "the land of wool." Also, the early trade of the Mediterranean area with the British Isles appears to have included wool cloth which the Phoenicians traded for the raw wool of Cornwall. The different kinds of wool and the cloth made from them in antiquity are described by Pliny and referred to by other writers. The sheep certainly was a domestic animal in Britain long before the period of the Roman occupation; and it is probable that use was made of sheepskins and of wool. The Romans established a wool factory whence the occupying army was supplied with clothing, and the value of the manufacture was soon recognized by the Britons. of whom Tacitus remarks, "Inde etiam habitus nostri honor et frequens toga" (*Agric.* c. 21). The product of the Winchester looms soon established a reputation abroad, it being remarked that "the wool of Britain is often spun so fine that it is in a manner comparable to the spider's thread." This reputation was maintained throughout the middle ages, and the fibre was in great demand in the Low Countries and other continental centres. There are many allusions to woollen manufactures in England in early times; but the native industry of the island could not rival the products of the continent.

In the time of William the Conqueror Flemish weavers settled under the protection of the queen at Carlisle, but later they were removed to Pembrokeshire. At various subsequent periods there were further immigrations of skilled Flemish weavers, who were planted at different places throughout the country. The cloth fair in the churchyard of the priory of St. Bartholomew was instituted by Henry II; guilds of weavers were established; and the exclusive privilege of exporting woollen cloth was granted to the City of London. Edward III made special efforts to encourage wool industries. He brought weavers, dyers and fullers from Flanders; he himself wore British cloth; but to stimulate native industry he prohibited, under pain of life and limb, the exportation of English wool. Previous to this time English wool had been in large demand on the continent, where it had a reputation exceeded only by the wool of Spain. The customs duties levied on the export of wool were an important source of the royal revenue. Edward III's prohibitory law was, however, found to be unworkable, and the utmost that both he and his successors were able to effect was to hamper the export trade by vexatious restrictions and to encourage much smuggling of wool.

Thus while Edward III limited the right of exporting to merchant strangers, Edward IV decreed that no alien should export wool and that denizens should export it only to Calais. Legislation of this kind prevailed till the reign of Elizabeth I, when the free exportation of English wool was permitted; and John Smith, in his *Memoirs of Wool*, points out that it was during this reign that the manufacture made the most rapid progress. In 1660 the absolute prohibition of the export of wool was again decreed, and it was not till 1825 that this law was finally repealed. The results of the prohibitory law were exceedingly detrimental; the production of wool far exceeded the consumption; the price of the raw material fell; wool running or smuggling became an organized traffic; and the whole industry became disorganized. Extraordinary expedients were resorted to for stimulating the demand for woollen manufactures. among which was an act passed in the reign of Charles II decreeing that all dead bodies should be buried in woollen shrouds—an enactment which remained in the statute book, if not in force, for a period of 120 years. On the opening up of the colonies, every effort was made to encourage the use of English cloth, and the manufacture was discouraged and even prohibited in Ireland.

Wool was "the flower and strength and revenue and blood of England," and till the development of the cotton trade, toward the end of the 18th century, the wool industries were, beyond comparison, the most important sources of wealth in the country. Toward the close of the 17th century the wool produced in England was estimated to be worth £2,000,000 yearly, furnishing £8,000,000 worth of manufactured goods, of which there was exported about £2,000,000 in value. In 1700 the official value of woollen goods exported was about £3,000,000, and in the third quarter of the century the exports had increased in value by about £500,000 only. In 1774 John Campbell *(Political Survey of Great Britain)* estimated the number of sheep in England at 10,000,000 or 12,000,000, the value of the wool produced yearly at £3,000,000 (or about 5*s.* per pound), the manufactured products at £12,000,000 and the exports at £3,000,000 to £4,000,000. He also reckoned that the industry then gave employment to 1,000,000 persons.

In 1800 the native crop of wool was estimated to amount to 96,000,000 lb.; and, import duty not being imposed till 1802, the quantity brought from abroad was 8,600,000 lb., 6,000,000 lb. of which came from Spain. In 1825 the importation of colonial wool became free, the duty leviable having been for several previous years as high as 6d. per pound, and in 1844 the duty was finally remitted on foreign wool also.

The major development in the history of wool during the 19th century was perhaps the opening up of vast new supplies of raw wool, partly from the western hemisphere, but with particular emphasis on the far reaches of the southern hemisphere. The world's wool was largely produced from sheep long known in Spain and the British Isles, or some mixture of those breeds. The common sheep of old Spain accompanied Coronado and later Juan de Oñate in Mexico and the southwest in the mid-16th century. English types were brought to eastern North America in the next century. So, too, sheep arrived in Australia in 1788, in South America and South Africa even earlier and in New Zealand before 1835.

But wool production did not really begin to flourish until the Merino sheep in one or more of its subtypes was imported into these newer areas. This was in 1797 in Australia, and in the South Island of New Zealand in the early 1840s, by way of Australia. Merino breeding stock arrived in the United States in considerable numbers between 1802 and 1810. The Rambouillet was brought to Argentina soon after 1842. The Merino was introduced into South Africa prior to introduction in Australia but did not thrive during that early period without periodic acquisition of fresh breeding stock from Europe (see Table I).

TABLE *I,—Trends in Wool Production by Major Producers*
(in 000,000 lb., greasy basis)

Year	Australia	South Africa	'New Zealand	Argentina	Uruguay	United States
1840 .	51	1	—	—	—	—
1880 .	307	43	69	226*		233†
1920 .	625	182	208	315	113	294
1940 .	1077	260	333	443	134	434
1950 .	1160	228	372	420	159	248

*For Argentina and Uruguay, 1879. †1879.

The crossbred sheep with their fine and medium wools did not flourish until the 1880s and thereafter, at which time they expanded, mostly at the expense of the Merino, in all except the dryest, wettest and roughest areas of the sheep world.

Production and Harvesting of Wool.—The something more than 800,000,000 head of sheep in the floeks of the world produce an annual crop of about 4,300,000,000 lb. of grease wool, or an average of about 5 lb. per sheep. However, 10 lb. per animal is more standard among the better wool-producing flocks, and a yield of 15 or 20 or more pounds is not extraordinary for some animals. The harvest is annual, normally in middle or late spring or even early in the summer, to give the animal the full advantage of its warm coat during the cooler part of the year. The geography of the world's wool production, rather highly correlated of course with sheep distribution, is interesting. Its predominance in the southern hemisphere, with Oceania producing more than three times the European clip, with South America far above Europe and with New Zealand as well as South Africa producing considerably more than North America is sufficiently different from most agricultural patterns to call for brief explanation (see Table II).

TABLE *11.—World Wool Production by Areas and Major Countries*
(in 000,000 *lb.*, greasy basis)

Area	1936–40	1946–50	1951	1952	1953
Oceania	1,366	1,422	1,459	1,653	1,668
Australia	1,052	1,050	1,052	1,240	1,250
New Zealand	314	372	407	413	418
South America	639	735	737	743	759
Argentina	411	449	420	420	430
Uruguay	126	163	187	190	195
Europe	483	426	475	485	488
United kingdom	110	81	93	95	97
Spain	70	83	90	93	94
Western Europe (total)	379	344	383	393	396
Other Europe	104	82	92	92	92
North America	452	309	273	288	281
United States	425	285	251	266	260
U.S.S.R. (Europe and Asia)	310	312	—	—	—
Asia	344	356	375	394	395
China	88	75	—	—	—
India	73	52	52	58	57
Turkey	68	71	73	78	80
Africa	337	282	324	330	337
Union of South Africa	252	216	240	245	250
World total	3,930	3,840	4,020	4,290	4,330

Note: Totals are estimated and figures are rounded. For summary purposes wool produced mostly in the spring in the northern hemisphere is combined with that produced July 1 or Oct. 1 of the same year in the southern hemisphere. Pulled wool is included for most countries at its greasy equivalent.

Source: United States Department of Agriculture, *Foreign* Crops *and Markets*, pp. 530–531 (June 15, 1953).

In part, it appears to be related to the newness of the southern hemisphere areas in terms of stage of settlement: there is still plenty of room for extensive animal industries. More than that, wool is a compact and storable product, sufficiently valuable in relation to its weight that it can bear the cost and time involved in reaching distant markets. Even more, some of these areas are subhumid if not actually semiarid—alternative possibilities for economic utilization neither were nor are outstanding and the sheep, particularly the fine-woolled Merino, is apparently reasonably well able to survive and flourish under conditions of variable and seasonal forage growth, under the sparse herbage of warm dry areas as well as high and rough areas. In spite of trends in sheep numbers and some difficulties with natural disaster particularly drought in the southern hemisphere, wool production seldom varies as much as 5% above or below the crop of the previous year and very rarely more than 10%.

To harvest the wool crop, it is necessary to confine the sheep flock in close quarters so each animal may be caught and clipped. Such capture and confinement may be no small problem in rugged territory under primitive conditions. At an earlier period in some places the sheep were washed in clean water to remove as much of the perspiration salts and accumulated dust as possible, after which it was necessary to allow them to dry before shearing.

In shearing, whether with hand clippers or more modern power-driven clippers, the sheep is held by the man doing the shearing who at the same time clips the wool close to the body so as to leave the fleece essentially in one piece. Positions of the sheep and the order and rapidity with which various parts of the body are cleared vary somewhat with the worker, but no development has removed the work from the category of hot, fatiguing stoop-labour. Even so, a trained, skilled and enduring shearer can remove 100 to 200 fleeces per day.

The fleece, once removed from the sheep, is taken over in some areas by another who skirts and rolls it, after which it is classed, baled, pressed and branded. In other areas it is not skirted and each fleece is merely tied with paper twine in a not very compact bale or bundle, to be later classed or sorted. In careful operation, skirting is the process of removing and packing separately those inferior portions of the fleece, such as the short wool of the belly. Rough and coarse ends or dirty or stained wool, particularly from around the breech, are removed. Sweaty locks and burry sections from the neck and shoulder are removed. Then the remaining wool is so divided and rolled as to expose the rib and shoulder portions of the fleece to view.

Classification.—No single classification system for wool is in universal use. This might be expected in view of the differences in historical development and the multitude of different uses, but more especially as a result of the wide variety of dissimilar characteristics found even in wools from the same country. The British Government Purchase scheme recognized 1,500 classified types of Australian wools, 950 from New Zealand and 350 from South Africa, with relatively few types in any one clip common to the clip of another part of the commonwealth. Fineness or diameter of the fibre, length of fibre, uniformity, colour, lustre, elasticity, strength and suppleness vary with area and breed of sheep as well as with individual sheep and from one part to another of the same fleece. Classifying, in spite of all science has done, still belongs in the category of an art or value judgment.

Alternative systems are used in the United States to designate fineness or grade of shorn apparel wool. The "blood" system refers to the closeness of relationship to the Merino. The numerical or count system has reference to the worsted count which it is estimated the fibre will spin. That is, a 50s-count fibre should spin that many hanks of yarn each of 560-yd. length from one pound of combed wool.

Blood system	Count or numerical system (Bradford system)	World trade
Fine	64s, 70s, 80	Merinos
Half blood (½ blood)	60s, 62s	
Three-eighths blood (⅜ blood)	56s, 58s	Fine crossbreds
Quarter blood (¼ blood)	[illegible]	
Lon-quarter blood	46s	Medium crossbreds
Common	44s	
Braid	36s, 40s	Low crossbreds

Factors other than spinning quality based on fineness of fibre enter into classing. Soundness, *i.e.*, an absence of pronounced weak areas in the fibre resulting from periods of malnutrition or sickness while growth was in progress, is very important in combing wools. Good tensile strength which will enable the fibre to undergo the seven-pound pull of the comb without breaking is desired. That factor governs to a high degree the yield of valuable tops in relation to noils; "tender" wool gives up to 25% of the much less valuable noils. Combing wools must also be of good length. The condition of wool relates to the adhering wax, salts and moisture and these must be estimated to judge probable yield when scoured. Colour, sheen and lustre are important with respect to wool from English breeds and crossbreds, ranging from the rich glossy metallic sheen of the Lincoln and Leicester to the second demilustre of the Romney Marsh.

Classifying or grading of wool probably reached its fullest development in Australia. On the great Australian sheep stations, wool classing is one of the most important operations, largely taking the place of sorting in the wool trade of England and some other areas. Fleeces as taken from the sheep are skirted and trimmed at one table, then passed on to the classer, who places them in the 56s, 60s, 64s, 70s, 80s or 90s class, according to their fineness in relation to worsted counts or as superclothing, ordinary clothing, etc., if they are shorter wools more suited to the woollen industry.

Wool classes under the Australian procedure emphasize the requirements of one branch of manufacture or another. The details may be generalized into Merino combing wool of eight groups ranging from super through AAA, AA, A, combing, first and second to fleece. Merino clothing wool of four grades (super, first, clothing and fleece), comeback wool of six grades and crossbred wool of eight grades, including that of the long-woolled and short-woolled British breeds. Among Australian wools the Geelong wool of the Western district of Victoria and those from the New England tablelands of New South Wales are known with particular favour. This highly skilled grading and related operations have been of much assistance in marketing Australian wool of known quality.

Marketing, Trade and Prices.—Wool moves rather promptly to local, national and international markets. The major southern hemisphere producers use a relatively small part of their production domestically; year-end stocks in most years are less than 5% and rarely more than 10% of the annual output except in the case of New Zealand. It is normally one of the three or four most valuable raw materials moving in international commerce. For some of the major producers it constitutes a very significant or even the major export item. For Australia and South Africa it commonly represents more than one-third of their total exports by value.

Prior to World War I, the marketing of wool was still in private hands, with London the leading wool auction market in the world. The auction market puts emphasis on special quality characteristics of each individual lot of wool, an emphasis well adapted to wool sales in which quality characteristics vary so widely. Other markets also developed. Boston, Mass., was important as a spot market. Futures markets in wool tops were established in Antwerp, Belg., in Roubaix-Tourcoing, Fr., and in New York city. The New York market also provided a grease-wool futures contract, though never of major importance.

World War I not only resulted in wide fluctuations in wool prices but stimulated government bulk purchases. Raw wool remained uncontrolled during the first two years. But the British cabinet in 1916 became concerned about the developing scarcity of wool supplies, partly resulting from a drought in Australia, a reduction in the South American clip and heavy foreign purchases. In Nov. 1916, therefore, the Australian and New Zealand clips were acquired and in 1917 also the South African clip. Such bulk purchases continued in force until June 1919 for South Africa and June 1920 for Australia and New Zealand.

In the spring of 1919 government-owned supplies were sold in competition with wools from South Africa and South America and prices declined rather drastically. In Jan. 1921 the disposal of all stocks left in the hands of the British government was taken over by B.A.W.R.A. (British Australia Wool Realization association), a limited company owned by Australian wool growers. Its operations continued for several years.

Meanwhile, auction sales in the various parts of the British Commonwealth developed rapidly and the Sydney market surpdssed the volume of the London market. Other Australian, New Zealand and South African markets grew in importance and the wool produced in those countries was marketed almost entirely by public auctions at central marketing points. In North American and South American producing countries, as well as in the United Kingdom and on the continent, farmers for the most part continued to sell their wool individually at pnvate sale or at local auctions. An arrangement equivalent to bulk purchase was made in 1934 by the South African and British governments and was renewed each year until World War II.

With the arrival of World War II, control of apparel wools was quickly organized, with the British government agreeing to purchase the entire Australian and New Zealand clips for the duration of the war and one year thereafter, at an initial average price of 13.4*d* per pound in the grease, later increased to about 15.5*d*. This was carried out in Australia under the Central Wool committee appointed by the government and representative of all interests. A considerable amount of this Australian wool, though British owned, was stored in the United States, some of it re-exported as late as mid-1947.

The United States domestic clip was first guaranteed as to price and in 1943 actually taken over by the government. The Defense Supplies corporation also purchased some Australian wool from the British, as well as wool from South America, New Zealand and South Africa but disposed of its holdings by the end of 1945. South American wools continued to be sold in a free market, with much of the total export going to the United States.

On balance, wool consumed during the war could absorb only about two-thirds of current supply from the five main exporting countries and by the end of the war there was a large accumulation of apparel wools in the hands of the Joint Disposals organization. This organization, incorporated as a private registered company, included representatives of the governments of United Kingdom, Australia, New Zealand and South Africa, somewhat after the precedent of B.A.W.R.A. of the 1920s.

The holdings of the joint organization amounted to about a two years' supply, and it was estimated in 1946 that such stocks would need to be distributed over the next 13 years in order to move them into consumption without greatly disturbing the marketing of current production. To the surprise of many, world wool consumption in the early postwar period was very high and the stocks had been completely marketed by the 1951–52 season, at which time the outbreak of hostilities in Korea put a new strain on the wool market and available supplies.

The International Wool Study group was created by resolution adopted at the International Wool talks in London in Nov. 1946. In several meetings it reviewed the world wool situation and problems in connection with production, trade and the consumption of wool, in order to make recommendations to governments for action.

After the outbreak of the Korean war the Wool committee of the International Materials conference was convened in April 1951; it held frequent meetings to consider the world supply and demand situation, whether international action mas necessary and what control measures might be practicable. The upward trend in world raw wool production and a 1951–52 slump in wool textile industries eased the situation and the committee was terminated in Sept. 1952.

The United States as a significant producer of wool as well as a major importer and user has a long history of wool legislation. A U.S. tariff on wool was enacted as early as 1816. In 1922 a specific duty per pound of clean fibre content by grade of fineness was introduced. Under the Tariff act of 1930 all wools not finer than 40s were made duty free if used in the manufacture of floor coverings, press cloths, knit or felt boots, heavy-fulled socks, etc. For those wools finer than 44s the rates which became effective in Jan. 1948 under the General Agreement on Tariffs and Trade (G.A.T.T.) provided some variation depending on stage of processing: on the skin, 24 cents per pound clean content; in the grease or washed, $25\frac{1}{2}$ cents; sortings or matchings, not scoured. 26$ cents; scoured, $27\frac{3}{4}$ cents. If the fibre had been advanced beyond the washed or scoured condition, including tops, an additional factor of $6\frac{1}{4}\%$ to $12\frac{1}{2}\%$ is added to the $27\frac{3}{4}$ cents per pound. Wools not finer than 44s carry loner rates.

Price support or purchase programs for domestically produced wools became common in the late 1930s. In 1938 and 1939 nonrecourse loans were made, after which military demand absorbed the supply. A wool purchase program existed from 1943 to 1947 under which farmers sold on a permissive basis at ceiling prices directly or indirectly to the Commodity Credit corporation, which could not resell at less than parity price. Sizable stocks thus accumulated in government hands (see Table III).

*TABLE III.—United States Stocks of Apparel Wool**
(in 000,000 *lb.*, scoured basis as of April 1)

Year	Owned by dealers and mills		Owned by the United States government		Total reported stocks
	Domestic wool	Foreign wool	Domestic wool	Foreign wool	
1935–39 average	77	33	—	—	109
1942	67	104	—	113	284
1943	60	86	—	168	315
1944	32	134	83	158	408
1945	34	154	126	36	349
1946	36	189	196	—	421
1947	51	160	193	—	404
1948	77	130	139	—	346
1949	58	75	67	—	199
1950	55	71	17	—	143
1951	36	95	—	—	130†
1952	55	75	—	—	131†

*Includes wool on consignment, in process of manufacture up to carding and wool in bond. Wool held by growers is excluded. †Excludes wool held for the department of defense.

Althaugh one wool price support proposal was vetoed by Pres. Harry Truman in 1947, support operations by purchases at the 1946 price level were resumed in Aug. 1947 and continued through 1948, later extended through June 1950. The CCC was also authorized to sell wool at less than parity price. Until 1952, under the Agricultural act of 1949, which required that the price of wool be supported by loans, purchases or other operations at a level between 60% and 90% of parity as the secretary of agriculture determines necessary in order to encourage an annual production of 360,000,000 lb. of shorn wool, price support programs were announced but not utilized because of the sharp upturn in price accompanying Korean hostilities.

The marketing pattern and price structure for wool essentially breaks into two major categories of which apparel or clothing wool dominated production and trade after mid-19th century. Nearly three-fourths of the world's wool production falls in the apparel category of Merino and crossbred; *i.e.,* 60s or more for Merino and 58s to 40s for crossbred. Most of these fine wools are produced in the southern hemisphere. As may be seen in Table IV, the five main surplus countries—Australia, Argentina, New Zealand, South Africa and Uruguay—account for more than 70% of the production and for more than 90% of such wool entering international trade. The five main deficit countries—United States, United Kingdom, France, Germany and Canada—account for an additional 20% of the total production. Even in the United States where there has been emphasis on lamb production for meat, practically all of the wool is of the apparel type. More than 80% of the "territory" wool grown in the United States grades half blood or fine. Texas wools are mostly fine wools. The "fleece" wools from east of the Great Plains grade 70% or more three-eighths blood or coarser. Nearly 60% of the total U.S. production in 1946 consisted of fine and half-blood wool.

TABLE IV.—Apparel Wool Production
(in 000,000 lb., greasy basis)

Year	In five principal exporting countries	In seven principal importing countries	World production
1934–39 average	1,908	832*	2,991
1945–46	1,984	726	2,964
1946–47	2,048	697	2,982
1947–48	2,011	658	2,931
1948–49	2,066	648	2,965
1949–50	2,230	637	3,100
1950–51	2,235	656	3,115
1951–52	2,118		3,190

*1934–38.

As can be seen in Tables III and IV, much of apparel type wool moves from the southern hemisphere producing areas to the deficit areas, particularly to western Europe, but also in substantial amounts to the United States. Imports into the United States fluctuate widely with variable demand, domestic production making up a more nearly stable supply.

Carpet wools make up slightly less than one-fourth of the world's wool clip. Only about one-third of the carpet wool produced is exported as compared with an export of fully two-thirds of the apparel wools. Hence, carpet wools account for only about 15% of the international trade in wool. These are not very uniformly defined. The International Wool Study group considers as "carpet type" all wools coarser than 46s, although those coarser than 40s are more commonly so recognized in the United States. Carpet wool also can be considered to be wool from unimproved sheep such as Chinese, East Indian, Donskoi, Smyrna—that is to say, those without Merino or English blood. However, a substantial proportion of the production from coarse crossbred sheep of English breed is used in carpet manufacture.

With the introduction of meat refrigeration in ocean transportation near the end of the 19th century, there was an important switch to meat production in Argentina and New Zealand; the mutton or crossbred sheep in these areas produces wools of 58s to 37s quality, much of which is also suitable for apparel manufacture. However, the bulk of the Argentine production of this type and some of the coarser New Zealand wools are used in carpet manufacture. It is carpet wools from these areas which account for most of the carpet wools entering international trade. The major exporters are Argentina and New Zealand, with India, Pakistan and the near east in secondary positions. In Asia, eastern Europe and North Africa where sheep are generally of unimproved breeds and sheep rearing has to some extent a traditional rather than a commercial character, the wool is used largely in household or village industries, and even there, to a considerable extent, in carpet manufacture.

TABLE *V.—Carpet Wool Production*
(in 000,000 metric tons, greasy basis)

Item	1934–38 average	1947–50 average	1951 average
Improved sheep,			
Argentina	55	49	45
New Zealand	20	23	23
British Isles	9	8	9
Subtotal	84	79	77
Unimproved sheep			
China	50	40	30
Other east Asians	61	58	58
Near east	53	64	72
North Africa	36	27	33
Europe	72	72	76
U.S.S.R.	35	43	50
Others	20	30	32
Subtotal	176	334	351
Total carpet	420	413	430

Source: Food and Agriculture Organization, "Carpet Wool," Commodity Reports, Fibers, no. 4 (Rome, Nov. 1952).

The chief carpet wool importing countries are the United States, the United Kingdom and the U.S.S.R. About half is consumed industrially, mainly in carpet manufacture; the other half is absorbed locally in household or village industries, mainly in the less well-developed areas.

During World War II. wool prices were so controlled and supplies so managed that the big rise did not occur until the postwar period, particularly the period after the outbreak of hostilities in Korea, at which time the large wartime stockpile accumulation had been disposed of.

Prices for carpet type wools lagged in the post-World War II period as compared with apparel types. This was partly the result of financial exchange difficulties but more largely of a less active demand in relation to supply, particularly as to the Argentine type wools. Competition with rayon and other man-made fibres also became an important factor.

Because wool supply is so inelastic from one year to the next, demand factors generally dominate the price situation. Wool prices are among the most volatile, particularly under situations of war and international tension.

Wool Processing **and** Use.—Though wool makes up only about 9% of the total fibre supply of the world, approximately all of it is put to apparel and household use. For those uses it must be processed.

The first stage or step in such processing is normally that of sorting. Even the bales of wool which have been carefully classed must be examined fleece by fleece. Each fleece is carefully spread out and examined by touch and sight, then pulled apart. The different qualities, known as matchings, are placed in separate baskets. This is a way of obtaining quality control, even if different qualities are later blended.

Sorting or stapling was formerly a distinct industry, and to some extent it is so still, though frequently the work is done on the premises of the comber or spinner. Clothing wools are separated and classed differently from combing wools, and in dealing with fleeces from different breeds. the classification of the sorter varies. In the woollen trade short-staple wool is separated into qualities, known. in descending series from the finest to the most worthless, as picklock. prime, choice, super, head, seconds. abb and breech, and the proportions in which the higher and lower qualities are present are determined by the class of the fleece. In the worsted trade the classification goes, also in descending series, from fine, blue, neat, brown, breech, downright seconds, to abb. for English wools. The last three are short and not commonly used in the worsted trade. The greater proportion of good English long wool will be classified as blue. neat and brown; it is only in exceptional cases that more than from 5% to 8% is fine on the one hand, or of lower quality than breech on the other. Generally speaking, the best portion of a fleece is from the shoulders and side of the animal. The quality decreases toward the tail end of the sheep, the "britch" being frequently long, strong and irregular. The belly wool is short, worn and dirty, as is also the front of the throat, while on the head and shins the product is short, stiff and straight, more like hair than wool, and is liable to contain gray hairs. The colonial wools come classed, and consequently are only as a rule sorted into three or four qualities. Thus a 60s fleece may be sorted into 56s, ordinary 60s, super 60s and skirtings.

Grease wool after sorting still contains the natural wax, the suint or perspiration salts and little or much foreign matter, dust. burs, etc., all of which must be removed before further processing takes place. The process of cleaning is called scouring. The qualities of the fibre may be seriously injured if this processing is not thoroughly and carefully done. If the wool is not perfectly cleansed it will dye unevenly and the manufacturing operations will be more or less unsatisfactory. Scrubbing in a series of tubs containing soap and soda in water is the long-established procedure still widely used. The water should be soft and pure, both to save soap and to avoid the formation of insoluble lime material which can be removed from the wool fibre only with much difficulty. A specially prepared potash soap has been the detergent principally used. Excess of uncombined alkali has to be guarded against and the soapy solution must not be too hot. The mechanical arrangements of the machines are such as to ensure the passage of the wool without undue lifting and "stringing"; to obviate the mixing of wool grease, sand. dirt, etc., once taken out of the wool with that wool again; to give time for the thorough action of the scouring agents. so that neither too strong a solution nor too great a heat be employed, and to allow of the ready cleansing of the machines so that there is no unnecessary waste of time. In England the recognized type of Merino wool-washing machine is the fork-frame bowl. Three to five of these machines are employed. The scour is strongest and hottest in the first bonl (unless this is used as a "steeper") as the wool at first is protected from the caustic by the wool fat, etc., present. The last bowl is simply a rinsing bonl. With modern nip rollers botany wool is sufficiently dry to be passed on directly—say by pneumatic conveyors—to the carding. This the worsted spinner does, thereby saving time and money. The woollen spinner, however, may require the wool for blending. and so may require it dry and in a fit state for oiling. For English and crossbred wools more agitation in the scouring bath may be desirable. If so. the eccentric fork action machine is employed, in which the agitation of the bath is satisfactorily controlled by the setting of the forks which propel the wool forward. An average wool will be in the scouring liquor about eight minutes, the temperature will vary from 120° F. to 110° F., and the length of bath through which it will have passed will be from 48 to 60 ft.

The main disadvantages of soap and soda scrubbing discussed above are slowness, some chemical damage to the wool by the alkaline solution and the difficulty of disposing of the wash water and the accompanying grease without violation of antipollution laws. Attempts to apply modern technology and research to the cleaning of wool have not been highly successful. Considerable wool is scoured by the so-called dry cleaning or solvent method, utilizing benzine perhaps, particularly in the United States. Recovery of the grease, however, is not easy; and sales of recovered grease have not sufficiently compensated for the solvent loss and distillation cost. A new method involving the use of water containing 3% alcohol in reaction with the suint salts has been found to emulsify the wool grease effectively, reducing it from the normal 12% prior to scouring to less than 1%. Moreover, the grease is recovered rather easily from the wash by raising the butyl alcohol concentration in the scouring water to 7%. This results in an upper layer of alcohol and grease which is removed. The grease and alcohol are separated by evaporating the alcohol. The liquid, which remains at 3% alcohol contraction, is reused. The advantages of the process are that the wool fibres are not in contact with an alkali and hence do not suffer deterioration. Moreover, the process is quicker and the equipment requires less space.

After scouring the wool is dried in one way or another by hot air, care being taken not to overheat the fibre in the process. If it should be in a matted condition it is put into a free and loose condition in a special machine of rotating cylinders and hooked teeth, called a Willey. If the wool contains adhering vegetable matter, as the heavily burred wools of interior Australia or Buenos Aires, that must be removed before further processing. Some mechanical devices are successful under some conditions but carbonization is more often utilized—immersing the wool for about 20 minutes in a bath of dilute sulphuric acid followed by draining and quick drying at about 250° F., after which the vegetable matter is sufficiently carbonized to be crushed and removed by a duster. Any acid remaining is neutralized and the wool mildly scoured and again dried.

Wool is a principal source of anthrax in humans, especially from contact with it prior to the weaving and finishing operations. Coarse wools originating from countries and districts where anthrax is a severe problem are the most likely sources. Grease wools are not so likely to be contaminated as pulled wools. Washing or scouring may result in the spread of the microorganism to previously uncontaminated material., But in general the danger diminishes considerably following scouring which reduces and perhaps germinates part of the spores as well as removes dirt and extraneous material. High temperatures of drying are perhaps lethal, and dyeing of raw wool eliminates the danger.

The United Kingdom sterilizes all wool from dangerous. sources. at a central sterilization plant' in Liverpool. It is washed for 10 minutes in 0.5% sodium carbonate solution at 37.8° C. This is followed by another washing in 3.5% soap solution for 10 minutes at 37.8° C. The third step is a ten-minute exposure to 2% formaldehyde at 37.8° C. This is follo ed by a second formaldehyde wash of 1.8% for 10 minutes. In between each two of these steps the wool is rolled out so as to remove as much of the previous wash water as possible. The fifth step is to rinse in a 0.25% formaldehyde solution at 37.8° C. Following this the wool is pressed out and dried in hot air at 110° C., the temperature dropping rapidly so that the wool will not be scorched. After the material is dried it is blown into baling presses.

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WOOL, WAR CONTROL OF. Wool is an indispensable article in war. No fibre has yet been discovered, the properties of which can equal, for the clothing of armies, its hygienic and durable qualities; while for munition purposes, such as felt mashers, for shells, guns, submarine and aeroplane engines. torpedoes. tanks, etc. and other equipment such as water-bottle covers, wool is essential. A soldier's clothing and equipment consumes on a war basis from four to ten times the average wool consumption of a civilian in times of peace.

The question of wool supplies during the World War was in part met by each country from its domestic production, and by the utilisation of old woollens in the manufacture of new goods. By this latter method and by substitution by inferior materials, the German armies, in fact, maintained their military clothing supplies throughout the war on a level of efficiency adequate for their purpose, in spite of the Allied blockade which effectually prevented supplies of overseas wool from reaching Germany and her Allies. Germany achieved this, however, at the expense of her non-combatants, who had to rely largely upon inferior substitutes for all their textile requirements.

From the point of view of the Allies the importance of conserving supplies could not be minimised. It was true that 85% of the wool production of Australia consisted of the finer merino quality not specially required for military purposes. After some discussion, however, the British Government agreed in the autumn of 1916 to purchase the whole wool production, excluding local manufacturing requirements, of Australia and New Zealand on a f.o.b. basis of 55% over average pre war prices (1913–14) with the stipulation that this price should be maintained for all military and other Government requirements both of Great Britain and of her Allies, but that in respect of civil consumption the fullest possible price should be obtained, and any net profit resulting be divided equally between the Treasuries of the imperial Government and the Governments of the commonwealth and the dominion. The purchase was repeated in practically the same terms for the 1917–18 and 1918–19 seasons.

In 191j the French Government had requisitioned its domestic wool clip on a price basis 25% over pre war, in 1916 the British Government requisitioned the British domestic clip on a level of 35% over pre war prices. The latter was a gesture rather than a necessity. In 1917 the price paid for the British clip was raised to 50% over pre war prices and in 1918 to 60%.

Institution of Control.—Owing mainly to factors external to its own peculiar difficulties the War Office in the autumn of 1916 found itself launched on a huge wool purchase scheme and had immediately to devise ways and means of dealing with the raw wool which it now owned. In the first place, arrangements were made with the shipping authorities by which the wool was brought from Australasia by requisitioned shipping at Blue Book rates. Special storage and transport arrangements had to be improvised both in Australia and at British ports. In the previous spring an organisation had been set up by the War Office for the valuation, collection, and distribution of the British domestic clip, a relatively small matter of 120,000,000 lb. The Australian and New Zealand clips, amounting to about 1,000,000,000 Ib., were valued, collected, and brought to Australasian ports by a machinery set up by the selling brokers and other trade organisations under the supervision of their Governments, which worked amazingly well within a very short time. When it is realised that whilst the average price of Australian wool was 15½d. there were almost a thousand different prices in the schedules prepared, the detailed work of valuation alone will be appreciated.

The War Office then expanded its British wool purchase executive under a wool controller to deal with the supplies of colonial wool now coming forward. The distribution of wool and tops to manufacturers at fixed prices made it possible to fix also the prices at which the finished cloth was to be delivered. In making purchases of cloth and other textiles, the War Office contracts department up to the end of 1916 endeavoured to purchase within fixed prices, but owing to rising prices of raw material this method in practice broke down. Not only was wool now issued for military but also for civilian purposes, whilst control of the raw material gave automatically the opportunity of controlling the use to which machinery should be put and ensured the supply of finished war material at fixed prices. To cope with these difficult problems a department of wool textile production was set up. The shipping and political factors involved were not known by and could not, therefore, be justly appreciated by the trade. It seemed, indeed, to a vast majority of those in the wool textile industry that an unnecessary degree of State control and interference had been instituted and this was vigorously opposed. As a method of understanding, a board of control of the wool textile industries was set up consisting of Government officials, mainly brought in from the trade, employers' and also trade union representatives. This board in practice represented a buffer between the War Office and the trade, and under its auspices problems concerning the rationing and control of civilian trade were decentralised. The responsibility, however, for meeting the increasingly growing demands not only of the British military, naval, and air forces, but of the armies of Russia, Belgium, Serbia and to a certain extent of Italy and France, and later the entire equipment in Europe of the American troops, remained with the responsible officials. In addition they were responsible for supplies of essential public services, both voluntary and Government, throughout the empire, including the Red Cross and prisoners of war organisations, post office, police and municipal requirements at home and abroad, women's organisations, as well as such services as the Indian and Egyptian Government services, together with the initiation and control of standard clothing schemes for the civil population and for the needs of demobilisation after the war.

In March 1918, when the British armies lost large reserves of stores in France, and the demands of the Allies and America were rapidly increasing, the department had to extend its production by over one million yards of material per week. It did this without apparent difficulty. A costings department was set up to investigate and fix conversion costs at each stage of production, but owing to technical complications the fixing of these rates was a most difficult business. The practical workings of a central statistical and costings staff necessarily lacked the flexibility of the normal play of individual units in competition. The system inevitably tended to fix the recognised conversion rate in excess of average efficiency, for otherwise output suffered.

Success of the Scheme.—Viewed broadly the scheme achieved its object. It produced necessary supplies at a calculable price. To produce the varied and changing demands of peace at competitive prices, the system must have broken down, but to meet a fairly standardised demand, in which finance as the governing factor was absent, the system was satisfactory, and inevitable in the circumstances of war.

The wool purchase scheme was of special benefit to Australia and New Zealand. During the first year of the purchase the imperial Government paid to the commonwealth and dominion Governments £25,000,000 and received for sales £330,000. By June 1918, it had paid out over £100,000,000 and received not much more than £50,000,000 by the end of 1919. A year after the war the imperial Government had expended many millions sterling in the purchase of wool more than it had received and at the conclusion of hostilities it was responsible for about £75,000,000 of wool accumulated in Australasian ports owing to lack of shipping to transport it. In addition, an arrangement was entered into by the surveyor-general of supply, who had been appointed in 1917 to control all War Office supply services, by which one clear season's (1919–20) wool clip after the war was purchased by the imperial Government. During the war a large part of the South African clip was also purchased, on optional terms to growers, as well as that of the Falkland islands and of Iceland (from which country wool cargoes had been running the North sea blockade). East Indian wool was marketed at fixed levels of prices under a special scheme. Numerous proposals were from time to time put forward for the purchase of the wool clips of South America but were in turn all vetoed by the Treasury owing mainly to exchange difficulties.

In all 9,895,000 bales (approximately 3,250,000,000 lb. of wool) were purchased, for which approximately £300,000,000 was paid and a net profit of £70,000,000 was divided equally between the British and colonial Governments. The aggregate sales of British wool amounted to £40,000,000 on which a profit of £5,000,000 was made. Within one year of the war the whole organisation of the department of wool textile production was liquidated, but owing to the new arrangement made with regard to the further purchase, wool control was maintained, and a wool control board set up to advise the War Office and the liquidation commission concerning the various post-war questions which arose.

Government wool control continued until 1921, when its functions were taken over by a company, called the British Australian Wool Realisation Association, referred to as B.A.W.R.A. This rearrangement was made in order to avoid the restrictions and international complications which direct Government trading involved, and, incidentally, to minimise domestic political interference. During the post-war period the policy was followed of establishing price by the release of wool at auction at calculated quantities and at reserve prices based upon estimates prepared from centralised Government and other statistics, and this for a short time appeared very successful. The basing of potential consumption figures upon such estimates proved, however, within a short time unreliable. In spite of having at its command the fullest possible information, and in addition, being in the enormously strong position of the largest holder of wool stocks, the wool control was unable to make any estimate of a useful nature of future wool consumption, or to control the market, and as a result its predictions on price did not eventuate, and sudden and severe slumps overwhelmed the world wool trade both in 1920 and 1924. Apart, however, from this post-war experiment, which endeavoured somewhat unsuccessfully to control prices, it is generally conceded that the wool control exercised during the war was justified in the circumstances and by its results. (E. F. H.)

WOOL COMBING: *see* COMBING.

WOOLF, VIRGINIA (1882–1941), English writer, daughter of Sir Leslie Stephen, married in 1912 Leonard Woolf. They controlled the Hogarth Press, which published most of her books. Her first novel, *The Voyage Out* (1915), was realized to be a remarkable book, and its success was followed up with *Night and Day* (1919) and *Jacob's Room* (1922). Meanwhile, Mrs. Woolf had published several shorter experiments in a new method, which were collected in *Monday or Tuesday* (1921). In this new style were written her next novels, *Mrs. Dalloway* (1925), *To the Lighthouse* (1927), and, to a lesser extent. *Orlando,* a "biography" (1928). Among her later novels, *The Years* (1937) was especially acclaimed by critics (nith whom, incidentally, she was in constant argument). Instead of writing novels in which the thoughts of the characters are to be deduced from what they say and do, or in which the thoughts of individuals are recorded to show to what sort of person they belong, Mrs. Woolf chose to urite novels in which thought is so minutely revealed that words and actions lose much of their importance. The merit of her books lies partly in her understanding of those about whom she wrote, partly in the felicity with which she used words. These gifts placed her among the best literary critics of her time; she published critical essays, *The Common Reader* (1925) and *The Common Reader, Second Series* (1932).

Mrs. Woolf was drowned near Lewes, Sussex, March 28, 1941, and the coroner returned a verdict of suicide.

WOOLLEN MANUFACTURE. The processes described in the article WOOL are common to English, cross-bred and botany wools, whether intended for woollen or for worsted yarns. From this point, however, differentiation starts. Wool may be manipulated with the idea of converting it into felt (*q.v.*), "woollen" fabrics or "worsted" fabrics.

Woollen and Worsted.—In a general way it may be said that *woollen* yarns are those made from short wools usually possessed of high felting qualities. These are prepared for spinning by the process of *carding,* a process which so thoroughly blends or mixes the fibres—long and short, black and white or coloured, or even of different materials—that a homogeneous fibrous mass in broad film form is obtained, which is then divided up longitudinally, as it emerges from the carder, into a number of pith-like filaments. These filaments are then extended into finer filaments and twisted to form the woollen thread upon the mule or mule-frame.

On the other hand *worsted* yarns are generally made from the long lustrous varieties of wool; the fibres are so combed as to bring them as far as possible parallel to each other; the spinning is usually effected on the frame, and the yarn is spun into a compact, smooth and level thread, which, when woven into cloth, is not necessarily milled or felted. At all points, however, woollen and worsted yarns and cloths as thus defined overlap each other, some woollens being made from longer wool than certain worsteds, and some worsteds made from short staple wool, carded as well as combed. The most fundamental distinction between the two rests in the crossing and intercrossing of the fibres in preparing woollen yarn, while for worsted yarn the fibres are treated by processes designed to bring them into a smooth parallel relationship to each other.

Woollen Yarn Manufacture— Toobtain a sliver which can be satisfactorily spun into a typical woollen thread the following operations are necessary: willowing, oiling and blending, teasing, carding (two or three operations), condensing and possibly roving. Spinning upon the woollen mule or frame completes the series of operations all of which are designed to lead up to the desired result. Of the foregoing operations the carding is perhaps the most important as it is certainly one of the most interesting. At the same time it must be fully realized that deficiencies in any one of these operations will result in bad work at every subsequent process. For example, let an unsatisfactory combination of materials be blended together and there will be trouble in both carding and spinning. The roving operation included above is not always necessary. In the old days, if a really fine thread were required, roving was absolutely necessary, as the carder could not turn off a sliver fine enough to be spun at one operation. To-day, however, with the "tape" condensers, such fine slivers can be turned off the condenser that it is easy to spin directly to the required count.

Blending and Oiling.—At the beginning of the 19th century woollen cloths were made of wool—some of them of the very finest wool obtainable. To-day woollen cloths are made from any and every kind of material, of which the following are the most important: noils (botany, cross-bred, English, alpaca and mohair), mungo, shoddy, extract, flocks, fud (short mill waste), cotton sweeping, silk waste, etc.; in fact it is said that anything which has two ends to it can be incorporated into a woollen thread and cloth. It does not follow, however, that all woollen cloth is cheap and nasty. On the contrary the west of England still produces the finest woollen fabrics of really marvellous texture and beauty, and Batley, Dewsbury, etc., produce many fabrics which are certainly cheap and yet not cheap appearing. The first essential for blending is that the materials to be blended should be fairly opened out. This is effected by passing each material, if necessary, through the willow or through the "fearnaught'—a machine coming between the willow and card—prior to beginning the "blend-stack." Sometimes it may be that a blending of different colours of wools to obtain a definite "colour mixture" is necessary, more often it will be a blending of various materials, such as noils, mungo, cotton, etc., to obtain a cheap blend which may be spun into a satisfactory warp or weft yarn. The blender proceeds as follows: first a layer of No. 1 material—say wool—is spread over the required area on the floor; it is then lightly oiled. A layer of No. 2 material—say noils—is now added to the first layer; then another layer of wool with rather more oiling; then No. 2, then No. 1 with still more oil until all the material is built up into layers in the stack. The stack is now beaten down sideways with sticks or pulled, and then the more or less mixed mass is passed through the willow and fearnaught still further to mix it prior to carding, where the true and really fine mixing takes place. After passing through the fearnaught the material is sheeted and left to "mellow," this no doubt consisting in the oil applied distributing itself throughout the material. If wool and cotton are blended together the wool must be oiled first, or the blend will not work to the greatest advantage. The oil may be best Gallipoli olive oil—which should not turn rancid—but there are many good oils—and unfortunately many bad oils—placed on the market at a reasonable rate which the really skilled judge may use to advantage. The percentage of oil varies from 2% to 12%—this remark applies both to the woollen and worsted trades—and there is no guide as to the amount required, saving and excepting experience, observation and common sense. Automatic oiling arrangements have now been applied in the woollen trade with a considerable amount of success, the sprinkling of the oil by means of a watering-can on the stack, made as described above, still being much in favour. The oil serves to lubricate the fibres, and to render them more plastic and consequently more workable, and to hold the fibrous mass together and thus prevent "fly" during the passage through the cards.

Carding. — Carding was originally effected by hand, two flat boards with convenient handles, covered with teeth or card cloth-

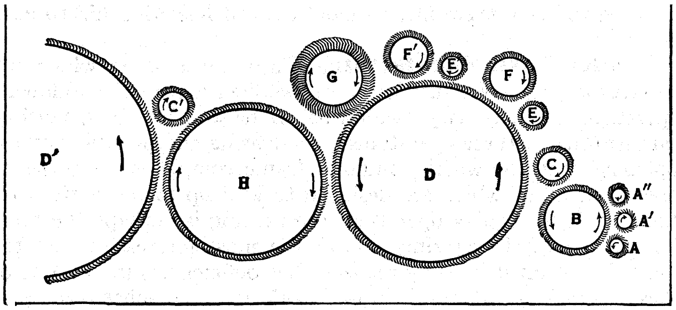


FIG. 1

ing, serving as a means of teasing out lock by lock, fibre by fibre, reversing root to tip and tip to root, so that a perfect mixing of the fibres resulted. It was but natural that, when an attempt was made to render the carding operation more mechanical, the operation should be converted into a continuous one through the adoption of rollers in place of flats. Flats combined with rollers still maintain their position in cotton carding, but in wool carding the pure roller card is employed. The factors of carding are size of rollers, speeds of rollers, inclination and shape of teeth and density of card clothing. Probably no operation in the textile industries is so little understood as carding. Thus the long wool carder would think a man an idiot who suggested the running of the teeth of the various cylinders actually into one another, while the short mungo carder regularly carries out this idea, and so on. The underlying principle of carding, however, is shown in fig. 1, in which a sectional drawing of part of a card is given. The wool is carried into the machine on a travelling lattice and delivered to the feed rollers A, A', A" of which A and A" in turn are stripped by the licker-in B working at a greater speed point to smooth side. This in turn is stripped by the angle stripper C again working at a greater speed point to smooth side, which in its turn is stripped by the breast D — the "carrying-forward" and swiftest carding cylinder in the machine. The swift carries the wool forward past the stripper E— which as a matter of fact is stripped by the swift still working point to smooth side — into the slowly retreating teeth of the first worker F, which, being set a fair distance from the swift, just allows well laid-down wool to pass, but catches any projecting and uncarded staples. The worker in its turn is stripped by the stripper E, which in turn is stripped by the swift as already described. The passage of the wool forward through the machine depends upon its being carried past each worker in turn. Thus from beginning to end of a machine the workers are set closer and closer to the swift, so that the last worker only allows completely carded wool to pass it. Immediately on passing the last worker F' the wool is brushed up on the surface of the swift by the "fancy" G—as a rule the only cylinder whose teeth actually work into the teeth of the swift and the only cylinder with a greater surface speed than the swift. The swift then throws its brushed-up coating of wool into the slowly retreating teeth of the doffer H, which carries it forward until angle stripper C strips the doffer, to be in its turn stripped by swift D' and so on. The speeds of the cylinders are in the first place obviously dependent upon the principle of carding adopted, the greater speed always stripping (save in the case of the fancy). As to whether the speed shall be obtained by actual revolutions or by a larger diameter of cylinder depends upon the nature of the wool to be carded (long or short), the part which each cylinder has to play in the card, and upon the question of wear of clothing and power consumed. As a rule the strippers are all driven from a smaller circumference of the swift to obtain conveniently the necessary reduction in speed, and the slowly revolving workers are chain driven from the doffer, which indirectly receives its motion from the swift. The principles involved in the relative inclinations of teeth are very apparent, but the principles involved in the relative densities of teeth on the respective cylinders are again much involved and little understood.

A complete scribbler or first card engine consists of a breast, or small swift, and two swifts with the accompanying workers, strippers, fancies, doffers, etc. The wool is stripped from this card as a thin film by means of the doffing comb. This film is sometimes weighed on to the next machine — whether intermediate or condenser—a given weight giving a definite count of condensed sliver. Should an intermediate carder be employed, there must be an automatic feed, taking the wool, as stripped from the last doffer of the intermediate, and cross-feeding it evenly on to the feed sheet of the condenser. It is now more usual to automatically weigh into the scribbler and automatically feed the condenser or, if an intermediate is employed, both the intermediate and condenser. The condenser is a one-swifted or two-swifted card, the only difference in principle being that, whereas the sliver comes out of the scribbler or intermediate in one broad film, it is broken up into a number of small continuous slivers or films as it issues from the condenser, each one of which will ultimately be drafted or drawn out and twisted into a more or less perfect thread. These slivers— which are delicate and pith-like in substance — are wound on to light bobbins, and these bobbins are placed on the mule for the roving, or final spinning operations. There are many forms of condensing mechanisms such as the single-doffer, the double-doffer and the tape-condensers, which cannot be described here.

Mule Spinning. — The principles involved in mule spinning are comparatively simple, but the necessary machinery is very complex; indeed it is questionable if a more ingenious machine than the mule exists. The pith-like slivers received from the card must be attenuated until the correct count of yarn is obtained; they must be twisted while this attenuation or drafting is in process, otherwise they would at once break; and after being attenuated to the required fineness the requisite number of turns must be inserted. Great stress must be laid on the effects of what is termed the "drafting-twist" noted above; it is probably this simultaneous drafting and twisting which develops the most pronounced characteristics of the woollen yarn and cloth, and differentiates it entirely from the worsted yarn and cloth. The mule (see fig. 2) consists fundamentally of the delivery cylinders A, upon which the sliver bobbins B from the condenser are placed, which deliver the slivers as required to the front delivery rollers C (these rollers controlling perfectly the delivery of sliver for each stretch of the carriage), and the carriage EE carrying the spindles which may be

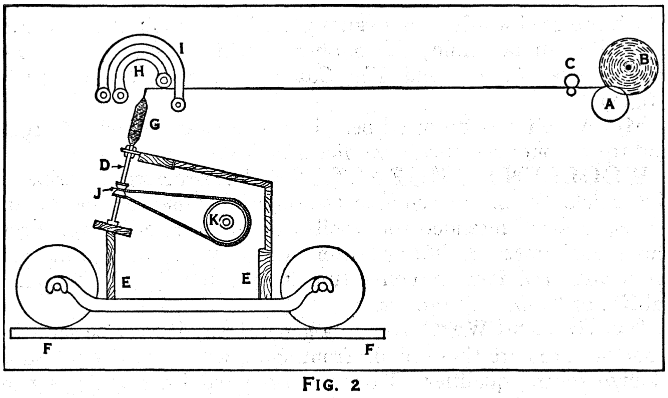


FIG. 2

run close up to the front delivery rollers and about two yards away from them to effect the "spin," which is of an intermittent character. The spindles D are turned by bands passing round a tin drum K in the carriage, but this motion, and every other motion in the mule, is controlled perfectly from the headstock. In brief, the operation of spinning is as follows: as the carriage begins to recede from the delivery rollers these rollers deliver condensed sliver at about the same rate as the carriage with its spindles moves out, the spindles putting in a little twist. When the carriage has perhaps completed half its traverse (say 36") away from the front rollers these suddenly stop delivering the condensed sliver, the carriage travelling more and more slowly outwards until it completes its traverse, drafting the sliver out to perhaps double the length. This drafting could not be effected but for the "drafting-twist," which, running into the thin parts of the yarn during drafting, strengthens them and thus from beginning to end equalizes the thread. Upon the completion of drafting the spindles are thrown on to "double speed" to complete the twisting of the 72″ of yarn just spun as rapidly as possible, the carriage being allowed to run inwards for a few inches, to allow for the take-up due to twisting. The mule now stops dead, backs-off the turns of yarn from the top of the spindle to the bottom, the faller H wire falls into position to guide the thread on to the spindle to form the required cop G, and the counter-faller I wire rises to maintain a nice tension on the yarn. The carriage now runs in, the spindles being revolved to wind up the yarn, and, in conjunction with the guiding on of the faller wire, builds up a firm cop or spool.

Woollen mules are made with several hundred spindles and of varying pitch to suit particular requirements. Thus if the mules are to follow a set of say three machines with a tape condenser, and are required to spin fine counts, the pitch of the spindles may be much finer than ordinarily, but a greater number will be required to work up the sliver delivered by the set of machines. There are many other details which require careful consideration; the inclination of the spindles, for example, must be suited to the material to be spun.

The mule-frame to which reference has been made is a ring-spinning frame arranged to spin condensed woollen slivers continuously, thus producing about double the weight per spindle as compared with the intermittent mule. Drafting-twist is introduced in this case between two pairs of drafting rollers by a "twizzler" which, however, only inserts false twist. The true twist is inserted later by the spindle and traveller. This method of spinning necessitates more twist than that necessary in mule spinning so that "frame" woollen yarn is most suitable for warp and is usually not soft enough for weft yarn.

The yarn as delivered by the mule is "single" and will serve as warp or weft for the great bulk of woollen cloths, warp being as a rule twisted harder than weft. Sometimes for strength, sometimes for colour, however, it will be necessary to twist two or more of these single strands together. This is best effected on a twisting frame of the ring type, which consists of delivery rollers, to deliver a specified length of yarn in relationship to the turns of the spindles, and the spindles, which serve to put in twist and to wind the yarn upon the bobbin or tube, which they effect by reason of the retarding action of the traveller. Fancy twists such as knops, loops, slubs, etc., may also be produced if the frame is fitted up with two pairs of delivery rollers and two or three special but simple appliances. (For woollen and worsted weaving, *see* WORSTED MANUFACTURE.) (A. F. B.)

WOOLLEY, MARY EMMA (1863–1947), U.S. educationist, was born at South Norwalk, Conn., on July 13, 1863. She was instructor at Wheaton college, Norton, Mass., 1886–91, before going to Brown university, where she was graduated in 1894. She was a teacher of biblical history in Wellesley college, 1895–98, becoming in the latter year professor and head of the department of biblical history and literature. From 1900 to 1937 she was president of Mount Holyoke college and became one of the most influential women educators in the United States. She died Sept. 5, 1947, at Westport, N.Y.

WOOLLY APPLE APHID, an American aphid (*Eriosoma lanigerum*), sometimes called the woolly root-louse of the apple. Although probably of American origin, this insect has become a cosmopolitan pest of the apple and pear. Making its appearance in England toward the close of the 18th century, it became known as the American blight; and either from England or from America it has been carried to many different parts of the world, probably on nursery stock. It is likely to have been an indigenous pest of *Crataegus* and to have established at an early date an alternate food plant in the American elm.

In the northern part of the United States and in general throughout its whole northern range, the insect lives almost entirely upon the roots of its host plants, causing swellings and other deformations and interfering seriously with the sap flow. In the southern part of its range it lives for the most part above ground, preferably upon suckers from the trunks but also upon normal twigs and even upon leaves. In south England and most parts of Europe, the aerial form predominates. This form is concentrated upon the tender growth and is conspicuous, the colonies appearing as whitish cottony masses beneath which are the reddish insects themselves. The winter eggs are laid in crevices of the bark on elm and occasionally on apple, and hatch in the spring. They develop parthenogenetically, winged forms appearing occasionally, by means of which the insect spreads. In the United States, the fourth generation is winged and migrates from elm to apple. There are usually seven generations each summer.

At present the insect is known in nearly all the European countries, in a number of South American countries, and also in Japan, Australia and New Zealand. Like all plant lice, it has many natural enemies among insects; its one specific parasite, *Aphelinus mali,* has been widely acclimatized. (L. O. H.)

WOOLMAN, JOHN (1720–1772), U.S. Quaker preacher whose *Journal* is recognized as one of the classic records of the inner life. was born on Oct. 19, 1720 at Ancocas in the present area of Burlington county, N.J. The son of a Quaker farmer. Woolman spent his youth working on his father's farm. At the age of 21 he moved into the town of Mount Holly. N.J., to enter trade and at this time made his first appearance in the ministry, a calling in which he learned, he said, "to watch the pure opening." In keeping with Quaker practice. Woolman exercised his ministry without financial remuneration; in 1743 he took up tailoring. which afforded a modest income, augmented at times by work as a surveyor, conveyancer and schoolmaster. From 1743 to his death on Oct. 7, 1772, at York, England, where he had gone to attend the quarterly meeting of the Society of Friends, he made frequent and often arduous preaching journeys, visiting, among other places, Maryland's east shore, where he carried to the owners his message against slaveholding; the Rhode Island coast. where he brought his antislavery doctrines to the attention of shipowners. because he recognized the north's interests in that institution. In Indian villages of the Pennsylvania frontier he supported Moravian missionary attempts, sought to curtail the sale of rum to the Indians and worked for a more just Indian land policy.

Woolman maintained a strict manner of life, making his trips on foot whenever possible, wearing undyed garments and abstaining from the use of any product connected with the slave trade. In his work against slavery he was successful in getting Quaker communities to go on record against that institution and in persuading many individuals to free their slaves. His *Journal,* published in 1774, was begun in his 36th year and continued until his death; it is a major document of American religious experience, written in a style of distinguished purity and simplicity. His other writings include *Some Considerations on the Keeping of Negroes* (pt. i, 1754; pt. ii, 1762); *Considerations on Pure Wisdom and Human Policy, on Labour, on Schools, on the Right Use of the Lord's Outward Gifts* (1758); *Considerations on the True Harmony of .$fankind, and How It Is to & Maintained* (1770); and *A Word of Remembrance and Caution to the Rich,* originally titled *A Plea for the Poor* (1793).

The Works of John Woolman (1774) is the major edition. The most complete edition of the *Journal* is that of A. M. Gummere (1922), and the best-known edition is that of John Greenleaf Whittier (1871).

BIBLIOGRAPHY.—For Woolman's life, *see* A. M. Gummere's introduction to the *Journal; see* also lives *by* W. T. Shore (1913); F. V. Morley (1926); J. Whitney (1942). His writings are considered in M. C. Tyler, *Literary History of the American Revolution* (1897). (L. Z.)

WOOLSACK, a sack stuffed with wool and covered with red cloth upon which the lord chancellor sits in the house of lords. Originally there were four woolsacks in the parliament chamber, upon which were seated the judges. barons of the exchequer. sergeants-at-law and masters in chancery. The uppermost woolsack now alone survives, but it is regarded as technically outside the precincts of the house.

WOOLSEY, THEODORE DWIGHT (1801–1889), U.S. educator, scholar, president of Yale and powerful leader in American higher education, was born in New York city, Oct. 31, 1801, a nephew of the "Hartford wits" Timothy and Theodore Dwight (*see* DWIGHT) and descendant of Jonathan Edwards. He graduated head of his class at Yale in 1820 and in 1831 was appointed professor of Greek there. Elected president of Yale in 1846, Woolsey bent his innovating forcefulness to the improvement of scholarly standards and to a foresighted university expansion. During his administration (1846–71) the scientific school was founded. the first American Ph.D. was awarded (1861), the first college school of fine arts was established, the law and divinity schools were rejuvenated, the corporation was reorganized and the "government of the faculty" was affirmed.

Woolsey's editions of the Greek tragedies brought the advanced methods of German scholarship to U.S. colleges, and his *Introduction to the Study of International Law* (1860) and *Essay on Divorce and Divorce Legislation* (1869) went through many editions. After retirement he wrote his *Political Science* (1877) and *Communism and Socialism* (1880), and headed the U.S. commission for revision of the New Testament. Woolsey died July 1, 1889.

His son, THEODORE SALISBURY WOOLSEY (1852–1929), was a jurist and professor of international law at Yale law school.

See biography by *H.* E Starr in the *Dictionary of American Biography;* George *A* King, S.J., *Theodore Dwight Woolsey: His Politzcal and Social Ideas* (1956). (G. *W* P)

WOOLSTON, THOMAS (1670–1733), English deist, born at Northampton, entered Sidney Sussex college. Cambridge, in 1685 and was elected a fellow in 1691. After studying Origen, he devoted himself to the allegorical interpretation of Scripture and advocated its use in his first book, *The Old Apology for the Truth* of *the Christian Religion Against the Jews and Gentiles Revived* (1705). In 1720–21 Woolston's open challenges to the clergy brought him into trouble. It was reported that his mind was disordered and he lost his fellowship. From 1721 he lived in London, on an allowance of F30 a year from his brother and other presents. His influence on the deist controversy began with his book *The Moderator Between an Infidel and an Apostate* (1725). Woolston denied the proof from miracles. called in question the resurrection of Christ and other miracles of the New Testament and maintained that they must be interpreted as types of spiritual things In a series of *Discourses,* he applied his principles to the miracles in detail. The six *Discourses,* 30.000 copies of which were apparently sold, appeared between 1727 and 1730, and for these publications he was tried in 1729 and sentenced to pay a fine, with imprisonment until paid, and also to a year's imprisonment and to give security for his good behaviour during life He failed to find this security and remained in confinement until his death on Jan. 27, 1733. *See* also DEISM.

BIBLIOGRAPHY.—*Life* of Woolston prefixed to his *Works* in five volumes (1733), *Memoirs of the Life and Writings of Mr. William Whiston,* 2nd ed, pp. 231–235 (1749); J Cairns, *Unbelief in the Eighteenth Century* (1880); *E* Sayous. *Les Déistes anglais et le christianisme principalement depuis Toland jusqu'a Chubb, 1696–1738,* pp. 122–145 (1882).

WOOLWICH, a metropolitan and parliamentary borough of London. Eng., 10 mi. E.S.E. from the city. It is the easternmost borough of London and is bounded north by the Thames and Essex and east and south by Kent. Pop. (1951) 147,891. Area 12.9 sq.mi. The borough was formed in 1899 by the amalgamation of the parishes of Woolwich, Plumstead and Eltham. It returns two members to parliament, for Woolwich East and Woolwich West.

Woolwich is mentioned as Uuluuich in a legal document of 918. In Domesday Book the manor is mentioned as Hulviz ("a hill reach'!) and consisted of 63 ac. of land. The Roman Watling street crossed Shooter's hill, and a Roman cemetery and various fragments of pottery, etc., have been dug up. Early in the 16th century Woolwich rose into prominence as a dockyard and naval station. Ships were built there in the reign of Henry VII, but it was with the purchase by Henry VIII of two parcels of land in the manor, called Boughton's docks, that the foundation of the town's prosperity was laid. The building of the "Henry Grace à Dieu," or "Great Harry" (1,000 tons), in 1514 marked an epoch in its history. Woolwich remained the chief dockyard of the royal navy until the introduction of iron shipbuilding; the dockyard was closed in 1869 and the site taken over by the war office for storage purposes.

In 1667 Woolwich Warren was fortified against the Dutch fleet; by 1683 gun carriages were being broken down and the royal carriage factory had originated; in 1716 guns were first cast at Woolwich Warren and the royal gun factory had been started. Woolwich Warren was the headquarters of the royal artillery from 1716 until 1775 when it moved to Woolwich common, on the east side of which the Royal Military academy, founded in 1741 inside the arsenal, was moved to new quarters in 1806. It was planned to transfer the academy to Sandhurst (*q.v.*) in 1940, but because of World War II. the present academy (the result of the amalgamation of the Royal Military college and the Royal Military academy) did not come into being until 1947. In 1805 Woolwich Warren was renamed the royal arsenal. The Rotunda museum, presented to the royal military repository by the prince regent after 1815, contains arms, models of ships, etc.

North Woolwich, across the river, is connected with Woolwich by a ferry and a footway tunnel. It contains large telegraph and gas works, parts of the Royal Albert and King George V docks of the Port of London and the Royal Victoria gardens (ten acres).

Plumstead, embracing four medieval manors, is entirely a residential and shopping area.

At Eltham, the banqueting hall (15th century) of the royal palace (*c.* 1300), last lived in by James I, has been incorporated into Eltham hall, now used as an army school of education. Eltham was a royal manor at the time of Edward the Confessor and contains many 15th- and 16th-century houses. Eltham is a residential area.

WOOLWORTH, FRANK WINFIELD (1852–1919), U.S. merchant, was head of the chain of five-and-ten-cent stores bearing his name. Born near Rodman, N.Y, on April 13, 1852, he attended public schools and for a brief period a business college at Watertown, N.Y. After working as a clerk in various stores, he opened a "five-cent" store in Utica, N.Y.. in 1879 with the help of W. H Moore, one of his early employers. His idea was to sell a large variety of goods at one fixed price. Although that store was a failure, he established later in the same year a "five-and-ten-cent" store, with a larger selection of merchandise, in Lancaster, Pa. The second enterprise proved successful and was followed by other stores in various cities.

Woolworth's brother, C S. Woolworth, his cousin Seymour H Knox and his close friends F. M Kirby and E. P. Charlton, as well as his mentor Moore later all started similar stores of their onn. They in general refrained from competing with each other and managed independent units until 1912, uhen they were merged into the F. W Woolworth company. When Woolnorth died at Glen Cove, L.I., on April 8, 1919, his company was operating more than 1,000 stores and he had accumulated a personal fortune of many millions of dollars.

The Woolworth firm continued to expand after his death and hundreds of new stores were opened, not only in the United States but also in several other countries, including Canada, Great Britain, Germany and Cuba.

See John *K.* Winkler, *Five and Ten: The Fabulous Life of F. W. Woolworth* (1940).

WOONSOCKET, a city of Rhode Island. U.S., in Providence county, is on the Blackstone river 15 mi. N W. of Providence. Most of the city is densely settled with much multiple housing and many churches. More than 75% of the people are Roman Catholic and of French-Canadian descent. Woonsocket is a part of the Providence-Pawtucket standard metropolitan statistical area. (For comparative population figures *see* table in RHODE ISLAND: *Population.*)

The city is industrial with, in the 1960s, heavy but sharply declining dependence on textiles, principally woolens and worsteds. Other leading manufactures included rubber products, fabricated metals and machinery, and apparel.

The first structure in uhat is now Woonsocket was a sawmill built by Richard Arnold in 1666. Water poner attracted the earliest cotton-spinning mill about 1810, and the first plant for spinning and weaving wool was erected by Edward Harris in 1840. Woonsocket, which was once part of Cumberland and North Smithfield. was not a separate town until 1871. Its name is said to have derived from the Indian Miswosakit, meaning "at the very steep. hill" (Woonsocket hill in North Smithfield). In 1888 it was incorporated as a city and from 1953 had a "strong-mayor" form of government with a unicameral governing body. (V. H. WH.)

WORCESTER, EARLS AND MARQUESSES OF. Urso de Abitot, constable of Worcester castle and sheriff of Worcestershire, is erroneously said to have been created earl of Worcester in 1076. Waleran de Beaumont (1104–66), count of Meulan in France, a partisan of King Stephen in his war with the empress Matilda, was probably earl of Worcester from 1136 to 1145. He was deprived of his earldom, became a crusader and died a monk.

From 1397 to 1403 the earldom was held by Sir Thomas Percy (*c.* 1343–1403), who in 1403 joined the other Percys in their revolt; he was taken prisoner at Shrewsbury and subsequently beheaded, the earldom becoming extinct. The title of earl of Worcester was revived in 1421 in favour of Richard Beauchamp, Lord Abergavenny, but lapsed on his death in 1422. The next earl was John Tiptoft, or Tibetot, a noted Yorkist leader during the Wars of the Roses, who was executed in 1470. On the death of his son Edward in 1485 the earldom reverted to the crown.

In Feb. 1514 the earldom was bestowed by Henry VIII on CHARLES SOMERSET (c. 1460–1526), a bastard son of Henry Beaufort, duke of Somerset. Having married Elizabeth, daughter of William Herbert, earl of Huntingdon, he was styled Baron Herbert in right of his wife, and in 1506 he was created Baron Herbert of Ragland, Chepstom and Gower. He was chamberlain of the household to Henry VIII. His son HENRY. 2nd earl (*c.* 1495–1549), obtained Tintern abbey after the dissolution of the monasteries. The title descended in direct line to HENRY: the 5th earl (1577–1646). who advanced large sums of money to Charles I at the outbreak of the Great Rebellion and was created marquess of Worcester in 1643.

EDWARD SOMERSET, 2nd marquess of Worcester (1601–67), the inventor. was earlier known by the title of earl of Glamorgan, conferred somewhat irregularly by Charles I in 1644. The "Glamorgan treaties" negotiated by him with the Irish Catholics alarmed Protestant opinion. and under the Commonwealth he was formally banished from England and his estates were seized. At the Restoration his estates were restored, and he claimed the dukedom of Somerset promised to him by Charles I; but he did not obtain this, nor was his earldom of Glamorgan recognized. His *Century of the Names und Scantlings of Such Inventions as at Present I Can Call to Mind to Have Tried and Perfected* was published in 1663.

His only son HENRY (1629–1700), the 3rd marquess, abandoned the Roman Catholic religion and was a member of one of Cromwell's parliaments. But he was quietly loyal to Charles II, who in 1682 created him duke of Beaufort. As the defender of Bristol, the duke took a considerable part in checking the progress of the duke of Monmouth in 1685, but in 1658 he surrendered the city to William of Orange. He inherited Badminton, still the residence of the dukes of Beaufort. The Worcester title was henceforth merged in that of Beaufort. HENRY, the 7th duke (1792–1853), was one of the greatest sportsmen of his day, and the Badminton hunt owed much to him and his successors.

WORCESTER, WILLIAM (*c.* 1415–*c.* 1482), English chronicler. was a son of William of Worcester, a Bristol citizen, and is sometimes called William Botoner. his mother being a daughter of Thomas Botoner. He was educated at Oxford and became secretary to Sir John Fastolf. When the knight died in 1459, Worcester, although an executor. found that nothing had been bequeathed to him, and with a colleague. Sir William Yelverton. he disputed the will, obtaining some lands near Norwich and in Southwark. He died about 1482. His *Itinerarium* of England is of great value. Portions were printed by James Nasmith in 1778, and the part relating to Bristol is in James Dallaway's *Antiquities oj Bristowe* (Bristol, 1834).

Worcester also wrote *Annales rerum Anglicarum, a* work of some value for the history of England under Henry VI. This was published by T. Hearne in 1728, and by Joseph Stevenson for the "Rolls Series" with his *Letters and Papers Illustrative of the Wars of the English in France During the Reign of Henry VI* (1864). Stevenson also printed here collections of papers made by Worcester respecting the wars of the English in France and Normandy. Worcester's other writings include the last *Acta domini Juhannis Fastolf*. *See* the *Paston Letters* edited by J. Gairdner (1904); and F. A. Gasquet, *An Old English Bible and Other Essays* (1897).

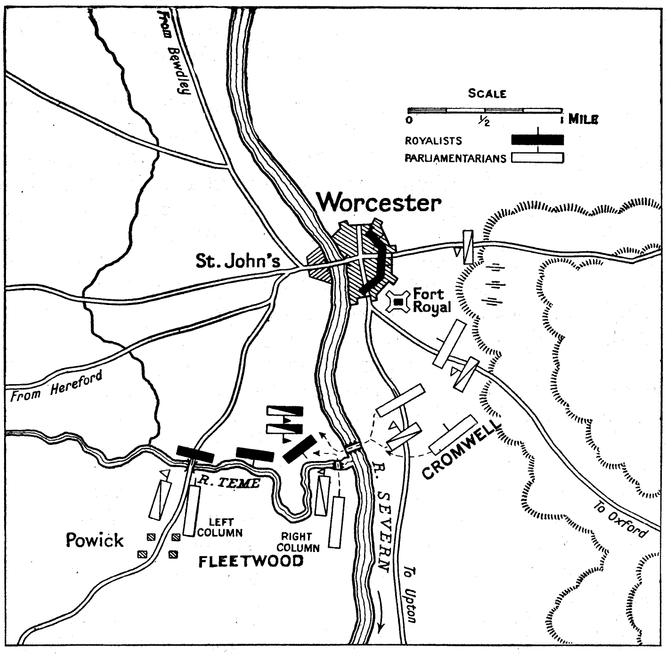
WORCESTER, a city, county and parliamentary borough and the principal and cathedral town of Worcestershire, Eng., 111 mi. N.W. of London by road. Pop. (1951) 59,703. Area 8.4 sq.mi. The town lies near the middle of the county on the Severn river, chiefly on its left bank, and the cathedral of pinkish-gray sandstone stands on a ridge above the river.

The first cathedral was the church of St. Peter built by missionaries before 680, in which year Bosel. a monk of Whitby, became its first bishop. In 969 Bishop Oswald (later St. Oswald) acquired St. Peter's for the Benedictine monastery of St. Mary; in 983 he completed a new cathedral dedicated to the Blessed Virgin Mary. The present building was begun by Bishop Wulstan (Wulfstan) in 1084 next to. and eventually superseding, the earlier ones. Little remains of the original besides the crypt. which inspired the building of the circular chapter house (about 1140) in which the great central pillar supports the roof. When St. Wulstan was canonized in 1203 pilgrims flocked to the cathedral, and in 1216 King John was buried there. After the fires of 1113, 1189 and 1202, when the city, castle and cathedral suffered much damage, the latter was restored (finished 1218) and rededicated to "St. Mary, Mother of God, and the Blessed Apostle St. Peter and the Holy Confessors Oswald and Wulstan." Bishop Blois built the Lady chapel in 1224 and rehuilt the choir, which was finished by Bishop Walter de Cantilupe. In 131; Bishop Thomas de Cobham began rebuilding the nave and erected the Jesus chapel as a chantry. The reconstruction of the tower was finished in 1374, and the following year Wakefield became bishop and began rebuilding the cloister and refectory (now the college hall for the Worcester Cathedral King's school). The misericords were carved in 1379, and with the building of the north porch in 1386 the cathedral was complete. In 1502 Prince Arthur's chantry was added, but in 1538 Henry VIII destroyed the shrines of the two saints Oswald and Wulstan before dissolving the monastery in 1540. In the charter for the new foundation (1541) the church is styled "The Cathedral Church of Christ and the Blessed Mary the Virgin, of Worcester." Twice the cathedral suffered terrible defacement, in 1551 after the publication of the new prayer book and during the Civil War when it was turned into stables, and books were burned and windows and carvings smashed. The outside was recased and the inside repaired in 1859.

The Queen Anne guild hall was built in 1721–23 and restored in 1877–80; the county or shire hall, in the Ionic style. stands next to the Victoria institute, which houses the technical and art schools, public library: museum and art gallery. There are many timber-framed houses still in existence, among them the Greyfriars (1480), built when Franciscans and Dominicans settled in the city. Much older (1085) is the Commandery, founded by St. Wulstan as a hospital and now in private hands; the hall was restored to its original condition in 1954. The oldest churches are St. Helen's (680). now occupied by the Y.M.C.A., and St. Alban's (8th-century), now the home of Toc H. St. John-in-Bedwardine is a 12th-century church and so was St. Andrew's, but all that remains of the latter is its tower and tall tapering spire ($245\frac{1}{2}$ ft.) standing overlooking the river opposite the county cricket ground. On the left bank, farther up, is Pitchcroft, the race course; there are several public parks.

Worcester was once an important wool town. Queen Elizabeth I in 1574 granted a charter to the Clothier's guild, a rich and powerful body which virtually ruled the city. The oldest trade is gloving (since the 13th century), and other varied industries include porcelain (since 1751), engineering, sauce (since 1845), hardware and carpets (since 1835) Worcester is also a market town lying in rich agricultural country with good transport connections by road, rail and water. For centuries there have been important markets and an annual hop fair, ram sale and horse fair.

History.—Wirecestre in Domesday Book, later Worcester, became an important tonn after the Synod of Whitby in 664 and the formation of a new see to serve the tribe of Huiccas by 679 Built where the Severn, which formed the boundary nith Wales, was forded. it was walled in Alfred's reign. One of the six remaining copies of the .Anglo-Saxon chronicle was made by the Benedictine monks there. In 1189 Richard I granted it its first charter, and it was made a county of itself in 1621. King John was a frequent visitor and was eventually buried in the cathedral between the shrines of the tno saints in 1216, and in 1502 Prince Arthur was buried there with magnificent ceremony. At the Dissolution the prior became the first dean of the cathedral; as part of the new foundation the Cathedral Grammar school (now the King's school) was opened in 1541, and as a result the much older school—now the Royal Grammar school—nas temporarily closed but revived when Queen Elizabeth I visited the city and cathedral in 1575. Samuel Butler was a pupil of the King's school, and Adam Lindsay Gordon, the national poet of Australia, of the Royal Grammar school The bishop of Worcester's register contains the two entries of 1582 concerning the marriage of William Shakespeare. The town was very important during the Civil War and was attacked four times nhile in royalist hands. The detached steeple of the cathedral, partly covered uith lead, was pulled down



PLAN OF THE BATTLE OF WORCESTER, SEPT. 3, 1651

and sold during those wars, and much damage was done in the city. The battle of Worcester took place in 1651.

By the beginning of the 18th century the cloth trade had died out, and this inspired John Wall in 1751 to start the making of porcelain. which became world famous.

The Three Choirs festival is held annually in Gloucester, Worcester and Hereford cathedrals in turn. Sir Edward Elgar was born at Broadheath. 2 mi. N.W. of Worcester, in 1857. (X.)

Battle of Worcester, **1651.**—This battle ended Charles II's attempt to regain his throne by Scottish arms. The Scottish army, after its defeat by Oliver Cromwell at Dunbar (Sept. 3, 1650), had taken up defensive positions around Stirling. In July 1651 Cromwell, who lacked the strength to storm these positions, moved over the Firth of Forth toward Perth to cut the Scots' supply lines to the north. By this move he deliberately left the road to England open, and Charles promptly marched south with 20.000 men, nearly all Scots. However, very few Englishmen proved willing to help the invaders: the militia everywhere turned out loyally at the Commonwealth's summons; Gen. John Lambert and Gen. Thomas Harrison's cavalry were soon at the king's heels, and Cromwell himself came up rapidly behind them. Moreover, the Scots. after marching about 300 mi. in three weeks, were reduced to a bare 16.000 men by the time they reached Worcester on Aug. 22. There, in the few days available. they did what they could to strengthen the city walls, which had been demolished in 1646 and only partially restored. They also threw up an earthwork, known as Fort Royal, outside the walls (see plan) and broke the bridge over the river Severn at Upton. But by Aug. 27 Cromwell's army was already concentrating at Evesham and on Aug. 28 Lambert brilliantly forced his way over the Severn at Upton. Cromwell, whose forces now outnumbered the king's by two to one, at once sent Gen. Charles Fleetwood across the river with about 11.000 men. He was to move up the west bank and force his way over the Teme river, which joins the Severn a mile or so below Worcester, while Cromwell with the main body and the artillery attacked the city from the east. Two bridges of boats were brought up, one to assist Fleetwood to cross the Teme close to its junction with the Severn, the other to be placed across the Severn just above its junction with the Teme. On Sept. 3. the anniversary of Dunbar, Fleetwood began to force his way over the Teme by his bridge of boats and by Powick bridge a little farther west. Both his columns met stiff resistance, and it was only when Cromwell led part of his own forces across the Severn by the second bridge of boats that the Scots along the line of the Teme were gradually forced back into Worcester. Charles, watching from the cathedral tower, sought to profit from Cromwell's move by leading an attack upon the troops left upon the hill to the east of the city. But after more stiff fighting this attempt, too. was repulsed. Cromwell was able to bring his own forces back over the Scvern in time to join in the concluding stages of the action. and the royalists were steadily pressed downhill into Worcester. The guns of Fort Royal. captured by a militia regiment. mere turned upon them, and men and horses. jammed together in the streets. were cut down and shot down until, as Harrison wrote, there was "such a nastiness that a man could hardly abide the town." Some horsemen escaped northward, only to be cut down or rounded up by Harrison's pursuing cavalry and other forces which Cromwell had posted to cut off their retreat. The infantry died or surrendered on the spot. and. though Charles himself after many adventures contrived to escape to France, his army was utterly destroyed. Eight thousand to 10.000 were prisoners, the rest slain or fugitives. For the Commonwealth it was, in Cromwell's phrase. "a crowning mercy." (R. B. WM.)

WORCESTER, a town in the Cape Province, U. of S.Af., near the Hex River mountains. Pop. (1951) 25,397 (9,202 white). It is the centre of a fruit growing area. The annual rainfall is less than 12 in., but irrigation is obtained from the Hex river. In 1954 a £1,250,000 water augmentation scheme was completed at Stettynskloof, 23 mi. S.W. of the town.

Wine and brandy are produced, and fresh and dried fruit exported. The largest industry is the manufacture of textiles.

WORCESTER, a city of central Massachusetts, U.S., the third largest in New England in the 1960s and seat of Worcester county, is located 40 mi. W. of Boston on Lake Quinsigamond. It is the centre of the Worcester standard metropolitan statistical area, which comprises part of Worcester county. The population of Worcester in 1960 was 186,587 (a decrease of 8.3% since 1950), of the metropolitan area 323,306 (an increase of 6.7% over 1950). (For comparative population figures see table in MASSACHUSETTS: Population.) The surrounding communities, in a region of low hills and valleys dotted with ponds, are primarily residential with a sprinkling of industry and orchards and general farming sections.

Two early attempts at settlement of Worcester (then called Quinsigamond but renamed later) in 1673 and 1684 were foiled within a few years by Indian attacks. Permanent settlement, pioneered by Jonas Rice and primarily agricultural in character, was finally effected in 1713. Industrialization was late in getting under way since there was little water power. With the coming of steam power the city became the manufacturing centre of central Massachusetts, a position it still held in the second half of the 20th century. Fewer than 6,000 people were living there in 1828 when the opening of the Blackstone canal linking the city with Providence, R.I., began a period of expansion and industrialization.

The building in the next quarter. century of railway connections with Boston, Norwich, Providence and Springfield developed further markets and sources of supply. In 1848 the town was incorporated as a city, and by 1870 its population had reached 25,000. During this period there were important local developments in the processing of wire, the production of grinding wheels and the invention by William Crompton of a revolutionary fancy textile loom. The first practical envelope-making machine resulted in a further mushrooming growth of industry so that by 1900 the population was almost 120,000, representing a twentyfold increase in seven decades. Thereafter, the city grew at a much slower rate. Worcester adopted a council-manager government in 1950.

The original Worcester population was almost wholly of British origin. Industrial growth brought first an influx of Irish (beginning around 1828), followed by Swedes and Canadian-French in the latter part of the 19th century. They were followed by Italians, Poles, Lithuanians, Greeks and in the 20th century an unusually large number of immigrants from the near east. All of these groups have added a distinctive character to the city's religious and cultural life and gravitated largely into the area's industries. By the 1960s almost 60% of the employed population was engaged in manufacturing. More than 600 firms produced a wide variety of products including machinery and machine tools, wire and other fabricated metals: primary metal products, grinding wheels, leather goods and textiles. Worcester's key position on arteries from New England to the west and to New York city, service by several airlines, railways and road transport facilities have helped to make it a regional wholesale and retail centre.

Worcester is a noted educational and cultural centre, and in addition to a number of junior colleges contains five institutions of higher education—the Jesuit College of the Holy Cross, founded 1843 and the oldest New England Catholic college; Clark university (1887), known for its graduate departments of psychology, chemistry and geography; Worcester Polytechnic institute (chartered 1865 as Worcester County Free Institute of Industrial Science), one of the oldest in the U.S.; Assumption college (Roman Catholic; 1904), which emphasizes the study of foreign languages and culture; and Worcester State Teachers' college (1874). Other institutions include the Worcester Art museum; the Library of the American Antiquarian society, containing a large collection of material printed in the U.S. before 1821; and a fine armour collection in the John Woodman Higgins armoury.

An annual music festival featuring symphonic and choral music was first held in 1859 and continued thereafter.

(M. H. Co.)

WORCESTERSHIRE, a midland county of England bounded by Staffordshire, Warwickshire, Gloucestershire, Herefordshire and Shropshire. Its geographical area is 699.5 sq.mi.

Physical Features.—Worcestershire covers a portion of the rich valleys of the Severn and Avon with their tributaries the Stour and the Teme. The Avon valley, known as the Vale of Evesham, lies on the Lias clays and provides an excellent soil for orchards and market gardening. The Jurassic escarpment of the Cotswold hills rises sharply from it in the southeast, the outlier of Bredon hill being a conspicuous spur. The Severn flows south by east to Worcester and then almost due south to Tewkesbury where the Avon joins it from the northeast. The Malvern hills, which run north and south forming part of the boundary with Herefordshire, rise from the flat vale of Worcester and reach a height of 1,395 ft. and 1,114 ft. in the Worcestershire and Herefordshire beacons. They are mostly built up of pre-Cambrian rocks, chiefly gneiss. The Malvern ridge is continued in the Abberley hills to the north. while east lies the great Midland plain where the earth is rich red marl. The Lickey hills (goo ft.), in which there are Silurian, Cambrian and Pre-Cambrian rocks. cross the northeast corner of the county. Their northern parts, the Clent hills (1,036 ft.), are formed of Permian breccias. Partly within the county are the sites of two ancient forests; that of the Wyre on the northern boundary retains some of its ancient character, but Malvern chase is hardly recognizable. Road metal is extensively quarried in the Malvern and the Lickey hills; lime is obtained from the Silurian limestones; coal is mined in portions of the forest of Wyre and those portions of the south Staffordshire coal fields which come within the county.

Early Settlement and History.—Worcestershire was largely wooded in early times and is consequently not rich in prehistoric remains, but some stone implements have been found on the surrounding hills and some bronze implements along the Severn. pointing to river communications or perhaps to occupation of the river banks. There are great Iron Age fortifications on the Malvern and the Bredon hills which have been dated to the last two centuries B.C., and there are others at Berrow hill above the Teme west of Worcester and at Round hill by Spetchley. A Saxon grave of considerable interest was discovered in Cpton Snodsbury, 6 mi. E. of Worcester, in the late 19th century.

The earliest English settlers were a tribe of the Hwiccas of Gloucestershire, who spread along the Severn and Avon valleys in the 6th century. By 679 the Hwiccan kingdom was formed into a separate diocese with its seat at Worcester, and the Hwiccas had made themselves masters of nearly the whole of the modern county. From this date the town of Worcester became not only a religious centre but the chief point of trading and military communication between England and Wales. The shire originated as an administrative area after the recovery of Mercia from the Danes. Worcester was destroyed by Hardicanute in 1041.

In no county has the monastic movement played a more important part. Foundations existed at Worcester, Evesham, Pershore and Fladbury in the 8th century; at Great Malvern in the 11th century, and in the 12th and 13th centuries at Little Malvern, Westwood, Bordesley, Whistones, Cookhill. Dudley. Halesowen and Astley. The cultivation of the Vale of Evesham for flowers, fruit and vegetables was begun by the monks of Evesham and Pershore. At the time of the Domesday survey more than half Worcestershire was in the hands of the church, and this prevented the rise of a local aristocracy. Dudley castle was a fortress belonging to William Fitz Ansculf; Worcester castle passed in the 12th century to the Beauchamps, who owned Elmley and Hanley castles. The possessions of William Fitz-Osbern in Doddingtree hundred and the Teme valley fell to the crown in 1074 and passed to the Mortimers. Three decisive battles of English history were fought in Worcestershire—at Evesham (*q.v.*) in 1265, Tewkesbury (*q.v.*) in 1471 and Jt'orcester (*q.v.*) in 1651. Simon de Montfort was killed at the battle of Evesham when the barons, whom he was leading, were defeated by the royalists. The Lancastrians were beaten at the battle of Tewkesbury. Though in the Civil War Worcestershire was conspicuously loyal, at the battle of Worcester Charles II was finally defeated. Worcester to this day is known as the "Faithful City."

The Droitwich salt industry was very important at the time of the Domesday survey. In the 13th and 14th centuries Bordesley monastery and the abbeys of Evesham and Pershore exported wool, and in the 16th century the Worcestershire clothing industry gave employment to 8,000, the centre of the trade being at Worcester; fruit culture with the manufacture of cider and perry, nailmaking and glassmaking also flourished, and scythe manufacture was carried on at Belbroughton near Stourbridge. The clothing industry declined in the 17th century; at Kidderminster it was replaced by carpet weaving which was introduced from Flanders in 1735. Coal and iron were mined at Dudley in the 13th century.

Architecture.—There are remains of Benedictine abbeys at Evesham and Pershore, a perfectly preserved priory church at Malvern and the ruins of a priory church of the 12th century at Dudley, in addition to the cathedral at Worcester and other monastic remains. The churches of Martley. Astley. Rous Lench. Bredon and Bockleton contain good Norman work. and the Early English churches of Kempsey and Ripple are noteworthy. Half-timbered buildings are numerous and include many "cruck" houses, some church towers, notably Pirton. Kington and Dormston. and the country houses of Birtsmorton court (a moated 16th-century house), Eastington hall. Salwarpe court. Lench court (partly Tudor), Pirton court. Shell manor and Huddington court and many others. In the south of the county half-timbering gives way to Cotswold stone, Broadway providirig fine examples. while Madresfield court embodies remains of an Elizabethan moated mansion.

Agriculture and Industries.— The climate is a factor of considerable importance as the Severn valley appears to act as a channel for warm air from the south which disperses on reaching the Clent and Lickey hills. The south is intensively cultivated for early market produce, and the Vale of Evesham is famous for fruit and vegetables. Hops are grown mainly west of the Severn, but dairy farming and permanent grass are predominant features generally. Other crops are wheat, barley. oats, potatoes. mangolds and sugar beets. In 1954 about 45% of the land was under cultivation; there were 23,617 ac. of orchards and 16,507 ac. of vegetables; *13,069* persons were engaged in agriculture. Salmon and lampreys are taken in the Severn, trout and grayling in the Teme.

There are four well-defined industrial areas: the northern boroughs of Oldbury, Halesowen and Stourbridge; Kidderminster and Stourport-on-Severn in the northwest; Redditch in the east; and Worcester city in the centre. The northern industries of ironworking, engineering and metal products. together with glass and chemical manufacture, owe their origin to the proximity of the fire clays and limestone to the coal measures: The Kiddenninster area is famous for carpets, but has increasing engineering and metal industries. Redditch produces needles. springs and fishing tackle, and metalwork is also increasing there, as it is in Worcester, where there are extensive engineering works and where porcelain. gloves and sauce are produced and railway repairs are carried out. Bromsgrove is another growing centre of heavy engineering activity. and important salt and chemical works are at Stoke Prior. near Droitwich. In 1951, 114,058 persons were engaged in industry, nearly 75% of them in the north.

Communications.— The county is served by two principal lines of railway, the Western Region line from London through Oxford to Worcester and Wolverhampton, and the London Midland Region line from Birmingham to Bristol. An important loop from Stoke Works to Abbotsnood enables London Midland trains to be routed through Droitwich and Worcester. The trend is for freight and passengers to be carried by road transport, and the administrative county is intersected by 1.894 mi. of roads, of which the most important are four trunk roads: the Exeter-Leeds, the east of Birmingham-Birkenhead. the Newport-Stafford and the Bath-Coventry-Lincoln. Both the Severn and the Avon are partly navigable. and the Lower Avon trust has done much to reopen the latter river. Canals are mainly in the north. but the Worcester-Birmingham canal is an important south-to-north waterway.

The Lickey hills provide a playground for Birmingham and the north of the county, the Malvern hills for the centre; while the Severn. Avon and Teme provide recreation for anglers and visitors from the industrial midlands.

Population and Administration.— The area of the geographical county is 699.*j* sq.mi. and the population (1951) *j22.846*, an increase of $24\frac{1}{2}$% since 1939. Several detached parts of the county existed till 1931 when adjustments were made with Warwickshire and Gloucestershire, leaving Dudley as the sole remaining "island"—surrounded by Staffordshire. The administrative county in 1951 had a population of *400.617* and an area of 684.7 sq.mi. The county town is Worcester and there are two county boroughs (Worcester and Dudley), seven municipal boroughs (Bewdley, Droitwich, Evesham, Halesowen, Kidderminster. Oldbury and Stourbridge), four urban districts (Bromsgrove, Malvern, Rèdditch and Stourport-on-Severn) and eight rural districts. The county is in the Oxford circuit and assizes are held at Worcester. The administrative county has one court of quarter sessions and there are *16* petty sessional divisions. The county boroughs of Worcester and Dudley have in addition separate courts of quarter sessions. The ancient county contained the hundreds of Halfshire. Blackenhurst. Doddingtree, Oswaldslow, Pershore, Cresselau, Fishborough, Clent, Esch and Came.

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WORDEN, JOHN LORIMER (1818–1897), U.S. navai officer who was commander of the Unjon ironclad ship "Monitor," was born in Westchester county, N.Y., March *12, 1818*. He was appointed a midshipman in *1834*. and he received his early naval training with the Brazilian squadron between *1835* and *18.38*. He served on the Pacific coast during the Mexican War, and afterward was in both the Mediterranean and home fleets. In the spring of *1861* Worden was sent on a secret mission to Pensacola in an effort to get naval reinforcements to Ft. Pickens, but he was arrested by Confederate authorities and was not exchanged until Dec. *1861*. On Jan. 16, *1862*, he was appointed to command John Ericsson's experimental "Monitor." He took the cumbersome "cheese box on a raft" down the Atlantic coast in perilous stormy weather, and arrived in Hampton Roads. on the evening of the day that the Confederate ironclad "Virginia," the rebuilt steamship "Merrimack," had spread consternation among the Union forces by sinking two wooden sailing vessels. The next day, March 9, 1862, Worden sailed forth in the "Monitor" to battle the "Merrimack." The three-hour battle, in which ironclads fought for the first time, ended when both withdrew from the conflict. Worden. stationed in the pilothouse, forward of the turret, had been wounded in the face and nearly blinded when a shell exploded outside his sighthole. *(See "MONITOR" AND* "MERRIMACK," BATTLE OF.)

For the rest of the Civil War period Worden commanded monitors stationed with the South Atlantic blockading squadron, and participated in the attack on Ft. McAllister and in the unsuccessful attack on Charleston in *1863*. Worden was promoted to commodore in *1868* and to rear admiral in *1872*. He commanded the European squadron from *1875* to 1877 and was in the eastern Mediterranean during the Russo-Turkish War. Retiring on Dec. *23, 1886*, congress voted him full sea pay as rear admiral for life. He died in Washington, D.C., on Oct. *18, 1897*.

See *Official Records of the Union and Confederate Navies in the War oj the Rebellion*, 30 vol. (1894–1922); W. S. Schley, *Forty-Five Years Under the Flag* (1904). (W. *B.* CK.)

WORDSWORTH, CHARLES (1806–1892), Scottish bishop. son of Christopher Wordsworth, master of Trinity, was born in London on Aug. *22, 1806*. and educated at Harrow and Christ Church. Oxford. He was a brilliant classical scholar and a famous cricketer and athlete. He was tutor at Christ Church (1834–35) and then second master at Winchester. In *1839* he brought out his *Greek Grammar*, which had a great success. In *1847* he became warden of Trinity college, Glenalmond, the new Scottish Episcopal public school and divinity college, where his views on Scottish church questions brought him into opposition at some important points to W. E. Gladstone. In 1853 he was consecrated bishop of St. Andrews, Dunkeld and Dunblane. Wordsworth was a strong supporter of the establishment, but conciliatory toward the Free Churches. He was a voluminous writer and one of the company of revisers of the New Testament (1870–81), among whom he displayed a conservative tendency. He died at St. Andrews on Dec. *j*. 1892.

See his *Annals of My Early Life* (1891) and *Annals of* My *Life*, edited by W. Earl Hodgson (1893); also *The Episcopate of Charles Wordsworth*, by his nephew John, bishop of Salisbury (1899).

WORDSWORTH, CHRISTOPHER (1774–1846), youngest brother of the poet. was born on June *9*, 1774, and became a fellow of Trinity college. Cambridge, in 1798. He obtained preferments through the patronage of Manners Sutton, bishop of Norwich, afterward (1805) archbishop of Canterbury. In 1810 he published an *Ecclesiastical Biography* in six volumes. On the death of Bishop Mansel, in 1820, he was elected master of Trinity, and retained that position till *1841*. His proposal as vice-chancellor

(1821) for a Classical Tripos, though then rejected, was adopted in 1822. He died on Feb. 2, 1846, at Buxted. In his Who *wrote Ikon* Basilike? (1824), he advocated the authorship of Charles I.; and in 1836 he published, in 4 volumes, a work of Christian Institutes, selected from English divines. He married in 1804 Miss Priscilla Lloyd (d. 1815), a sister of Charles Lamb's friend Charles Lloyd; and he had three sons, John W. (1805–1839), Charles (*q.v.*) and Christopher (*q.v.*); the two latter both became bishops, and John, who became a classical lecturer at Trinity College, Cambridge, was an erudite scholar.

WORDSWORTH, CHRISTOPHER (1807–1885), English bishop and man of letters, was born in London on Oct. 30, 1807, and was educated at Winchester and Trinity, Cambridge. He, like his brother Charles, was distinguished as an athlete as well as for scholarship. He was public orator at Cambridge, Headmaster of Harrow from 1836–44, and bishop of Lincoln in 1869. He died on March 20, 1885. He married in 1838 Susanna Hartley; his eldest son was John, bishop of Salisbury, and author of Fragments of Early Latin (1874), and his daughter Elizabeth was first principal of Lady Margaret Hall, Oxford. As a scholar he is best known for his edition of the Greek New Testament (1856–60), and the Old Testament (1864–70), with commentaries; and for his Inscriptiones *Pompeianae* (1837).

His Life, by J. H. Overton and Elizabeth Wordsworth, was published in 1888:

WORDSWORTH, DOROTHY (1771–1855), English writer and diarist, the third child and only daughter of John Wordsworth, of Cockermouth, and his wife, Anne Cookson-Crackanthorpe, was born on Dec. 25, 1771, and, after her mother's death in 1778, lived chiefly at Halifax with a Mrs. Threlkeld, her mother's cousin. In 1787 she went to live with her maternal grand-parents in Penrith, where she was not very happy. From 1788–93 she stayed with an uncle at Forncett, in Norfolk. She and her brother William, the poet, who was a year older than Dorothy, were early drawn to one another; in 1794 they visited the Lakes together, and in the autumn of the following year they combined their small capitals and set up house at Racedown, in Dorsetshire, where they lived a frugal but ideally happy life. In 1797 they made the acquaintance of Coleridge, and in the same year moved to Alfoxden, on the northern slope of the Quantock hills, Coleridge about the same time settling near by in the town of Nether Stowey. On Jan. 20, 1798, Dorothy Wordsworth began her invaluable Journal, used by successive biographers of her brother, but first printed in its quasi-entirety by Prof. W. Knight in 1897. The Wordsworths, Coleridge and Chester, left England for Germany on Sept. 14, 1798; and of this journey also Dorothy Wordsworth preserved an account, portions of which were published in 1897. On May 14, 1800, she started another Journal at Dove cottage, Grasmere, which she kept very fully until Dec. 31 of the same year. She resumed it on Jan. 1, 1802, for another 12 months, closing on Jan. 11, 1803. These were printed first in 1889. She composed Recollections of a Tour in Scotland, in 1803, with her brother and Coleridge; this was first published in 1874. Her next contribution to the family history was her Journal of *a* Mountain Ramble, in Nov. 1805, an account of a walking tour in the Lake District with her brother. In July 1820 the Wordsworths made a tour on the Continent, of which Dorothy preserved a very careful record, portions of which were given to the world in 1884, the writer having refused to publish it in 1824 on the ground that her "object was not to make a book, but to leave to her niece a neatly-penned memorial of those few interesting months of our lives." Meanwhile, without her brother, but in the company of Joanna Hutchinson, Dorothy Wordsworth had travelled over Scotland in 1822, and had composed a Journal of that tour. In 1829 she had a serious nervous breakdown, from which she never recovered. For the last 26 years of her life her mind and body seemed broken; she died on Jan. 25, 1855, five years after William's death in 1850.

Dorothy Wordsworth claims a distinct place in the history of English prose as one of the very earliest writers who noted, in language delicately chosen, and with no other object than to preserve their fugitive beauty, the little picturesque phenomena of homely country life amid simple scenes and quiet people.

A *Life,* by E. Lee, was published in 1886; but it is only since 1897, when Prof. Knight collected and edited her scattered mss., that Dorothy Wordsworth has taken her independent place in literary history. The Journals of Dorothy Wordsworth, edit. by W. Knight, were republished in 1924; see also C. M. Maclean, Dorothy *and William* Wordsworth (Cambridge, 1927).

WORDSWORTH, WILLIAM (1770–1850), English poet, was born at Cockermouth, Cumberland, on April 7, 1770, the second son of John Wordsworth, attorney-at-law and agent to Sir James Lowther (afterwards first earl of Lonsdale). His mother was Anne, daughter of William Cookson, a Penrith mercer, and Dorothy, born Crackanthorp, "of the ancient family of that name, who from the time of Edward the Third had lived in Newbiggen Hall, Westmorland" (*Autobiographical* Memoranda). The Wordsworths were a Yorkshire family "settled at Peniston . . probably before the Norman Conquest" (ib.); the first of the family to settle in the Lake District was the poet's grandfather.

Wordsworth's mother died in 1778; and in that year he was sent to the ancient grammar school of Hawkshead, boarding in the village with Anne Tyson, at the cottage still known as "Wordsworth's cottage." His father died five years later — Wordsworth speaks of him as having "never recovered his usual cheerfulness" after the loss of his wife. The family were placed under the guardianship of two uncles, Richard Wordsworth and Christopher Crackanthorp. Beyond the claims which he had against the Lowther family (amounting to well over £4,000), claims which were the subject of protracted dispute, until they were acknowledged and discharged, in 1802, by the second earl of Lonsdale, the father had left small provision for his children. Wordsworth, however, was sent in 1787 to St. John's, Cambridge, of which college his uncle, William Cookson, had been a fellow. Already he had contracted both the habit of verse and the temperament of poetry. Among his published works are included two sets of verses written as early as 1786; and "I wrote," he says, "while yet a schoolboy, a long poem running upon my own adventures and the scenery of the country in which I was brought up": a poem containing "thoughts and images" most of which were used later in the poet's "other writings." He had been sufficiently well taught at Hawkshead, at least in mathematics, to have "a full twelve months' start" of the freshmen of his year at St. John's; and to this circumstance he attributes it that he "got into rather an idle way," "reading nothing but classic authors according to my fancy, and Italian poetry" (Autobiogr. Mem.). His Italian master was a man who had "been well acquainted with the poet Gray." During his freshman year he composed a large part of the Evening Walk, finishing it in 1789. Of his Cambridge friends the chief was Robert Jones, who subsequently took orders, with whom, in 1790, Wordsworth undertook the walking tour in France and Switzerland which is commemorated in Descriptive Sketches. Forty years later, Jones, "fat and roundabout and rosy, and puffing and panting" up very moderate hills, "looked back to that journey as the golden and sunny spot in his life" (Dorothy Wordsworth: Letters ii., 497).

In Jan. 1791 Wordsworth took his B.A. degree. It is clear from Books iii.–vi. of the Prelude that he conceived himself to have derived from his three years residence in Cambridge little intellectual profit; and "the manners of the young men," he wrote later, "were very frantic and dissolute at that time" (Letters, i., 162). His guardians had destined him for the Church. But the thought of "vegetating on a paltry curacy" made no strong appeal to him (ib. i., 33); and it is probable that already before he had taken his degree he had experienced some unsettlement both of religious and of moral belief. He pleaded for delay; and Re seems to have persuaded his guardians that the best preparation for the study of oriental languages (pressed upon him as a likely means of advancement) would be a year spent in learning French. He went to France at the end of Nov. 1791, and he remained there till the end of 1792, for the most part in Orleans and Blois. He took to France a keen sympathy with the principles of the revolution; and his faith in the revolutionary idea was deepened and intensified by the intimate friendship which he formed in Blois with Michel de Beaupuy, a captain (later general) in the republican army. The ninth book of the *Prelude* bears witness to the profound influence exercised upon his political thinking by Beaupuy. In Orleans he formed an attachment to Marie-Anne Vallon ("Annette"), a girl of royalist family, by whom he had a daughter, Anne-Caroline (baptised Dec. 15, 1792); and by whose marriage in 1816 with Jean Baptiste Martin Baudouin he has a number of French descendants. Of "Annette" the *Prelude* tells us nothing. Yet, as first sketched, it contained the story of *Vaudracour and Julia,* of which the earlier sections, at least, were not written without some thought of her. The amatory colouring of the second paragraph of the poem is unlike the Wordsworth whom we know best; and the third paragraph attempts (we must suppose) such justification of the "Annette" episode as Wordsworth felt to be possible. He felt himself to have been betrayed by a false philosophy, by his creed of nature and freedom:

tempted to decline
To perilous weakness, and entrust the cause
To nature, for a happy end of all.

During his sojourn in France he wrote the greater part of *Descriptive Sketches.* Isolated passages crudely expressed his revolutionary sympathies, his deep moral dejection; and even a mood of religious unbelief. Yet as late as May 1792, "it is at present my intention," he writes, "to take orders in the approaching winter or spring. My uncle the clergyman will furnish me with a title" *(Letters,* i., 42). "I should certainly have wished to defer the moment" *(Letters,* i., 42). The failure here, at once of religious and moral conviction, seems complete.

In Feb. 1793 Wordsworth published both *Descriptive Sketches* and *An Evening Walk.* Of both poems perhaps the principal interest resides in the conflict between style and substance: things freshly and romantically observed fight for expression within the limits of a diction which has all the faults of the worst 18th-century work. In the same month England declared war upon France —the first real shock, Wordsworth tells us, which his moral nature had received (*Prelude* x., 268 *et seq.).* At once he ranged himself on the side of his country's enemies. February 1793 was further notable in that it saw the publication of Godwin's *Political Justice.* Hitherto, Wordsworth had been content to take his philosophy from Rousseau, in ethics deifying "nature," and in politics making a gospel of "the general will." Under the influence of Godwin, he began now to deify Reason, the individual reason—collective reason being only another name for the general will, that is, for a tyranny.

The period 1793–96 is, in respect both of the external and of the internal biography of Wordsworth, still involved in considerable obscurity; an obscurity not much illumined by the rather confused account of his own development which he himself furnishes to us in Books xi.–xii. of the *Prelude.* Early in 1793 he wrote the "Letter to the Bishop of Llandaff . . . by a Republican," in which he is still the champion of the general will. The Letter attacks monarchy, the clergy and (here under Godwinian influence) the state penal code. For the bishop, a renegade liberal, Wordsworth entertains some such sentiments as, later, were felt for himself by Hazlitt and others. The Letter was not published until 1876. If its self-conscious loftiness of style and sentiment does not altogether lift it out of the commonplace, it is yet a composition which may be accounted, for the years from which it proceeded, remarkable. In the autumn of 1793, he began upon *Guilt and Sorrow,* his first considerable poem, in many parts of it distinctively "Godwinian." It was finished in 1794, and a portion of it, under the title of *The Female Vagrant* was printed in the *Lyrical Ballads* (1798); the whole saw the light (a good deal revised) in 1842. In 1795 he began, and in 1796 finished, *The Bordcrers: A Tragedy,* of which the gloomy perversities show him struggling out of the Godwinism in which he had been for two painful years involved. Sometime in 1795 he wrote his first truly characteristic piece, "Nay, Traveller, rest . . .", in which the victory over Godwinism is already complete.

For two years since his return from France Wordsworth had led a wandering life, making no attempt to find for himself a profession. In the early part of 1795 occurred the death of his friend Raisley Calvert, who left him a bequest of £900. He used the independence afforded to him to settle with his sister Dorothy at Racedown, Crewkerne. It was here that *The Borderers* was finished; and here (more important) *Margaret, or The Ruined Cottage* (incorporated, later, in Book i. of *The Excursion)* was begun. The poem was finished at Alfoxden, whither, in the summer of 1797, the Wordsworths moved, in order to be near Coleridge at Nether Stowey. In the *Prelude* Wordsworth traces the recovery of his moral, and poetical, health to the influence, first of his sister, and secondly of Coleridge. It was while these "three persons and one soul" were living in close conjunction in Somerset that the *Lyrical Ballads* were conceived and written.

The publication (September 1798) of the *Lyrical Ballads* constitutes the most important event in the history of English poetry after Milton. Of the genesis of the book Coleridge has given, in the first section of chap. xiv. of the *Biographia Literaria,* an account which may be summarised by saying that, while his own share in the work was directed towards illustrating (in *The Ancient Mariner)* the naturalness of the supernatural, Wordsworth's task was to point the supernatural meanings, the inner spirituality of actions and incidents the most natural conceivable. We are concerned here only with Wordsworth; and it is notable that the *Advertisement* to the *Lyrzcal Ballads* is concerned only with him (save for the excuses made, in its last section, for the diction of *The Ancient Mariner).* "It is the honourable characteristic of poetry"—says the opening sentence of the *Advertisement*—"that its materials are to be found in every subject which can interest the human mind." That is only to say that the natural, the ordinary, the obvious, has its poetry, its supernaturalness. It states the theme which, in Coleridge's account, it was Wordsworth's task to illustrate. But if poetry can draw its supernatural effects from natural objects and happenings, to what extent can it employ (its primary means being language) merely natural language? The *Ballads,* says the *Advertisement,* are an "experiment" to discover "how far the language of conversation . . . is adapted for the purposes of poetic pleasure." Perhaps the principal result of it was the discovery of a new blank verse—that of what Coleridge christened the "Conversation Poem." If we leave aside *The Anczent Marzner,* the best of the *Lyrical Ballads* of 1798 is that part for which blank verse is used; a biank verse neither Shakespearian nor Miltonic; domestic, but with a telling quality wanting to the domestic blank verse of Cowper; individual without eccentricity; attaining its perfection in *Tintern Abbey.* The same conversational triumph meets us in the second volume of the *Lyrical Ballads* (1800) in "There was a Boy . . .", *Michael* and *The Brothers;* and indeed, wherever in the two volumes blank verse is used, it is used to fine effect.

In the purely lyrical species Wordsworth is, in the 1798 volume, less successful. Perhaps, in this kind, only "It is the first mild day of March . . ." and "I heard a thousand blended notes . . ." have the perfect lyric quality which, two years later, he was to show in the Lucy Poems, *The Fountain, The Two April Mornings,* the *Poet's Epitaph.* Several of the lyrical experiments fail badly; e.g., *Goody Blake,* to which the *Advertisement* unhappily directed special attention. But the volumes of 1798 and 1800 contained, together, a sufficient number of lyrical successes to afford an overwhelming demonstration of the power of poetry to use natural language, even the "language of conversation." But Wordsworth had an affection for his failures; and in the preface of 1800 he threw after them many paradoxes of theory and much false history.

It is, however, neither a theory of diction nor the successful practice of a new diction which gives to the *Lyrical Ballads* the importance which they have in literary history. The greatness of the book may more truly be conceived to lie in the metaphysic of the imagination from which it proceeds (and from which. indeed, the theory of diction itself proceeds). The outlines of this metaphysic are hinted in Wordsworth's Prefaces and Notes, and in passages of the poems themselves (the *Prelude* being, in this connection, particularly valuable). The *Lyrical Ballads* owe their greatness to the power with which they revindicate for poetry the life of the senses. We are only poets in so far as we confide ourselves to the senses. We see into the life of things only when we receive the impressions of sense in a "wise passiveness," disconnecting ourselves from the tie of reason and custom, from "the meddling intellect[x] — the operation of which is only one of the effects of custom. The source of truth — poetic truth — is not reason, but the eyes and ears. What is the matter with the poetry of the Age of Reason is that it had lost the art of seeing and hearing, or of performing these acts *purely,* in a fashion, that is to say, not vitiated by custom or theory. It had lost, at the same time, the gift of pure expression, using a mere customary or conventional diction. It is the supreme achievement of the *Lyrical Ballads* to have brought back the glory and the freshness of the senses. The work is done with the greater power and convincingness from the circumstance that Wordsworth had won his way back to nature and the senses through the valley of the shadow, through the rationalism of Godwin. To say that he had come back from Godwin to Rousseau would be to misconceive him. Obviously he supposes his later naturalism to escape the perils of Rousseauism. Obviously also he believes his metaphysic of the imagination — which might easily be taken for a very bare philosophic "sensationalism" — to rise above the difficulties of the ordinary sensationalist creed. A logical demonstration of his metaphysic he nowhere essays. We may be content with that practical demonstration of it which his poetry furnishes.

The six months following the publication of the *Lyrical Ballads* Wordsworth spent in Germany. In Oct. 1799 he settled in Grasmere; and in that neighbourhood, save for occasional tours in Scotland and on the Continent, the rest of his life was spent. A new edition of the *Lyrical Ballads* was called for in 1800, and this edition Wordsworth enriched by the famous preface and by a second volume of poems — among them some of his best and most original pieces. A third edition appeared in 1802 (with the appendix on Poetic Diction), and a fourth in 1805. In 1804 he married Mary Hutchinson — in 1802 he had visited "Annette," and her story had been revealed to Mary.

In the year in which the first edition of the *Lyrical Ballads* appeared, Wordsworth had already begun upon the *Prelude* (de Selincourt, p. xxxi.); and in the year which saw the fourth edition of the Ballads he finished it. In this poem, "after *Paradise Lost* the greatest long poem in the language" (A. C. Bradley), he traces his spiritual autobiography, "the Growth of a Poet's Mind," from earliest childhood, from the first intimations which came to him of poetry and immortality, down to the date at which he took the resolution of devoting himself wholly to poetry. As a document of the romantic revival the book (not published until after his death) is of the first importance; and apart from this historical interest, it constitutes ? handbook of the imaginative life unique in subtlety and power. It was intended to be a preparation for "a philosophical poem, containing views of Man, Nature and Society," of which the *Excursion* was a part (the only part finished). Of the same poem another part is the impressive fragment of *The Recluse,* written in 1800 but only published some years after in 1888.

In 1807 Wordsworth published the *Poems in Two Volumes.* These show a wide extension of his poetical power. New life is given to the sonnet—used with fine effect to express lofty patriotic sentiment—and to the ode—here were printed for the first time the *Ode to Duty* and the immortal *Ode* on *Intimations of Immortality.* The volumes of 1800 and 1807 establish Wordsworth as one of the great inventors of poetical forms. But, form apart, these volumes, taken together with the *Prelude,* the *Recluse* fragment, *Margaret, or the Ruined Cottage* (all written before 1807), constitute a body of poetical work of which the compass and original power are such as to place him among the greatest poets. By 1807, in fact, his best work was done; not all his good work, but his best work. The death in 1805 of his brother John Wordsworth (of whom the *Happy Warrior* is, in part, a commemoration) had affected deeply a temperament to which melancholy was native, inducing in Wordsworth a regress upon religious orthodoxy, and upon orthodoxies less venial. By the end of the first decade of the nineteenth century his thinking, in religion and in politics, loses that speculative rebel quality from which it drew so much of its early strength; and his imagination, ever a miser of its memories, and now more so, tends to hoard barren incidents and trivial perceptions, to be the material of later poetry. It requires, henceforth, some cause in which his affections are passionately engaged to educe the old power. Perhaps he is, after 1808, most like himself, not in poetry, but in the noble prose of the tract upon the *Convention of Cintra* (1809). In 1814 appeared the *Excursion;*. "This will never do," said Jeffrey. Yet Keats thought it "one of the three things to rejoice at in this age." Even outside the two first books, which belong to the Somerset period, the poem has lofty and noble reaches. The general decline of power, however (especially if it be compared with the *Prelude),* is marked. In 1815 was published the first collected edition of the poet's works (with the *Essay Supplementary to the Preface);* in the same year the *White Doe of Rylstone;* in 1819 *Peter Bell* (written in 1798) and the *Wagoner;* in 1820 *The River Duddon,* and *Miscellaneous Poems.* A further decline of power is witnessed, in 1822, by the *Ecclesiastical Sketches* and the *Memorials of a Tour on the Continent.* To the last, however, it is unsafe to regard Wordsworth as negligible; at any moment the old power is apt to reassert itself. It is to the period of his decline that we owe, in the *Prelude,* the magic of the famous description of Newton's statue--

The marble index of a mind for ever
Voyaging through strange seas of thought alone.

Many, again, of his best sonnets come from the late period. Here and there, from the *Evening Voluntaries* (1835) the old greatness flashes out. After 1835 Wordsworth published nothing new in poetry.

"Up to 1820 the name of Wordsworth," said De Quincey, "was trampled under foot; from 1820 to 1830 it was militant; from 1830 to 1835 it has been triumphant." In 1839 Wordsworth received the honorary degree of D.C.L. from the University of Oxford: he was presented by Keble, and the ceremony showed how deep was the hold that his poetry now had on youpg and old alike. In 1842 he was awarded a civil list pension of £300 a year (resigning the Distributorship of Stamps which he had held since 1813, a sinecure which had brought on him many reproaches). In 1843 he was appointed poet laureate, in succession to Southey. He died on April 23, 1850; and is buried in the churchyard of Grasmere. His wife survived him by nine years. Of his five children, two had died in 1812; his daughter, Dora, wife of Edward Quillinan, had died in 1847. Two surviving sons, John and William, left children.

BIBLIOGRAPHY.—The authorised edition of the Poetical Works is that published by Moxon in 1849–50 (6 vol.); which, however, does not contain *The Prelude* (first printed in 1850) or *The Recluse* (1888, Macmillan). Of subsequent texts the principal are: W. Knight, 1882–86, 8 vols.; E. Dowden, 1892–93, 7 vols.; Nowell Smith, 1908, 3 vols.; and in one volume, J. Morley, 1888; T. Hutchinson, 1895. In 1926 E. de Selincourt published, from the original mss., Wordsworth's first version of- *The Prelude* (with the "authorised" text *vis-a-vis).* The Prose Works were collected by A. B. Grosart, 1876, 3 vols. (out of print), and are accessible in W. Knight's edition, 1896, 2 vols. *The Letters of the Wordsworth Family* were printed by W. Knight in 1907 (out of print); other letters of Wordsworth are in Edith Morley's *Correspondence of Crabb Robinson with the Wordszoorth Circle* (1927). Wordsworth's *Tract on the Convention of Cintra* was edited separately by A. V. Dicey in 1915; the *Guide to the Lakes* by E. de Selincourt in 1906; the *Poems and Extracts from the Works of Anne, Countess of Winchelsra* by J. R. Rees in 1905. *A Concordance to the Poenzs of W. W.* by Lane Cooper was published in 1911.

For the life of Wordsworth chief authorities are: *Memoirs of W. W.*, by Christopher Wordsworth, 1851 (with the poet's "Autobiographical Memoranda"); *Life of William Wordsworth* by W. Knight, 1889; *William Wordsworth, his Life, Works and Influence, by* G. M. Harper, rev. ed. (1920); *The Early Life of Wordsworth* by E. Legouis, E.T. (1897). New facts about Wordsworth were given in G. M. Harper's *Wordsworth's French Daughter,* 1921, and in E. Lepouis' *Wordsworth in a New Light* (1923). Among general interpretative studies of Wordsworth may be mentioned those of F. W. H. Myers, W. Raleigh, H. W. Garrod, O. Elton; among special studies E. Barstow, *Wordswovtk' Theory of Poetic Diction* (1917); W. Beatty, *William Wordsworth: his Doctrine and Art in their Historical Relations* (1927). Upon bibliographical questions *Two Lake Poets: a Catalogue,* etc., by T. J. Wise (1927) should be consulted. (H. W. GA.)

WORK: *see* LABOUR.

WORK ACCIDENTS: *see* INDUSTRIAL ACCIDENTS.

WORKERS, EDUCATION OF: *see* ADULT EDUCATION.

WORKHOUSE, THE (in Scotland known as the poorhouse)! a British institution for the maintenance of paupers. Administration in England and \Vales was placed under the board oi guardians (the parish council in Scotland), under regulations prescribed by a central authority; the ministry of health or the Scottish board of health. Destitute persons gained admittance to the workhouse by a written order of the board of guardians or the relieving officer, or in exceptional cases by the master or matron without an order. Inmates were made subject to strict discipline while remaining in the workhouse and, under ordinary circumstances. were not allowed to leave the institution without first giving "reasonable notice." usually held to mean not less than 24 hr. and in some situations as long as three days.

Primitive workhouses were set up here and there in the 17th century under the Poor Relief act of 1601, which directed the ox-erseers oi every parish, among other things, to raise funds "for providing a convenient stock of flax, hemp, wool,'thread, iron and other ware and stuff to set the poor on work." But in this early period the authorities were for the most part content with "houses of correction" for the chastisement of the vagabond.

The 18th century saw the establishment of workhouses in towns and rural parishes. The administration was either brutally hard or incredibly lax; they ranged. it has been said, from "houses of terror" to "houses of debauchery." In 1833 the modern system was introduced. The 15,000 parishes of England and Wales were organized into a few hundred poor law "unions," each of which was required to set up a "well-regulated workhouse." Only in this institution could an able-bodied man and his family get relief! and in order to deter him from coming, the regimen was purposely made repugnant.

The Workhouse Condemned. — In the course of the 19th century the strict principles of 1834 were generally relaxed, and in 1909 a royal commission found the state of the workhouses with few exceptions deplorable. and unanimously recommended their abolition. They were not abolished, but some improvement was effected under pressure from the central authority. In particular, a better classification of the inmates was enjoined. Married couples aged over 60 were not to be separated if they wished to live together, and children between the ages of 3 and 16 could not be maintained in the workhouse. Some boards of guardians, however, persisted in breaking this latter regulation.

An effort was also made to render the workhouse less repellent to the poor by calling it "the institution," but there was no popular enthusiasm over this, and the old name continued in general use. After World War I, with the general relaxation of the restrictions on outdoor relief, the workhouse became less than ever a place for "testing" the able-bodied by disagreeable tasks of work. The inmate population comprised chiefly aged and infirm.

(*See* POOR LAW.) (C. M. L.)

WORKING MEN'S CLUBS existed for workmen in England and Wales (a few were established in either Scotland or Northern Ireland) from the middle of the 19th century.

The majority mere organized in the Working Men's Club and Institute union, which was brought into'existence by the Rev. Henry Solly. a Unitarian minister. The union was founded at a meeting at which Lord Brougham presided, on June 14, 1862.

It was at first intended that such clubs should be teetotal, but apart from the abandonment of this policy their objects remain as in the beginning, being as follows:

(1) That working men's clubs and institutes are calculated not only to diminish excessive use of intoxicating liquors but also to promote self-culture and the growth of a healthful public spirit arnong the mass of people.

(2) That there are few social reforms of greater importance to this country than the substitution of clubs and institutes for public houses as places of resort for the recreation and business of the working classes.

Although the union did not become entirely independent of outside support until 1890 it had, under the guidance of Hodgson Pratt (1867–83), worked steadily to that end. In 1884 it became completely democratic in constitution. The union itself is non-political as are the majority of its clubs, but political clubs of all parties may be admitted to membership, providing they are democratically controlled by the members or a committee appointed by the members.

In the mid-1950s the union comprised about 3,400 clubs with a total membership of about 2,000,000 persons throughout Great Britain. The union maintains four convalescent homes, accommodating about 6,000 members yearly.

The union provides about 1,400 trophies for indoor and outdoor sports and games contests among its clubs, and organizes day schools each weekend as well as spring and summer schools at University college. Leicester. and at Ruskin college, Oxford.

WORKINGTON, a seaport and municipal borough in Cumberland. Eng.. 33 mi S.W. of Carlisle by road. Pop. (1951) 28.891. Area 7.9 sq.mi. It is at the mouth of the Derwent river where the Prince of Wales dock (4.4 ac.) was opened in 1927. Coal is mined and there are engineering, cloth, carpet and clothing works. Iron ore is imported and steel is made.

The town was incorporated in 1888 and is in the Workington parliamentary division. Workington hall, the seat of the Curwens since the 13th century, was given to the town in 1946 for a civic centre.

WORKMAN, FANNY BULLOCK (1859–1925). U.S. mountaineer, explorer and writer, was born on Jan. 8, 1859, in Worcester, Mass.. the daughter of Alexander Hamilton, n-ho was a governor of Massachusetts. In 1881 she married William Hunter Workman. Her husband gave up the practice of medicine in 1889 because of ill-health and thereafter they spent many years travelling in Europe. Asia and Africa.

Mrs. Workman achieved a world mountaineering record for women in 1906 on a Himalayan expedition. A recognized Alpinist, she was honoured by the French Alpine club with the Grand Medaille in 1904. She was the first U.S. woman to lecture beiore the Sorbonne in Paris.

With her husband she was the author of numerous publications describing their expeditions, including *Algerian Memories* (1895), *Sketches Awheel in Fin de Siècle Iberia* (1897). *In the Ice World of Himalaya* (1900), *Through Town and Jungle* (1904), *Ice-Bound Heights of the Mustagh* (1908), *Peaks and Glaciers of Nun Kun* (1909), *The Call of the Snowy Hispar* (1910), and *Two Summers in the Ice Wilds of the Eastern Karakoram* (1917). She spent the latter part of her life in France and died on Jan. 22, 1925, in Cannes.

WORKMEN'S COMPENSATION. Until 1880 the only remedy which the law of Great Britain provided for a workman who had suffered physical injury in the course of his employment was a common law action in which the plaintiff had to establish that his injury was caused by some personal fault in the employer, or that the employer had been guilty of personal negligence. or had knowingly employed an incompetent servant or had committed a breach of some statutory duty. Even if the expense uhich had to be incurred was not an insurmountable obstacle, the cases where a workman could hope to recover damages for his injury by means of a common law action were comparatively rare. In an action for negligence formidable defenses were available to the employer. Contributory negligence in the workman himself would be pleaded as a matter of course, and if it was established that the plaintiff could. by the exercise of ordinary care, have avoided the consequences of the defendant's negligence the action must fail. The doctrine of *volenti non fit injuria* might destroy the injured workman's right to damages on the ground that, knowing the risk he was running, he expressly or impliedly agreed to accept that risk.

There was also the deiense of "common'! employment, which deprived the plaintiff of his right to damages when his injury resulted from the negligence of a fellow workman. Moreover. the position of the dependents of a workman whose injuries had proved fatal was more desperate still. for the right of action was personal to the injured man and died with him. Lord Campbell's act of 1846 created an exception to this rule in favour of a wife, husband, parent or child of the deceased, and enabled an action to be brought for the benefit of that limited class of persons in respect of the workman's death as a result of another's wrongful act or negligence. But the defenses which were available in an action by the injured workman himself remained available as against the dependents of a workman whose injuries had proved fatal.

Thereafter two different currents of opinion as to the manner in which the unsatisfactory state of the law should be remedied are ybservable. On the one hand, there was the view that any remedial measure should fit into the framework of the existing common law rules, and that all that was necessary was that those rules should be modified to remedy particular grievances. This school of thought found expression in the Employers' Liability bill, introduced in 1893 by Asquith, who thus indicated its three vital principles: "The first is that it abolishes the doctrine of common employment; the second is that it prohibits contracts by a workman renouncing his statutory rights; and third, it simplifies the procedure by means of which the workman can seek his statutory remedy." The views of the opposing body of opinion were expressed in the amendment moved by Joseph Chamberlain when Asquith's bill was before the house of commons, "That no amendment of the law relating to employers' liability mill be final or satisfactory which does not provide compensation to workmen for all injuries sustained in the ordinary course of their employment and not caused by their own acts or default." The house of commons passed Asquith's bill, but abandoned it rather than accept an amendment of the house of lords, the purpose of which was the preservation of the principle of contracting-out, although subject to certain safeguards.

The British Workmen's Compensation Acts.—The Workmen's Compensation act, 1897, introduced a new principle into the law of the relationship between master and servant by imposing a liability on the employer to pay compensation to an injured workman, or, if his injury proved fatal. to his dependents, although there had been no wrongful act or omission on the part of the employer or of anyone employed by him. Liability was imposed no less upon the employer who was blameless than upon him who had been guilty of negligence. Contracting-out was forbidden, save where an equally advantageous scheme duly certified as such by the registrar of Friendly societies, was substituted for liability under the act.

The act of 1897 came up for review before a departmental committee appointed for the purpose in 1903. Many of the recommendations of that committee (Report of Departmental Committee on Compensation for Injuries to *Workmen,* 1904, Cmd. 2208) were embodied in the Workmen's Compensation act, 1906, by which the act of 1897 was repealed. In 1919 the departmental committee generally known as the Holman Gregory committee was appointed to report what alterations of the lam were required "to remedy defects which experience has disclosed"; and "whether it would be desirable to establish a system of accident assurance under the control or supervision of the state." The committee reported in 1920 (Report of *Departmental Committee on* Compensation for Injuries to *Workmen,* 1920, Cmd. 816; *Minutes* of Evidence, Cmd. 908 and 909). Postwar conditions were not favourable to the achievement of the whole of the scheme of reform recommended by the committee: but a good deal of it was embodied in the amending act of 1923. A consolidating act was passed in 192j.

From the first the remedy by way of the Workmen's Compensation acts was in Great Britain an alternative. and not an exclusive remedy. The injured workman or his representatives were not barred from bringing an action at common law or under the Employers' Liability act if the evidence necessary to support an action was forthcoming. But an employer could not be liable to pay compensation twice over in respect of the same accident.

Employments to Which the Acts Applied.—The Workmen's Compensation act of 1897 applied only to the more dangerous industries. But the Workmen's Compensation act. 1900, applied the 1897 act to "the employment of workmen in agriculture by any employer who habitually employs one or more workmen in such employment." Whereas the first Workmen's Compensation act excluded from its scope all norkmen not expressly included, the act of 1906 included all "workmen" except the few classes expressly excluded, namely nonmanual workers whose remuneration exceeded £250 a year (the limit was raised to £350 by the 1923 act); persons employed casually otherwise than for the purposes of the employer's trade or business; outworkers; members of the employer's family dwelling in his house. members of a police force and persons in the army and navy. With the specific exceptions mentioned, the expression "workman" was defined to include "any person who has entered into or works under a contract of service or apprenticeship with an employer whether by way of manual labour, clerical work or otherwise." The sweep of the act was thus widened in 1906 so as to include not only the coal miner and the engineer but also the clerk in the countinghouse, the shop assistant and the general servant.

Yet there were still workers excluded from the protection of the act. A seaman on a British ship meeting with an accident when abroad would be outside the acts; so with the crews of British aircraft. when outside Great Britain. Again. if the legal relationship between, say, a cab proprietor and his driver was that of bailor and bailee, the relationship, the basis of which is a contract of service, which was the fundamental test for inclusion in the acts, was absent. To bring such cases within the Workmen's Compensation acts specific enactment was accordingly necessary.

Operation of the Scheme.—It was open to the employer, and in some cases obligatory on him, to insure against his liability; it was for the workman to make his claim and to take steps to enforce it. if challenged, in the courts. Inevitably compensation thus became a disputable issue between the two parties or their representatives. This resulted in the growth of legal complexity and the emergence of certain unsatisfactory features; *i.e.,* the practice of paying. in full discharge of liability for what might prove to be a permanent or long contiriued loss of earnings, a lump sum which the employer might offer for the sake of simplicity and finality, and the workman accept for the same reason.

The Beveridge Plan.—In 1941 the Beveridge committee was appointed by the government to survey existing national schemes of social insurance and allied services. including workmen's compensation. Sir William Beveridge (later Lord Beveridge). in his report which was published in Nov. 1942, advised the abolition of the separate scheme of workmen's compensation. This recommendation followed the practice already operating in many foreign countries and in the dominions overseas. In Sept. 1944 the government announced its proposals in two white papers on social insurance. Part I dealt with social insurance generally (except for industrial injuries) and part II with social insurance for a new scheme of industrial injury allowance. Part I was embodied in the National Insurance act, 1946 (see SOCIAL SECURITY), and part II in the National Insurance (Industrial Injuries) act, 1946. Amending acts were passed in 1952 and 1954 to increase the benefits originally provided.

Basis of the New Scheme.—Under the Workmen's Compensation acts the benefits were related to the estimated loss of earning capacity. Under the new scheme benefits were made payable at flat rates, with supplements for family responsibilities. In the earlier weeks, while the workman is incapacitated for work, injury allowances were to be made at uniform rates. Afterward, if disablement continued, industrial pensions were to be based, not on loss of earning capacity. but upon the extent to which the workman has suffered disablement by the injury in comparison with a normal healthy person of the same age and sex. The pensions were not affected by any subsequent earnings of the workman and not replaced by lump sum payments.

There also were provided pensions for widows, parents and certain other dependents of those who died as the result of industriai injury. The basis of the scheme was similar in many respects to that of the war pensions scheme. It thus recognized a certain similarity between the position of the soldier wounded in battle and that of the man injured, each being comperisated for whatever he lost in health, strength and the power to enjoy life and not for loss of earning capacity.

The scheme covered broadly all persons working under a contract of service or apprenticeship and applied to personal injury by accident arising out of and in the course of employment, and to specified industrial diseases. It also covered accidents to persons engaged in rescue work and other specified classes of emergency work in connection with industrial undertakings generally. The scheme did not apply to members of the armed services nor to employment outside Great Britain except in the case of persons employed in British ships and aircraft. Married women were insurable if they were employed persons even though they might have chosen to contract out of the main National Insurance scheme. If it was proved that the injury was attributable to the serious and wilful misconduct of the workman. benefit would be not payable unless the injury resulted in death or serious and permanent disability.

Finance and Administration. — Financed from an Industrial Injury Insurance fund maintained by weekly contributions from employers and workmen together with a contribution from the exchequer, the scheme required weekly contributions each of the insured person and the employer of *4d.* for a man over the age of 18 years and *3d.* for a woman over that age with lower contributions for juveniles. Contributions were subsequently raised to *5d.* for an insured man and *6d.* for his employer, and to *4d.* for the employer of an insured woman. Under an amendment made by an act of 1953, special provision could be made for contributions being based on the amount of work done or remuneration received instead of being payable for each week during which the insured person was employed. This was to meet the special position of those engaged in employment of a casual or subsidiary nature.

The minister of national insurance was held responsible to parliament for the general administration of the scheme as for the main National Insurance scheme.

It was provided that all claims would be dealt with by a local industrial pensions officer, normally being met on an application by or on behalf of the workman and on confirmation of the injury by the employer. The pensions officer was given the right to require the applicant to submit to a medical examination. In cases of industrial disease a report by a specially appointed medical officer might be required The decision of the industrial pensions officer on questions of entitlement was made subject to appeal to a local appeal tribunal on which employers and workmen would be equally represented and presided over by an independent chairman nith legal qualifications. It was also open to the pensions officer to refer any such question to the tribunal without himself giving a decision. Provision was made for medical practitioners to serve on the tribunal in special cases. There were further rights of appeal to an industrial injury insurance commissioner if leave was given either by the chairman of the local appeal tribunal or by the commissioner on questions of law. The medical assessment for pension. when necessary, was made by a medical board with a right of appeal to a tribunal consisting of a chairman of a local appeal tribunal and two medical practitioners. An assessment might be either final or provisional and a final assessment could be made either for a limited period or for life.

Benefits. — An insured person was entitled in 1955 to an injury benefit of *67s.6d.* weekly (increased by acts of 1952 and 1954 from *45s.)* for an adult workman alone and *92s.6d.* (increased from *61s.*) for a married couple. As under the main National Insurance scheme there was an allowance of *11s.6d.* (increased from *10s.*) weekly in respect of an only or eldest child and an allowance of *3s.6d.* (increased from *2s.6d.*) for each additional child. The normal allowance for the second and other children was also payable under the Family Allowances scheme. The injury benefit was payable in respect of any day on which the injured person was, during a period of 26 weeks thereafter, incapable of work. Disablement benefit was payable where the injured person continued to be incapable of work after the injury benefit period expired. Under the original scheme this benefit could only be paid if the loss of physical or mental capacity resulting from the accident was substantial (*i.e.,* causing disablement assessed at 20% or more) or was likely to be permanent or in some circumstances both substantial and permanent. These limitations were revoked by the act of 1953 and disablement benefit became payable for any period during which the disablement was assessed at 1% or more whether or not it was likely to be permanent.

The rate of disablement benefit varied, according to the degree of disability, up to *67s.6d.* for 100% disablement. An increment of *25s.* (increased from *16s.*) was payable in respect of a wife, or in certain circumstances, any other adult dependent and *11s.6d.* for the first or only child. Death benefit, by way of widow's (or sometimes widower's) pension was, payable at the rate of *45s.* weekly (increased from *30s.*) when the widow was living with her husband at the date of his death, or in some cases *20s.* A higher pension of *55s.* was payable for the first 13 weeks after the husband's death.

Systems in Other Countries. — Workmen's compensation, or employment injuries schemes as they are generally called, providing for cash benefits and usually for medical care, were in many countries the first type of social security legislation to be enacted. In some systems the employer is required to insure; in others he is under obligation to provide the benefits specified by law but insurance is voluntary. In some countries insurance is arranged by private insurance companies or employers' mutual associations. In a few countries insurance is arranged either through private insurance companies or a public insurance fund. More recently there was a trend toward compulsory insurance administered exclusively by public agencies.

Many of the early workmen's compensation laws only covered disability resulting from accidents but later they often covered provision for disability resulting from occupational diseases also.

Some recent laws extended the notion of employment injury to accidents which occur on the way to and from work. Most schemes distinguish between temporary incapacity and permanent incapacity and some between total and partial incapacity. Employment injury benefit is commonly provided without qualifying period or means test. Unlike the practice in Great Britain, temporary benefit in other countries was usually related (subject to a maximum payment) to the previous earnings of the beneficiary or to the basic earnings of the category of workers to which he belonged. The percentage varied from a minimum of 42% to a maximum of 80% in the Netherlands and Switzerland; in the German Federal Republic it was 663%.

In some countries (Bulgaria, Norway and Czechoslovakia) the benefit was made the same as for sickness. Temporary incapacity benefit often continued to be paid until the injury was healed or the disease cured or until the injury, if of a permanent nature, was consolidated. In many countries, however, a time limit was prescribed after which permanent incapacity benefit became payable. When the temporary incapacity benefit ceased to be payable and incapacity for work was found to have become permanent the degree of such incapacity was assessed and a proportionate pension granted. Frequently the rate of pension for total incapacity was made the same as the temporary incapacity allowance, as in Australia, India and New Zealand. On the contrary, the pension was set lower than the temporary incapacity benefit in Denmark. In Czechoslovakia the pension was set at two-thirds of basic earnings for total incapacity but the rate of the temporary benefit varied for different classes of employment. In the Netherlands and Switzerland the pension was made 70% of earnings as against 80% for temporary incapacity. In Sweden, however, it was $91\frac{2}{3}$% as compared with 70% for temporary incapacity.

In most countries benefit is also payable in respect of partial permanent incapacity, the pension being such fraction of the full rate for total incapacity as corresponds to the degree of incapacity. In France, however, it was provided that the allowance would be relatively higher if the degree of incapacity exceeded 50%. In the case of injury entailing only a minor degree of incapacity and sometimes also when loss of a limb is suffered but no loss of earning capacity, a lump sum might be provided instead of periodical payments. A considerable number of schemes grant supplements to invalids who need constant attendance; such supplements may bring the benefit up to 100% of former earnings.

By mid-20th century schemes providing employment injury benefits were financed exclusively by employers in more than three-quarters of the countries which were state members of the International Labour organization. **A** small proportion were financed by employers and workmen and the remainder also partly by the state.

Australia and New Zealand. — In Australia the matter came under the jurisdiction of state laws and not by commonwealth legislation, the arrangements not being uniform although very similar. Normally a person would be covered if he were employed under a contract of service or apprenticeship, but there was usually exclusion if the person's earnings exceeded a specified figure. The benefit was based on a percentage of the person's earnings prescribed by the legislation of each state. This varied up to $66\frac{2}{3}\%$ and in some states there were also supplements for dependents. There was also an allowance for medical treatment and hospitnlization.

In Queensland the scheme came under the administration of the agency of a public department — the state insurance office—which levied upon employers compulsory contributions and itself assumed the liability to pay compensation. It was to the fund and not to the individual employer that the injured workman or his dependents must look for comaensation. In the other states of Australia intervention by the state was directed to the compulsory insurance of workmen's compensation risk coupled usually with the setting up of a state insurance office with which, however, insurance companies might compete. In South Australia, only private insurance companies were established. The settlement of claims is in some cases a matter ior the courts and in others for special magistrates or commissioners. In Victoria, the county court judges were made responsible for the administration, acting with a workers' compensation board consisting of representatives of workers and employers.

In New Zealand, the scheme covered all employed persons and was financed by the employers. The contribution rates, fixed by order in council, varied n-ith the degree of risk in the undertaking. Benefit was based on a proportion of earnings with an allowance at a lower rate for permanent disability. An additional allowance was payable for medical and other special treatment. Injury benefit was based on 75% of earnings for total incapacity subject to a prescribed minimum and maximum. Earlier, insurance could only be affected through the state fire and accident insurance office but by the latter 1950s it could be arranged also through private insurance companies, or a co-operative association. It was compulsory for each employer, unless specially exempted, to insure.

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THE UNITED STATES

Historical Development. — In comparison with Europe, workmen's compensation came late in the United States. To be sure, the common law rules of employers' liability had scarcely been laid down by the courts before legislative attempts to modiiy them began. By 1910 practically every state had passed some sort oi employers' liability statute. But these lams merely mitigated the harshness of the common lam, Many applied only to railway accidents and none was adequate to assure pro\-ision for the disabled or the survivors of workers killed on the job. The essential basis of employers' responsibility remained tort liability.

The first acts to be based on the compensation principle of "liability without fault" were enacted by Maryland in 1902 and Montana in 1909. Both were held unconstitutional. But by this time public opinion was aroused. The peak of industrial injury rates was reached around 1907–10. Under such diverse leadership as represented by Theodore Roosevelt, John R. Commons of Wisconsin, and John B. Andrews of the American Association for Labor Legislation, three related and contemporaneous reform movements began — workmen's compensation, industrial safety and industrial hygiene.

In 32 states, 40 official commissions investigated and strongly condemned the existing legal situation and, with virtual unanimity, recommended adoption of laws based on "liability without fault." An important setback, however, resulted from a 1911 New York court of appeals decision which invalidated the New York law of 1910, the most comprehensive up to that time. Nevertheless, 30 compensation laws were enacted between 1910 and 1915. In 1917 the issue of constitutionality was permanently settled by the United States supreme court which declared the state police power an adequate basis ior all proposed types of compensation laws.

The New York ruling, though reversed, leit a heritage. Although seven states amended their constitutions to make certain that compensation would be legal, most laws were narrowed and restricted because of the decision. The resulting "elective" provisions and limited coverage of industries, occupations and injuries persisted in curtailing the effectiveness oi workmen's compensation. By 1920 all but six states had enacted legislation; slowly they joined the ranks also and by 1948, with the action of Mississippi, all states were covered. Federal jurisdictions were covered by the Federal Employees' Compensation act and the Longshoremen's and Harbor Workers' act.

Despite its wide spread, workmen's compensation never completely supplanted the common law and employers' liability legislation as remedies for occupational injury. The latter, especially, continued to remain a significant factor. By the mid-1950s, at least a fiith of U.S. workers were still not covered. Prominent among the omissions were interstate railway workers and merchant seamen who felt that their experience under special federal employers' liability legislation compared favourably with the state compensation systems. Other exclusions were caused by elective laws, exclusion oi certain types of employment (*e.g.*, small firms), and some types of injuries: particularly occupational diseases. Following World War II, injury coverage was greatly broadened through judicial expansion of the concept of causal relationship of injury to employment and the meaning of such terms as accidental injury.

Benefit Provisions. — There are three categories oi compensation benefits: cash, medical and rehabilitation, designed to indemnify the injured worker or his dependents for loss of wages, medical and hospital expenses, loss of occupational capacity and skills, and where possible to restore the latter.

Cash benefits vary in accordance with four types of injuries: temporary-total disability, permanent-total disability, permanent-partial and death. The basic benefit formula in all types of cases is similar, but complex. The factors involved are numerous: (1) a specified maximum percentage of the worker's normal wages; (2) a weekly dollar maximum and minimum; (3) a maximum total dollar amount; (4) a maximum amount of time ior which benefits may be paid; (5) variations according to dependents; (6) a waiting period, and (7) a formula by which normal wages are computed. The first of these was originally considered most important since the relation of benefits to wage loss was a theoretical foundation stone of workmen's compensation in the United States. Later, however, the specified percentage — usually 662% — was submerged by the other limitations, particularly the maximum dollar amounts. The general result was an approximation of a flat-sum system determined by the weekly maximums; in a typical year, average benefits did not replace more than a third oi wage loss.

Medical benefits had been, in some degree, universally included and probably represented the most significant quantitative advance in the program, accounting for about a third of all benefit payments. Qualitatively the results were less impressive. Medical administration was under attack, accused of not having become rehabilitation oriented.

Financing. — Compensation benefits in the United States are generally financed by employers, who must give assurance of their ability to meet such obligations. This may be done by insuring with a private carrier (the most common method), or with a state fund in certain states or by giving prooi of ability to carry one's own risk, called self-insurance. The annual cost to employers by the mid-1950s had increased to about $1.500.000.000. As a percentage of payroll, net costs had remained fairly constant — about 1% since the mid-1930s, declining during the 1940s, and rising again in the early 1950s. This national average concealed great variations among states, among industries and among individual employers, rising from negligible proportioris to 30% or more in the case of extra-hazardous industries in some states. Overhead costs — insurance, legal fees and administration — mere consuming about hali the total costs. Insurance remained the major factor.

Basic Issues. — These related to whether workmen's compensation was meeting its stated objectives and, more profoundly, whether the original objectives were enough for contemporary conditions. The disappointing level of benefits had raised the question of whether the program could be adequate as the injured worker's exclusive remedy. Increasingly, the issue had arisen as to whether it is practicable to separate occupational and nonoccupational disability. Most important, perhaps, was the challenge of modern rehabilitation techniques.

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WORKS' COUNCILS: *see* INDUSTRIAL RELATIONS.

WORKSOP, a municipal borough in the Bassetlaw parliamentary division of Nottinghamshire, Eng., on the Chesterfield canal, $27\frac{1}{2}$ mi. N. of Nottingham by road. Pop. (1951) 31,034. Area

28.0 sq.mi. The borough contains 3,784 ac. of Sherwood forest, belonging to the National trust. The south door of the priory church possesses 12th- or 13th-century iron scrollwork, the oldest in England.

In 1296 a royal charter was granted for the holding of a market and fair. Worksop was incorporated in 1931. Coal mining has been the chief industry since 1859 and other industries include timber, glass, quarrying and the manufacture of bricks, nylon and hosiery. Worksop college was founded in 1890.

WORLD COUNCIL OF CHURCHES, THE, was constituted in 1948 as "a fellowship of Churches which accept Jesus Christ our Lord as God and Saviour." It consists of nearly 200 churches in all parts of the world which have accepted this basis, but these do not include the Roman Catholic Church. the Southern Baptists in the U.S. and some other large Evangelical bodies.

The controlling body of the World Council of Churches is the assembly. which meets at intervals of roughly five years (Amsterdam. Neth., 1948; Evanston. Ill., 1954; New Delhi, India, 1961). This appoints a central committee of 90 members and an executive committee of 12 members, as far as possible to represent all interests and to carry on the work of the council between assemblies. There are six presidents. The headquarters of the council in Geneva has a large staff under a general secretary. There are three main divisions of work: church relations; ecumenical study' and promotion; and interchurch aid and service to refugees. Under these are a number of groups and commissions, such as faith and order, the commission on the life and work of the laity in the church, and that on the co-operation of men and women in church and society. At the Château de Bossey, the ecumenical institute 15 mi. from Geneva, Switz., study conferences are in progress during most of the year.

The World Council is not a church, nor does it issue orders or directions to the churches. It works for the unity and renewal of the church and offers the churches an instrument by means of which they may talk together, pray together and work together in the spirit of tolerance and mutual understanding. In 1961 the World Council of Churches was united with the other great ecumenical body, the International Missionary council. See also ECUMENICAL MOVEMENT.

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WORLD COURT: *see* INTERNATIONAL COURT OF JUSTICE.

WORLD GOVERNMENT MOVEMENTS. Various proposals to replace the system of sovereign nations with a world government arose out of the collapse of international order in 1939 and the advent of the atomic age in 1945. In contrast to earlier plans for a universal government and attempts at world empire, these proposals, known collectively as the "world government movement," had three distinctive features: (1) they received a degree of popular support and some consideration at the governmental level; (2) they were based upon the idea of a voluntary surrender or limitation of national sovereignty; and (3) they reflected a sense of urgency, maintaining that the social, economic and technological interdependence of the modern world had made the nation-state system obsolete, and that the prospects of nuclear warfare left mankind with catastrophe as the only alternative to the achievement of a common government. The United Nations was criticized, especially in its earlier years, on the ground that an association of sovereign states would be hopelessly inadequate to deal with the problem of war and peace in contemporary society.

Regional v. Universal Approach.—One of the proposals contemplated a federal union of the North Atlantic democracies as the nucleus of an eventual world government. On the eve of World War II, Clarence K. Streit had published *Union Now* (1939), expounding the view that a common federal government would greatly increase the strength of the democracies in relation to the dictatorships. Support for the idea continued after the war and in 1949 the Atlantic Union committee was organized under the leadership of Owen J. Roberts, formerly an associate justice of the U.S. supreme court. This committee had as its main purpose the calling of a convention to explore the possibilities of federal union among the North Atlantic countries.

Great emphasis was placed on freedom and democracy as the criterion for eligibility to membership. Unity to increase the power of the free democracies was the central purpose, and peace was to be achieved by strengthening the area of freedom. The functions and powers assigned to the federal union would be important ones, including a common citizenship and defense force, a customs-free economy and a common currency. The political and economic success of such a union was expected to attract additional members, thus bringing about a gradual expansion into a federal government of the entire world.

A different approach was that of the United World Federalists, who insisted that substantial universality of membership was an essential requirement from the beginning. This organization, formed in the United States after World War II, faced the dilemma of believing that world peace could be assured only within the jurisdiction of a common government, but that nations were not ready for a surrender of broad powers. The solution offered was the establishment of a world government that would be able to prevent war, but also would be so limited in functions and powers that interference in the domestic affairs of member nations would be precluded. Support for similar ideas in other countries was reflected in the World Movement for World Federal Government, organized at a conference held in Luxembourg in 1946. This group reached its peak membership of about 67,000 by 1949; of the total, almost two-thirds were in the United States and a majority of the remainder in Great Britain.

Proposed Powers.—The extent of the powers to be delegated was a central issue for advocates of a federal world government. Varying answers to this question were given by different groups, and the so-called maximalist-minimalist controversy resulted. The United World Federalists stressed both adequacy and limitation, but always in general terms. Another approach was to develop a detailed plan, which would specify exactly the limited powers to be transferred to a federal world government. The Citizens Committee for United Nations Reform, organized in 1946 by Ely Culbertson on the basis of an earlier and more ambitious plan, proposed to eliminate the veto in the UN Security council, provide for international control of armaments on the basis of an enforceable quota system and establish an effective international police force. Another plan, worked out in considerable detail by Grenville Clark and Louis Sohn, was strictly limited to the enforcement of complete and universal disarmament. The New Commonwealth plan in Great Britain advocated an equity tribunal to settle disputes and a police force to uphold international law and order.

The necessity of granting maximal powers to a world government was urged by the Committee to Frame a World Constitution, established at The University of Chicago in 1945. The committee assembled a research staff, exchanged ideas through memoranda and periodic meetings, and published its proposals in the form of a preliminary draft of a world constitution. The purpose of the draft was to serve as a basis for discussion, to focus attention on what a world government might look like and to help in the process of education toward a world community. The assumptions were that war must and can be outlawed, that world government is the only alternative to world destruction and is possible because it is necessary, and that world government must be based upon a universal community of justice. The proposal called for a world government with broad and extensive powers, a system of regional representation and a unique and complex structure. It would grant to the world authorities all the functions and powers needed to maintain peace and justice and to manage major segments of the world economy. Only this was considered sufficient to accomplish the purpose.

Another approach to solving the dilemma of broad versus limited powers was that of the British Parliamentary Group for World Government. In 1952 the group suggested alternative plans, one designed for early establishment of a world government and the other for strengthening the UN as an interim step.

A different type of world government proposal was that based on the concept of functionalism. The essential idea was that people working together on a common task can develop the appropriate methods and machinery as the need arises. Co-operation in dealing with problems of mutual concern was expected to produce better results than attempts to agree in advance on a plan of government. Some advocates of functionalism did, however, combine that principle with endorsement of movements to set up a world government structure. Other functionalists saw great possibilities in the gains which might result from expanded social and economic co-operation through the UN.

Post-Korean Developments. — The high tide of public and political interest in the world government movement was reached between 1948 and 1950. After the outbreak in 1950 of the Korean war and the Chinese Communist intervention, it was obvious that the mutual confidence required for world-wide participation in a common government did not exist. At the same time. the nations of the North Atlantic area continued to rely on an association of sovereign states, instead of forming a federal union among themselves. Most proponents of world federalism began to talk in terms of supporting and strengthening the United Nations as the best immediate hope. The Atlantic Union committee, for its part. placed emphasis upon co-operation through the North Atlantic Treaty organization (NATO) (*q.v.*) and other interim measures to increase unity among the North Atlantic democracies. Thus, proposals for the immediate establishment of a supranational federation were largely replaced by an effort to bring about conditions which might eventually permit the achievement of world government. It is true that a few countries made constitutional provision for a reciprocal modification of sovereignty and that some governmental proposals, notably in the case of atomic energy, applied the supranational principle to a limited functional area. Nevertheless, the pattern of world political organization remained on the basis of the voluntary association of sovereign states.

See FEDERAL GOVERNMENT; GOVERNMENT; LEAGUE OF NATIONS; PAN-EUROPEAN MOVEMENT; UNITED NATIONS.

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WORLD HEALTH ORGANIZATION. The World Health Organization (WHO), established in 1948, is a specialized agency of the United Nations designed to further international co-operation for improved health conditions throughout the world. The culmination of nearly a century of efforts to this end, WHO inherited from the Health organization of the former League of Nations, set up in 1923, and from the International Office of Public Health at Paris, dating from 1907, various international duties relative to epidemic control, quarantine measures and the standardization of drugs. Under its constitution, however, WHO is given a much broader mandate—to promote the attainment of "the highest possible level of health" by all peoples. Health is defined positively as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"; and good health is held to be fundamental to world peace and security.

Administration. — With administrative headquarters in Geneva, Switz.. WHO operates through three principal instrumentalities: the World Health assembly, meeting annually as the general policy-making body; an executive board of 18 health specialists elected for three-year terms by the assembly, and holding two sessions each year; and a secretariat, which had in the late 1950s a staff of about 1,300 persons representing over 50 different nationalities. The secretariat is headed by a director-general appointed for a five-year term by the assembly on nomination by the executive board. The first director-general, Brock Chisholm, a Canadian psychiatrist, served until 1953; M. G. Candau of Brazil succeeded him and was re-appointed in 1957.

To stimulate and co-ordinate WHO's work "at the grass roots." six regional offices were established in Alexandria, Egypt; Brazzaville, French Equatorial Africa; Copenhagen; New Delhi; Manila; and Washington. Each regional office is supervised by a committee of representatives of member states in the region concerned. The Washington office also serves as the headquarters of the Pan American Sanitary bureau (founded in 1902), which co-operates with WHO in the western hemisphere.

The membership of WHO consists of sovereign states and non-self-governing territories, their number growing from 26 in 1948 to 88 ten years later, 85 of which were independent states. The organization is financed primarily from annual contributions made by member governments on the basis of relative capacity to pay. The regular budget expanded in the first decade from $5,000,000 in 1949 to $15,000,000 for 1959, the largest contributor being the United States, which provided in the latter year approximately one third of the total. In addition, after 1951 WHO was allocated substantial resources from the expanded technical assistance program of the UN, amounting in 1958 to $5,500,000. Grants for special purposes were also made to WHO from time to time by private foundations and individual governments.

Functions. — The work of WHO embraces three fairly distinct categories of activities:

1. The provision of central "clearing house" and research services. As an example, information about the occurrence of pestilential disease anywhere in the world is broadcast over an international radio network to national health authorities, seaports, airports and ships at sea. In 1952 13 outdated international sanitary agreements were replaced by a codified set of international sanitary regulations designed to standardize quarantine measures without interfering unnecessarily with trade and air travel across national boundaries. These were subsequently accepted by most of the world's governments. Another WHO regulation (published in 1951) requires national health administrations to adopt a uniform system for reporting diseases and causes of death, thus facilitating the statistical study of world health trends. A closely related activity was the establishment of international pharmaceutical standards for some zoo drugs, intended to encourage the manufacture of drug products of uniform strength and quality. Scientific medical research is stimulated and the results disseminated by means of numerous WHO technical publications and the work of 30 advisory panels drawn from over 1,000 of the world's leading health specialists. The central WHO secretariat also keeps member countries informed of the latest developments in use of vaccines, cancer research, nutritional discoveries, control of drug addiction and health hazards of nuclear radiation.

2. Measures for the control of epidemic and endemic disease. This category consists chiefly of mass campaigns promoted by WHO against communicable diseases. These campaigns, some of them conducted with the co-operation of the United Nations Children's fund (UNICEF), have been dramatically successful in reducing the incidence of tuberculosis, malaria and venereal disease in the more backward regions of the globe. The organization launched a world-wide campaign for the complete eradication of malaria within five years—a program to which the United States made a special contribution of $7,000,000 in 1957. Considerable progress was likewise made by WHO in attacking such diseases as cholera, yellow fever, yaws and trachoma. Among the techniques employed in these campaigns are nationwide vaccination programs; instruction in the use of antibiotics and such insecticides as DDT; the improvement of laboratory and clinical facilities for early diagnosis and prevention; assistance in providing pure water supplies and sanitation systems; and health education for rural communities.

3. Efforts to strengthen and expand the public health administrations of member nations. As its program developed, WHO set as its most important task the strengthening of national and local health services. especially in Africa, Asia and Latin America. In furthering this vital objective, a wide variety of devices are utilized. The organization provides technical advice to governments on request in the preparatipn of long-term national health plans; sends out to the field international teams of experts to conduct surveys and demonstration projects; helps set up local health centres; offers aid in the development of national training institu-

tions for medical and nursing personnel; makes available teachers for on-the-spot short course training experiments; and makes traveling fellowship awards to doctors, public health administrators, nurses, sanitary inspectors and laboratory technicians. In the late 1950s over 5,000 individuals had benefited from these fellowships to study advanced techniques.

Participation in UN **Technical** Assistance Program.—After 1951 WHO's types of assistance were materially expanded with supplementary funds from the United Nations Expanded Technical Assistance program (ETAP), a program initially stimulated by Pres. Harry S. Truman's "point four" proposal of 1949. ETAP resources were used primarily to recruit experts from the more advanced countries for assignments of a few months up to two years in economically underdeveloped areas of the globe. By 1957 over 400 such experts (in addition to several hundred members of WHO's permanent staff) had served on field missions. During 1958, a typical year, WHO was involved in 700 health projects distributed among 112 countries and territories over the globe. To a limited extent ETAP funds were also drawn upon for supplies, drugs and apparatus required for training and demonstration undertakings. (See FOREIGN AID PROGRAMS.)

Compared with the staggeringly vast needs of the world's peoples for more and better-trained doctors, nurses and medical scientists, for more adequate public health services of all kinds and for additional medical schools, hospitals and clinics, WHO's financial and staff resources were decidedly limited. Yet it served as an increasingly important instrument, at the international level, in mankind's perennial battle against disease, squalor, infant mortality and ignorance of the elements of better health.

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WORLD SOUL, in the history of philosophy, denotes the conception that there is in the world a universal spirit or soul which is related to the material world in a way that is similar or analogous to the relation of the human soul to the body. This view was taught by various Greek philosophers, notably by Plato and the Stoics. In modern times Schelling held a similar conception, and attributed to the world soul the function of acting as an organizing principle of the material world, which is thereby made into a coherent system. *See* PLATO; STOICS; SCHELLING, FRIEDRICH WILHELM JOSEPH VON.

WORLD WAR I. The aim of this article is to trace the main strategic currents of World War I, and also the conditions and ideas which guided them. The causes of the war are not within its scope. (For the political and diplomatic history of the struggle *see* the article EUROPE.) A process of 50 years had gone to make Europe inflammable, and a few days were enough to detonate it. To study the causes of the conflict on the German side we should have to trace the influence of Prussia on the creation of the Reich, the political conceptions of Bismarck, the German philosophical tendencies, her economic situation—a medley of factors which transmuted Germany's natural desire for commercial outlets, unhappily difficult to obtain, into a vision of world power. We should have to analyse that heterogeneous relic of the middle ages known as Austria-Hungary, appreciate her complex racial problems, the artificiality of her governing institutions, the superficial ambitions which overlay a haunting fear of internal disruption and frantically sought to postpone the inevitable end.

On the other side we should have to examine the strange mixture of ambition and idealism which swayed Russian policy; we should have to understand the constant and justifiable fear of fresh aggression which France had suffered since 1870, and follow the regrowth of confidence which fortified her to resist further threats; finally, we should have to trace Britain's gradual movement from a policy of isolation into membership of the European system and her slow awakening to the reality of German ambitions. Beside these fundamental causes the international "incidents" that took place between 1899 and 1914 are but symptoms.

This article is divided into the following sections:

Following this is a discussion of the part played by naval forces during World War I.

I. INTRODUCTION

The Armed Forces.—World War I may be briefly epitomized as a progress from convention through chaos to co-operation. The nations entered upon the conflict with the conventional outlook and system of the 18th century merely modified by the events of the 19th century. Politically, they conceived of it as a struggle between rival coalitions based on the traditional system of diplomatic alliances, and militarily as between professional armies—swollen, it is true, owing to the continental system of conscription, yet essentially fought out by soldiers while the mass of the people watched, from seats in the amphitheatre, the efforts of their champions. The Germans alone had a glimpse of the truth, but—one or two prophetic minds apart—the "Nation in Arms" theory evolved by them during the 19th century visualized the nation rather as a reservoir to pour its reinforcements into the army than as a mighty river in which are merged many tributary forces, of which the army is but one. Their conception was the "Nation in Arms," hardly the "Nation at War." Even after the war this truth had still to be grasped in its entirety and its full implications understood. Progressively throughout the years 1914–18 the warring nations enlisted the research of the scientist, the inventive powers and technical skill of the engineer, the manual labour of industry and the pen of the propagandist. For long this fusion of many forces tended to a chaotic maelstrom of forces; the old order had broken down, the new had not yet evolved. Only gradually did a working co-operation emerge, and it is a moot point whether even in the last phase co-operation of forces had attained to the higher level of co-ordination-direction by unity of diversity.

The German army of 1914 was born in the Napoleonic Wars, nursed in infancy by Gneisenau and Scharnhorst, and trained in adolescence by the elder Moltke and Roon. It reached maturity in the War of 1870, where it emerged triumphantly from a test against the long-service army of France. Every physically able citizen was liable to service, and the state took the number it desired, trained them to arms for a short period of full-time service, and then returned them to civil life. The feature, as also the object, of this system was the production of a huge reserve by which to expand the active army in war. A man served two or three years full-time, according to his branch of the service, followed by five or four years in the regular reserves. He then went into the Landwehr for 12 years, and finally passed into the Landsturm from 39 till 45. Further, an Ersatz reserve was formed of those who were not called on for service with the colours.

In this organization and the thoroughness of the training lay the secret of the first great surprise of the war, one which almost proved decisive. For instead of regarding their reservists as troops of doubtful quality, fit only for an auxiliary rôle or garrison duty, the Germans during mobilization were able to duplicate every first line army corps with a reserve corps—and had the courage, justified by events, to use them in the opening clash. This surprise upset the French calculations, as it dislocated their plan.

The Germans have been reproached for many miscalculations; less than justice has been done to the correctness of many of their intuitions. They alone realized what became an axiom—that, given a highly trained cadre of leaders, a military machine can be rapidly manufactured from the levies of the led, like molten liquid poured into a mould. The German mould was a long-service body of officers and n.c.o.s who in their standard of technical knowledge and skill had no equal in the world. But if the machine was manufactured by training, it gained its solidity from another process. The psychological element plays an even greater part in a "national" than in a professional army. Esprit de corps is not enough; the stimulus of a great moral impulse to action is necessary, a deep-rooted belief in the policy for which citizens are called on to fight. The leaders of Germany had worked for generations to inspire their people with a patriotic conviction of the grandeur of their country's destiny. And if their opponents went forth to battle in 1914 with as intense a belief in their country's cause, this flaming patriotism had not the time to consolidate such a disciplined combination as years of steady heat had produced in Germany. The German people had an intimacy with and a pride in their army, notwithstanding its severity of discipline, that was unknown elsewhere.

This unique instrument was handled by a general staff which, by rigour of selection and training, was unmatched for professional knowledge and skill, if subject to the mental "grooves" which characterize all professions. Executive skill is the fruit of practice; and constant practice, or repetition, tends inevitably to deaden originality and elasticity of mind. In a professional body, also, promotion by seniority is a rule difficult to avoid. The Germans, it is true, tended towards a system of staff control, which in practice frequently left the real power in the hands of youthful general staff officers. As war memoirs and documents reveal, the chiefs of staff of the various armies and corps often took momentous decisions with hardly a pretence of consulting their commanders. But such a system had grave objections, for such a happy combination as that of a Hindenburg and Ludendorff is rarely found, and from it came the grit in the wheels which not infrequently marred the otherwise well-oiled working of the German war-machine.

Tactically, the Germans began with two important material advantages. They alone had gauged the potentialities of the heavy howitzer, and had provided adequate numbers of this weapon. And if no army had fully realized that machine-guns were "concentrated essence of infantry," nor fully developed this preponderant source of fire-power, the Germans had studied it more than other armies, and by their method of grouping the machine-guns under regimental control, instead of distributing them among battalions, were able to exploit its inherent battlefield-dominating power sooner than other armies. Strategically, also, the Germans had brought the study and development of railway communications to a higher pitch than any of their rivals.

The Austro-Hungarian army, if patterned on the German model, was a vastly inferior instrument. Not only had it a tradition of defeat rather than of victory, but its racial mixture prevented the moral homogeneity that distinguished its ally. This being so, the replacement of the old professional army by one based on universal service lowered rather than raised its standard of effectiveness. The troops within the borders of the empire were often racially akin to those beyond, and this compelled her to a politically instead of a militarily based distribution of forces, so that kinsmen should not fight each other. And her human handicap was increased by a geographical one—the vast extent of frontier to be defended. Nor were her leaders, with rare exceptions, the professional equals of the Germans, and if common action was better than with the Entente Powers, Austria did not accept German direction gladly.

Yet despite all its evident weaknesses this loosely knit conglomeration of races withstood the shock and strain of war for four years, in a way that surprised and dismayed her opponents. The explanation is that this complex racial fabric was woven on a stout Germanic and Magyar framework.

From the Central we turn to the Entente Powers. France possessed but 60% of the potential man-power of Germany, and this debit balance had forced her to call on the services of practically every able-bodied male. A man was called up at 20. did three years' full-time service, then 11 in the reserve and finally two periods of seven years each in the Territorial Army and Territorial Reserve. This system gave France an initial war strength of some 4,000,000 men, equal to her German rival, but, in contrast, she placed little reliance on the fighting values of reservists. The French command counted only on the semi-professional troops of the first line, about 1,500,000 men, for the short and decisive campaign which they expected and prepared for. Moreover, they assumed a similar attitude on the part of their enemy—with dire result. But this initial surprise apart, a more profound handicap was the lesser capacity of France for expansion, in case of a long war, due to her smaller population—under 40,000,000 compared with Germany's 65 millions. Col. Mangin, later to become famous, had advocated tapping the resources in Africa, the raising of a huge native army, but the Government had considered the dangers to outweigh the advantages of such a policy.

The French general staff, if less technically perfect than that of Germany, had produced some of the ablest military thinkers in Europe, and its level of intelligence could well bear comparison. Unfortunately, in recent years a sharp division of thought had arisen, which did not make for combined action. Worse still the new French philosophy of war in its abstraction with the moral element had become more and more separated from the inseparable material factors. Abundance of will cannot compensate a definite inferiority of weapons, and the second factor, once realised, inevitably reacts on the first. In *matériel*, the French had one great asset in their quick-firing 75 mm. field gun, the best in the world, but its very value had led them to undue confidence in a war of movement and a consequent neglect of equipment and training for the type of warfare which came to pass.

Russia's assets were in the physical sphere, her defects in the mental or moral. If her initial war strength was no greater than that of Germany, her man-power resources were immense and the courage and endurance of her troops were famous. But corruption and incompetence permeated her leadership, her rank and file lacked the intelligence and initiative for scientific warfare—they formed an instrument of great solidity but little flexibility—and her manufacturing resources for equipment and munitions were far below those of the great industrial Powers. This handicap was made worse by her geographical situation, cut off from her allies by ice- or enemy-bound seas, and with immense land frontiers. Another radical defect was the poverty of her rail communications, the more essential as she relied for success on bringing into play the weight of her numbers. In the moral sphere Russia's condition was less clear. Her internal troubles were notorious and must be a brake on her efforts unless the cause was such as to prove a crusade-like appeal to her primitive and incoherent masses.

Between the military systems of Germany, Austria, France and Russia there was a close relation, differences of detail rather than of fundamental, and this similarity threw into greater contrast the system of the other great European Power—Britain. Throughout modern times she had been essentially a sea-power, intervening on land through a traditional policy of diplomatic and financial support to Allies, whose military efforts she reinforced with a leaven from her own professional army. This regular army was primarily maintained for the protection and control of the overseas dependencies—India in particular—and had always been kept down to the minimum strength for this purpose. The reason for the curious contrast between Britain's determination to maintain a supreme navy and her consistent neglect, indeed starvation of the army, lay partly in her insular position, which caused her to regard the sea as her essential life-line and main defence, and partly in a constitutional distrust of the army, an illogical prejudice, which had its almost forgotten source in the military government of Cromwell. Small as to size, it enjoyed a practical and varied experience of war without parallel among the Continental armies. Compared with them, its professional handicap was that the leaders, however skilled in handling small columns in colonial expeditions, had never directed large formations in la *grande guerre.*

Further, the foundations of a general staff had only been laid since the bitter lessons of the South African War, and the interval was too short, the distractions too great, for this to have been developed to the level of Germany and France. For the progress in organization in the years before 1914, the British army owed much to Lord Haldane, and to him also was due the creation of a second line of part-trained citizens — the Territorial Force. Lord Roberts had pleaded for compulsory military training, but the voluntary principle was too deeply embedded in the national mind for this course to be adopted, and Haldane wisely sought to develop Britain's military effectiveness within the bounds set by traditional policy. As a result, 1914 found England with an expeditionary force of some 160,000 men, the most highly trained striking force of any country — a rapier among scythes, and to maintain this at strength the old militia had been turned into a special reserve for drafting. Behind this first line stood the Territorial Force, which if only enlisted for home defence had a permanent fighting organization unlike the amorphous volunteer force which it superseded. The British army had no special outstanding asset in war armament, but it had developed a standard of rifle-shooting unique among the world's armies.

The reforms by which the army was brought into line with Continental models had one defect, which was accentuated by the close relations established between the British and French general staffs since the Entente. It induced a "Continental" habit of thought among the general staff, and predisposed them to the rôle, for which their slender strength was unsuited, of fighting alongside an Allied army. This obscured the British army's traditional employment in amphibious operations through which the mobility given by command of the sea was exploited. A small but highly trained force striking "out of the blue" at a vital spot could produce a strategical effect out of all proportion to its slight numbers.

The last argument brings us to a comparison of the naval situation, which turned on the balance between the fleets of Britain and Germany. Britain's sea supremacy, for long unquestioned, had in recent years been challenged by a Germany which had deduced that a powerful fleet was the key to that colonial empire which she desired as an outlet for her commerce and increasing population. To the spur of naval competition the British people eventually responded, determined at any cost to maintain their "two-power" standard. If this reaction was instinctive rather than reasoned, its subconscious wisdom had a better foundation than the catchwords with which it was justified, or even than the need of defence against invasion. The industrial development of the British Isles had left them dependent on overseas supplies for food, and on the secure flow of seaborne imports and exports for industrial existence. For the navy itself this competition was a refining agency, leading to a concentration on essentials. Gunnery was developed and less value attached to polished brasswork; warship design and armament were transformed — the "Dreadnought" ushering in a new era, of the all big-gun battleship. By 1914 Britain had 29 such capital ships and 13 building, to the 18 built and nine building, of Germany. Further, Britain's naval strength had been soundly distributed, the main concentration being in the North sea.

More open to criticism, in view of the forecasts of several naval authorities, was her comparative neglect of the potential menace of the submarine. Here German opinion was shown rather by the number building than those already in commission. It is to Germany's credit that though lacking a sea tradition, her fleet an artificial rather than a natural product, the technical skill of the German navy made it a formidable rival to the British ship for ship, and perhaps its superior in scientific gunnery.

But in the first stage of the struggle the balance of the naval forces would affect the issue far less than the balance on land. For a fleet suffers one inherent limitation — it is tied to the sea, and hence cannot strike direct at the hostile nation. The fundamental purpose of a navy is therefore to protect a nation's sea communications and sever those of the enemy, and, although victory in battle may be a necessary prelude, blockade is the ultimate purpose. And as blockade is a weapon slow to take effect, its influence could only be decisive if the armies failed to secure the speedy decision on land, upon which all counted.

The Economic Forces. — In this idea of a short war lay also the reason for the comparative disregard of economic forces. Few believed that a modern nation could endure for many months the strain of a large-scale conflict. The supply of food, of munitions and their manufacture, of funds, were problems only studied on brief estimates. Of belligerents, all could feed themselves save Britain and Germany, and Germany's deficit of home-grown supplies could only be serious in the event of a struggle of years. But Britain would starve in three months if her outside supplies were cut off.

In munitions and other war material Britain's industrial power was greatest of all, though conversion to war production was a necessary preliminary, and all, again, depended on the security of her sea communication. France was weak, and Russia weaker still, but the former, unlike the latter, could count on outside supplies so long as Britain held the seas. As Britain was the industrial pivot of the one alliance, so was Germany of the other. A great manufacturing nation, she had also a wealth of raw material, especially since the annexation of the Lorraine iron-fields after the 1870 war. But the stoppage of outside supplies must be a handicap in a long war, increasing with its duration, and serious from the outset in such tropical products as rubber. Moreover, Germany's main coal and iron fields lay dangerously close to her frontier, in Silesia on the east and in Westphalia and Lorraine on the west. Thus for the Central Alliance a quick decision and an offensive war were more vital than for the Entente.

Similarly, the financial resources were calculated on a short war basis, and all the Continental Powers relied mainly on large gold reserves accumulated specially for war purposes. Britain alone had no such mar chest, but she was to prove that the strength of her banking system and the wealth distributed among a great commercial people furnished the "sinews of war," in a way that few pre-war economists had realized.

The Psychological Forces. — If the economic forces were neglected in the war calculations of the Powers, the psychological forces were an unexplored region, except in their purely military aspect. And even here little study had been devoted to the moral element compared with the physical element. Ardant du Picq, a soldier-philosopher who fell in the 1870 war, had stripped battle of its aura of heroic fictions, portraying the reaction of normal men in the presence of danger. Several German critics had described from experience the reality of battle moral as shown in 1870, and had deduced how tactics should be based on the ever-present and balancing elements of fear and courage. At the close of the century a French military thinker, Col. Foch, had demonstrated how great was the influence of the moral element in the higher sphere of command. But only the fringe of the subject had been penetrated. Its civil aspects were untouched, and in the opening weeks of the conflict the general misunderstanding of national psychology was to be shown in the undue muzzling of the Press, followed by the equally stupid practice of issuing communiqués which so veiled the truth that public opinion became distrustful of all official news and rumour was loosed on its infinitely more damaging course. The true value of wisely calculated publicity and the true application of the propaganda weapon was only to be learnt after many blunders.

The Rival Plans. — In this survey the German plan justly takes priority, for not only was it the mainspring which set in motion the hands of the war clock in 1914, but it may even be said to have governed the course of the war thereafter. It is true that outwardly this course from the autumn of 1914 onwards seemed to be of the nature of a stupendous "siege" of the Central Powers, an idea which is incompatible with the terms we have used. But the conception of the Germanic alliance as a besieged party, although true of the economic sphere, suggests a passivity which their strategy contradicts. Although the initial German plan miscarried, even in its failure it dictated the general trend of operations thereafter. Tactically, most of the fighting resembled siege operations, but the actual strategy on land for long erred rather by its disregard of these tactical conditions than by its conformity with them.

The Germans were faced with the problem that the combined forces of themselves and Austria were decidedly inferior to those of France and Russia. To offset this adverse balance, however, they had a central position and the anticipation that Russia's mobilization would be too slow to allow her to exert serious pressure in the opening weeks. While this assumption might suggest a decisive blow at Russia before she was ready, it was equally probable that she would concentrate her main forces too far back for such a German blow to reach—and the experience of Napoleon was not an example to encourage an advance deep into the interior of Russia, with its vast distances and poor communications. The plan adopted by Germany was, therefore, a rapid offensive against France while holding the Russian advanced forces at bay, and later, when France was crushed, to deal with the Russian army.

But this plan, in turn, was complicated by the great natural and artificial barriers which the French frontier offered to an invader. It was narrow, only some 150 m. across, and so afforded little room for manoeuvre or even to deploy the masses that Germany planned to launch against her foe. At the south-eastern end it abutted on Switzerland, and after a short stretch of flat country known as the Gap of Belfort the frontier ran for 70 m. along the Vosges mountains. Thence the line was prolonged by an almost continuous fortress system, based on Epinal, Toul, Verdun and just beyond the last-named lay not only the frontiers of Luxembourg and Belgium but the difficult Ardennes country. Apart from the strongly defended avenues of advance by Belfort and Verdun, the only feasible gap in this barrier was the Trouée de Charmes between Epinal and Toul, left open originally as a strategic trap in which the Germans could be first caught and then crushed by a French counter-stroke.

Faced with such a mental and physical blank wall, the logical military course was to go round it—by a wide manoeuvre through Belgium. Graf von Schlieffen, chief of the German general staff from 1891 to 1906 conceived and developed from 1895 onwards the plan, by which the French armies were to be enveloped and a rapid decision gained, and as finally formulated it came into force in 1905. To attain its object Schlieffen's plan concentrated the mass of the German forces on the right wing for this gigantic wheel and designedly took risks by reducing the left wing, facing the French frontier, to the slenderest possible size. The swinging mass, pivoting on the fortified area Metz-Thionville, was to consist of 53 divisions, backed up as rapidly as possible by Landwehr and Ersatz formations, while the secondary army on the left wing comprised only nine divisions. Its very weakness promised to aid the main blow in a further way, for if a French offensive pressed them back towards the Rhine, the attack through Belgium on the French flank would be all the more difficult to parry. It mould be like a revolving-door—if a man pressed heavily on one side the other side would swing round and strike him in the back. The German enveloping mass was to sweep round through Belgium and northern France and, continuing to traverse a vast arc, would wheel gradually east. With its extreme right passing south of Paris and crossing the Seine near Rouen it would then press the French back towards the Moselle, where they would be hammered in rear on the anvil formed by the Lorraine fortresses and the Swiss frontier.

Schlieffen's plan allowed ten divisions to hold the Russians in check while the French were being crushed. It is a testimony to the vision of this remarkable man that he counted on the intervention of Britain, and allowed for an expeditionary force of 100,000 "operating in conjunction with the French." To him also was due the scheme for using the Landwehr and Ersatz troops in active operations and fusing the resources of the nation into the army. His dying words are reported to have been, "It must come to a fight. Only make the right wing strong."

Unhappily for Germany, if happily for the world, the younger Moltke, who succeeded him, lacked his moral courage and clear grasp of the principle of concentration. Moltke retained Schlieffen's plan, but he whittled away the essential idea. Of the nine new divisions which became available between 1905 and 1914 Moltke allotted eight to the left wing and only one to the right. True, he added another from the Russian front, but this trivial increase was purchased at a heavy price, for the Russian army of 1914 was a far more formidable menace than when Schlieffen's plan came into force. In the outcome two army corps were taken from the French theatre at the crisis of the August campaign, in order to reinforce the Eastern front.

If the fault of the final German plan was a lack of courage, that of the French plan was due to an excess. In their case, also, a miasma of confused thought seemed to creep over the leadership in the years just before the war. Since the disasters of 1870 the French command had planned an initial defensive, based on the frontier fortresses, followed by a decisive counter-stroke. To this end the great fortress system had been created, and gaps like the Trouée de Charmes left to "canalize" the invasion ready for the counter. But in the decade before 1914 a new school of thought had arisen, who argued that the offensive was more in tune with French character and tradition, that the possession of the "75"—a field gun unique in mobility and rapidity of fire—made it tactically possible, and that the alliance with Russia and Britain made it strategically possible. Forgetful of the lessons of 1870 they imagined that *élan* was proof against bullets. Napoleon's much quoted saying that "the moral is to the physical as three to one" has much to answer for; it has led soldiers to think that a division exists between the two, whereas each is dependent on the other. Weapons without courage are ineffective, but so also are the bravest troops without efficient weapons to protect them and their *moral*.

The outcome was disastrous. The new school found in Gen. Joffre, appointed chief of the general staff in 1912, a lever for their designs. Under the cloak of his authority, the advocates of the *offensive à outrance* gained control of the French military machine, and, throwing aside the old doctrine, formulated the now famous, or notorious, Plan XVII. It was based on a negation of historical experience—indeed, of common sense—and on a double miscalculation—of force and place, the latter more serious than the former. Accepting the possibility that the Government might employ their reserve formations at the outset, the strength of the Germany army in the West was estimated at a possible maximum of 68 infantry divisions. The Germans actually deployed the equivalent of $83\frac{1}{2}$, counting Landwehr and Ersatz divisions. But French opinion was and continued to be doubtful of this contingency, and during the crucial days when the rival armies were concentrating and moving forward the French Intelligence counted only the active divisions in its estimates of the enemy strength—a miscalculation by half! If the plan had been framed on a miscalculation less extreme, this recognition does not condone but rather increases its fundamental falsity, for history affords no vestige of justification for a plan by which a frontal offensive was to be launched with mere equality of force against an enemy who would have the support of his fortified frontier zone, while the attackers forswore any advantage from their own.

The second miscalculation, of place, was that although the possibility of a German move through Belgium was recognized, the wideness of its sweep was utterly misjudged. The Germans were expected complaisantly to take the difficult route through the Ardennes in order that the French might conveniently smite their communications! Based on the idea of an immediate and general offensive, the plan ordained a thrust by the 1st and 2nd Armies towards the Saar into Lorraine. On their left were the 3rd Army opposite Metz and the 5th Army facing the Ardennes, which were either to take up the offensive between Metz and Thionville, or, if the Germans came through Luxembourg and Belgium, to strike north at their flank. The 4th Army was held in strategic reserve near the centre and two groups of reserve divisions were disposed in rear of either flank—relegation to such a passive rôle expressing French opinion on the capacity of reserve formations.

Britain's share in this plan was settled less by calculation than by the "Europeanization" of her military organization during the previous decade. This Continental influence drew her insensibly into a tacit acceptance of the rôle of acting as an appendix to the French left wing, and away from her historic exploitation of the mobility given by sea-power. At the council of war on the outbreak, Lord Roberts, summoned from retirement, advocated the dispatch of the expeditionary force to Belgium—where it would have stiffened the Belgian resistance and threatened the flank of the wheeling German mass. But his was a voice crying in the wilderness, and in acy case the British general staff, through Gen. Wilson, had virtually pledged themselves to act in direct co-operation with the French. When the general staffs of the two countries conducted their informal negotiations between 1905 and 1914 they little realized that they were paving the way for a reversal of England's centuries-old policy, for a war effort such as no Englishman had ever conceived.

On the Eastern front, the plans of campaign were more fluid, less elaborately worked out and formulated—although they were to be as kaleidoscopic in their changes of fortune as in the Western theatre. The calculable condition was geographical; the main incalculable, Russia's rate of concentration. Russian Poland was a vast tongue of country projecting from Russia proper, and flanked on three sides by German or Austrian territory. On its northern flank lay East Prussia with the Baltic sea beyond. On its southern flank lay the Austrian province of Galicia with the Carpathian mountains beyond, guarding the approaches to the plain of Hungary. On the west lay Silesia. As the Germanic border provinces were provided with a network of strategic railways whilst Poland, as well as Russia itself, had only a sparse system of communications, the Germanic alliance had a vital advantage, in power of concentration, for countering a Russian advance. But if they took the offensive, the further they progressed into Poland or Russia proper the more would they lose this advantage. Hence their most profitable strategy was to lure the Russians on into position for a counter-stroke rather than to inaugurate an offensive themselves. The one drawback was that such a Punic strategy gave the Russians time to concentrate and set In motion their cumbrous and rusty machine.

From this arose an initial cleavage between German and Austrian opinion. Both agreed that the problem was to hold the Russians in check during the six weeks before the Germans, it was hoped, having crushed France, could switch their forces eastwards to join the Austrians in a decisive blow against the Russians. The difference of opinion was on the method. The Germans, intent on a decision against France, wished to leave a minimum force in the East, and only a political dislike of exposing national territory to invasion prevented them evacuating East Prussia and standing on the Vistula line. But the Austrians, under the influence of Conrad von Hötzendorf, chief of their general staff, were anxious to throw the Russian machine out of gear by an immediate offensive, and as this promised to keep the Russians fully occupied while the campaign in France was being decided Moltke fell in with this strategy. Conrad's plan was that of an offensive north-eastwards into Poland by two armies, protected by two more on their right, further east. Complementary to it, as originally designed, the Germans in East Prussia were to strike south-east, the two forces converging to cut off the Russian advanced forces in the Polish "tongue." But Conrad failed to induce Moltke to provide sufficient German troops for this offensive thrust.

On the opposing side, also, the desires of one ally vitally affected the strategy of the other. The Russian command, both for military and for racial motives, wished to concentrate first against Austria, while the latter was unsupported, and leave Germany alone until later, when the full strength of the Russian army would be mobilized. But the French, anxious to relieve the German pressure against themselves, urged the Russians to deliver a simultaneous attack against Germany, and got the Russians to consent to an extra offensive for which they were neither ready, in numbers, nor organized. On the south-western front two pairs of two armies each were to converge on the Austrian forces in Galicia; on the north-westem front two armies were to converge on the German forces in East Prussia. Russia, whose proverbial slowness and crude organization dictated a cautious strategy, was about to break with tradition and launch out on a gamble that only an army of high mobility and organization could have hoped to bring off.

II. THE CLASH IN THE WEST

The Detonation.—On June 28, 1914, the murder of the Austrian Archduke Francis Ferdinand at Sarajevo set light to a powder trail which within a brief span exploded the European magazine in a series of detonations. Exactly one month later Austria-Hungary declared war against Serbia, whose appeal to her ally and protector led Russia to order a partial mobilization on her southern front. The same day, July 29, an Imperial council at Potsdam decided on war against Russia, and, as a corollary, against France, although hoping to bargain for Britain's neutrality. While the chancelieries of Europe argued at cross-purposes, the military tide swept them off their feet. On July 31 Russia ordered a general mobilization and Germany, taking equivalent steps, sent a 12 hours' ultimatum. Austria, seeking belatedly to temporize, was dragged in the train of her more determined ally. By noon on Aug. 1 a state of war existed between Russia and Germany and next day German troops entered French territory. At 7 P.M. came Germany's ultimatum to Belgium, demanding an unopposed passage. On Aug. 3 Germany's formal declaration of war on France followed, and on Aug. 4 her troops crossed the Belgian frontier, for the sanctity of which England stood guarantor. At midnight, in reply, England also entered the war—while the Belgian populace, rising to resist the German invaders, sounded the death-knell of gladiatorial wars and inaugurated the new warfare of peoples. And coincidently, by Italy's declaration of her neutrality, her refusal to fulfil the alliance with her hereditary enemy—Austria—the artificiality of the political alliance system broke down before the new wave of national feeling which was to characterize the World War.

Invasion of Belgium.—The German advance into France was designed as a methodical sweep, so that unexpected checks should not upset its time-table. Confronted with the fact that the Belgians would resist, a detachment was formed under Gen. von Emmich to clear a passage through the Belgian plain north of the Ardennes, ready for the ordered advance of the main armies concentrating behind the German frontier. The ring fortress of Liége (*q.v.*) commanded this channel of advance, but, after an initial check, a German brigade penetrated between the forts and occupied the town. The interest of this feat is that it was due to the initiative of an attached staff officer, Ludendorff, whose name ere long was to be world-famous. The forts themselves offered a stubborn resistance and forced the Germans to await the arrival of their heavy howitzers, whose destructive power was to be the first tactical surprise of the World War.

The very success of the Belgians' early resistance cloaked the weight of the main German columns and misled the Allies' intelligence. The Belgian field army lay behind the Gette covering Brussels, and even before the Liége forts fell the advanced guards of the German 1st and 2nd Armies were pressing against this line. The Belgians, deprived of support owing to the mistaken French plan and British conformity with it, decided to preserve their army by falling back on the entrenched camp of Antwerp—where its location would at least make it a latent menace to the German communications. The Germans, their passage now clear, entered Brussels on Aug. 20, and on the same day appeared before Namur, the last fortress barring the Meuse route into France. It must be noted that despite the Belgian resistance the German advance was slightly ahead of its time-table.

French Offensive in Lorraine.—Meanwhile, away on the other flank, the French offensive had opened on Aug. 8 with the advance of a force under Gen. Pau into upper Alsace, a move intended partly as a military distraction and partly for its political effect. Soon brought to a halt, it was renewed on the 19th, only to meet with a fresh check. Thereafter the pressure of disasters elsewhere compelled the abandonment of the enterprise and the dissolution of the force—its units being dispatched westward as reinforcements. Meantime the main thrust into Lorraine by the French 1st (Dubail) and 2nd (de Castelnau) Armies, totalling 19 divisions, had begun on Aug. 14 and been shattered in the battle of Morhange-Sarrebourg, Aug. 20 (see FRONTIERS, BATTLES OF THE) where the French discovered that the material could subdue the moral, and that in their enthusiasm for the offensive they had blinded themselves to the defensive power of modern weapons, a condition which was to throw out of balance the whole mechanism of orthodox warfare. Yet it is but fair to add that this abortive French offensive had an indirect effect on the German plan, although this would hardly have been so if a Schlieffen or a Ludendorff had been in charge at German headquarters instead of the vacillating opportunist Moltke. The fact that Moltke had almost doubled the strength of his left, compared with Schlieffen's plan meant that it was unnecessarily strong for a yielding and "enticing" defensive such as Schlieffen had conceived, while lacking the superiority necessary for a crushing counter-offensive. But when the French attack in Lorraine developed and Moltke appreciated that the French were leaving their fortified barrier behind he was tempted momentarily to postpone the right wing sweep and instead seek a decision in Lorraine. This impulse led him to divert thither the six newly formed Ersatz divisions that should have been used to increase the weight of his right wing.

He had hardly conceived this new plan before he abandoned it and, on Aug. 16, reverted to Schlieffen's "swing-door" design. But the princely commanders in Lorraine were loath to forfeit this opportunity of personal glory. The Crown Prince Rupprecht of Bavaria, instead of continuing to fall back and draw the French on, halted his 6th Army on the 17th, ready to accept battle. Finding the French attack slow to develop, he planned to anticipate by one of his own. He struck on Aug. 20 in conjunction with the 7th Army on his left, but although the French were taken by surprise and rolled back from the line Morhange-Sarrebourg, the German counter-stroke had not the superiority of strength (the two armies now totalled 2 j divisions) or of strategic position to make it decisive. Thus its strategic result was merely to throw back the French onto a fortified barrier which both restored and augmented their power of resistance. Thus they were enabled to despatch troops to reinforce their western flank—a redistribution of strength which was to have far-reaching results in the decisive battle, on the Marne.

With similar disregard of superior authority, the German Crown Prince, commanding the pivotal 5th Army between Metz and Thionville, attacked when he had been ordered to stand on the defensive. The lack of what Col. Foch had termed "intellectual discipline" was to be a grave factor in Germany's failure, and for this the ambitions of "court" generals were to be largely responsible.

The North-West Frontier. — While this "see-saw" campaign in Lorraine was taking place, more decisive events were occurring to the north-west. The attack on Liége awakened Joffre to the reality of a German advance through Belgium, but not to the wideness of sweep. And the sturdy resistance of Liége confirmed him in the opinion that the German right would pass south of it, between the Meuse and the Ardennes. Plan XVII. had visualized such a move, and prepared a counter. Grasping once more at phantoms, the French command embraced this idea so fervently that they transformed the counter into an imaginary coup de *grâce*. Their 3rd Army (Ruffey) and the reserve 4th Army (de Langle de Cary) were to strike north-east through the Ardennes against the rear flank of the Germans advancing through Belgium. The left wing (5th) Army, under Lanrezac, was moved further to the north-west into the angle formed by the Sambre and Meuse between Givet and Charleroi. With the British expeditionary force coming up on its left, it was to deal with the enemy's forces north of the Meuse and to converge on the supposed German main forces in conjunction with the attack through the Ardennes. Here was a pretty picture—of the Allied pincers closing on the unconscious Germans! Curiously, the Germans had the same idea of a pincer-like manoeuvre, with rôles reversed, and with better reason.

The fundamental flaw in the French plan was that the Germans had deployed half as many troops again as the French Intelligence estimated, and for a vaster enveloping movement. The French 3rd and 4th Armies (23 divisions) pushing blindly into the Ardennes against a German centre supposedly denuded of troops, blundered against the German 4th and 5th Armies (20 divisions) and were heavily thrown back in encounter-battles around Virton-Neufchateau. Fortunately the Germans were also too vague as to the situation to exploit their opportunity.

But to the north-west the French 5th Army (13 divisions) and the British (four divisions) had, under Joffre's orders, put their head almost into the German noose. The German masses of the 1st and 2nd Armies were closing on them from the north, and the 3rd Army from the east—a total of 30 divisions. Lanrezac alone had an inkling of the hidden menace. All along he had suspected the wideness of the German manoeuvre, and it was through his insistence that his army had been permitted to move so far north-west. It was due to his caution in hesitating to advance across the Sambre, to the arrival of the British on his left unknown to the German Intelligence, and to the premature attack of the German 2nd Army, that the Allied forces fell back in time and escaped from the trap.

Retreat to the **Marne.**—The British, after concentrating near Maubeuge, had moved up to Mons on Aug. 22, ready to advance further into Belgium as part of the affensive of the Allied left wing. On arrival, however, Sir John French heard that Lanrezac had been attacked on the 21st and deprived of the crossings of the Sambre. Although thus placed in an exposed forward position, he agreed to stand at Mons to cover Lanrezac's left. But next day Lanrezac had word of the fall of Namur and of the appearance of the German 3rd Army (Hausen) on his exposed right flank near Dinant, on the Meuse. In consequence, he gave orders for a retreat that night. The British, after resisting the attacks of six German divisions during the day, fell back on the 24th in conformity with their allies. Not a moment too soon in view of the fact that the rest of the German 1st Army was marching still further westward to envelop their open left flank.

At last Joffre realized the truth and the utter collapse of Plan XVII. Resolution was his greatest asset, and with imperturbable coolness he formed a new plan out of the wreckage. He decided to swing back his centre and left, with Verdun as the pivot, while drawing troops from the right and forming a fresh 6th Army on his left to enable the retiring armies to return to the offensive.

The German Breakdown. — His optimism might have been again misplaced but for German mistakes. The first was Moltke's folly in detaching seven divisions to invest Maubeuge and Givet and watch Antwerp, instead of using Landwehr and Ersatz troops as Schlieffen had intended. More ominous still was his decision on Aug. 25 to send four divisions to check the Russian advance in East Prussia. All these were taken from the right wing, and the excuse afterwards given for this violation of the principle of concentration was that the German command thought that the decisive victory had already been won! Further, the German command lost touch with the advancing armies and the movements of these became disjointed. The British stand at Le Cateau and Lanrezac's riposte at Guise (see FRONTIER, BATTLES OF THE: *Le* Cateau; Guise) were also factors in checking the German enveloping wing, and each had still greater indirect effects. For Le Cateau apparently convinced the German 1st Army commander, Kluck, that the British army could be wiped from the slate, and Guise led Biilow (2nd Army) to call on the 1st Army for support, whereupon Kluck wheeled inwards, thinking to roll up the French left. The idea of a Sedan was an obsession with the Germans, and led them to pluck the fruit before it was ripe. This premature wheel before Paris had been reached was an abandonment of the Schlieffen plan, and exposed the German right to a counter-envelopment. One further factor must be mentioned, perhaps the most significant of all: the Germans had advanced so rapidly, out-running their time-table, that their supplies failed to keep pace.. Thus, in sum, so much grit had worked into the German machine that a slight jar would suffice to cause its breakdown. This was delivered in the battle of the Marne (*q.v.*).

III. THE CRISIS OF THE MARNE

The Abandoned Plan. — Let us trace the sequence of events. The first, highly coloured, reports from the army commands in the battles of the Frontiers had given the German supreme command the impression of **a** decisive victory. Then the comparatively small totals of prisoners raised doubts in Moltke's mind and led him to a more sober estimate of the situation. The new pessimism of Moltke combined with the renewed optimism of his army commanders to produce a fresh change of plan, which contained the seeds of disaster. When, on Aug. 26, the British left wing fell back southwards badly mauled from Le Cateau, Kluck had turned south-westwards again. If this direction was partly due to a misconception of the line of retreat taken by the British, it was also in accordance with his original rôle of a wide circling sweep. And by carrying him into the Amiens-Peronne area, where the first elements of the newly formed French 6th Army were just detraining after their "switch" from Alsace, it had the effect of dislocating Joffre's design for an early return to the offensive compelling the 6th Army to fall back hurriedly towards the shelter of the Paris defences.

But Kluck had hardly swung out to the south-west before he was induced to swing in again. For, in order to ease the pressure on the British, Joffre had ordered Lanrezac to halt and strike back against the pursuing Germans, and Bulow, shaken by the threat, called on Kluck for aid. Lanrezac's attack, on Aug. 29, was stopped before Bulow needed this, but he asked Kluck to wheel in nevertheless, in order to cut off Lanrezac's retreat. Before acceding Kluck referred to Moltke. The request came at a moment when Moltke was becoming perturbed in general over the way the French were slipping away from his embrace and, in particular, over a gap which had opened between his 2nd and 3rd Armies through the latter having already turned south, from south-west, to help the 4th Army, its neighbour on the other flank. Hence Moltke approved Kluck's change of direction—which meant the inevitable abandonment of the original wide sweep round the far side of Paris. Now the flank of the wheeling German line would pass the near side of Paris and across the face of the Paris defences. By this contraction of his frontage for the sake of security Moltke sacrificed the wider prospects inherent in the wide sweep of the Schlieffen plan. And, as it proved, instead of contracting the risk he contracted a fatal counterstroke.

The decision to abandon the original plan was definitely taken on Sept. 4, and in place of it Moltke substituted a narrower envelopment, of the French centre and right. The 4th and 5th Armies were to press south-east while the 6th and 7th Armies, striking south-westwards, sought to break through the fortified barrier between Toul and Epinal, the "jaws" thus closing inwards on either side of Verdun. Meantime the 1st and 2nd Armies were to turn outwards and, facing west, hold off any counter move which the French attempted from the neighbourhood of Paris.

The **Allied Counter.**—But such a counter move had begun before the new plan could take effect.

The opportunity was perceived, not by Joffre, who had ordered a continuance of the retreat, but by Galliéni, the military governor of Paris. On Sept. 3 Galliéni realized the meaning of Kluck's wheel inwards, directed Maunoury's 6th Army to be ready to strike at the exposed German right flank, and next day with some difficulty won Joffre's sanction. Once convinced, Joffre acted with decision. The whole left wing was ordered to turn about and return to a general offensive, beginning on Sept. 6. Maunoury was already off the mark on the 5th and as his pressure developed on the Germans' sensitive flank, Kluck was constrained to draw off first one part and then the remaining part of his army to support his threatened flank guard. Thereby a 30 m. gap was created between the 1st and 2nd German Armies, a gap covered only by a screen of cavalry. Kluck was emboldened to take the risk because of the rapid retreat of the British opposite, or rather with their backs, to this gaping sector. Even on the 5th, when the French on either flank were turning about, the British continued a further day's march to the south. But in this "disappearance" lay the unintentional cause of victory. For, when the British retraced their steps, it was the report of their columns advancing into the gap which, on Sept. 9, led Bulow to order the retreat of his 2nd Army. The temporary advantage which the 1st Army, already isolated by its own act, had gained over Maunoury was thereby nullified, and it fell back the same day. By the 11th the retreat had extended, independently or under orders from Moltke, to all the German armies. The attempt at a partial envelopment, pivotting on Verdun, had already failed, the jaw formed by the 6th and 7th Armies merely breaking its teeth on the defences of the French eastern frontier. The attack by Rupprecht's 6th Army on the Grand Couronné, covering Nancy, was a particularly costly failure. It is difficult to see how the German command could have reasonably pinned their faith on achieving as an improvised expedient the very task which in cool calculation before the war had appeared so hopeless as to lead them to take the momentous decision to advance through Belgium as the only feasible alternative.

Thus, in sum, the battle of the Marne was decided by a jar and a crack. The jar administered by Maunoury's attack on the German right flank causing a crack in a weak joint of the German line, and this physical crack in turn producing a moral crack in the German command.

The Pursuit Fails.—The result was a strategic but not a tactical defeat and the German right wing was able to re-knit and stand firmly on the line of the Aisne. That the Allies were not able to draw greater advantage from their victory was due in part to the comparative weakness of Maunoury's flank attack and in part to the failure of the British and the French 5th Army (now under Franchet d'Espérey) to drive rapidly through the gap while it was open. Their direction of advance was across a region intersected by frequent rivers, and this handicap was intensified by a want of impulsion on the part of their chiefs. It seems, too, that greater results might have come if more effort had been made as Galliéni urged, to strike at the German rear flank instead of the front, and to direct reinforcements to the north-west of Paris for this purpose. This view is strengthened by the sensitiveness shown by the German command to reports of landings on the Belgian coast, which might threaten their communications. The alarm caused by these reports had even led the German command to contemplate a withdrawal of their right wing before the battle of the Marne was launched. When the moral effect of these phantom forces is weighed with the material effect—the detention of German forces in Belgium—caused by fears of a Belgian sortie from Antwerp, the balance of judgment would seem to turn heavily in favour of the strategy which Lord Roberts had advocated in vain. By it the British expeditionary force might have had not merely an indirect but a direct influence on the struggle, and might have made the issue not merely negatively but positively decisive.

But, considering the battle of the Marne as it shaped, the fact that 27 Allied divisions were pitted against 13 German divisions on the decisive flank is evidence, first, of how completely Moltke had lapsed from Schlieffen's intention; second, of how well Joffre had re-concentrated his forces under severe pressure; third, of how such a large balance afforded scope for a wider envelopment than was actually attempted. The frontal pursuit was checked on the Aisne before Joffre, on Sept. 17, seeing that Maunoury's attempts to overlap the German flank were ineffectual, decided to form a fresh army under de Castelnau for a manoeuvre *round and behind* the German flank. By then the German armies had recovered cohesion and the German command was expecting and ready to meet such a manoeuvre, now the obvious course.

IV. THE SECOND CRISIS—STALEMATE

Centre of Gravity Shifts.—On the Aisne was re-emphasized the preponderant power of defence over attack, primitive as were the trench lines compared with those of later years. Then followed, as the only alternative, the successive attempts of either side to overlap and envelop the other's western flank, a phase known somewhat inaccurately as the "race to the sea." This common design brought out what was to be a new and dominatiiig strategical feature—the lateral switching of reserves by railway from one part of the front to another. Before it could reach its logical and lateral conclusion, a new factor intervened. Antwerp, with the Belgian field army, was still a thorn in the German side, and Falkenhayn, who had succeeded Moltke, determined to reduce it while a German cavalry force swept across to the Belgian coast as an extension of the enveloping wing in France.

Belgian Operations. — We must pause here to pick up the thread of operations in Belgium from the moment when the Belgian field army fell back to Antwerp, divergently from the main line of operations. On Aug. 24 the Belgians began a sortie against the rear of the German right wing to ease the pressure on the British and French left wing, then engaged in the opening battle at Mons and along the Sambre. The sortie was broken off on the 26th when news came of the Franco-British retreat into France, but the pressure of the Belgian army (six divisions) led the Germans to detach four reserve divisions, besides three Landwehr brigades, to hold it in check. On Sept. 7 the Belgian command learnt that the Germans were despatching part of this force to the front in France; in consequence King Albert launched a fresh sortie on Sept. 9—the crucial day of the battle on the Marne. The action was taken, unsolicited by Joffre, who seems to have shown curiously little interest in possibilities outside his immediate battle zone. The sortie led the Germans to cancel the despatch of one division and to delay that of two others to France, but the Belgians were soon thrown back. Nevertheless the news of its seems to have had a distinct moral effect on the German command, coinciding as it did with the initiation of the retreat of their 1st and 2nd Armies from the Marne. And the unpleasant reminder that Antwerp lay menacingly close to their communications induced the Germans to undertake, preliminary to any fresh attempt at a decisive battle, the reduction of the fortress and the seizure of potential English landing places along the Belgian coast.

A Strategic Key.—The menace to Britain, if the Channel ports fell into German hands, was obvious. It is a strange reflection that the British command should have neglected to guard against the danger hitherto, although the first lord of the Admiralty, Winston Churchill, had urged the necessity even before the battle of the Marne. When the German guns began the bombardment of Antwerp on Sept. 28 England awakened, and gave belated recognition to Churchill's strategic insight. He was allowed to send a brigade of marines and two newly-formed brigades of naval volunteers to reinforce the defenders, while a regular division and cavalry division, under Rawlinson, were landed at Ostend and Zeebrugge for an overland move to raise the siege. Eleven Territorial divisions were available in England, but, in contrast to the German attitude, Kitchener considered them still unfitted for an active rôle. The meagre reinforcement delayed, but could not prevent, the capitulation of Antwerp, Oct. 10, and Rawlinson's relieving force was too late to do more than cover the escape of the Belgian field army down the Flanders coast.

Yet, viewed in the perspective of history, this first and last effort in the West to make use of Britain's amphibious power applied a brake to the German advance down the coast which just stopped their second attempt to gain a decision in the West. It gained time for the arrival of the main British force, transferred from the Aisne to the new left of the Allied line, and if their heroic defence at Ypres, aided by the French and Belgians along the Yser to the sea, was the human barrier to the Germans, it succeeded by so narrow a margin that the Antwerp expedition must be adjudged the saving factor.

Second German Bid for Victory. — In the French theatre of operations, the month following the battle of the Marne was marked by an extremely obvious series of attempts by each side to turn the opponent's western flank. On the German side this pursuit of an opening was soon replaced by a subtler plan, but the French persevered with a straight forward obstinacy curiously akin to that of their original plan. By Sept. 24, de Castelnau's outflanking attempt had come to a stop on the Somme. Next a newly formed 10th Army under de Maudhuy tried a little further north, beginning on Oct. 2, but instead of being able to pass round the German flank soon found itself struggling desperately to hold Arras. The British expeditionary force was then in course of transfer northwards from the Aisne, in order to shorten its communications with England, and Joffre determined to use it as part of a third effort to turn the German flank. To co-ordinate this new manoeuvre he appointed Gen. Foch as his deputy in the north. Foch sought to induce the Belgians to form the left of this wheeling mass, but King Albert, with more caution, or more realism, declined to abandon the coastal district for an advance inland that he considered rash. It was. For on Oct. 14, four days after the fall of Antwerp, Falkenhayn planned a strategic trap for the next Allied outflanking manoeuvre which he foresaw would follow. One army, composed of troops transferred from Lorraine, was to hold the expected Allied offensive while another, composed of troops released by the fall of Antwerp and of four newly-raised corps, was to sweep down the Belgian coast and crush in the flank of the attacking Allies. He even held back the troops pursuing the Belgians in order not to alarm the Allied command prematurely.

Meanwhile, the new Allied advance was developing piecemeal, as corps detrained from the south and swung eastwards to form a progressively extended "scythe." The British expeditionary force, now three corps strong, deployed in turn between La Bassée and Ypres, where it effected a junction with Rawlinson's force. Beyond it the embryo of a new French 8th Army was taking shape, and the Belgians continued the line along the Yser to the sea. Although the British right and centre had already been held up, Sir John French, discounting even the underestimate of the German strength furnished by his Intelligence, ordered his left to begin the offensive from Ypres towards Menin. The effort was still-born, for it coincided with the opening of the German offensive, on Oct. 20, but for a day or two Sir John French persisted in the belief that he was attacking while his troops were barely holding their ground. With Foch the delusion persisted still longer, and this failure to grasp the situation was partly responsible for the fact that Ypres was essentially, like Inkerman, a "soldiers' battle." Already, since the 18th, the Belgians on the Yser had suffered growing pressure which threatened a disaster that was ultimately saved by the end of the month through the opening of the sluices and the flooding of the coastal area. At Ypres the crisis came later and was repeated, Oct, 31 and Nov. 11 marking the turning points of the struggle. That the Allied line, though battered and terribly strained, was in the end unbroken was due to the dogged resistance of the British and the timely arrival of French reinforcements. (See YPRES, BATTLE OF, 1914.)

This defence of Ypres is in a dual sense the supreme memorial to the British regular army, for here they showed the inestimable value of the disciplined morale and unique standard of musketry which were the fruit of long training, and here was their tombstone. "From failing hands they threw the torch" to the new national armies rising in England to the call of patriotism. With the Continental Powers the merging of conventional armies into national armies was a hardly perceptible process, because of their system of universal service. But with Britain it was clearly stamped as revolution, not evolution. While the little professional army sacrificed itself as the advanced guard of the nation, the truth of the new warfare of peoples was beginning to come home to the civilian population. Lord Kitchener, a national symbol because of his imperial achievements, had been summoned to the post of war minister, and with a supreme flash of vision had grasped, in contrast to Governments and general staffs alike, the probable duration of the struggle. The people of Britain responded to his call to arms, and like an ever-rising flood the "New Armies" came into being. By the end of the year nearly 1,000,000 men had enlisted, and the British empire had altogether some 2,000,000 under arms. Perhaps Kitchener was wrong in not basing this expansion, from a professional to a national scale, on the existing Territorial foundation. It must be remembered, however, that the Territorial Force was enlisted for home defence and that initially its members' acceptance of a wider role was voluntary. Perhaps, also, he was tardy in recognizing their military value.

The duplication of forces and of organization was undoubtedly a source of delay and waste of effort. Kitchener has also been reproached for his reluctance to replace the voluntary system by conscription, but this criticism overlooks how deeply rooted was the voluntary system in British institutions, and the slowness with which lasting changes can be effected in them. If Kitchener's method was characteristic of the man, it was characteristic of England. If it was unmethodical, it was calculated to impress most vividly on the British people the gulf between their "gladiatorial" wars of the past and the national war to which they were committed.

While a psychological landmark, the battle of Ypres is also a military landmark. For, with the repulse of the German attempt to break through, the trench barrier was consolidated from the Swiss frontier to the sea. The power of modern defence had triumphed over attack. and stalemate ensued. The military history of the Franco-British alliance during the next four years is a story of the attempts to upset this deadlock, either by forcing the barrier or by finding a way round.

On the Eastern front, however, the greater distances and the greater differences between the equipment of the armies ensured a fluidity which was lacking in the West. Trench lines might form, but they were no more than a hard crust covering a liquid expanse. To break the crust was not difficult, and once broken, mobile operations of the old style became possible. This freedom of action was denied to the Western Powers, but Germany, because of her central position, had an alternative choice, and from Nov. 1914 onwards her command adopted a defensive in France while seeking to cripple the power of Russia.

V. THE RUSSIAN FRONT

Invasion of East **Prussia.**—In the East the opening encounters had been marked by rapid changes of fortune rather than by any decisive advantage. The Austrian command, emulating their allies in violating the principle of concentration, detached part of their strength in an abortive attempt to crush Serbia. (See SERBIAN CAMPAIGNS.) And their plan for an initial offensive to cut off the Polish "tongue" was further crippled by the fact that the German part of the pincers did not operate. It was, indeed, being menaced by a Russian pair of pincers instead, for the Russian commander-in-chief, the Grand Duke Nicholas. had urged his 1st and 2nd Armies to invade East Prussia without waiting to complete their concentration, in order to ease the pressure on his French allies. As the Russians had more than a two-to-one superiority, a combined attack had every chance of crushing the Germans between the two armies. On Aug. 17, Rennenkampf's 1st Army (six and a half divisions and five cavalry divisions) crossed the East Prussian frontier, and on Aug. 19–20 met and threw back the bulk (seven divisions and one cavalry division) of Prittwitz's 8th Army at Gumbinnen. On Aug. 21 Prittwitz heard that the Russian 2nd Army (ten divisions and three cavalry divisions) under Samsonov had crossed the southern frontier of East Prussia in his rear, which was guarded by only three divisions. In panic Prittwitz momentarily spoke of falling back behind the Vistula, whereupon Moltke superseded him by a retired general, Hindenburg, to whom was appointed as chief of staff, Ludendorff, the hero of the Liège attack.

Developing a plan which, with the necessary movements, had been already initiated by Col. Hoffmann of the 8th Army staff, Ludendorff concentrated some six divisions against Samsonov's left wing. This force, inferior in strength to the Russians, could not have been decisive, but Ludendorff, finding that Rennenkampf was still near Gumbinnen, took the calculated risk of withdrawing the rest of the German troops, except the cavalry screen. from that front and rushing them back against Samsonov's right wing. This daring move was aided by the absence of communication between the two Russian commanders and the ease with which the Germans deciphered Samsonov's wireless orders to his corps. Under the converging blows Samsonov's flanks were crushed and his centre surrounded. The outcome of this military masterpiece, afterwards christened the battle of Tannenberg (*q.v.*), was the destruction of almost the whole of Samsonov's army. Then receiving two fresh army corps from the French front, the German commander turned on the slowly advancing Rennenkampf, whose lack of energy was partly due to his losses at Gumbinnen and subsequent lack of information, and drove him out of East Prussia. As a result of these battles Russia had lost a quarter of a million men and. what she could afford still less, much war material. But the invasion of East Prussia had at least. hy causing the despatch of two corps from the West. helped to make possible the French "come-back" on the Marne.

Galician Battles.—Away on the southern front, moreover, the scales had tilted against the Central Powers. The offensive of the Austrian 1st and 4th Armies into Poland had at first made progress, but this was nullified by the onslaught of the Russian 3rd and 8th Armies upon the weaker 2nd and 3rd Armies which were guarding the Austrian right flank. These armies were heavily defeated (Aug. 26–30), and driven back through Lemberg. The advance of the Russian left ning thus threatened the rear of the victorious Austrian left wing. Conrad tried to swing part of his left round, in turn, against the Russian flank, but this blow was parried and then, caught with his forces disorganized by the renewed advance of the Russian right wing, he was forced on Sept. 11 to extricate himself by a general retreat, falling back almost to Cracow by the end of September. (See LEMBERG, BATTLES OF.) Austria's plight compelled the Germans to send aid, and the bulk of the force in East Prussia was formed into a new 9th Army and switched south to the south-west corner of Poland, whence it advanced on Warsaw in combination with a renewed Austrian offensive. But the Russians were now approaching the full tide of their mobilized strength; regrouping their forces and counter-attacking, they drove back the advance and followed it up by a powerful effort to invade Silesia.

The Grand Duke Nicholas formed a huge phalanx of seven armies—three in the van and two protecting either flank. A further army, the 10th, had invaded the eastern corner of East Prussia and was engaging the weak German forces there. Allied hopes rose high as the much-heralded Russian "steam-roller" began its ponderous advance. To counter it the German eastern front was placed under Hindenburg and Ludendorfi, who devised yet another master-stroke, based on the system of lateral railways inside the German frontier. The 9th Army, retreating before the advancing Russians, slowed them down by a systematic destruction of the scanty communications in Poland. On reaching its own frontier, unpressed, it was first switched northward to the Posen-Thorn area, and then thrust south-east on Nov. 11, with its left flank on the Vistula, against the joint between the two armies guarding the Russian right flank The wedge, driven in by Ludendorff's mallet, sundered the two armies, forced the 1st back on Warsaw and almost effected another Tannenberg against the and, which was nearly surrounded at Lodz (*q.v.*), when the 5th Army from the van turned back to its rescue. As a result, part of the German enveloping force almost suffered the fate planned for the Russians, but managed to cut its way through to the main body. If the Germans were baulked of decisive tactical success, this rnanoeuvre had been a classic example of how a relatively small force, by using its mobility to strike at a vital point, can paralyse the advance of an enemy several times its strength. The Russian "steam-roller" was throun out of gear, and never again did it threaten German soil.

Within a week, four new German army corps arrived from the Western front, where the Ypres attack had now ended in failure, and although too late to clinch the missed chance of a decisive victory, Ludendorff was able to use them in pressing the Russians back by Dec. 15 to the Bzura-Ravka river line in front of Warsaw. This set-back and the drying up of his munition supplies decided the Grand Duke Nicholas to break off the see-saw fighting still in progress near Cracow and fall back on winter trench lines along the Nida and Dunajec rivers, leaking the end of the Polish "tongue" in the hands of the enemy. Thus, on the East as on the West, the trench stalemate had settled in, but the crust was less firm and the Russians had drained their stock of munitions to an extent that their poorly industrialized country could not make good.

The Beginning of Air Attack.—The same period witnessed the dawn of another new form of war which helped to drive home the new reality that the war of armies had become the war of peoples From Jan. 1915, Zeppelin raids began on the English coast and reached their peak in the following winter. to be succeeded by aeroplane raids. The difficulty of distinguishing from the air between military and civil objectives, smoothed the path for a development which. beginning with excuses, ended in a frank avowal that in a war for existence the will of the enemy nation, not merely the bodies of their soldiers, is the inevitable target.

The Psychological Situation. — The first psychological symptom of the World War, as it seemed to many, was an immeasurable sigh of relief. Had the peoples of Europe sat on the safety-valve too long? The war-weary mind of to-day cannot reconstruct the tension and anxiety, the strain and stress of hope and fear of the long years of the peace that was no peace and yet was not war. It may be read as a revolt of the spirit against the monotony and triviality of the everyday round, the completion of a psychological cycle when the memories of past war have faded, and paved the way for the emergence and revival of the primal "hunting" instinct in man.

This first phase of enthusiasm was succeeded by one of passion, the natural ferocity of war accentuated by a form of mob spirit which is developed by a "nation in arms." The British army was relatively immune because of its professional character, whereas in the German army, the most essentially "citizen," it gained scope because of the cold-blooded logic of the general staff theory of war. With the coming of autumn 1914, a third phase became manifest, more particularly among the combatants. This was a momentary growth of a spirit of tolerance, symbolized by the fraternization which took place on Christmas Day, but this in turn was to wane as the strain of the war became felt and the reality of the struggle for existence came home to the warring sides.

VI. THE EVENTS OF 1915

The Deadlock on Land. — Well before the end of 1914, the reality of the deadlock on the Western front was clear to the Governments and general staffs of the warring countries, and each was seeking a solution. The reaction varied in form and in nature according to the mental power and predisposition of the different authorities. With the Central Powers the opinion of Falkenhayn was the decisive factor, and the impression derived not merely from his critics but from his own account is that neither the opinion nor the direction was really clear as to its object. He was too obsessed with the principle of security at the expense of the principle of concentration, and in his failure to fulfil the second he undermined the foundations of the first.

On his appointment after the Marne reverse, he still adhered to the Schlieffen plan of seeking a decision in the West, but he did not follow the Schlieffen method of weakening his left wing in order to mass on the vital right wing. The October–November attack round Ypres was made largely with raw formations, while war-experienced troops lay almost idle between the Aisne and the Vosges. Col. Groner, chief of the field railways, even went so far as to submit a detailed plan to Falkenhayn for transferring six army corps to the right wing, but it was rejected. When we remember how close to breaking point was the Allied line at Ypres, it can only be said that for a second time the German supreme command saved the Allies. At this juncture, too, Ludendorff was pleading for reinforcements to make his wedge-blow at the Russian flank near Lodz decisive, but Falkenhayn missed the chance by delaying until the Ypres failure had passed from assurance to fact.

Convinced at last of the strength of the Allied trench-barrier, Falkenhayn took the momentous decision to stand on the defensive in the West. But his object in so doing seems to have been vague. His feeling that the war must ultimately be decided in France led him to distrust the value, as he doubted the possibility, of a decision against Russia. Hence while he realized that the Eastern front was the only practicable theatre for operations in the near future, he withheld the necessary reinforcements until forced to do so by the threatening situation of the Austro-Hungarian front. And even then he doled out reserves reluctantly and meagrely, enough to secure success but never in the quantity and the time for decisive victory.

It is to his credit, however, that he realized a long war was now inevitable, and that he set to work to develop Germany's resources for such a warfare of attrition. The technique of field entrenchment was carried to a higher pitch than with any other country, the military railways were expanded for the lateral movement of reserves, the supply of munitions and of the raw material for their manufacture was tackled so energetically and comprehensively, that an ample flow was ensured from the spring of 1915 onwards — a time when the British were only awakening to the problem. Here were laid the foundations of that economic organization and utilization of resources which was to be the secret of Germany's resisting power to the pressure of the British blockade. For the scientific grasp of the economic sphere in war Germany owed much to Dr. Walther Rathenau, a brilliant captain of industry. Germany also pioneered in the psychological sphere, for as early as the autumn of 1914, she launched a vast scheme of propaganda in Asia, to undermine British prestige and the loyalty of Britain's Mohammedan subjects. The defect of her propaganda, its crudeness, was less apparent when directed to primitive people than when applied to the civilized peoples of Europe and America.

The same period witnessed also the one great success for German diplomacy, the entry of Turkey into the war, although this was fundamentally due to a combination of pre-war causes with military events. Since 1909 the country had been under the control of the Young Turk party, to whom traditions, including that of friendship with Britain, were abhorrent. Germany, filled with her own dream of a Germanic Middle East—of which the Baghdad railway was the symbol, had skilfully exploited the opportunity to gain a dominating influence over the new rulers of Turkey. Their leader, Enver Pasha, had been military attaché in Berlin, German instructors permeated the Turkish army, and a definite understanding existed between Germany and the Young Turk leaders as to common military action — urged by the common bond of necessary safeguard against danger from Russia. The arrival of the "Goeben" and "Breslau" reinforced the moral pressure of Wangenheim, the German ambassador, and eventually on Oct. 29 the Turks committed definite acts of war, at Odessa against Russia, and in Sinai against Britain.

Falkenhayn has shown "the decisive importance of Turkey joining in the struggle" — first as a barrier across the channel of munition supply to Russia, and secondly as a distraction to the military strength of Britain and Russia. Under German dictation, Turkey struck as early as mid-December against the Russians in the Caucasus but Enver's over-ambitious plan ended in disaster at the battle of Sarikamish. Turkey was no more fortunate in her next venture; to cut Britain's Suez canal artery with the East. The Sinai desert was a check on an invasion in strength, and the two small detachments which got across were easily repulsed, at Ismailia and El Kantara, although allowed to make good their retreat But if both these offensives were tactical failures, they were of great strategic value to Germany by pinning down large Russian and British forces.

As an offset to Turkey joining the Central Powers, Italy definitely threw over the artificial ties of the old Triple Alliance and joined the Entente. On May 24 she declared war on Austria — her hereditary enemy — although avoiding an open breach with Germany. If her main object was to seize the chance of redeeming her kinsmen in Trieste and the Trentino from Austrian rule, there was also a spiritual desire to reassert her historic traditions. Militarily, however, her aid could not have an early or great effect on the situation, for her army was unready to deliver a prompt blow, and the Austrian frontier was a mountainous obstacle of great natural strength.

Franco-British Plans.—On the Entente side the reality of the trench deadlock produced different and diverse reactions. If the desire to hold on to her territorial gains swayed German strategy, the desire to recover her lost territory dominated French strategy. It is true that their mental and material concentration on the Western front, where lay the main armed force of the enemy, was justified by military tenets, but without any key to unlock the barrier they were merely knocking themselves to pieces Winter attacks in Artois, on the Aisne, in Champagne and the Woevre afforded costly proof, and against the Germans' skill in trench-fighting Joffre's "nibbling" was usually attrition on the wrong side of the balance sheet. As for any new key, the French were singularly lacking in fertility of idea

Britain's trouble was rather an excess of fertility, or rather an absence of concentration in choosing and bringing to fruition these mental seeds. Yet in great measure this failing was due to the obscurantism of professional opinion, whose attitude was that of blank opposition rather than expert guidance.

British-inspired solutions to the deadlock crystallized into two main groups, one tactical, the other strategical. The first was to unlock the trench barrier by producing a machine invulnerable to machine-guns and capable of crossing trenches, which would restore the tactical balance upset by the new preponderance of defensive over offensive power. The idea of such a machine was conceived by Col. Swinton in October 1914, was nourished and tended in infancy by Winston Churchill, then first lord of the Admiralty, and ultimately, after months of experiment hampered by official opposition, came to maturity in the tank of 1916.

The strategical solution was to go round the trench barrier. Its advocates—who became known as the "Eastern" in contrast to the "Western" school—argued that the enemy alliance should be viewed as a whole, and that modern developments had so changed conceptions of distance and powers of mobility, that a blow in some other theatre of war would correspond to the historic attack on an enemy's strategic flank. Further, such an operation would be in accordance with the traditional amphibious strategy of Britain, and would enable it to exploit the advantage of sea-power which had hitherto been neglected. In October 1914, Lord Fisher, recalled to the office of first sea lord, had urged a plan for a landing on the German coast. In Jan. 1915, Lord Kitchener advocated another, for severing Turkey's main line of eastward communication by a landing in the Gulf of Alexandretta. The post-war comments of Hindenburg and Enver show how this would have paralysed Turkey. It could not, however, have exercised a wider influence, and it was anticipated by another project—partly the result of Churchill's strategic insight and partly due to the pressure of circumstances.

This was the Dardanelles expedition, about which controversy has raged so hotly that the term just applied to Churchill may be disputed by some critics. This is answered by the verdict of Falkenhayn himself: "If the straits between the Mediterranean and the Black sea were not permanently closed to Entente traffic, all hopes of a successful course of the war would be very considerably diminished. Russia would have been freed from her significant isolation . . . which offered a safer guarantee than military successes . . . that sooner or later a crippling of the forces of this Titan must take place . . . automatically." The fault was not in the conception, but in the execution. Had the British used at the outset even a fair proportion of the forces they ultimately expended in driblets, it is clear from Turkish accounts that victory would have crowned their undertaking.

The cause of this piecemeal application of force and dissipation of opportunity lay in the opposition of Joffre and the French general staff, supported by Sir John French. Despite the evidence of the sequel to the Marne, of the German failure at Ypres, and subsequently of his own still more ineffectual attacks in December, Joffre was still confident of his power to achieve an early and decisive victory in France. His plan was that of converging blows from Artois and Champagne upon the great salient formed by the entrenched German front, to be followed by an offensive in Lorraine against the rear of the enemy armies. The idea was similar to that of Foch in 1918 but the vital difference lay in the conditions existing and the methods employed. A study of the documents conveys the impression that there has rarely been such a trinity of optimists in whom faith was divorced from reason as Joffre, Foch, his deputy in Flanders, and French—albeit the latter's outlook oscillated violently. In contrast the British Government considered that the trench-front in France was impregnable to frontal attacks, had strong objection to wasting the man-power of the new armies in a vain effort, and at the same time felt increasing concern over the danger of a Russian collapse. These views were common alike to Churchill, Lloyd George and Lord Kitchener, who on Jan. 2, 1915, wrote to Sir John French: "The German lines in France may be looked upon as a fortress that cannot be carried by assault and also that cannot be completely invested, with the result that the lines may be held by an investing force while operations proceed elsewhere."

Lloyd George advocated the transfer of the bulk of the British forces to the Balkans both to succour Serbia and to develop an attack on the rear of the hostile alliance. This view was shared by a section of French opinion and, in particular, by Galliéni, who proposed a landing at Salonika as a starting point for a march on Constantinople with an army strong enough to encourage Greece and Bulgaria to combine with the Entente. The capture of Constantinople was to be followed by an advance up the Danube into Austria-Hungary in conjunction with the Rumanians. But the commanders on the Western front, obsessed with the dream of an early break-through, argued vehemently against any alternative strategy, stressing the difficulties of transport and supply and insisting on the ease with which Germany could switch troops to meet the threat. If there was force in their contention, it tended to ignore the experience of military history that "the longest way round is often the shortest way there," and that the acceptance of topographical difficulties has constantly proved preferable to that of a direct attack on an opponent firmly posted and prepared to meet it.

The weight of military opinion bore down counter-proposals and the Balkan projects were relinquished in favour of a concentration of effort on the Western front. But misgivings were not silenced and at this juncture a situation arose which revived the near Eastern scheme in a new if attenuated form.

The Dardanelles **Expedition.**—On Jan. 2, 1915, Kitchener received an appeal from the Grand Duke Nicholas for a diversion which would relieve the Turkish pressure on Russia's army in the Caucasus. Kitchener felt unable to provide troops and suggested a naval demonstration against the Dardanelles, which Churchill, appreciating the wider strategic and economic issues, proposed to cohvert into an attempt to force the passage. His naval advisers, if not enthusiastic, did not oppose the proposal and in response to a telegram the admiral on the spot, Carden, submitted a plan for a methodical reduction of the forts and clearance of the mine-fields. Fisher, while clinging to his own North sea project, strongly advocated a combined naval and military expedition. On Jan. 13, the War Council decided for a naval expedition to "take the Gallipoli peninsula, with Constantinople as its objective." A naval force, mainly of obsolete vessels was got together with French aid, and after preliminary bombardment, entered the straits on March 18. Drift mines, however, caused the sinking of several ships, and the attempt was abandoned.

It is a moot point whether a prompt renewal of the advances would not have succeeded, for the Turkish ammunition was exhausted, and in such conditions the mine obstacle might have been overcome. But the new naval commander, Admiral de Robeck decided against it, unless military aid was forthcoming. Already, a month before, the War Council had determined on a joint attack, and began the despatch of a military force under Sir Ian Hamilton. (See DARDANELLES CAMPAIGN.) But as the authorities had drifted into the new scheme, so were they tardy in releasing the necessary troops, and even when sent in inadequate numbers, several more weeks' delay had to be incurred—at Alexandria—in order to redistribute the force in its transports suitably for tactical action. Worst of all, this fumbling policy had thrown away the chance of surprise, which was vital for a landing on an almost impregnable shore. When the preliminary bombardment took place in February only two Turkish divisions were at the straits; this was increased to four by the date of the naval attack, to six when Hamilton was at last able to attempt his landing. For this he had only four British divisions and one French division—actually inferior in strength to the enemy in a situation where the inherent preponderance of defensive over offensive power was multiplied by the natural difficulties of the terrain. His weakness of numbers and his mission of aiding the passage of the fleet compelled him to choose a landing on the Gallipoli peninsula in preference to one on the mainland or on the Asiatic shore; and the rocky coastline limited his possible landing places.

On April 25, he made his spring, at the southern tip of the peninsula near Cape Hellas and—with Australian and New Zealand troops—near Gaba Tepe, some 1 j m. up the Aegean coast; the French, as a diversion, made a temporary landing at Kum Kale on the Asiatic shore. The troops effected the impossible and made good their lodgment on beaches strewn with barbed wire and swept by machine-guns. But the momentary asset of tactical surprise had passed, the difficulties of supply were immense, while the Turks held the commanding heights and were able to bring up their reserves. The invaders managed to hold on to their two precarious footholds, but they could not expand them appreciably, and the stagnation of trench warfare set in. They could not go on, and national prestige forbade them to go back.

Ultimately, in July, the British Government decided to send a further five divisions to reinforce the seven by now on the peninsula. By the time they arrived the Turkish strength in the region had also risen to 1 j divisions. Hamilton decided on a double stroke—a reinforced blow from Gaba Tepe and a new landing at Suvla bay a few miles north—to sever the middle of the peninsula and secure the heights commanding the Narrows. He deceived the Turkish command and achieved surprise (Xug. 6), but the first blow failed and the second lost a splendid chance by the inexperience of the treops and still more the inertia and fumbling of the local commanders. For over 36 hours, before reserves arrived, only one and a half Turkish battalions barred the path. Energetic new commanders, for whom Hamilton had previously asked, were sent out when the opportunity had passed. The British were once more condemned to hang on to tenuous footholds, and with the autumn rains setting in their trials were increased. The Government had lost faith and were anxious to withdraw, but fear of the moral effect delayed their decision. Hamilton was asked for his opinion, however, and when he pronounced in favour of continuing—in which course he still had confidence—he was replaced by Sir Charles Monro, who immediately declared for evacuation. Kitchener was then sent out to investigate, and on his verdict a withdrawal was sanctioned and carried out from Suvla and Anzac on the night of Dec. 18–19 and from Hellas on that of Jan. 8–9. If the bloodless evacuation was an example of masterly organization and co-operation it was also a proof of the greater ease of such operations in modern warfare. Thus the curtain rang down on a sound and far-sighted conception marred by a chain of errors in execution almost unrivalled even in British history.

The Menace to **Russia.**—While the British were striving to unlock the back door to Russia, the Germanic Powers were hammering their Russian allies, whose resistance was collapsing in large measure from a lack of munitions which could only be made good by foreign supplies through that locked entrance, the Dardanelles. On the Eastern front, the campaign of 1914 had shown that a German.force could count on defeating any larger Russian force, but that when Russians and Austrians met on an equality victory rested with the Russians. Falkenhayn was forced, reluctantly, to despatch German reinforcements as a stiffening to the Austrians, and thus was dragged into an offensive in the East rather than adopting it as a clearly defined plan Ludendorff, in contrast, had his eyes firmly fixed on the ultimate object, and from now on advocated unceasingly a whole-hearted effort to break Russia. Ludendorff's was a strategy of decision, Falkenhayn's a strategy of attrition.

In the conflict of wills between these two men lies the clue to the resultant strategy of Germany—highly effective, yet not decisive. On the other side the fresh Russian plan embodied the lessons of experience and was soundly conceived, but the means were lacking and the instrument defective. The Grand Duke Nicholas aimed to secure both his flanks solidly before attempting a fresh blow towards Silesia. From January until April, under bitter winter conditions, the Russian forces on the southern flank of the Polish salient strove to gain possession of the Carpathians and the gateways into the Hungarian plain. But the Austrians, with a German infusion, parried their efforts, and the loss was disproportionate to the small gains The long-besieged fortress of Przemysl (see PRZEMYSL, SIEGES OF). however, at last fell into their hands on March 22. In northern Poland the Russians were preparing to strike upward at East Prussia, when they were forestalled by a fresh Ludendorff stroke eastward toward the frontier of Russia proper. The blow was launched on Feb. 7, over snow-buried roads and frozen swamps. and was distinguished by the envelopment of four Russian divisions in the Augustovo forests. Aforeover. it extracted the sting from the Russian attack further west.

These moves were, however, merely a "curtain-raiser" to the real drama of 1915. But before turning to this it is necessary to glance at events on the Western front, the importance of which is partly as a signpost to the future and partly because of their reaction on the Eastern front.

The Western Front.—While a way round the trench barrier was being sought in Gallipoli and experiments with a novel key were being carried out in England, the Allied commands in France were trying more orthodox solutions. The most significant was the British attack at Neuve Chapelle (*q.v.*) on March 10. Save as a pure experiment the attempt stood self-condemned. For it was an isolated attempt on a small front with inadequate resources. The arrival in France of several new regular divisions made up from foreign garrisons, of the Indian Corps, and the 1st Canadian Division had brought the British strength up to 13 divisions and 5 cavalry divisions, besides a number of selected territorial battalions. This increase enabled French to divide his fcrces into two armies and gradually to extend his share of the front. But Joffre was insistent that he should relieve the French of the Ypres salient, which they had taken over in November, and made the intended French attack contingent on this relief. Sir John French considered that he had not sufficient troops for both purposes, and so decided to carry out the attack single-handed. An additional motive was his resentment of the constant French criticisms that the British were not "pulling their weight."

In design, however, the attack, entrusted to Haig's 1st Army, was both original and well thought out. After an intense bombardment of 3; minutes duration on a 2,000 yd. frontage, the artillery lengthened their range and dropped a curtain of fire to prevent the reinforcement of the enemy's battered trenches, which were rapidly overrun by the infantry.

Complete surprise was attained and most of the first positions captured, but when in the second phase, the frontage was extended, the artillery support was inadequate. Further, owing to scanty information and to the two corps commanders waiting upon each other a long pause occurred which gave the Germans five clear hours to organize fresh resistance. Then, too late and mistakenly, the attack was ordered to be pushed "regardless of loss." And loss proved the only result. An underlying factor was that the narro ness of the attack sector made the breach more easy for the defenders to close, although this defect was unavoidable owing to the general shortage of munitions. The British had been slower than the Germans to awaken to the scale of ammunition supply required for this new warfare, and, even so, deliveries fell far behind contract, owing largely to the handicap imposed by trade union rules on the dilution of skilled labour. These could only be modified after long negotiation and the shortage of shells became so obvious in the spring of 191 j as to lead to a public outcry which culminated in the establishment of a Ministry of Munitions, under Lloyd George, to co-ordinate and develop both manufacture and the supply of raw materials. Apart from shells the crudeness and inferiority of all the British trench-warfare weapons compared with those of the Germans, made such a radical organization overdue, and its urgency was emphasized by the near approach of the time when Britain's new armies would take over the field. If the task was undertaken late, it was carried out with energy and thoroughness, and by 1916 the flow of munitions reached a volume, still expanding, which finally removed any material handicap on the strategy of the British leaders.

The tactical sequel of Neuve Chapelle was less fortunate. It was clear that the small-scale experiment had only missed success by a narrow margin and that there was scope for its development. But the Entente commands missed the true lesson, which was the surprise attainable by a short bombardment that compensated its brevity by its intensity. And only partially did they appreciate that the sector attacked must be sufficiently wide to prevent the defender's artillery commanding, or his reserves closing the breach. Instead, they drew the superficial deduction that mere volume of shell-fire was the key to success. Not until 1917 did they revert to the Neuve Chapelle method. It was left to the Germans to profit by the experience against the Russians in May.

But before that came, the Western front was destined to increase the tally of military blunders. In the first, it was the Germans' turn to find and misuse a new key to the trench deadlock. This was the introduction of gas, and, unlike the British introduction of tanks later, the chance, once forfeited, did not return, owing to the relative ease of providing an antidote. In a local attack in Poland on Jan. 31, the Germans had tried the use of gas-shells, but the experiment had been a failure owing to the nullifying effect of the intense cold. At the next attempt it was discharged from cylinders owing to the failure of the authorities to provide the inventor, Haber, with adequate facilities for the manufacture of shells. Further, the initial disappointment led the German command to place little trust in its value In consequence, when discharged against the French trenches at Ypres on April 22, there were no reserves at hand to pour through the wide breach it created. (See YPRES, BATTLES OF, 1915.) A strange green vapour, a surging mass of agonized fugitives, a 4 m. gap without a living defender—such was the sequence of events. But the heroic resistance of the Canadians on the flank of the breach and the prompt arrival of English and Indian reinforcements saved the situation in the absence of German reserves.

The chlorine gas originally used was undeniably cruel, but no worse than the frequent effect of shell or bayonet, and when it was succeeded by improved forms of gas both experience and statistics proved it the least inhumane of modern weapons. But it was novel and therefore labelled an atrocity by a world which condones abuses but detests innovations. Thus Germany incurred the moral odium which inevitably accompanies the use of a novel weapon without any compensating advantage. *(See* CHEMICAL **WARFARE.)**

On the Entente side, wisdom would have counselled a period of waiting until their munition supply had grown and the new British armies were ready, but the desire to regain lost territory and the duty of relieving the pressure on Russia, combined with ill-founded optimism to spur Jofire to premature offensives. The German losses were exaggerated, their skill and power in defence underrated, and a series of diffused and unconnected attacks were made. The chief was by the French between Lens and Arras, under Foch's direction, and the earlier experience of failure to make an effective breach in the trench barrier was repeated. The attack was launched on May 9 by d'Urbal's army on a four-mile frontage. It was quickly checked with murderous losses except on the front of Pétain's corps which, thanks to meticulous preparation, broke through to a depth of three miles. But the penetration was too narrow, reserves were late and inadequate and the gap closed. Foch, however, persevered with vain attacks which gained a few acres of ground at excessive loss. Meantime Haig's 1st Army had attacked towards Aubers Ridge simultaneously with the larger French attempt. The plan was to penetrate at two points north and south of Neuve Chapelle, 4 m. apart, the total frontage of the two being $2\frac{1}{4}$ m, and then to converge in exploiting the double penetration. But the Germans, profiting also from the experimental value of Neuve Chapelle, had developed their defences. Thus the attack died away quickly from a surfeit of German machine-guns and an insufficiency of British shells. Under pressure from Joffre the attack was renewed on May 15 on the Festubert sector south of Neuve Chapelle, and continued by small bites until May 27. The larger French offensive between Lens and Arras was not abandoned until June 18, when the French had lost 102,000 inen—rather more than double the defender's loss.

The effect of these attacks was. moreover, to convince even the dubious Falkenhayn of the strength of his Western line and of the remoteness of any real menace from the Franco-British forces. His offensive on the Eastern front had already opened. Tactically unlimited, its strategic object was at first only the limited one of relieving the pressure on the Austrian front and, concurrently, reducing Russia's offensive power. Conrad proposed and Falkenhayn'accepted a plan which aimed at a rupture of the Russian centre as the best means to this end, and in which the Dunajec sector between the upper Vistula and the Carpathians was selected as offering the fewest obstacles to an advance and best protection to the flanks of a penetration. The break-through was entrusted to Mackensen, whose force comprised the newly formed German 11th Army—strengthened by divisions from the West, and the 4th Austro-Hungarian Army. The Ypres gas attack and a large cavalry raid from East Prussia were initiated to cloak the concentration on the Dunajec river of 14 divisions and 1.500 guns against a front held by only six Russian divisions and lacking rear lines of trenches.

The **Dunajec** Break-through.—On May 2, after an intense bombardment had flattened the Russian trenches, the attack was launched and swept through with little opposition. The surprise was complete, the exploitation rapid, and despite a gallant stand on the Wisloka river, the whole line along the Carpathians was rolled up, until on May 14 the advance reached the San, 80 m. from its starting point. Defeat almost turned into disaster when this was forced at Jaroslav, but the impetus of the advance had momentarily spent itself and reserves were lacking. A new factor was introduced by Italy's declaration of war against Austria, but Falkenhayn persuaded the Austrian command, with some difficulty, not to move troops from the Russian front, and to maintain a strict defensive on their Italian frontier, which was secured by the mountain barrier. He realized that he had committed himself too far in Galicia to draw back, and that only by bringing more troops from France could he hope to fulfil his object of transferring troops back there, as this could only be possible when Russia's offensive power was crippled and her menace to Austria removed. Strengthened by these reinforcements, Mackensen attacked again in co-operation with the Austrians, retook Przemysl on June 3 and captured Lemberg on June 22, cutting the Russian front into two separated portions.

But the Russians, from their vast man-power resources had almost made good the loss of 400,000prisoners, and Falkenhayn's anxiety about the stability of his Austrian allies decided him to continue the offensive, although still with limited objects and with one eye on the situation in France. He changed its direction, however, from eastwards to northwards, between the Bug and Vistula, where lay the main Russian forces. In conjunction, Hindenburg was ordered to strike south-east from East Prussia, across the Naren (*q v*) and towards the Bug.

Ludendorff disliked the plan as being too much of a frontal attack; the Russians might be squeezed by the closing in of the two wings but their retreat would not be cut off. He urged once more his spring scheme for a wide enveloping manoeuvre through Kovno on Vilna and Minsk, but Falkenhayn rejected it, fearing that it nould mean more troops and a deeper commitment The result justified Ludendorff's expectation—the Grand Duke extricated his troops from the Warsaw salient before the German shears could close on him. Falkenhayn, on the other hand considered that Ludendorff had not put his full weight into the attack.

Nevertheless, 750,000 prisoners had been taken by the middle of August, Poland had been occupied, and Falkenhayn decided to break off large scale operations on the Eastern front. Bulgaria's entry into the war was now arranged and he wished to support the combined attack of Austria and Bulgaria against Serbia, as well as to transfer troops hack to meet the French offensive expected in September. Mackensen was sent to the Serbian front and Ludendorff was given a belated permission to carry out his Vilna scheme, with such resources as he had, but as an independent operation.

It began on Sept. 9, Below's Army of the Niemen and Eichhorn's 10th Army forming two great horns which gored their way into the Russian front, the one east towards Dvinsk and the other south-east towards Vilna. The Russians were driven back in divergent directions and the Germany cavalry advancing between the horns far overlapped Vilna and drew near the Minsk railway. But the German strength was slender, the Russians free to concentrate against this isolated menace, and in face of the stiffening resistance Ludendorff took the wise course of suspending operations. The crux of the situation was that the Russian armies had been allowed to draw back almost out of the net before the long delayed Vilna manoeuvre was attempted; the degree of success attained with such weak forces was confirmation of its practicability and of Ludendorff's claim that a powerful blow delivered while the Russians were deeply enmeshed in the Polish salient might have annihilated the armed force of Russia. She had been badly lamed, but not destroyed, and although never again a direct menace to Germany, she was able to delay the full concentration of German strength in the West for two years, until 1918. Falkenhayn's cautious strategy was to prove the most hazardous in the long run, and indeed to pave the way for Germany's bankruptcy.

Thus, at the end of September, the Russian retreat, after a nerve-racking series of escapes from the salients which the Germans systematically created and then sought to cut off, came to a definite halt on a straightened line, stretching from Riga on the Baltic to Czernomitz on the Rumanian frontier. But the Russian armies had gained this respite at a ruinous price, and their Western allies had effected little in repayment of Russia's sacrifice on their behalf in 1914.

Allied Offensive in the West.—For the Franco-British relief offensive of Sept. 25 had been no more fruitful than its predecessors. The main blow was launched by the French in Champagne, in conjunction with a Franco-British attack in Artois, on either side of Lens. One fault was that the sectors were too far apart to have a reaction on each other, but a worse was that the command tried to reconcile two irreconcilable factors—they aimed at a break-through but preceded it with a prolonged bombardment which gave away any chance of surprise. Joffre's plan was that the break-through in these two sectors was to be followed by a general offensive on the whole Franco-British front which would "compel the Germans to retreat beyond the Meuse and possibly end the war." The unquenchable optimist! The British attack at Loos (*q.v.*) was undertaken against the opinion of Haig, whose 1st Army had to carry it out. The British resources in artillery were still much less than those of the French, and Haig, after personal reconnaissance, reported that the sector was unsuitable for an attack. But Joffre, with the enchantment that distance lends, declared that it was "particularly favourable ground." Sir John French vacillated as usual, but finally ordered the attempt under pressure from Kitchener. The latter, in this reversal of his own previous attitude was apparently influenced by the grave situation in Russia, as well, perhaps, by his reaction from the disappointment at the Dardanelles. But as he had long since declared his view that the Western front was impassable, it is difficult to see how he could feel that a hopeless offensive there could bring fresh hope to the Russians. Both in Champagne and Artois the attacks penetrated the forward German positions without difficulty, but the delay in bringing reserves forward allowed the German reserves to close the gaps, a task simplified by the narrowness of the attack front: age. The slight gains of ground in no way compensated for the heavy price paid for them—the Allied loss was approximately 242,000 against 141,000 Germans. And if the Allied commands had gained more experience so had the Germans, in the art of defence. The British share in this offensive is, however. notable as marking the appearance in strength of the New Armies; at Loos they were "blooded" and if inexperience detracted from their effectiveness, their courage and driving force were an omen of Britain's power to improvise a national effort comparable with the long-created military machines of the Continent.

The direction of this effort inspired less confidence, and Sir John French gave place to Sir Douglas Haig as commander-in-chief, just as already in September the Russian command had been transferred from the Grand Duke Nicholas, nominally to the Tsar, as a moral symbol, but actually to a new commander-in-chief, Gen. Alexeiev, the newly appointed chief of staff.

The Italian Front, 1915.—Italy's military contribution to the Allied cause was handicapped not only by her unreadiness but by the awkward strategic position of her frontier, difficult for initiating an offensive and hardly more favourable for a secure defensive. The Italian frontier province of Venezia formed a salient pointing to Austria and flanked on the north by the Austrian Trentino, on the south by the Adriatic. Bordering on the Adriatic was a stretch of relatively low ground on the Isonzo front but the frontier then followed the Julian and Carnic Alps in a wide sweep round to the north-west. Any advance eastwards inevitably suffered the potential menace of an Austrian descent from the Trentino upon its rear.

Nevertheless, the eastern front, though difficult enough, seemed to offer more prospect of success, besides threatening a vital part of Austria, than an advance northward into the Alps. When Italy was preparing to enter the war Gen Cadorna, who assumed command, drew up his plan on this basis of an offensive eastwards and a defensive attitude in the north. The overhanging menace of the Trentino was mitigated by the expectation of simultaneous pressure upon Austria from Russia and Serbia. But on the eve of Italy's declaration of war this hope faded, the Russian armies falling back under Mackensen's blows, while the Serbs, despite requests from the Allies, failed to make even a demonstration. This enabled the Austrians to despatch five divisions to the Isonzo from the Serbian front, these being relieved by three newly formed German divisions. Even so there were only some eight divisions in all available to oppose the Italians, who had a numerical superiority of more than three to one.

In order to secure good covering positions on the north a limited advance was made into the Trentino, with success, but another into the north-east corner of the frontier salient—towards Tarvis in the Carnic Alps—was forestalled. This local failure was to have unfortunate results later for it left the Austrians with a good strategic sally port into the Tagliamento valley. Meantime the main Italian advance, by the 2nd and 3rd Armies, had begun at the end of May, but out of their total of 14 divisions only seven were ready. Bad weather increased the handicap, the Isonzo coming down in flood, and the initial advance soon came to a standstill. The Isonzo front crystallized, like the others, into trench warfare The Italian mobilization, however, was now complete and Cadorna mounted a deliberate attack, which opened on June 23. This first battle of the Isonzo continued until July 7 with little gain to show. A fresh series of efforts after a ten days' pause were hardly more effective, and the front then relapsed into the spasmodic bickering characteristic of trench warfare, while Cadorna made preparations for a new and larger effort in the autumn. When it was launched in October he had a two to one superiority in numbers but was weak in artillery. This defect coupled with the superior experience of the defender rendered the new offensive as barren as its predecessors. It was sustained perhaps too obstinately and when finally broken off on Dec. 5, the Italian loss in the six months' campaign totalled some 280,000—nearly twice that of the defenders, who had shown on this front a fierce resolution which was often lacking when they faced the Russians

The Conquest of Serbia, Oct., 1915.—While stalemate, although with marked changes beneath the surface, had once more settled in on both the Eastern and Western fronts, the latter months of 1915 witnessed fluid operations elsewhere which were to have an uncalculated influence on the war.

Austria had proved capable of holding the Italians on the Isonzo, and once the Russian danger began to fade under the pressure of the summer offensive, her command was anxious to deal with Serbia conclusively. Austria's attempted invasions in August and September 1914, and again in November, had been brusquely repulsed by Serbian counter-strokes, and it was not pleasant for a great Power, especially one with so many Slav subjects, to swallow such military rebuffs. Her impatience coincided with Falkenhayn's desire to gain direct railway communication with Turkey, hard pressed at the Dardanelles. Throughout the summer the rival coalitions had been bidding for Bulgaria's support, and in this bargaining the Entente suffered the moral handicap of military failure and the material handicap caused by Serbia's unwillingness to give up any part of Macedonia—of which she had despoiled Bulgaria in 1913. As Austria had no objection to offering territory that belonged to her enemy, Bulgaria accepted her bid. This accession of strength enhanced the chance of a decision against Serbia and in August Falkenhayn decided to reinforce Kovess's Austrian 3rd Army with Gallwitz's German 11th Army from the Russian front. In addition two Bulgarian armies were available. Mackensen was sent to direct the operations. To meet this new threat Serbia, apart from her own relatively small forces, had only a treaty guarantee of Greek aid and promises from the Entente Powers. The first disappeared with the fall of Venizelos, the pro-Ally Greek premier, and the second, as usual, was too late.

On Oct. 6, 1915 (*see* further, SERBIAN CAMPAIGNS) the Austro-German armies attacked southwards across the Danube, with a flanking movement across the Drina on the right. The sturdy resistance of the Serbs in delaying actions, and the natural difficulty of the mountainous country, checked the advance, but before Franco-British reinforcements could arrive, the Bulgarian armies struck westwards into southern Serbia, across the rear of the main Serbian armies. This drove a deep wedge between the Serbs and their allies, moving up from Salonika, and automatically loosened the props of the resistance in the north. With their line bent at both ends until it resembled a vast bow, threatened with a double envelopment, and with their retreat to the south cut off, the Serbian armies decided to retire west through the Albanian mountains. Those who survived the hardships of this mid-winter retreat were conveyed to the island of Corfu, and after being re-equipped and reorganized, joined the Entente force at Salonika in the spring of 1916. The conquest of Serbia, though not, as it proved, of Serbian military power, relieved Austria of danger on her southern frontier, and gave Germany free communication and control over a huge central belt from the North sea to the Tigris. For the Entente this campaign dug a military sump-pit which for three years was to drain their military resources, there to lie idle and ineffective. Yet ultimately that sump-pit was to overflow and wash away one of the props of the Central Alliance.

The Salonika Expedition.—When at the beginning of October the Entente Governments had awakened to Serbia's danger, British and French divisions had been despatched hurriedly from Gallipoli to Salonika, which was the only channel of aid to Serbia —by the railway to Uskub. The advanced guard of this relieving force—which was under the command of Gen. Sarrail—pressed up the Vardar and over the Serbian frontier, only to find that the Bulgarian wedge had cut it off from the Serbians, and it was forced to fall back on Salonika, pursued by the Bulgarians. On military grounds an evacuation of Salonika was indicated, but political reasons induced the Allies to remain. The Dardanelles failure had already diminished their prestige, and by convincing the Balkan States of German invincibility had induced Bulgaria to enter the war and Greece to break her treaty with Serbia. To evacuate Salonika would be a further loss of prestige, whereas by holding on the Allies could check German influence over Greece, and maintain a base of operations from which to aid Rumania, if, as expected, she entered the war on their side. To this end the Salonika force was augmented with fresh British and French divisions, as well as contingents from Italy and Russia, and there also the rebuilt Serbian army was brought. But apart from the capture of Monastir in Nov. 1916, and an abortive attack in April 1917, the Entente force made no serious offensive until the autumn of 1918. Its innocuousness was partly due to the natural difficulties of the country—the chain of mountain ridges which guarded the approach to the Balkans, partly to the feeling of the Allied Governments that it was a bad debt, and partly to the personality of Sarrail, whose conduct and reputation for political intrigues failed to command the confidence and co-operation essential if such a mixed force was to "pull its weight." On their side the Germans were content to leave it in passivity, under guard of the Bulgarians, while they steadilv withdrew their own forces for use elsewhere. With gentle sarcasm they termed Salonika their "largest internment camp," and with half a million Allied troops locked up there the jibe had some justification—until 1918. (*See* further SALONIKA CAMPAIGNS 1915–18.)

The Mesopotamia Expedition to the Fall of Kut.—Nor was Salonika the only "drain" opened in 1915. Mesopotamia was the site of a fresh diversion of force from the centre of military gravity, and one which could only be excused on purely political grounds. It was not, like Salonika and the Dardanelles, begun to relieve a hard-pressed ally, nor had it the justification of the Dardanelles expedition of being directed at the vital point of one of the enemy States The occupation of Mesopotamia might raise British prestige, and it might annoy Turkey, but it could not endanger her power of resistance. Although its origin was sound, its development was another example of "drift," due to the inherent faultiness of Britain's machinery for the conduct of war. (*See* further MESOPOTAMIA, OPERATIONS IN.)

The oilfields near the Persian gulf were of essential importance for Britain's oil supply, and thus when war with Turkey was imminent, a small Indian force, of one division, was despatched to safeguard them. To fulfil this mission effectively it was necessary to occupy the Basra vilayet at the head of the Persian gulf, in order to command the possible lines of approach.

On Nov. 21, 1914, Basra was captured, but the rising stream of Turkish reinforcements compelled the Indian Government to add a second division. The Turkish attacks in the spring of 1915 were repulsed, and the British commander, Gen. Nixon, judged it wise to expand his footing, for greater security. Townshend's division was pushed up the Tigris to Amara, gaining a brilliant little victory, and the other division up the Euphrates to Nasiriya. Southern Mesopotamia was a vast alluvial plain, roadless and railless, in which these two great rivers formed the only channels of communication. Thus a hold on Amara and Nasiriya covered the oilfields; but Nixon and the Indian Government, inspired by these successes, decided to push forward to Kut-al-Amara, a move which was 180 m. further into the interior but had a partial military justification in the fact that at Kut the Shatt-el-Hai, issuing from the Tigris, formed a link with the Euphrates by which Turkish reserves might be transferred from one river line to the other.

Townshend was sent forward in August, defeated the Turks near Kut, and his cavalry carried the pursuit to Aziziya, half way to Baghdad. Enthusiasm spread to the home Government, anxious for a moral counterpoise to their other failures, and Nixon received permission for Townshend to press on to Baghdad. But after an indecisive battle at Ctesiphon, the growing superiority of the Turkish strength compelled Townshend to retreat to Kut. Here, isolated far from help, he was urged to remain, as several fresh divisions were being sent to Mesopotamia. Kut was invested by the Turks on Dec. 8, 1915, and the relieving forces battered in vain against the Turkish lines covering the approach on either bank of the Tigris. The conditions were bad, the communications worse, the generalship faulty, and at last on April 29, 1916, Kut was forced to surrender. However unsound the strategy which despatched Townshend on this adventure, it is just to emphasize that the actual achievements of his small force in face of superior numbers, with inadequate equipment and primitive communications, and utterly isolated in the heart of an enemy country, wrote a glorious page of British history. When these handicaps are compared with the four to one superiority in number, and highly organized supply system of the force which ultimately took Baghdad, the comparison explains the awe in which Townshend and his men were held by the Turks.

The Home Front 1915.—Perhaps one of the most significant landmarks of the transition of the struggle from a "military" to a "national" war was the formation of a National Ministry in Britain which occurred in May 1915. For the prototype of Parliaments to abandon the deep-rooted party system and pool the direction of the war was proof of the psychological upheaval of traditions. The Liberal prime minister, Asquith, remained, but the real lead began to pass insensibly into other hands, notably those of Lloyd George. Churchill, whose vision had saved the menace to the Channel ports and made possible the future key to the deadlock, was shelved, as already had been Haldane, the creator of the expeditionary force.

Political chdnges were general in all countries, and were symptomatic of a readjustment of popular outlook. The early fervour had disappeared and been replaced by a dogged determination which, if natural to the British, was in strange contradiction to popular, if superficial, conceptions of the French temperament.

Economically, the strain had yet to be felt severely by any country. Finance had shown an unexpected power of accommodation, and neither the blockade nor the submarine campaign had seriously affected the food supply. If Germany was beginning to suffer some shortage, her people had more tangible omens of success to fortify their resolution than had their enemies.

VII. FROM VERDUN TO THE ENTRY OF AMERICA

Verdun, 1916.—In 1914 the centre of gravity of the World War had been on the Western front, in 191j it shifted to the Eastern front, and in 1916 once more moved back to France. Although the Entente had dissipated some of their strength in Salonika and Mesopotamia, the rising tide of England's new armies and of her munition supplies promised the power for an effort far larger in scale than before to break the trench deadlock. Measures had also been taken to keep these new divisions up to strength. By the end of 191j the British force in France had risen to 36 divisions through the entry into the field of "Kitchener's Army," as well as of the territorial divisions. Although the principle of voluntary enlistment had not yet been abandoned, the method was systematized and based on a national register. This scheme, launched in Oct. 191j, under the aegis of Lord Derby, aimed to reconcile the demands of the army with the needs of industry, calling up men by groups as they were wanted, and taking single men first. But the response among the latter was not adequate to preserve this graduated principle and in Jan. 1916, by the Military Service Act, the voluntary system—system is hardly the correct term—was replaced by conscription.

At the close of 191j the first serious effort to obtain unity of action between the Allies was made, and a conference of the leaders of the French, British, Belgian and Italian armies, with representatives present from the Russian and Japanese, was held at Joffre's headquarters in December. As a result they adopted the principle of a simultaneous general offensive in 1916 by France, Britain, Russia and Italy. In view of the rawness of the British troops, it was recognized that time must be allowed for training, and that the offensive could not begin before the summer of 1916, although it was hoped to carry out preliminary attacks to wear down the enemy's strength.

But German action was to dislocate this scheme, and only the British share came fully into operation, and not even that into full effect. Falkenhayn was about to fulfil his long-cherished plan for a Western offensive, but with characteristic limitations. Always a believer in the strategy of attrition, he now carried this ruling idea into tactics, and produced the new form of attack by methodical stages. each with a limited objective. In a memorandum to the German emperor at Christmas 1915 he argued that England was the staple of the enemy alliance. "The history of the English wars against the Netherlands, Spain, France and Napoleon is being repeated. Germany can expect no mercy from this enemy, so long as he still retains the slightest hope of achieving his object." Save by submarine warfare, however, England and her army were out of reach, for their sector of the front did not lend itself to offensive operations. "In view of our feelings for our arch-enemy in the war that is certainly distressing, but it can be endured if we realize that for England the campaign on the Continent . . . is at bottom a side-show. Her real weapons here are the French, Russian and Italian armies." He regarded Russia as already paralysed, and Italy's military achievements as unlikely to affect the situation. "Only France remains. France has almost arrived at the end of her military effort. If her people can be made to understand clearly that in a military sense they have nothing more to hope for, breaking-point would be reached, and England's best sword knocked out of her hand." He added that a break-through in mass was unnecessary, and that instead the Germans should aim to bleed France to death by choosing a point of attack "for the retention of which the French command would be compelled to throw in every man they have." Such objectives were either Belfort or Verdun, and Verdun was chosen, because it was a menace to the main German communications, because it offered a salient and so cramped the defender, and because of the moral effect if so renowned a place was lost to France.

The keynote of the tactical plan was a continuous series of limited advances which by their menace should draw the French reserves into the mincing-machine of the German artillery. And each of these advances was itself to be secured from loss by an intense artillery bombardment, brief for surprise and making up for its short duration by the number of batteries and their rapidity of fire. By this means the objective would be taken and consolidated before the enemy could move up his reserves for counter-attack. Although the French Intelligence branch at general headquarters gave early warning of the German preparations, the Operations branch were so full of their own offensive schemes that the warning fell on deaf ears. Further, the easy fall of the Belgian and Russian fortresses had led to a commonly held view that fortresses were obsolete, and Joffre, persuading the French Government to "declass" Verdun as a fortress, had denuded it of guns and troops. The forts were only used as shelters and the trench lines which took their place were inadequate and in poor repair. Yet in the outcome eight months' bombardment was to leave the forts almost undamaged!

At 7.15 A.M. on Feb. 21, the German bombardment began, on a front of 15 m., and progressively trenches and wire were flattened out or upheaved in a chaos of tumbled earth, giving to the countryside a weird resemblance to the surface of the moon. At 4.45 P.M. the German infantry advanced, although the first day only on a $2\frac{1}{2}$ m. front. From then until Feb. 24 the defenders' line east of the Meuse was crumbled away as by the erosion of the tide.

"Operations" still argued that it was only a feint, but Joffre decided to send de Castelnau to discover the true situation and with full powers to act. De Castelnau swung back the right flank but ordered the line of the forts to be held at all costs and entrusted the defence to Pétain, for whose use a reserve army was assembled. Pétain's first problem was not so much defence as supply—the German heavy guns had closed all avenues into the salient except one light railway and the Bar-le-Duc road. While gangs of territorial troops worked night and day to keep this in repair and widen it, Pétain organized the front into sectors and threw in repeated counter-attacks, which, helped by the narrowness of the front, at least slowed down the advance. Falkenhayn sought, somewhat late, to widen the front, and on March 6 the Germans extended the attack to the west bank of the Meuse. But the defence was now stiffening, the numbers balanced, and the immediate thrust to Verdun was checked.

A slight lull followed, and during it the Allies of France made efforts to relieve the pressure on her. The British took over the Arras front from the French 10th Army, their front becoming now continuous from the Yser to the Somme, the Italians made their fifth attack, though in vain, on the Isonzo front, and the Russians hurled untrained masses on the German front at Lake Narocz, near Vilna, once more striking prematurely and gallantly sacrificing themselves to help their Allies. The slight gains were soon lost through a counter-stroke. These efforts did not prevent Falkenhayn pursuing his attrition offensive at Verdun. (See further VERDUN, BATTLES OF.) The advances were slight but they were cumulative in effect, and the balance of loss turned definitely against the defenders. On June 7 Fort Vaux fell, and the German tide crept ever closer to Verdun, seeming to the anxious watchers to resemble the forces of nature rather than of men. And in the Asiago region. Conrad had launched his offensiveagainst Italy's Trentino flank.

Brusilov's Offensive.—Again Russia came to the rescue. In the spring of 1916 she had 130 divisions, but was woefully short of equipment, facing 46 German and 40 Austrian divisions. The preparation and reorganization for her intended share in the year's Allied offensive were cut short by the emergency at Verdun and in relief of her French allies she had launched a costly and obstinately prolonged attack at Lake Narocz in March. When it was at last broken off, the preparations for the main offensive were resumed. This was to begin in July, coincidently with the Somme offensive and Brusilov, commanding the south-western front, was ordered to prepare such attacks as he could stage from his own resources as a distraction of the enemy's attention from the main offensive. But the distraction was released prematurely, on June 4, in response to Italy's appeal to Russia to prevent the Austrians reinforcing their Trentino attack. Without warning, because without any special concentration of troops, Brusilov's troops advanced against the Austrian 4th Army near Luck (*q.v.*) and the Austrian 7th Army in the Bukovina, whose resistance collapsed at the first shock. In three days Brusilov took 200,000 prisoners. This last vital effort of the Russian army in the war had important consequences. It stopped the Austrian attack on Italy, already impaired by an Italian riposte. It compelled Falkenhayn to withdraw troops from the Western front, and so abandon his plan for a counter-stroke against the British offensive preparing on the Somme, as well as the hope of nourishing his Verdun attrition process. It led Rumania to take her fateful decision to enter the war on the Entente side, and caused the supersession of Falkenhayn in the supreme command and his replacement by Hindenburg — with Ludendorff, officially styled First Quartermaster-General, as the directing brain.

Although Rumania's entry was the ostensible reason, the underlying one was the fact that Falkenhayn's "limited" strategy in 1915 had made possible the Russian recovery which stultified the strategy of 1916. Falkenhayn was history's latest example of the folly of half-measures, the ablest and most scientific general — "penny wise, pound foolish" — who ever ruined his country by a refusal to take calculated risks. In 1916 he had turned back westwards to pursue his long cherished goal, and his strategy had faithfully fulfilled the canons of military orthodoxy by taking for its objective the enemy's strongest army and the strongest point of that army's position. It certainly achieved the object of compelling the French to pour their reserves into the Verdun "blood-bath," but did not effect any decisive strategic result. Falkenhayn had rejected Conrad's proposal for a concentration against Italy such as had previously overthrown Serbia. Conrad's reasons had been that such a blow against the "hereditary enemy" would act as a tonic to the Austro-Hungarian forces and that the theatre of war lent itself to decisive results by a thrust southwards from the Trentino against the rear of the Italian armies engaged on the Isonzo. The success attained by the relatively light blow of 1917—Caporetto—lends historical support to his contention. But Falkenhayn was dubious both of the feasibility and value of the plan and was unwilling even to lend the nine German divisions which Conrad asked for to relieve Austrian divisions in Galicia. In default of this aid Conrad persisted in attempting his design single-handed, taking some of his best divisions from Galicia, and thereby exposing their front to Brusilov's advance without obtaining adequate force to achieve his Italian front plan. Falkenhayn's smouldering resentment at this disregard of his views was fanned into flame by the Galician disaster, and he intervened in Vienna to procure the deposition of Conrad. His own fall followed hard on Conrad's heels.

Brusilov's offensive continued for three months with fair success, but reserves were not at hand for immediate exploitation, and before they could be moved down from the north the Germans were patching up the holes. His later efforts were never so dangerous, but they absorbed all the available Russian reserves, and their ultimate loss of 1,000,000 casualties completed the virtual ruin of Russia's military power.

The Somme.—Great as was the influence of Brusilov's offensive on German strategy, its effect on the Verdun situation was less immediate, and on June 23 the Germans almost reached the Belleville height, the last outwork of Verdun. Pétain made all ready for an evacuation of the east bank of the Meuse, though to his troops he showed no sign of anxiety, and ever repeated the now immortal phrase, "On les aura!"

But on July 1, the long-planned offensive on the Somme (*q.v.*) began, and from that day on the Germans at Verdun received no new divisions, and their advance died away from pure inanition. Nevertheless, although the Germans at Verdun had fallen short of their object, moral and material, they had so drained the French army that it could play but a slender part in the Allied plan for 1916. The British had now to take up the main burden of the struggle, and the consequence was to limit both the scope and effect of the Entente strategy.

On July 1, after a week's prolonged bombardment, the British 4th Army (recently created and placed under Kawlinson) attacked with 13 divisions on a front of 15 m. north of the Somme, and the French with five divisions on a front of 8 m., mainly south of the river, where the German defence system was less highly developed. The unconcealed preparations and the long bombardment had given away any chance of surprise, and in face of the German resistance, weak in numbers but strong in organization, the attack failed along most of the British front. Owing to the dense and rigid wave formations that were adopted the losses were appallingly heavy. Only on the south of the British front, near Fricourt and Montauban, did the attack gain a real footing in the German defences. The French, with slighter opposition, and being less expected, made a deeper advance.

This setback negatived the original idea of a fairly rapid penetration to Bapaume and Cambrai, and Haig adopted the attrition method of limited advances aimed to wear down the German strength. Rejecting Joffre's desire that he should again throw his troops frontally on the Thiepval defences, the attack was resumed on the southern British flank alone, and on July 14 the capture of the Germans' second position offered the chance of exploitation, which was not taken. From now onward a methodical but costly advance continued, and although little ground was gained the German resistance was seriously strained when the early onset of winter rains suspended operations in November. The effect, however, can be exaggerated, for it did not prevent the Germans withdrawing troops for the attack on Rumania. But in one respect the Somme shed a significant light on the future, for on Sept. 15 the first tanks (*q.v.*) appeared. Their early employment before large numbers were ready was a mistake; losing the chance of a great strategic surprise, and owing also to tactical mishandling and minor technical defects they only had a limited success. Although the higher military authorities lost faith in them, and some urged their abandonment, more discerning eyes realized that here was a key which, when properly used, would unlock the trench barrier. The Somme offensive had a further indirect effect, for its relief to the Verdun pressure enabled the French to prepare counter-strokes, carried out by Mangin's corps on Oct. 24 and Dec. 15, which regained most of the lost ground with small casualties. These economic successes were due to a revival of surprise, to a more elastic use of the limited objective method, and to a high concentration of artillery, with a minimum of infantry, to occupy the defences crushed by the guns.

The Conquest of Rumania. — Rumania, sympathetic to the Entente cause, had been waiting a favourable opportunity to enter the war on their side, and Brusilov's success encouraged her to take the plunge. Her command hoped that this success, combined with the Allied pressure on the Somme and at Salonika, would draw off the German reserves. She might have fared better and contributed more if she had taken the decision earlier, when Serbia was still an active force and Russia a real one. The two years of preparation had doubled the numbers of the Rumanian army, but in reality reduced its relative efficiency, for while other armies had developed with experience, Rumania's isolation and the incapacity of her military leadership had prevented the transformation of her army from a militia of "bayonet men" into a modern force. Her 10 active divisions had only a low proportion of machine-guns, 5 of the 13 newly formed divisions had none at all, the artillery was inadequate and the air force negligible. She had only six weeks' supply of ammunition at the start and her allies failed to fulfil their guarantees of supply. Moreover, her strategical situation was another source of weakness—her territory forming an "L" reversed with the bottom section, Wallachia, sandwiched between Transylvania and Bulgaria, while the length of the frontier was out of all proportion to the depth of the country, with a shortage of lateral railways snd the capital within 30 m. of the Bulgarian frontier. Further, she had in the Dobruja, on the other side of the Danube, a "back-yard" strip which offered an easy way of access.

These handicaps were accentuated by the divergent counsels of the Allies. While the British General Staff favoured a southward advance against Bulgaria which might have crushed the latter between the Rumanians and the Salonika army, the Russians urged a westward advance which would, in theory, be in closer co-operation with their own Bukovina advance. The political and moral advantages of a move into Transylvania led the Rumanians to adopt the second course. This has been much criticized, but without sufficient appreciation of the fact that the advance into Transylvania placed the Austro-German command in an awkward predicament, which might easily have been disastrous if the invasion had not been so sluggish. At the outset she had 23 divisions against 7 opposing her, but within a week the enemy would be, and were, able to raise this figure to 15.

The Rumanian advance began, on Aug. 27, with three main columns each of about 4 divisions, moving north-west through the Carpathian passes, the general conception being to pivot on the left and wheel the right up into line facing west when the Hungarian plain was reached. To guard the Danube three divisions were left and three more in the Dobruja, whither the Russians had promised to send two—Rumania's original stipulation had been that a force of 150,000 Russians should be sent.

The slow and cautious advance of the Rumanian columns, hampered by the poverty and destruction of communications, but not by resistance, withheld danger from the five weak Austrian divisions which covered the frontier and enabled their reinforcement by five German and two Austrian divisions. In fulfilment of the other half of the plan, made by Falkenhayn before his fall, four Bulgarian divisions with Austro-German technical troops were to be placed under Mackensen for the invasion of the Dobruja.

While the Rumanian columns were creeping westward into Transylvania, Mackensen stormed the Turtucaia bridgehead on Sept. 5, destroying the three Rumanian divisions which covered the Danube front, and then, with his flank secure, pressed eastwards into the Dobruja. This automatically drew away reserves from, and thereby halted the Rumanian offensivein Transylvania, while Falkenhayn had arrived to take charge. Finding that the Rumanian columns, now at a standstill were dispersed over a zoo-mile front, Falkenhayn concentrated against the southern column which had crossed the Rother Turm Pass, while using smaller forces to hold off the others. Having thrown this column back through the mountains by a convergent manoeuvre in which the Alpine Corps made a 50-mile march in three days, Falkenhayn then profited by the despatch of the Rumanian reserves against Mackensen to concentrate his forces against the Rumanian centre column at Brasov (Kronstadt). By Oct. 9 he had driven this back in turn but he missed his greater goal of encircling it, which would have opened for him a clear passage into Rumania. The mischance jeopardised the whole German plan and almost saved Rumania, for with all the passes still in their hands, her troops sturdily repulsed all efforts to press through on their heels. A prompt attempt by Falkenhayn to swing further south and force a way by the Vulcan and Szurduk passes was foiled and the beginning of the winter snows was on the point of blocking operations when a concentrated last-hour effort at the same point, Nov. 11–17, broke through. It was the signal for the next move in the German plan. Mackensen had switched his main forces westwards, and on Nov. 23 crossed the Danube close to Bucharest, on which both armies now converged. It fell on Dec. 6, and, despite belated Russian aid, the Rumanian forces were driven north into the upper section of the Rumanian "L." The brilliantly co-ordinated German strategy had crippled their new foe, gained possession of the bulk of Rumania, with its oil and wheat, and gave the Russians another 300 m. of front to hold. Sarrail, at Salonika, had not succeeded in detaining the Bulgarian reserves.

The Capture of Baghdad.—The only territorial success that the Entente could show for their year's campaign was away in Mesopotamia—the capture of Baghdad, and this moral token was seized on with an enthusiasm which, militarily, it hardly warranted. The bitter experience of the past had damped the ardour of the British Government, and Sir William Robertson, the new Chief of the Imperial General Staff, was opposed to any further commitments which drained the strength available for the Western front. But Maude, the new commander on the spot, by subtle, if unconscious, steps succeeded in changing this defensive policy into one of a fresh offensive. After thorough reorganization of the Mesopotamian force and its communications, he began on Dec. 12, 1916, a progressive right wheel and extension of his front on the west bank of the Tigris above and below Kut. These methodical trench-warfare operations had placed him ready for a spring across the Tigris at the Turks' line of retreat, which was thus parallel to his front. But despite his four-to-one superiority of force, the failure of his right to pin down the enemy and of his cavalry to cut off their retreat prevented a decisive success. But it led to permission for an advance on Baghdad, and he entered the Mesopotamian capital on March 11, 1917. A series of skilfully conducted operations then drove the Turks into divergent lines of retreat and secured the British hold on the province.

The Advance on Palestine.—Ever since the abortive Turkish attempt to invade Egypt early in 1915, the British had kept large forces there, even when the Dardanelles expedition was crying out for troops. When Gallipoli was evacuated, the release of the Turkish forces threatened a fresh move on Egypt. To anticipate this by gaining command of the Sinai desert, Sir Archibald Murray advanced in the spring of 1916, defeating the Turkish forces, freshly arrived, at Romani, Magdhaba and Rafa. The rate of advance was governed by the time taken in extending a railway and pipe-line (for water) across the desert. This new "Exodus" inspired the British Government to carry out an invasion of Palestine, at as cheap a cost in troops as possible. The towns of Gaza, on the coast, and Beersheba. 25 m. inland, guarded the approach to Palestine. Murray attacked Gaza on March 26, but the attempt fell short when on the brink of success. By nightfall Gaza was practically surrounded but the victorious position was given up bit by bit, not under enemy pressure but on the orders of the executive British commanders, through faulty information, misunderstandings and over-anxiety. Nor did the harm end there for Murray reported the action to the Government in terms of a victory, and without hint of the subsequent withdrawal, so that he was encouraged to attempt, without adequate reconnaissanct or fire support, a further attack on April 17–19 which proved a costlier failure against defences now strengthened. (See further PALESTINE, OPERATIONS IN)

The Capture of Gorizia.—The Austrian offensive in the Trentino had interrupted Cadorna's plans for a renewed effort on the Isonzo, but when the former was halted, Cadoma switched his reserves back to the Isonzo. In preparation for this offensive the whole sector from Monte Sabotino to the sea was entrusted to the Duke of Aosta's 3rd Army, under which 16 divisions mere concentrated, against six Austrian divisions. Following a preliminary feint near the sea on Aug. 4, the attack opened well two days later. North of Gorizia Capello's corps swept over the long impregnable Monte Sabotino, which guarded the approach to the river, and, crossing the river on the night of Aug. 8, occupied the town. This compelled an Austrian retreat on the Carso sector to the south, but attempts to exploit the success eastward failed against fresh positions of resistance Three more efforts were made in the autumn and if they imposed a wearing strain on the Austrians they caused greater loss to the attackers. During the year Italians had suffered some 483,000 casualties and inflicted 260,000.

The War at Sea, **1915–16.**—Germany's first submarine campaign—associated by Allied opinion with the name of Admiral von Tirpitz, the exponent of ruthlessness—had been a signal failure, both in its meagre results and the disproportionate ethical damage it did to Germany's cause. A series of Notes exchanged between the American and German Governments, culminated in April 1916 in a virtual ultimatum from President Wilson, and Germany abandoned her unrestricted campaign. The deprivation of this weapon spurred the German navy to its first, and last, attempt to carry out the initial plan on which it had begun the war. On May 30, 1916, the British Grand Fleet left its bases on one of its periodical sweeps through the North sea, but with reason to expect a possible encounter. On May 31, early in the morning, the German High Sea Fleet also put to sea, in the hope of destroying some isolated portion of the British fleet.

For such an encounter the British admiral, Jellicoe, had formulated an outline plan in the early mbnths of the war. Its basis was the cardinal necessity of maintaining the unimpaired supremacy of the Grand Fleet, which he viewed as an instrument not merely of battle but of grand strategy, the pivot of the Allies' action in all spheres, economic, moral and military. Hence while desirous of bringing the German fleet to battle under his own conditions he was determined not to be lured into mine and submarine infested waters.

Early in the afternoon of May 31, Beatty, with his battle-cruisers and a squadron of battleships, after a sweep to the south was turning north to rejoin Jellicoe, when he sighted the German battle-cruisers, five in number. In the initial engagement two of Beatty's six battlecruisers were hit in vital parts and sunk; when thus weakened he came upon the main German fleet under Admiral Scheer. He turned north to lure them into reach of Jellicoe, 50 m. distant, who raced to support him. To describe the intricate and much debated manoeuvres which followed is neither possible nor would it be just within the limits of this article, *a* strategical and not a tactical survey. Mist and failing light put an end to an indecisive action, which, however, left the British fleet between the German and its bases. During the night Scheer broke through the destroyer guard, and, although sighted, was not reported. Then he slipped safely through a net which Jellicoe dared not draw too close in view of his guiding principle and the danger of torpedo attack.

But if the battle of Jutland (*q.v.*) could be counted *a* tactical advantage to the Germans, it had no effect on their strategic position. Britain's command of the sea was intact, and the grip on the blockade on Germany unrelaxed. Once more she fell back on submarine warfare, and the first development was an extension of range. In July one of her new large submarine-cruisers appeared off the American coast and sank several neutral ships. In British and Mediterranean waters the pressure began seriously to affect the sea-borne trade and food supplies of the Entente. Various remedies were tried—the most effective being a system of sailing in convoys—but the only truly adequate measure, that of penning the Germans in their bases by close-in minefields, was debarred by Britain's failure to obtain a decisive battle success. But if Britain was feeling the strain of economic pressure, so also was Germany, and her leaders feared that the race between decisive success on land and economic collapse would end against her. The naval authorities declared that a renewal of the "unlimited" submarine campaign, which with her increased numbers could now be far more intense, would bring the Entente to their knees. Accepting this opinion, Ludendorff consented to a step which he had hitherto opposed, and on Feb. 1, 1917, it was inaugurated—with the full realization that it involved the weight of America being thrown into the scales against them.

VIII. THE PENULTIMATE YEAR

Despite incessant provocation for two years, since the "Lusitania" incident, President Wilson had held to his neutral policy, and if his excess of patience angered many of his own people it at least was the means of consolidating American opinion and reconciling it as a whole to intervention in the war. Meantime he strove by speech and by the agency of Col. House—his unofficial ambassador—to find a basis of peace on which the belligerents could agree. This effort was doomed to failure by its misunderstanding of the psychology of the warring peoples and of the fundamental objects for which they were fighting. He was still thinking in terms of traditional warfare, between governmental policies, while the conflict had long since passed into the wider sphere of the struggle of peoples dominated by the primitive instinct of self-preservation.

The declaration of the unlimited submarine campaign brought convincing proof of the futility of these peace hopes and of the reality of the German intentions, and when followed by the deliberate sinking of American ships and an attempt to instigate Mexico to action against the United States, President Wilson hesitated no longer, and on April 6, 1917, America entered the war against Germany.

Her potential force in man-power and material was illimitable but, even more unready than Britain in 1914, it must be long in exerting more than a moral influence, and Germany confidently anticipated that the submarine campaign would take decisive effect within a few months. How near her calculation came to fulfilment the record of 1917 and 1918 bears witness.

The Western Front Campaign of 1917.—The year 1916 closed in gloom for the Entente The simultaneous offensive on all fronts, planned a year before, had misfired, the French army was at a low ebb, the Russian still lower, the Somme had failed to produce visible results in any way proportional to its cost, and another fresh ally had been overrun. At sea the negativeness of Jutland was a disappointment, and although Germany's first submarine campaign had been abandoned a stronger one was threatened. To offset these debits, the Entente could only show the capture of distant Baghdad and the limited Italian success at Gorizia in August, whose value, however, was mainly as a moral tonic to Italy herself.

Among the Allied peoples and their political representatives there was a growing sense of depression. On the one hand it took the form of dissatisfaction with the conduct of the war and, on the other, of discouragement over the prospects of a victorious conclusion to the war, and a tendency to discuss the possibilities of a peace by negotiation. The first-named tendency was the first to come to a head and was signalized in London, the political mainspring of the Allies, by the replacement of Asquith's Government on Dec. 11 by one with Lloyd George as its chief. The order of precedence in events had a significant effect. For Lloyd George had come into power as the spokesman of a widespread demand for a more vigorous and more efficient prosecution of the war.

The second tendency received an impulse from the German peace move of Dec. 12, after the fall of Bucharest, which proposed an opening of peace discussions. This suggestion was rejected as insincere by the Allied Governments, but it afforded the opportunity of President Wilson, on whose behalf Col. House had long been sounding the belligerent Governments as to the prospects of mediation, to invite these to define their war aims as a preliminary to practical negotiation. The German reply was evasive, the Allied replies were considered by their opponents inacceptable as a basis of discussion, and the tentative peace moves subsided.

But while this wave of depression was surging on the "home-front," the Allied commanders continued optimistic. In November Joffre assembled, at Chantilly, a further conference of the commanders at which it was agreed that the Germans were in great difficulties on the Western front, and that the situation of the Allies was more favourable than it had ever been.

The fighting strength of the British army had grown to about 1,200,000 men, and was still growing. The fighting strength of the French army had been increased by the incorporation of native troops to some 2,600,000, so that, including the Belgians, it was estimated that the Allies disposed of about 3,900,000 men against about 2,500,000 Germans.

Joffre declared that the French army could maintain its strength for one more great battle, but that thereafter it must progressively decline, as France had no longer a sufficient number of men of military age to replace losses. He therefore warned Haig that during the coming year the burden must fall more and more upon the British army. It was also agreed that in view of these factors the relative superiority of the Allies on the Western front would be greater in the spring of 1917 than at any time which could be foreseen with certainty. In consequence it was decided to take the earliest opportunity of pressing the advantage gained on the Somme, and to continue the process of exhausting the enemy's reserves as preparation for an effort which should be decisive. An alternative proposal was made by Gen. Cadorna that the French and .British should co-operate in a combined thrust from the Italian front against Austria with the object of knocking this "weaker partner" out of the war. But it was rejected by the French and British commanders, despite Lloyd George's espousal of it at the Allied conference held in Rome in January. Their objection was that it involved a fresh diversion of strength away from the main front, where alone, they held, success could have decisive results.

The Entente plan for 1917 was soon to be complicated by changes in the command. French opinion had tired of the meagre results of Joffre's attrition strategy, and the method of the limited objective had fallen ints disfavour because of the unlimited losses on the wrong side, which accompanied it without apparent gain. They contrasted the dull course of his strategy with the brilliant results gained by Mangin at Verdun, in the autumn, under Nivelle's direction, and as a result Joffre gave place to Nivelle, who promised a real break-through. His confidence so inspired Lloyd George, the new British prime minister, that Haig was subordinated to him for the forthcoming operations—an arrangement which violated the axiom that a general cannot direct one force while exercising executive command of another. For carrying out a plan essentially audacious, Nivelle had two further handicaps; he failed to convert several of his subordinates to the idea, and he was given less rein by the Government than his predecessor. Again, while Joffre had intimated that the British must take the chief part, Nivelle changed this policy, and in his desire to conserve the glory for France overlooked how severely the French fighting power had been strained. Joffre's plan had been for a convergent attack on the great German salient Lens-Noyon-Reims, first against its west flank and then against its south—the British to attack north of the Somme, including but extending beyond the old battle ground, and the French south of it to the Oise. The attacks were to begin early in February and to be followed by a French main attack in Champagne. Kivelle's change was to ask the British to take over more of the front—south of the Somme—in order to release French troops for the Champagne blow, and as a result the start was postponed a month.

Before it could begin the Germans had dislocated it. Ludendorff's first step had been to set on foot a complete programme for the reorganization and expansion of German man-power, munitions and supplies. While this was developing, he intended to stand on the defensive, hoping that the new submarine campaign would either decide the issue or pave the way for a decisive blow on land when his new reserves of men and material were ready. Anticipating the renewal of the Entente advance on the Somme, he had a new line of defence. of great artificial strength, built across the chord of the arc Lens-Koyon-Reiins. Then after devastating the whole area inside the arc, he began a methodical retirement, by stages, to the new line called by the Germans the "Siegfried" and by the Allies the "Hindenburg" line. A consummate manoeuvre, if brutal in application, it showed that Ludendorff had the moral courage to give up territory if circumstances advised it. The British, confronted with a desert, were inevitably slow in pursuit, and their preparations for an attack on this front were thrown out of gear, limiting them to the sector around Arras (*q.v.*), where the front was unchanged.

On April 9 Allenby's 3rd Army opened the spring offensive at this point, taking the long-sought Vimy ridge, but failed to develop its initial success, and continued the attack too long after the resistance had hardened. This costly action was partly prolonged in order to take the pressure off the French. For the French blow between the Somme and the Oise had been stultified by the German retirement, and the main attack on April 16 east and west of Reims was a worse fiasco with a dangerous sequel. With a prolonged bombardment giving away any chance of surprise, and without first drdwing away the German reserves, the idea of a rapid break-through was doomed to fail. The high hopes that had been raised caused the greater reaction, and the troops were weary of being thrown against barbed wire and machine-guns to no apparent effect.

Accentuated by service grievances, mutinies broke out in the French armies, and no less than 16 corps were affected. In these circumstances Nivelle was replaced by Pétain, whose first concern was to restore the shaken morale of the French troops, and for the rest of the year the British bore the brunt of the campaign. Their strength in France was now at its highest—64 divisions, supplied with an abundance of artillery and ammunition. The strain, however, was increased by the failure of Russia to make any effective contribution to the pressure on Germany, owing to the revolution which broke out in March. Haig decided to keep the Germans occupied by carrying out the original plan for an offensive in Belgium, and if the principle was right the method and choice of site were open to criticism.

The initial move was an attack on the Messines ridge in order to straighten out the Ypres salient and attract the enemy's reserves. Carried out by the 2nd Army under Plumer, with Harington as chief of staff, it proved a model example of the "limited" attack with success economically gained by able staff work and co-operation between the arms.

It was followed on July 31 by the main attack at Ypres (*see* YPRES, BATTLES OF, 1917) which, hampered by the heavy rain, was foredoomed by its own destruction of the intricate drainage system of the area. The British command had persevered for two and a half years with the method of a prolonged preparatory bombardment, believing that quantity of shells was the key to success, and that, unlike all the great captains of history, they could disregard the element of surprise. The offensive at Ypres, which was finally submerged in the swamps of Passchendaele in early November, threw into stronger relief than ever before the fact that such a bombardment blocked the advance for which it was intended to pave the way—because it made the ground impassable. The discomfiture was increased by the new German method of defence, which Ludendorff introduced, of thinning the front defences and using the men so saved for prompt local counter-attacks The defence was built up of a framework of machine-guns distributed in concrete "pill-boxes" and disposed in great depth. On the British side the profitless toll of this struggle in the mud was to some extent mitigated by better staff work when the direction of the attack was handed over to Plumer's 2nd Army.

Three months of dreadful struggle came to an end with the British not appreciably nearer their immediate object of driving the Germans from their submarine bases in the Belgian ports, and if they had worn down the German strength they had worn down their own still more.

The Renaissance of Surprise at **Cambrai.**—The 1917 campaign in the West closed, however, on a note brighter in promise if not in accomplishment. Appreciating from the first days the futility of using tanks in these Flanders swamps, the Tank Corps headquarters looked around for an area where they could try out a new and different method. The chief general staff officer, Col. Fuller, drew up a project for a large scale raid to scour a canal-enclosed "pocket" near Cambrai (q *v.*), where the rolling downland lent itself to tank movement. The basic idea was the release of a swarm of tanks without any preparatory bombardment to give warning of the attack. When their hopes at Ypres waned, the British command adopted the scheme, retaining the basic idea, but transforming the operation into a definite offensive with far-reaching aims, for which they had not the resources because of the drain of Tpres. The operation was to be carried out by Byng's 3rd Army with six divisions, and the date was fixed for Nov. 20. Led by nearly 400 tanks, the attack came as a complete surprise, and despite minor checks achieved a penetration far deeper and at less cost than any past British offensive. But all the available troops and tanks were thrown into the first blow, and the higher command failed to give Byng the few reserves they still possessed in time to exploit the success. The cavalry, as always throughout the operations on the Western front, proved totally unable to carry out this important rôle.

Thus the advance died away, and on Nov. 30 the German army commander, Marwitz, launched a counter-stroke against the flanks of the salient created by the British advance. In the north it was parried, but in the south broke through, and a disaster was only averted by the superb counter-attack, first of the Guards Division and later of a tank brigade. But if Cambrai was a disappointment it revealed that surprise and the tank were the combination by which the trench barrier could be unlocked. Meanwhile Pétain, after overhauling his instrument, the French army, sought to test its readiness for 1918. In August a stroke by Guillaumat's army recovered all the remainder of the ground lost in 1916, and in October Maistre's army flattened the south-west corner of the German front, seizing the Chemin des Dames ridge.

The Collapse of Russia.—The temporary breakdown of the French fighting power was not the worst of the troubles which together crippled the Entente offensive in 1917. The collapse, first partial and then complete, of Russia was a loss which even the entry of America into the war could not possibly compensate for many months, and before the balance was restored the Western Allies were to be perilously near the brink of defeat. Russia's enormous losses, due to her own defective machine but incurred in sacrifice for her Allies, had undermined the morale even more than the material endurance of her forces. Revolution broke out in March, superficially against the corrupt entourage of the tsar, but with more deep-seated moral causes beneath. The tsar was forced to abdicate and a moderate Provisional Government climbed into the saddle, but without reins. This was only a makeshift, and in May another succeeded it, more Socialist in tendency and outwardly led by Kerensky. While clamouring for a general peace and undermining discipline by a system of committee control suitable to a trade union but not to the field of battle, Kerensky imagined he could send troops against the enemy by platform appeals.

Brusilov succeeded Alexeiev in the supreme command, and on July 1 the army gained some initial success against the Austrians, especially in the region of Stanislau, only to stop as soon as real resistance was met, and to crumble directly the Germans counter-attacked. By early August the Russians had been driven out of Galicia and the Bukovina, and it was only policy which halted the Austro-German forces on the frontiers of Russia itself. In September the Germans took the opportunity to practise their new method of attack intended for use in France, and this surprise attack, under Hutier's command, resulted in the capture of Riga. Next month the Bolsheviks under Lenin overthrew the wordy Kerensky, imposed their self-constituted rule on the Russian people and sought an armistice with Germany, which was concluded in December.

Italy's Caporetto Disaster.—The defection of Russia did not end the Entente tale of woe. Each autumn, with demoralizing regularity, Germany had seized an opportunity to eat up one of the weaker Allies. In 1915 it had been Serbia's fate, in 1916 Rumania's, and now it was Italy's turn, or so the Germans intended. Ludendorff's decision, taken in September, was determined by the appeals of the Austrian authorities, who felt that their troops could not endure the strain of another defensive battle on the Italian frontier. In May, Cadorna had attacked once more on the Isonzo front, but an Austrian counter-attack in the Carso sector had retaken part of the small gains. Losses, however, were more nearly balanced than formerly. The question of Allied co-operation on the Italian front was raised afresh without result, but Cadorna, nevertheless, initiated in August an "eleventh battle of the Isonzo." Capello's 2nd Army captured a large part of the Bainsizza plateau, north of Gorizia, but a long sustained effort brought no further success and Cadorna was forced to break off the offensive after four weeks' struggle. But it had so strained the Austrian resistance that, in Ludendorff's words, "it became necessary to decide for the attack on Italy in order to prevent the collapse of Austria-Hungary."

Ludendorff had a difficult problem to solve. Russia had not yet capitulated, the front there was already weakly held for its extent, and the British offensive in Flanders made impossible a large withdrawal of troops from France. All he could spare was his slender general reserve of six divisions, which had already been his instrument in countering the Kerensky offensive and in the Riga coup. His adviser in the strategic design of operations, Lt.-Col. Wetzell, was, however, of opinion that the application of even this small force at a "soft spot" such as was offered by the Tolmino-Caporetto sector, north of the Bainsizza plateau, would suffice to cripple the Italian menace. The result proved him right—the trouble was that it unduly exceeded the most sanguine expectations. On Aug. 29 Waldstatten, of the Austrian general staff, had brought to Ludendorff a scheme for a break-through at Tolmino, followed merely by rolling up the Isonzo front. But this plan was expanded into a more ambitious one without an increase of means. The Germans at Caporetto, like the British subsequently at Cambrai, were to provide an example of the profound strategic error of not "cutting your coat according to your cloth."

On hearing the Austrian proposals Ludendorff sent Gen. Krafft von Dellmensingen, an expert in mountain warfare and commander of the Alpine Corps in the Rumanian campaign, to reconnoitre the ground, and on receiving his report, approved the scheme. The six German divisions with nine Austrian formed the 14th German Army under Otto von Below, with Krafft as chief of staff and guiding brain. These troops were to penetrate the mountain barrier at the north-east corner of the Venetian salient, while Boroevic's two Austrian armies were to advance along the stretch of lower ground near the Adriatic shore. The organization and deployment of the attack in such mountainous country were difficult, but were ably overcome. Guns were brought up mostly by hand and at night; the infantry came up by night marches with all their ammunition and supplies on pack animals. Thanks to skilful precautions and the Italians' limited air reconnaissance, the concentration was undiscovered. On Oct. 24, after four hours' gas shell bombardment and one hour general, the blow was launched and pushed deep down the western slopes of the mountains, imperilling the Italian forces to both south and north. On Oct. 28 Below's van reached Udine, the former Italian general headquarters, and on Oct. 31 the Tagliamento.

Not the least significant feature of this offensive was the way it was prepared by a moral bombardment. Propaganda has been exploited for months as a means of sapping the Italian discipline and will to resist. But its effect can be exaggerated—the most formidable propaganda, as with the French in April, was that supplied by the attrition strategy of the Italian command, which had sickened the troops by its limited results at unlimited cost. Cadorna, too, offset undoubted ability by his lack of touch with and understanding of the fighting troops. Troops already too highly tried were kept too long without relief. Despite warnings of a hostile offensive, he had paid too little heed to Capello's complaints about the defensive suitability of the positions on which the Italian offensive had stopped, and had overruled his desire to forestall the enemy by a flank thrust northwards from the Bainsizza plateau.

But the result also surprised Ludendorff, who, with his slender forces, had not calculated on such distant objectives as were now possible of attainment. Boroevic was slow in following up the Italian right, and Ludendorff tried to switch part of his force to Conrad's army which flanked the north of the Venetian salient, but was foiled by the inadequacy of the rail communications. Even so, Cadorna, with his centre broken through, only saved his wings by a precipitate retreat to the line of the Piave, covering Venice, and on Nov. 9 the whole Italian army was behind this river, except for 250,000 prisoners in the enemy's hands, and nearly twice as many other casualties—killed, missing or sick. The same day Cadorna was superseded in supreme command by Diaz. Italy's allies had begun to rush reinforcements, a British and a French army corps, to her aid, and on Nov. 5 their political and military chiefs arrived at Rapallo for a conference, out of which sprang the Allied Council at Versailles, and ultimately a unified command.

The invaders had outrun their transport, and the resistance of the Italians, morally braced by the emergency, succeeded in holding the Piave (*q.v.*) in face of direct assaults and strenuous efforts by Conrad to turn their left flank from the Trentino. Here Cadorna's preparations for defence had been long initiated and were well matured. At the beginning of December the British and French, who had been waiting in reserve in case of a fresh break-through, moved forward to take over vulnerable sectors, but the attack was only renewed in the north, and on Dec. 19 it came to an end with the snows. If Caporetto seriously damaged Italy, it also purged her, and after an interval of recuperation she was to vindicate herself at Vittorio Veneto.

The Capture of Jerusalem.--Once more a distant theatre of war provided the sole triumph of the Entente cause during the year—this time in Palestine (*q.v.*). The second reverse at Gaza, in April 1917, had led to a change in command, Murray being succeeded by Allenby, who was strong enough and fortunate enough to obtain the adequate force for which Murray had asked in vain. The British Government was anxious for a spectacular success to offset the moral depression of the Nivelle failure and the decline of Russia, and the British general staff desired to dislocate the Turkish attempt to recapture Baghdad by drawing away their reserves.

Allenby took over in July and devoted the first three months to intensive preparations for an autumn offensive, when the season would be suitable. The command was reorganized, the communications developed, and his own headquarters moved forward from Cairo to the front. By complete secrecy and ruses he deceived the Turks as to the main point of attack. The defences of Gaza were bombarded from Oct. 20 onwards, and an attack followed on Nov. 1 to pin the enemy and draw in his reserves. Meanwhile, as a necessary preliminary to the real blow, the inland bastion of Beersheba was seized by a convergent manoeuvre on Oct. 31, a prelude to the decisive attack on Nov. 6, which broke through the enemy's weakened centre and into the plain of Philistia.

Falkenhayn, now in command at Aleppo, had also been planning an offensive, but the better communications of the British had decided the race, and although Falkenhayn tried to stem the tide by a counter-stroke against Beersheba, the breaking of his centre compelled a general retreat. The pursuit was hampered owing to lack of water, but, even so, by Nov. 14 the Turkish forces were driven apart in two divergent groups, the port of Jaffa was taken, and Allenby wheeled his main force to the right for an advance inland on Jerusalem. He gained the narrow hill passes before the Turks could block them, and after a necessary pause to improve his communications, brought up reserves for a fresh advance, which secured Jerusalem on Dec. 9. By the time the winter rains set in the British had expanded and consolidated their hold on the region. As a moral success the feat was valuable, yet viewed strategically, it seemed a long way round to the goal. If Turkey be pictured as a bent old man, the British, after missing their blow at his head—Constantinople—and omitting to strike at his heart—Alexandretta—had now resigned themselves to swallowing him from the feet upwards, like a python dragging its endless length across the desert.

The Conquest of East Africa.—The year 1917 witnessed another overseas success, the clearing of German East Africa, although not the close of the campaign. More than a year elapsed after the rebuff at Tanga before a serious attempt was made to subdue the last German stronghold on the African continent. To spare troops from the main theatres was difficult, and the solution was only made possible by the loyal co-operation of the South African Government. In Feb. 1916 Gen. Smuts was appointed to command the expedition, and formed the plan of a drive from north to south through the difficult interior, in order to avoid the fever-rampant plain on the coast. In conjunction with this central wedge, a Belgian force under Tombeur was to advance eastwards from Lake Tanganyika, and a small British force under Northey was to strike in from Nyasaland in the south-west. The Germans under Lettow-Vorbeck were weak in numbers but handled with masterly skill, and with all the advantages of an equatorial climate, a vast and trackless region—mountainous in parts and covered with dense bush and forest—to assist them in impeding the invader. From Dar-es Salaam on the coast to Ujiji on Lake Tanganyika ran the one real line of rail communication, across the centre of the colony. After driving the Germans back across the frontier and seizing the Kilimanjaro gap, Smuts moved direct on this railway at Morogoro, over 300 m. distant, while he dispatched a force under Van Deventer in a wide sweep to the west to cut the railway further inland and then converge on Morogoro. Lettow-Vorbeck delayed this manoeuvre by a concentration against Van Deventer, but Smuts's direct advance compelled him to hurry his force back, and thus enabled Van Deventer to get astride the railway.

However, Letto-Vorbeck evaded the attempt to cut him off and fell back in September on the Uluguru mountains to the south. The Belgians and Northey had cleared the west, and the net had been drawn steadily closer, confining Lettow-Vorbeck to the south-east quarter of the colony. Early in 1917 Smuts returned to England, and Van Deventer conducted the final operations which ended with Lettow-Vorbeck, avoiding envelopment to the end, slipping across the frontier into Portuguese Africa. Here he maintained a guerrilla campaign throughout 1918 until the general Armistice. With an original force of only 5,000, 5% being Europeans, he had caused the employment of 130,000 enemy troops and the expenditure of £72,000,000.

The Mastering of the Submarine.—The military side of 1917 is thrown into shadow by the naval, or more strictly the economic, side. The vital issue turned on the balance between Germany's submarine pressure and Britain's resistance. April was perhaps the most critical month. The Allies lost nearly a million tons of shipping, 60% British, and although the German navy's promise of victory by the end of the month was proved a miscalculation, it was clear that, ultimately, the continuance of such a ratio of loss must starve the civilian population and automatically prevent the maintenance of the armies. Britain, indeed, had only food enough to sustain her people for another six weeks. The British Government sought to counter the menace by the indirect means of rationing, increasing home production and the expansion of shipbuilding; by the direct means of the system of convoys with naval escorts, and a counter-offensive against the submarine. Aided by new devices to detect the presence of submarines and the use of thousands of patrol craft, this highly organized campaign exacted an ever-rising toll, and by the end of 1917 the menace, if not broken, was at least subdued. In this task America's aid became a potent factor long before her military assistance. It embraced her provision of light craft to reinforce the British anti-submarine fleet, her rapidly developed construction of new mercantile ships, and still more her financial aid. By July 1917 Britain had spent over £5,000,000,000, her daily expenditure had risen to £7,000,000, and the burden of financing her Allies as well as her own efforts was straining even her resources, when America's aid came to ease the pressure.

These were the defensive benefits; the offensive were at least as great. No longer was the grip of the naval blockade hampered by neutral quibbles, but instead, America's co-operation converted it into a strangle-hold under which the enemy must soon grow limp, since military power is based on economic endurance. As a party to the war, the United States, indeed, wielded the economic weapon with a determination, regardless of the remaining neutrals, far exceeding Britain's boldest claims in the past years of controversy over neutral rights. The submarine menace, crippled in 1917, was ended to all intents during the early months of 1918. To this conclusion the greatest single contribution was the laying of a mine-barrage by the American navy across the 250 m. wide passage between Norway and Scotland. This was a direct counter to the main submarine operations against the ocean-brought supplies of Great Britain. For the small submarines which carried out the shorter range operations the ports on the Belgian coast had afforded a base unpleasantly close to English shores, but these also were now closed by the daring attacks of Sir Roger Keyes's force on Zeebrugge and Ostend. Yet the removal of the menace should not lead to an underestimate of its powers for the future. The 1917 campaign was launched with only 148 submarines and from the most unfavourable strategic position. Great Britain lay like a huge breakwater across the sea approaches to northern Europe and the submarines had to get outside through narrow and closely-watchec! outlets before they could operate against the arteries of supply. And despite these handicaps they almost stopped the beat of England's heart.

The **Air** Offensive.—Another new form of action reached its crest at the same time as the submarine campaign. As the submarine was primarily an economic weapon, so was the aeroplane primarily a psychological weapon. The explosive bullet had virtually ended the Zeppelin raids in 1916, but from early in 1917 aeroplane raids on London grew in intensity until, by May 1918, the air defences were so thoroughly organized that the raiders thereafter abandoned London, as a target, for Paris. If the stoicism of the civil population took much of the sting from a weapon then in its infancy, the indirect effect was serious, interrupting business and checking output in industrial centres, as well as drawing off, for defence, many aircraft from the front. In reply the British formed an Independent Air Force, which carried out extensive raids into Germany during the closing months of the war, with marked effect on the declining morale of the "home front." To relate the action of aircraft in the military sphere is not possible, for it formed a thread running through and vitally influencing the whole course of operations, rather than a separate strategic feature.

The beginning of 1918 witnessed the development and thorough organization of another psychological weapon, when Lord Northcliffe was appointed director of propaganda in enemy countries, and for the first time the full scope of such a weapon was understood and exploited.

IX. GERMANY'S BID FOR VICTORY

On the Threshold **of** 1918.—The middle years of the World War had been, in a military sense, a tussle between a lean Hercules and a bulky Cerberus. The Germanic alliance mas weaker in numbers but directed by a single head, the Entente stronger in numbers but with too many heads. Owing to their own excessive losses, diffusion of effort and the collapse of Russia, the Entente, at the end of 1917, were faced with the grim fact that the numerical balance had been reversed, and months must elapse before the prospective stream of America's new divisions came to tilt the scales once more in their favour. The emergency paved the way for the creation of a unified command, but it still needed disaster to bring it into being.

At the conference at Rapallo in November, the formation of a Supreme War Council was decided upon, to be composed of the principal ministers of the Allies, with military representatives, and to sit permanently at Versailles. If the fundamental defect was that it merely substituted a formal for an informal committee, a further flaw was that the military representatives had no executive status. In the economic sphere, where deliberation rather than instant action was necessary, it led to a real improvement in the combination of shipping, food and munition resources. Militarily, it was futile, for it set up a dual advisorship—the Versailles representatives on the one hand and the chiefs of the national general staffs on the other. As the menace of the German attack grew closer and with it the need for common action, this advisory body was converted into a military executive committee to handle an inter-Allied general reserve, a fresh compromise which set up a dual control—the commanders-in-chief and the Versailles committee.

If concentration of control was lacking, so also was concentration of force. Since early in November the stream of German troop-trains from East to West had been steadily swelling. When the 1917 campaign opened there had been a proportion of nearly three Allies to two Germans—actually, in March 178 British, French and Belgian divisions against 129 German divisions. But now the Germans had a slight balance and the likelihood of bringing still more. But the Allied statesmen, recalling how often their own offensive had failed with equal or greater superiority of force, were slow to appreciate the gravity of the menace or to respond to the sudden fall in the temperature of military opinion. Nor could they agree to draw reinforcements from the other fronts. The Italians strove against any withdrawal of the Allied contingents from their front, and the French opposed any reduction of the Salonika force. Lloyd George went further and urged an offensive in Palestine, a scheme which was sanctioned on the understanding that no reinforcements went there from France, but which also meant that none came from there to France. Robertson, the chief of the imperial general staff, disagreed both with this Palestine plan and the creation of the Versailles executive committee, and resigned, being succeeded by Sir Henry Wilson. The position was still further weakened by the insistence of Clemenceau, the new French premier, that the British should extend their front south to the Oise. This meant that Gough's 5th Army was dangerously stretched out and took over ill-prepared defences on the very front that Ludendorff was about to strike. Meantime. the German strength had increased to 177 divisions by the end of January, with 30 more to come. The Allied strength, owing to the despatch of divisions to Italy and the breaking up of others owing to the French shortage of drafts, had fallen to the equivalent of 173—counting as double the four and one-half large size American divisions which had arrived. For the French and British had been constrained to follow the Germans in reducing their divisions from 12 to g battalions each.

The prolonged pouring of soldiers' lives into the swamps beyond Ypres had led Lloyd George and his cabinet to withhold reinforcements for fear of encouraging fresh squandering. This undoubtedly weakened Haig's initial power of resistance to the German onslaught, yet it is just to point out that it was weakened worse—in quality as well as quantity—by the 400,000 British casualties suffered in the offensive of the later part of 1917. Moreover, we should not forget that the Government had the heavy responsibility of being the trustees for the lives of the nation. The real ground of criticism is that it was not strong enough to make a change in, or place a check upon, a command which it did not trust, while supplying the reinforcements necessary for defence. And for this lack of moral strength the public must share the blame, for they had already shown themselves too easily swayed by clamour against political interference with the generals, and too prone to believe that the politician is invariably wrong on such occasions. The civilian public, indeed, is apt to trust soldiers too little in peace, and sometimes too much in war.

These political handicaps, and their accompanying tendency to work deviously towards what dared not be demanded openly, were also seen in the project for a unified command. The prime minister, indeed, had gone so far in December as to disclaim faith in his own long-sought cure. Instead he sought a palliative in an inter-Allied executive committee, under Foch's chairmanship, which should control a common general reserve of 30 divisions. This scheme was stillborn in face of the opposition of the respective commanders-in-chief, Haig and Pétain. The decisive act came from Haig, who, when called on by Foch for his contribution of seven divisions, replied that he could spare none. He and Pétain united in preferring an arrangement between themselves for mutual support.

When the test came, a week later, this broke down, and Haig then took a foremost part in hastening and facilitating the appointment of a generalissimo, which he had formerly opposed. For the actual breakdown the blame has been commonly thrown upon the French, and there is no question that Haig understood from Pétain on March 24 that if the Germans continued their rapid progress the French reserves would have to be used to cover Paris. But in fairness it is essential to add that, whereas the original compact had only pledged the aid of some six French divisions, Pétain actually sent nine by March 24, and 21 (including four of cavalry) by March 26. If these reinforcements were, perhaps, slower in coming into action than in despatch, it does not affect the fact that the original pledge was amply exceeded. Thus, the fundamental fault would seem to lie in trusting to an arrangement for such slender support by either Ally.

The German Plan.—On the German side the submarine panacea for victory had been replaced by a military panacea, and hopes were perhaps exaggerated by the unexpected collapse of Russia. But although Ludendorff promised victory in the field, he did not disguise that a Western offensive would be a far harder task than the conquests in the East. He realized also that it would be a race between the effect of Germany's blow and the arrival of American reinforcements, although he hoped to win the race. To secure the rear of his offensive, a definite peace was won from the Bolshevik Government of Russia by a military demonstration, and also forced on Rumania. And to secure if possible the economic base of his offensive the Ukraine was occupied, for its wheat supplies, with little resistance except from Czechoslovak troops, who had formerly been taken prisoners from the Austrian army.

Ludendorff's next problem was to decide his first point of attack. The sector between Arras and St. Quentin was chosen, on the western face of the great salient formed by the German front in France. The choice was governed by tactical reasons—this sector was the enemy's weakest point and the ground offered fewer difficulties than elsewhere—although Ludendorff had in mind the possibility of separating the Allied armies and driving the British back against the Channel coast, too closely penned in to evade the blows. From the experience of the vain Allied attacks Ludendorff had drawn the deduction that "Tactics had to be considered before purely strategical objects which it is futile to pursue unless tactical success is possible." Hence he formulated a strategical plan based on the principle of taking the tactical line of least resistance. Presumably he hoped by firm control to guide these tactical movements to a strategic destination. If so, he failed.

Where did the fault lie? The general view at the end of the war was that the tactical bias had led Ludendorff to change direction and dissipate his strength. That if the Franco-British command had previously erred by aiming at the strategically correct target without enough attention to the tactical difficulties, the German command had followed it with an equal if opposite error by concentrating on tactical success at the expense of the strategical goal. But a closer examination of the German documents since available, and of Ludendorff's own orders and instructions, throws a different light on the question. It would seem, indeed, that the real fault was that Ludendorff failed to carry out in practice the new principle he had adopted in theory; that he either did not grasp or shrank from the full implication of this new theory of strategy. He dissipated too large a part of his reserves in trying to redeem tactical failures and hesitated too long over the decision to exploit his tactical successes. Ludendorff's strategy in the East had been so masterly and so far-sighted that his indecision and short-sight in the West is difficult to explain. Perhaps he himself was feeling the strain of directing so many vast operations; perhaps it was that he missed the strategical insight and balanced view of Hoffmann who, after being at his side throughout the 1914–16 campaigns, had stayed in the East when Ludendorff went to the supreme command. The modern vice of seniority prevented Germany from making the fullest use of the man who perhaps approached nearer to military genius than any other military figure of the war.

In any case the campaign leaves the impression that Ludendorff had neither his former clearness as to the goal, nor quite the same grip on the changing situations. But in the organization of his attacks his powers were at their highest level. Surprise was to be the key by which a gate in the long-locked front was opened. In forging the key gas-shell was to be the main constituent, for Ludendorff had failed to grasp the significance of the tank and neglected to develop it in time. Only in Aug. 1918, when it was used to strike him a mortal blow did he put it in the "urgent" class of war material. The troops were trained in the new infiltration tactics already tested at Riga, and the most thorough arrangements were made for concealing and for exploiting the attacks. The assaulting divisions were to be brought up over night, the masses of artillery brought close to the front line in concealment, and their ranges obtained by methods which did away with preliminary "registration." The bombardment was to be brief but intense, and its surprise effect to be increased by lavish use of gas and smoke shell. Further, while Ludendorff had settled to strike first on the Somme sector, to which blow the code-name "Michael" was given, he also made preparations for successive attacks at other points, which besides being in readiness for the future helped to mystify the enemy. Two were on the British front and one on the French—"St. George I." against the Lys sector, "St. George II." against the Ypres sector and "Blücher" in Champagne.

The "Michael" attack was to be made by the German 17th, 2nd, and 18th Armies (62 divisions in all) on the 47 m. front Arras-St. Quentin-La Fere, but its main force was intended to be exerted north of the Somme, and after breaking through, the 17th and 2nd Armies were to wheel north-west and press the British army against the coast, while the river and the 18th Army guarded their flank. This plan was radically changed in execution because Ludendorff gained rapid success where he desired it little and failed to gain success where he wanted it most. The attack was launched on March 21 (see ST. QUENTIN, BATTLE OF 1918), and the surprise was helped by an early morning mist. But while the thrust broke through completely south of the Somme, where the defence—but also the attacking force—was thinnest, it was held up near Arras, a check which reacted on all the attack north of the river. Ludendorff, violating his new principle, spent the following days in trying to revive his attack against the strong, and strongly held bastion of Arras, maintaining this direction as his principal line of effort. Meantime he kept a tight rein on the 18th Army which was advancing in the south without serious check from its opponents. As late as March 26 he issued orders which restrained it from crossing the Avre and tied it to the pace of its neighbour, the 2nd, which in turn was held back by the very limited success of the 17th Army near Arras.

Thus we see that in reality Ludendorff was bent on breaking the British army by breaking down its strongest sector of resistance in a direct assault. And because of this obsession he failed, until too late, to throw the weight of his reserves along the line of least resistance south of the Somme. The intended wheel to the north-west might have come to pass if it had been made after passing the flank, and thus being directed against the rear, of the Arras bastion. On March 26 the attack north of the Somme (by the left wing of the 17th Army and the right of the 2nd Army) was visibly weakening as the price of its hard-earned gains. South of the Somme the left of the 2nd Army reached, and was now to be embarrassed by, the desert of the old Somme battlefields—a brake on progress and supply. The 18th Army alone was advancing with unslackened impetus. This situation led Ludendorff to adopt a new plan, but without relinquishing his old. He ordered for March 28 a fresh and direct attack on the high ground near Arras—by the right of the 17th Army and to be followed by a 6th Army attack just to the north between Vimy and La Bassée. But the promising situation south of the Somme led him to indicate Amiens as an additional main objective. Even so, he restrained the 18th Army from pushing across the Avre without further orders! On March 28 the fresh Arras attack was launched, unshielded by mist or surprise, and failed completely in face of the well prepared resistance of Byng's 3rd Army. Only then did Ludendorff abandon his original idea, and direct his main effort, and some of his remaining reserves, towards Amiens. By March 27 the advance had penetrated nearly 40 m. and reached Montdidier, cutting one railway to Paris; by March 30 the German flood was almost lapping the outworks of Amiens. Once the crust was broken, the very elaboration of the methods of control communication built up during three years of static warfare caused the greater flux behind the front. The extent of the retreat was primarily the measure of the loss of control by the British commanders.

Disaster had driven the Allies to an overdue step, and on Haig's appeal and Lord Milner's intervention Foch had been appointed on March 26 to "co-ordinate" the operations of the Allied armies. If he had fallen into disfavour owing to the heavy cost of his attacks in Artois during 1915 and the barren fruit of the Somme in 1916, his will-power and energy earned and created confidence. On April 14 he was definitely made commander-in-chief of the Allied armies. But before this a fresh German menace had developed—though not intended as such.

When Ludendorff decided to change his main line of attack to the sector south of the Somme, he diverted reserves thither. But meantime he ordered the 18th Army to mark time for two days. When the attack was renewed in force on March 30 it made little progress in face of a resistance that had been afforded time to harden, helped by the cement of French reserves which were now being poured into the breach. A further effort on April 4 had still less success and Ludendorff, rather than be drawn into an attrition struggle, suspended the attack towards Amiens. With a large part of his reserves holding the vast bulge south of the Somme, Ludendorff turned, if without much confidence and merely as a diversion, to release, on April g, his "St. George I." attack. (See LYS, BATTLE OF THE, 1918.) Its astonishing early success against a weakened front led him to convert it bit by bit into a major effort. The British were desperately close to the sea, but their resistance stopped the German tide after a 10 m. invasion just short of the important railway junction of Hazebrouck, and an attempt to widen the front towards Ypres was nullified by Haig's swinging his line back just before and by the gradual arrival of French reinforcements. Haig complained strongly that Foch was too slow in sending French reserves northward, but the event justified Foch's reluctance to commit himself thither and his seeming excess of optimism in declaring that the danger was past. Ludendorff had doled out reserves sparingly, usually too late and too few for real success; so apprehensive that his new bulge would become another sack, that after the capture of Kenmel Hill, when opportunity opened its arms, he stopped the exploitation for fear of a counter-stroke.

Thus Ludendorff had fallen short of strategic results; on the other hand he could claim huge tactical successes—the British casualties were over 300,000. The British lion had been badly mauled, and although fresh drafts to the number of 140,000 were hurried out from England and divisions brought back from Italy, Salonika and Palestine, months must elapse before it could recover its offensive power. Ten British divisions had to be broken up temporarily, while the German strength had now mounted to 208, of which 80 were still in reserve. A restgration of the balance, however, was now in sight. A dozen American divisions had arrived in France and, responding to the call, great efforts were being made to swell the stream. Further, Pershing, the American commander, had placed his troops at Foch's disposal for use wherever required. For Germany the sands were running out, and, realizing this, Ludendorff launched his "Blücher" attack between Soissons and Reims, on May 27. Falling by surprise with 15 divisions against seven, it swept over the Aisne and reached the Marne on May 30, where its impetus died away. (See CHEMIN-DES-DAMES, BATTLE OF THE, 1918.) This time the German superiority of force had not been so pronounced as before nor aided by nature's atmospheric cloak. It would seem that the extent of the opening success was due in part to the strategic surprise—the greater unexpectedness of the time and place of the blow—and in part to the folly of the local army command in insisting on the long-exploded and obsolete method of massing the defenders in the forward positions—there to be compressed cannon-fodder for the German bombardment. Pétain's recent instructions for a deep and elastic system of defence had been disregarded. This indeed, was an additional form of surprise, for the object of all surprise is the dislocation of the opponent's moral and mind and the effect is the same whether he be caught napping by deception or allows himself to be trapped with his eyes open. Further, the Germans' success on May 27, 1918, deserves study in comparison with their other offensives whose success was almost in mathematical ratio to their degree of surprise. This final year, indeed, read in the light of previous years, affords fresh proof that surprise—or, more scientifically, the dislocation of the enemy's balance—is essential to true success in every operation of war. At the bar of universal history, any commander who risks lives without seeking his preliminary guarantee stands condemned.

But once again Ludendorff had obtained a measure of success for which he was neither prepared nor desirous. The surpriser was himself surprised. The attack had been conceived merely as a diversion, to attract the Allied reserves thither preparatory to a final and decisive blow at the British front in Flanders. But its opening success attracted thither too large, yet not large enough, a proportion of their own reserves. Blocked frontally by the river, an attempt was made to push west, but it failed in face of Allied resistance—notable for the appearance of American divisions at Chateau-Thierry, where they gallantly counter-attacked.

Ludendorff had now created two huge bulges, and another smaller one, in the Allied front. His next attempt was to pinch out the Compihgne "tongue" which lay between the Amiens and Marne bulges. But this time there was no surprise, and the blow on the west side of the "tongue," June g, was too late to coincide with the pressure on the east. A month's pause followed. Ludendorff was anxious to strike his long-cherished decisive blow against the British in Belgium, but he considered that their reserves here were still too strong, and so again decided to take the line of least tactical resistance, hoping that a heavy blow in the south would draw off the British reserves. He had failed to pinch out the Compihgne "tongue" on the west of his Marne salient; he was now about to attempt the same method on the east, by attacking on either side of Reims. But he needed an interval for rest and preparation, and the delay was fatal, giving the British and French time to recuperate, and the Americans to gather strength. The British divisions previously broken up had now been reconstituted, and as a result of an urgent appeal made to President Wilson in the crisis of March, and the provision of extra shipping, American troops had been arriving at the rate of 300,000 a month since the end of April. The tactical success of his own blows had been Ludendorff's undoing; yielding to their influence, he had pressed each too far and too long, so using up his own reserves and causing an undue interval between each blow. He had driven in three great wedges, but none had penetrated far enough to sever a vital artery, and this strategic failure left the Germans with an indented front which invited flanking counter-strokes.

X. THE FINAL PHASE

The **Turning of** the Tide.—On July 15 Ludendorff launched his new attack, but its coming was no secret. East of Reims it was foiled by an elastic defence, and west of Reims the German penetration across the Marne merely enmeshed them more deeply to their downfall—for on July 18 Foch launched a long-prepared stroke against the other flank of the Marne salient. (See MARNE, SECOND BATTLE OF THE.) Here Pétain, who directed the operation, turned the key which Ludendorff lacked, using masses of light tanks to lead a surprise attack on the Cambrai method. The Germans managed to hold the gates of the salient open long enough to draw their forces back into safety and straighten their line. But their reserves were depleted, Ludendorff was forced to postpone if not yet to abandon the offensive in Flanders and the initiative definitely and finally passed to the Allies. Foch's first concern was to keep it, by giving the enemy no rest while his own reserves were accumulating. To this end he arranged with Haig, Pétain and Pershing for a series of local offensives, aimed to free the lateral railway communications and to improve the position of the front ready for further operations. To Haig he proposed an attack in the Lys sector, but Haig saw "no advantage in an advance over this flat and marshy region" and suggested instead the Somme area as more suitable and more strategically effective. Already, before the Marne counter-stroke Rawlinson, commanding the British 4th Army in front of Amiens (*q.v.*), had submitted to Haig a plan for a large surprise attack there, and Foch agreed to this in place of his own proposal. He also placed under Haig the French 1st Army (Debeney) to extend the attack to the south. Rawlinson's army was doubled, and by skilful precautions the enemy were kept in the dark until, on Aug. 8, the attack was delivered—led by 450 tanks. The blow had the maximum shock of surprise, falling on an opponent who had done nothing to strengthen his position by entrenchments, and south of the Somme the troops of the Australian and Canadian Corps rapidly overran and overwhelmed the German forward divisions. By Aug. 12 when the advance came to a halt through reaching the tangled wilderness of the old 1516 battlefields, if also through lack of reserves, the 4th Army had taken 21,000 prisoners at a cost of only 20,000 casualties. Great, if not fully exploited, as a material success, it was far greater as a moral one.

Ludendorff has said: "Aug. 8 was the black day of the German army in the history of the war. . . . It put the decline of our fighting power beyond all doubt. . . . The war must be ended." He informed the emperor and the political chiefs that peace negotiations ought to be opened before the situation became worse, as it must. After July 18 Ludendorff had by no means lost hope and as late as Aug. 2 was ordering preparations for four fresh attacks, including his cherished Flanders design, if on a reduced scale. But after Aug. 8 these dreams vanished. The conclusions reached at a Crown Council held at Spa were that "We can no longer hope to break the war-will of our enemies by military operations" and "the object of our strategy must be to paralyse the enemy's war-will gradually by a strategic defensive." In other words the German command had abandoned hope of victory or even holding their gains, and hoped only to avoid surrender—an insecure moral foundation.

On Aug. 10 Foch issued a fresh *directive* for the preparation of an "advance" by the British 3rd Army "in the general direction of Bapaume and Peronne." Meantime he wished Haig to continue the 4th Army's frontal pressure, but Haig demurred to it as a vain waste of life and gained his point. Economy of force was henceforth to be added to the advantages of the new strategy now evolved. Thus the momentum of the 4th Army had hardly waned, before the 3rd Army moved. From then on Foch beat a tattoo on the German front, a series of rapid blows at different points, each broken off as soon as its initial impetus waned, each so aimed as to pave the way for the next, and all close enough in time and space to react on each other. Thus Ludendorff's power of switching reserves to threatened spots was stopped, as his balance of reserves was drained.

On Aug. 10 the French 3rd Army had struck to the south; then on Aug. 17 the French 10th Army still farther south; next, on Aug. 21, the British 3rd Army, followed by the British 1st Army on Aug. 26. Ludendorff's order to the troops holding the Lys salient to retire was hastened in execution by the attacks of the reformed British 5th Army, and by the first week in September the Germans were back on their original starting line—the strong defences of the Hindenburg line. And on Sept. 12 Pershing completed the series of preliminary operations by erasing the St. Mihiel (q v) salient—the first feat of the Americans as an independent army. Pershing had originally intended to make this a stepping stone to an advance towards the Briey coalfields and the eastern end of the Germans' main lateral railway near Metz, but the project was abandoned for reasons that will be referred to later. Thus no exploitation of the success was attempted.

The clear evidence of the Germans' decline and Haig's assurance that he mould break the Hindenburg line where the German reserves were thickest, decided Foch to seek victory that autumn instead of postponing the attempt until 1919. All the Allied armies in the West were to combine in a simultaneous offensive.

The Collapse of Bulgaria.—But before it could develop an event occurred in the Balkans which. in the words of Ludendorff, "sealed the fate of the Quadruple Alliance" He had still hoped to hold fast in his strong lines in the West, falling back gradually to fresh lines if necessary, and with his strategic flanks in Macedonia and Italy covered, while the German Government was negotiating for a favourable peace. At the same time there was alarm as to the moral effect of the Western front defeats on the German people, their will-power already undermined by shortage of food, and perhaps also by propaganda.

But on Sept. 15 the Allied armies in Salonika (*q.v.*) attacked the Bulgarian front, which crumpled in a few days. Guillaumat, who had succeeded Sarrail in Dec. 1917, had prepared the plan for an offensive, and when recalled to France in the crisis of July as governor of Paris he won over the Allied Governments to consent to the attempt. His successor in Salonika, Franchet d'Esperey, concentrated a Franco-Serb striking force, under Michich, on the Sokol-Dobropolye sector, west of the Vardar, where the Bulgarians trusted to the strength of the mountain ridges and were weak in numbers. On Sept. 15 Michich attacked and while the British attack at Doiran pinned a large part of the Bulgarian reserves, he broke right through towards Uskub. With their army split into two parts the Bulgarians, already tired of the war, sought an armistice, which was signed on Sept. 29. Franchet d'Esperey's achievement not only knocked away the first prop of the Central Alliance but opened the way to an advance on Austria's rear.

The Collapse of Turkey.—The offensive planned for the spring in Palestine had been interrupted by the crisis in France and the consequent withdrawal of most of Allenby's British troops. The depletion was made up by reinforcements from India and Mesopotamia, and by September Allenby was again ready to take the offensive. (See PALESTINE, OPERATIONS IN.) He secretly concentrated, on the Mediterranean flank, the mass of his infantry, and behind them the cavalry. In this way he changed a two to one superiority on the general front into four to one at the decisive point. At dawn on Sept. 19 the western mass attacked, rolling the Turks back north-east towards the hilly interior—like a door on its hinges. Through the open doorway the cavalry passed, riding straight up the coastal corridor for 30 m., before swinging east to cut the Turkish communications and close all exits of retreat. Completely trapped, the main Turkish armies were rounded up, while the British cavalry exploited the victory of Megiddo by a swift and sustained pursuit which gained first Damascus and finally Aleppo. Defenceless, and threatened with a direct advance of Milne from Macedonia on Constantinople, Turkey capitulated on Oct. 30.

The First Peace Note.—The capitulation of Bulgaria, convinced Ludendorff that it was necessary to take a decisive step towards securing peace. While he was scraping together a paltry half dozen divisions to form a new front in Serbia, and arranging a meeting with the political chiefs, Foch's grand assaults fell on the Western defences, Sept. 26–28, and the line threatened to crack.

The German supreme command lost its nerve—only for a matter of days, but that was sufficient, and recovery too late. On Sept. 29 they took the precipitate decision to appeal for an armistice, saying that the collapse of the Bulgarian front had upset all their dispositions—"troops destined for the Western front had had to be despatched there." This had "fundamentally changed" the situation in view of the attacks then being launched on the Western front, for though these "had so far been beaten off their continuance must be reckoned with."

This remark refers to Foch's general offensive. The American attack in the Meuse-Argonne had begun on Sept. 26, but had come practically to a standstill by the 28th. A Franco-Belgo-British attack had opened in Flanders on the 28th, but if unpleasant did not look really menacing. But on the morning of the 29th Haig's main blow was falling on the Hindenburg line, and the early news was disquieting.

In this emergency Prince Max was called to be chancellor to negotiate a peace move, with his international reputation for moderation and honour as its covering pledge. To bargain effectively and without confession of defeat he needed, and asked, a breathing space "of ten, eight, even four days, before I have to appeal to the enemy." But Hindenburg merely reiterated that "the gravity of the military situation admits of no delay," and insisted that "a peace offer to our enemies be issued at once."

Hence on Oct. 3 the appeal for an immediate armistice went out to President Wilson. It was an open confession of defeat to the world, and even before this—on Oct. 1—the supreme command had undermined their own home front by communicating the same impression to a meeting of the leaders of all political parties.

Men who had so long been kept in the dark were blinded by the sudden light. All the forces of discord and pacifism received an immense impulse.

While the German Government was debating the conditions for an armistice and questioning Ludendorff as to the situation of the army for further resistance if the terms were unacceptable, Foch continued his military pressure.

The Final Advance.—The plan agreed upon between Foch and the Allied commanders had been for a series of convergent and practically simultaneous attacks:—

1 and 2. By the Americans west of the Meuse, and by the French west of the Argonne, both in the direction of Mezières—beginning on Sept. 26. *(See* MEUSE-ARGONNE OPERATION.)

3. By the British on the St. Quentin-Cambrai front in the general direction of Maubeuge—beginning on Sept. 27. *(See* HINDENBURG *LINE,* BATTLES OF, 1918.)

4. By the Belgian and Allied forces in the direction of Ghent—beginning on Sept. 28.

The general aspect was that of a pincer-like manoeuvre against the vast salient jutting out between Ypres and Verdun. The attack towards Mezibres would shepherd that part of the German armies towards the difficult country of the Ardennes and away from their natural line of retreat through Lorraine; it was also dangerously close to the hinge of the Antwerp-Meuse line which the Germans were preparing in rear. The attack towards Maubeuge would threaten the other main line of communication and retreat through the Libge gap, but it had further to go. In these attacks, the Americans had the hardest natural obstacle, the Argonne forest; the British had to face the strongest defences and the heaviest weight of enemy troops.

Pershing's attack, adding surprise to its five to one superiority in numbers, opened well, but lost impetus owing to the difficulties of supply and exploitation in such country. When it was eventually suspended on Oct. 14, after bitter fighting and severe losses, the American army was still far distant from the vital railway. A new force, it was suffering the growing pains which the British had passed through in 1915–16. Pershing's difficulties were enhanced by the fact that he had waived his own proposal for an exploitation of the St. Mihiel success towards Metz in view of Haig's objection to a move which, however promising in its ultimate aim, would diverge from the general direction of the other Allied attacks. Haig desired that Pershing's attack should converge towards his in order more immediately to ease the task of the British troops. Foch's original plan for the general offensive had accordingly been readjusted, and in consequence Pershing had not only a more difficult sector but a bare week in which to prepare his blow. The shortness of time led him to use untried divisions instead of switching the more experienced divisions used at St. Mihiel. But in the outcome, Haig's insistence was proved unnecessary, for the British attack broke through the Hindenburg line before the Meuse-Argonne attack had drawn away any German division from his front.

Haig, by pushing forward his left wing first, facilitated the attack of his right on the strongest section of the Hindenburg line—the Canal du Nord—and by Oct. 5 the British were through the German defence system, with open country beyond. But on this front the attackers were in actually inferior numbers to the defenders, their tanks were used up, and they could not press forward fast enough to endanger the German retreat.

Within a few days the supreme command became more cheerful, even optimistic when it saw that breaking into the Hindenburg line had not been followed by an actual break-through of the fighting front. More encouragement came from reports of a slackening in the force of the Allies' attacks, particularly in the exploitation of opportunities. Ludendorff still wanted an armistice, but only to give his troops a rest as a prelude to further resistance and to ensure a secure withdrawal to a shortened defensive line on the frontier. By Oct. 17 he even felt he could do it without a rest. It was less that the situation had changed as that his impression of it had been revised. It had never been quite so bad as he had pictured it on Sept. 29. But his first impression had now spread throughout the political circles and public of Germany—as the ripples spread when a pebble has been dropped in a pool.

The combined pressure of the Allied armies, and their steady advance, were loosening the will-power of the German Government and people. The conviction of ultimate defeat, slower to appeal to them than to the army chiefs, was the more forcible when it was realized. And the indirect moral effect of military and economic pressure was accentuated by the direct effect of peace propaganda, skilfully directed and intensively waged by Northcliffe. The "home front" began to crumble later but it crumbled quicker than the battle front.

The Collapse of Austria.—The last Austrian attempt at an offensive on the Italian front, in conjunction with the German assaults in France, had been repulsed on the Piave in June. Diaz waited until conditions were ripe for an offensive in return, until Austria's internal decay was spreading and she was without hope from Germany. On Oct. 24 Cavan's army moved to seize the crossings of the Piave and on Oct. 27 the main attack opened, driving towards Vittorio Veneto *(q.v.)* to divide the Austrians in the Adriatic plain from those in the mountains. By Oct. 30 the Austrian army was split in two and the retreat became a rout, and the same day Austria asked for an armistice, which was signed on Nov. 3.

The Curtain Falls on the Western Front.—Already on Oct. 23 President Wilson had replied to the German requests by a note which virtually required an unconditional surrender. Ludendorff wished to carry on the struggle in hopes that a successful defence of the German frontier might damp the determination of the Allies. But the situation had passed beyond his control, the nation's will-power was broken, and his advice was in discredit. On Oct. 26 he was forced to resign.

Then, for 36 hours, the chancellor lay in coma from an overdose of sleeping draught after influenza. When he returned to his office on the evening of Nov. 3, not only Turkey, but Austria, has capitulated. If the situation on the Western front was felt to be rather easier, Austrian territory and railways were now available as a base of operations against Germany. Several weeks before, military opinion had tended to regard such a contingency, then unrealized, "as decisive." Next day revolution broke out in Germany, and swept rapidly over the country. And in these last days of tremendous and diverse psychological strain the "reddening" glare behind was accentuated by a looming cloud on the Lorraine front—where the renewed American pressure, since Nov. 1, was on a point more sensitive than other parts, where "they must not be allowed to advance if the Antwerp-Meuse line was to be held any longer." If this continued the Rhine and not the frontier would have to be the next line of resistance.

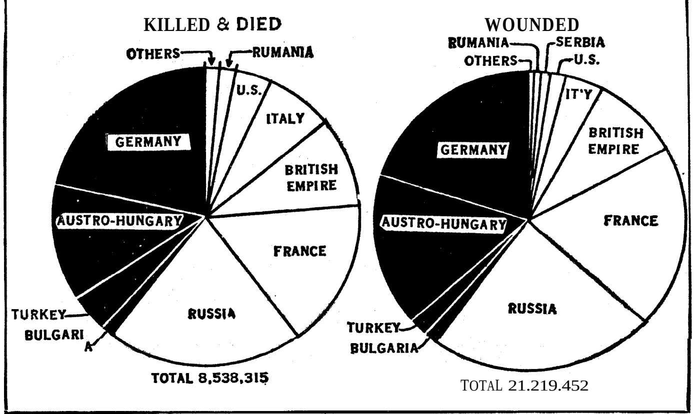
But hourly the revolution was spreading, fanned as peace negotiations were delayed, by the Kaiser's reluctance to abdicate. Compromise with the revolutionaries was the only chance, and on Nov. 9 Prince Max resigned to the Socialist Ebert. Germany had become a republic in outward response to President Wilson's demand and in inward response to the uprising of the German people against the leaders who had led them into disaster. The German fleet had already mutinied when their commanders sought to send them out on a forlorn hope against the British.

On Nov. 6 the German delegates left Berlin to treat for an armistice. Their acceptance of the severe terms was hastened less by existing military events than by collapse of the "home front," coupled with the imminence of a fresh blow. The Allied advance was still continuing, in some parts seeming to gather pace in the last days, but the main German forces had escaped from the perilous salient, and their complete destruction of roads and railways made it impossible for supplies to keep pace with the advancing troops. A pause must come while these communications were being repaired, and thus the Germans would have breathing space to rally their resistance. The advance reached the line Pont à Mousson-Sedan-Mezières-Mons-Ghent by Nov.

	Total Mobil-ized Forces	Killed and Died*	Wound Casualties	Prisoners and Missing	Total Casualties	Total Casualties in Per Cent of Total Mobilized
Allies						
Russia	12,000,000	1,700,000	4,950,000	2,500,000	9,150,000	76.3
France?	8,410,000	1,357,800	4,266,000	537,000	6,160,800	73.3
Brit. Empt†	8,904,467	908,371	2,090,212	191,652	3,190,235	35·8
Italy	5,615,000	650,000	947,000	600,000	2,197,000	39·1
U. S.‡	4,355,000	126,000¶	234,300¶	4,500	350,300	8·0
Japan	800,000	300	907	3	1,210	·2
Rumania	750,000	335,706	120,000	80,000	535,706	71·4
Serbia	707,343	45,000	133,148	152,958	331,106	46·8
Belgium	267,000	13,716	44,686	34,659	93,061	34·9
Greece	230,000	5,000	21,000	1,000	27,000	11·7
Portugal	100,000	7,222	13,751	12,318	33,291	33·3
Montenegro	50,000	3,000	10,000	7,000	20,000	40·0
Total	42,188,810	5,152,115	12,831,004	4,121,090	22,089,709§	52·3
Central ***Powers***						
Germany	11,000,000	1,773,700	4,216,058	1,152,800	7,142,558	64.9
Austro-Hungary	7,800,000	1,200,000	3,620,000	2,200,000	7,020,000	90·0
Turkey	2,850,000	325,000	400,000	250,000	975,000	34·2
Bulgaria	1,200,000	87,500	152,390	27,029	266,919	22.2
Total	22,850,000	3,386,200	8,388,448	3,629,829	15,404,477	67.4
G. Total	65,038,810	8,538,315	21,219,452	7,750,919	37,494,186§	57·6

* Includes deaths from all causes. † Official figures. ‡ Includes Marines serving with the Army. ¶ Includes "Died of Wounds" (14,500). § See note "¶."

MILITARY CASUALTIES IN THE WORLD WAR, AS ESTIMATED BY THE UNITED STATES WAR DEPARTMENT



11—the line of the opening battles in 1914—but strategically it had come to a standstill.

To meet this situation Foch had concentrated a large Franco-American force, of 28 divisions and 600 tanks, to strike below Metz directly east into Lorraine. The general Allied advance had almost absorbed the enemy's reserves, and now this decisive manoeuvre was to fall on his bared flank. It promised the chance of turning the whole of his new line of defence and if rapidly successful might intercept his retreat. In addition Trenchard's Independent Air Force was about to bomb Berlin, on a scale hitherto unattempted in air warfare. And the number of American divisions in France had risen to 42. Whether this final thrust, intended for Kov. 14, would have solved the hitherto insoluble problem of maintaining the momentum of advance after an initial break-through can never be known. But the attempt was unnecessary. For with revolution at home and the gathering menace on their frontier, the German delegates had no option but to accept the drastic terms of the Armistice, which was signed in Foch's railway-carriage in the Forest of Compiègne at 5 A.M. on Nov. 11, and at 11 o'clock that morning the World War came to an end.

XI. EPILOGUE

Controversy has long raged as to what was the deciding act of the conflict, what were the causes of victory, and, even less profitably, which country won the war.

The truth is that no one act, still less one cause, was, or could be, decisive. The Western front, the Balkan front, the tank, the blockade and propaganda have all been claimed as the cause of victory. All claims are justified, none is wholly right. In this new warfare between nations victory is a cumulative effect, to which all weapons—military, economic, and psychological—contribute. Victory comes, and can only come, through the utilization of all the resources existing in a modern nation.

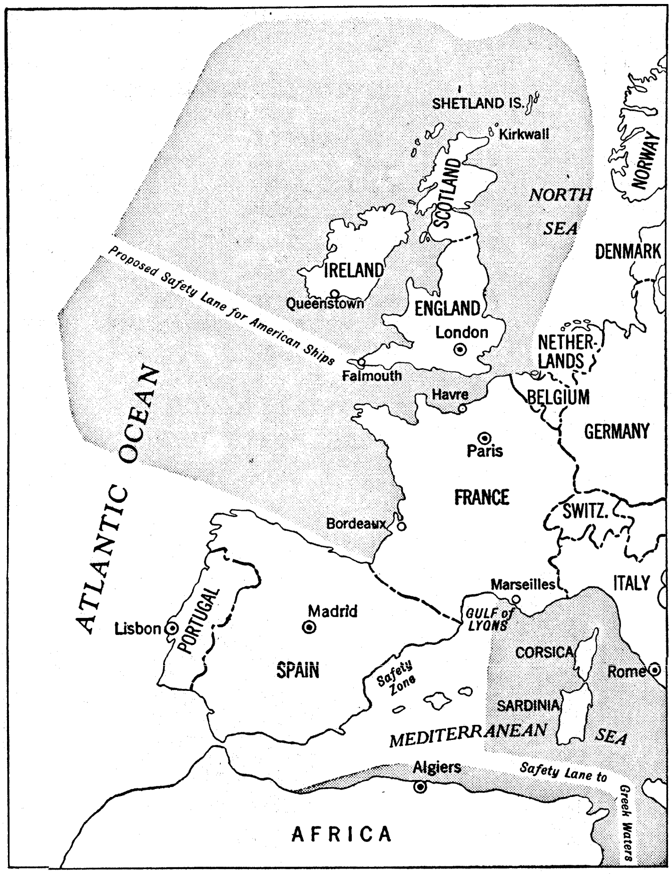
Among the fundamental causes of Germany's surrender the blockade, wielded by the British navy, is seen to assume larger and larger proportions as the fog of war disperses in the clearer light of these post-war years. It was a constructive hold which the Germans werepowerless to loosen. Helplessness induces hopelessness, and history attests that loss of hope and not loss of lives is what ultimately decides the issue of war. The intangible all-pervading factor of the blockade intrudes into every consideration of the military situation.

The naval factor again intervenes in the question whether Germany could have avoided capitulation in Nov. 1918 and whether, but for the revolution, her armies could have stood firm on their own frontiers. For even if the German people, roused to a supreme effort in visible defence of their own soil, could have held the Aliied armies at bay the end could only have been postponed—because of the grip of sea-power.

But in hastening the surrender, in preventing a continuance of the war into 1919 military action ranks foremost. Hence the success of the Allied armies is chief among the immediate causes of victory. That conclusion does not necessarily, or even naturally, imply that at the moment of the Armistice Germany's military power was broken or her armies decisively beaten. Nor that the Armistice was a mistaken concession. Rather does the record of the last "hundred days," when sifted, confirm the immemorial lesson that the true aim in war is the mind of the hostile rulers, not the bodies of their troops; that the balance between victory and defeat turns on mental impressions and only indirectly on physical blows. It was the shock of being surprised and the feeling that he was powerless to counter potential strategic moves which shook Ludendorff's nerve more than the loss of prisoners, guns, and acreage.

It is even more futile to ask which country won the war; France did not nin the war. but unless it had held the fort while the forces of Britain were preparing and those of the United States were still a dream the release of civilization from this nightmare of militarism would have been impossible.

Great Britain did not win the war, but without its command of the sea, its financial support and its army to take over the main



FROM CARLTON HAYES, "BRIEF HISTORY OF THE WORLD WAR (MACMILLAN)

SAFETY LANES FOR NEUTRALS IN MINE FIELDS

burden of the struggle from 1916 onward, defeat would have been inevitable.

The United States did not win the war, but without its economic aid to ease the strain. without the arrival of its troops to turn the numerical balance, and. above all, without the moral tonic which their coming gave, victory would have been impossible.

Finally, whatever be the verdict of history on its policy, unstinted tribute is due to the incomparable endurance and skill with which Germany more than held its own for four years against superior numbers, an epic of military and human achievement.

The development of the means and methods of warfare during the struggle are described in the following articles: AIR WARFARE; ARTILLERY; CAVALRY; INFANTRY; STRATEGY; TACTICS; TANK.

The campaigns and battles have received separate and detailed treatment in articles such as the following: CAMBRAI, BATTLE OF; CAPORETTO, BATTLE OF; DARDANELLES CAMPAIGN; FRONTIER. BATTLES OF THE; JUTLAND, BATTLE OF; LEMBERG, BATTLES OF; LUCK (LUTSK), BATTLES OF; MARNE, THE FIRST BATTLE OF THE; MARNE, SECOND BATTLE OF THE; NAREW, BATTLES OF THE; NAROCZ. BATTLE OF LAKE; PRZEMYSL, SIEGES OF; SALONIKA CAMPAIGNS, 1915–18; SERBIAN CAMPAIGNS (1914–1915); SOMME, BATTLES OF THE, 1916; VERDUN, BATTLES OF; VITTORIO VENETO, BATTLE OF; YPRES, THE BATTLE OF, 1914; YPRES, THE BATTLES OF, 1915; YPRES, BATTLES OF, 1917; YSER, BATTLE OF THE.

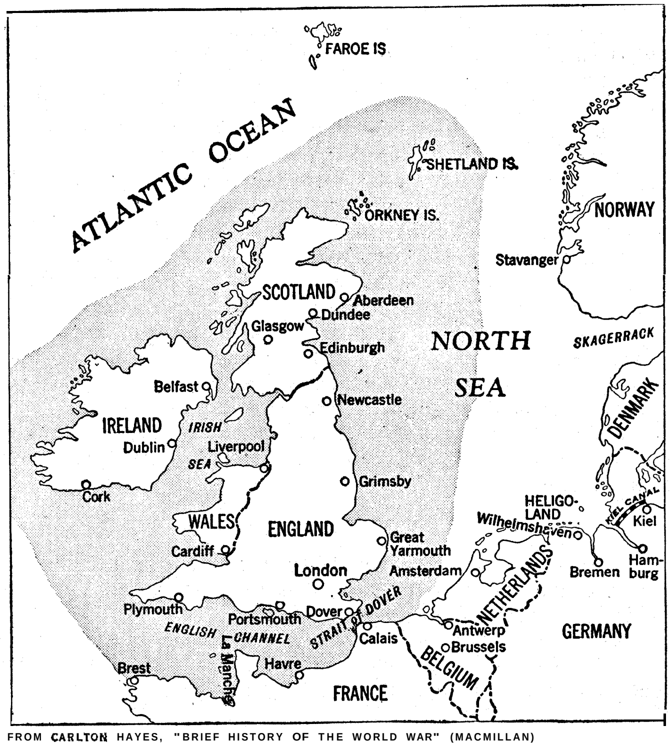
The mechanism of war, the organization of naval, military and air forces, and the scientific aspects of military machinery are also dealt with in such articles as those on ADMIRALTY; AIR FORCES; BALLISTICS; BRIDGING, MILITARY; CAMOUFLAGE; CHEMICAL WARFARE; FLAME THROWER; INTELLIGENCE, MILITARY AND POLITICAL; MINE, NAVAL; TRANSPORT, MILITARY; ORDNANCE; PARAVANE; RANGE FINDERS; SMALL ARMS, MILITARY; SUPPLY AND TRANSPORT, MILITARY. (B. H. L. H.)

NAVAL

To follow the world-wide ramifications of naval operations during World War I it is best to consider. year by year, the events in each area. At the outset they covered all the seas of the earth, but as the net was drawn around the Central Powers, the area of naval warfare was gradually reduced to European waters and to the seas around the British Isles. In addition to classical fleet and cruiser actions, commerce raiding and blockade tactics, all of which aided greatly in bringing the war to a close, World War I saw the emergence of the submarine as a potent naval weapon and brought about many of the earliest experiments concerned with the operation of aircraft from and against naval vessels.

Preliminary Moves.—In July 1914 in place of the usual summer manoeuvres, a test mobilization of the British fleet in home waters was carried out. The ships of the 2nd and 3rd fleets, their crews completed from the reserves, joined the 1st fleet at Portland on July 16th for exercises in the channel. On July 23, the day of the Austrian ultimatum to Serbia, the fleets were ordered to disperse. The ships of the 2nd and 3rd fleets returned to their home ports.

The 1st fleet remained at Portland, the defense flotillas were sent to their stations around the coast, and at the same time



FROM CARLTON HAYES, "BRIEF HISTORY OF THE WORLD WAR" (MACMILLAN)

GERMAN WAR ZONE, FEBRUARY 1915

the Mediterranean fleet was ordered to concentrate at Malta. On July 29 the 1st fleet left Portland for Scapa Flow, and, by Aug. 2 the 1st and 2nd fleets were at their war stations, the 3rd fleet was on the move, the defense flotillas were at their posts, and the organizations for taking up auxiliaries and for arming merchant liners were in force. On Aug. 1 the order for general mobilization was issued, followed next day by the calling up of the naval reserve. Because of the recent exercise the machinery of mobilisation worked smoothly and by the morning of Aug. 4 the state of naval readiness around the British Isles was such as to preclude the possibility of surprise before the outbreak of hostilities.

The German High Sea Fleet, which had been visiting Norwegian ports, was recalled. By July 30 all ships had returned to Wilhelmshaven and Kiel and no German ships were sighted by the British Fleet as it passed northward to its war stations.

Distribution of Fleets.—The following table shows the distribution of the British and German Fleets upon the outbreak of hostilities.

	British	German
	North Sea and Home Waters	
Dreadnought battleships:		
13·5 inch guns	10	..
12 inch guns	10	9
11 inch guns		4
Pre-dreadnought battleships	38*	22†
Battlecruisers	4	4
Cruisers	24	5
Lightcruisers	24	27
Destroyers	270‡	144
Submarines	65	28 (?)§
	North Atlantic and Trade Routes	
Cruisers	20	..
	Mediterranean	
Battlecruisers	3	1
Cruisers	4	..
Lightcruisers	4	1
Destroyers	16	..
Submarines	6	..
	North America and West Indies	
Cruisers	4	..
Light cruisers	1	2
	South Atlantic and West Coast of Africa	
Cruisers	4	..
Lightcruisers	1	
Gunboats	1	..
	Cape of Good Hope	
Lightcruisers	3	..
	East Indies Station	
Pre-dreadnought battleship		..
Light cruisers		1
Sloopsandgunboats	4	..
	China Station	
Pre-dreadnought battleship	1	..
Cruisers	2	2
Light cruisers	2	3
Destroyers and torpedo boats	12	..
Submarines		..
Sloops and gunboats		3
	Australia and New Zealand	
Battlecruiser	1	..
Lightcruisers	7‖	..
Destroyers	3	..
Submarines	2	..
Sloops	1	..
	West Coast of North America	
Sloops	2	..
submarines	2	..

*Including 5 "Canopus" and 9 "Majestics," obsolete ships of the third fleet.

†Including 10 obsolete "Wittelsbach" class stationed in the Baltic.

‡116 attached to Grand Fleet and Harwich Force. Remainder were old boats employed in patrol flotillas.

§Number is uncertain.

¶10 of these were non-seagoing river gunboats.

‖3 of these were old ships of the "P" class.

THE NORTH SEA AND CHANNEL 1914

The Commencement of Hostilities.—On the morning of Aug. 4 the Grand Fleet, commanded by Admiral Sir John Jellicoe, left Scapa Flow on the first of its many "sweeps" through the North Sea. Its object was to intercept any German commerce raiders that might put to sea before war was declared. At 11 P.M. that night all ships received the fateful wireless message to "commence hostilities against Germany." For three days the fleet cruised without seeing an enemy and on Aug. 7 returned to Scapa. The 10th Cruiser squadron, drawn from 3rd fleet cruisers, was not yet complete and this shortage of cruisers enabled one raider, the "Kaiser Wilhelm der Grosse," to escape through the cordon. Meanwhile the Harwich Force (Commodore Tyrwhitt) made a search of the Heligoland Bight, which resulted in the sinking of the minelayer "Konigin Luise" by the "Amphion." But the German mines had been laid and the "Amphion" ran into them on her return and was sunk. Thus early was first blood drawn upon both sides and Germany showed her intention to disregard, not only the customs of the sea, but her own signature to the Hague convention, by laying mines without warning, in international waters.

The Expeditionary Force.—The decision, on Aug. 5, to send the Expeditionary Force to France threw upon the navy the duty of safeguarding its passage. In the Channel were stationed the 5th, 7th and 8th Battle squadrons (eighteen pre-dreadnoughts) with one French and two British Cruiser squadrons. The Dover Straits were guarded by British and French destroyer and submarine flotillas, and an aerial patrol was established between the North Foreland and Ostend. Further north the Harwich Force patrolled the "Broad Fourteens" to the Dutch coast and the Grand Fleet took up a position in the centre of the North Sea, its cruisers and destroyers spread southward, ready to counter any move of the High Sea Fleet. Several unsuccessful submarine attacks were made upon ships of the Grand Fleet and on Aug. 9, "U. 15" was rammed and sunk by the cruiser "Birmingham" close to the fleet rendezvous. Regardless of the submarine risk, the fleet maintained its watch and from Aug. 15 to 17, when the bulk of the troops were afloat the Heligoland Bight was closely blockaded. Nothing was seen of the German fleet, whose inertness appeared surprising, it not then being realised that the policy of the German High Command was to preserve its fleet and to make only minor attacks with submarines and mines. By Aug. 18 the first four divisions were in France without the loss of a man and five days later the 5th Division was safely across. The enemy made their only appearance on Aug. 18, when two cruisers were sighted but escaped without being brought to action. The safe transport of the main body of troops being complete the Grand Fleet battleships withdrew to the west coast of Scotland, leaving two battlecruisers in the Humber to support the southern force.

Heligoland Bight Action.—To assist the Belgian army in creating a diversion on the German flank a brigade of Royal Marines was sent to Ostend: they landed with difficulty, in bad weather, on Aug. 27–28 from battleships of the Channel Fleet. This force being exposed to a sudden blow from the German Fleet, the Harwich flotillas, supported by battlecruisers and cruisers from the Grand Fleet, made an organised drive towards the German coast on the morning of Aug. 28. The outcome was the battle of the Heligoland Bight (*q.v.*) in which three German light cruisers and a destroyer were sunk and several other ships damaged, whilst the damage to British ships was small. This success in the first serious contact with the enemy at sea, did much to dispel the gloom cast by the retreat of the Allied armies before the German advance.

The shifting of the British army base from the Channel Ports to St. Nazaire, following the retreat from Mons threw a heavy burden upon the navy and especially upon the Admiralty transport service. Ships could no longer be spared for the Ostend diversion and the Royal Marine brigade was withdrawn on Aug. 31. The moving of the base began on Sept. 2 and was smoothly and rapidly completed.

In the last days of August, German mines, laid in the open sea off the Humber and Tyne caused the loss of several neutral ships and of the minesweeping gunboat "Speedy." Submarines were active in the North Sea and on Sept. 1, the report that one had entered Scapa Flow caused the Grand fleet to put hurriedly to sea. After sweeping in force to the Skaagerak the fleet returned on Sept. 5 to Loch Ewe to fuel and on that day the British navy suffered its first loss by submarine attack, when the scout "Pathfinder" was sunk by "U. 29."

On Sept. 10, in order to cover the passage of the 6th Division to France, a great sweep was made through the North Sea by the Grand Fleet supported by the Harwich Force and the Channel squadron. The Bight of Heligoland was searched but no German ships were seen excepting several submarines, one of which was rammed by the "Zealandia." On Sept. 12 the British submarines scored their first success when "E. 9" sank the cruiser "Hela" off Heligoland. The High Sea Fleet being known to be escorting troops in the Baltic, the opportunity was taken to give the Grand Fleet a few days rest, the first since war broke out. The fleet arrived at Loch Ewe on Sept. 13: its rest was but a short one for on the 17th it was again sweeping down the North Sea to the Horns Reef following the sinking of the "Cressy," "Hogue" and "Aboukir." These three cruisers were sunk within an hour by a single submarine ("U. 9"). They were steaming in line abreast on the "Broad Fourteens" patrol, having been deprived of their destroyer support by bad weather. The "Aboukir" was hit first and the other two were torpedoed in succession as they closed to pick up survivors. In this disaster 1,400 lives were lost: and orders were given that in future, heavy ships were not to stop to pick up survivors of consorts torpedoed by submarines, nor were armoured ships to be used for patrol or examining merchant ships in submarine waters.

The Fall of Antwerp.—In the closing days of September, the Belgian Government asked for assistance in the defence of Antwerp. Some naval guns were sent and a brigade of Royal Marines reached the city on Oct. 2, followed by two untrained brigades of the newly formed Royal Naval Division. On Oct. 2 the eastern approach to the Dover Straits was closed by a minefield, extending from the Goodwins to Ostend, every publicity being given to its limits. The 7th Division was landed at Zeebrugge on Oct. 7 without loss, in spite of a number of submarine attacks, but this desperate attempt to support the Belgian Army failed. Antwerp surrendered on Oct. 10 and the coast ports fell into the hands of the enemy as the Belgian Army retreated to the line of the Tser. One of the Naval Brigades, in the retreat, was forced across the Dutch frontier and interned. The German pursuit of the exhausted Belgian Army along the coast was stayed by the gallant work of a British flotilla under the command of Rear-Admiral Hood.

Meanwhile the Harwich Force watching for a move on the part of the Germans, obtained its reward on Oct. 16, when the "Undaunted" and four destroyers met and chased four German destroyers and sank them all. This was the only attempt, apart from submarine activities. by the German navy to interfere on the Belgian Coast at this phase.

Submarine Menace to the Grand Fleet.—The last days of September saw the Grand Fleet at Scapa Flow and from Oct. 2–12 the whole fleet was at sea engaged in safeguarding the passage of the Canadian convoy. On Oct. 7 a German submarine entered Loch Ewe, rendering that place unsafe as a fleet anchorage. The fleet returned to Scapa Flow, where a partial submarine obstruction was in place, on Oct. 12. At this time submarines were active in the vicinity of the northern bases and several attacks were made upon patrolling cruisers. On Oct. 15 the cruiser "Hawke" was sunk with heavy loss off the Aberdeen coast and the next day a submarine was again reported inside Scapa Flow. Knowing that the German fleet was still in the Baltic, Jellicoe decided to seek a safe anchorage to the westward until the submarine defences of Scapa Flow could be made secure. On Oct. 20 he took the fleet to Lough Swilly where it remained until the end of the month, resting and carrying out practices. Meanwhile three British "E" class submarines had entered the Baltic. They were not successful in attacking the German fleet, but their presence caused much anxiety and gave moral support to the Russian fleet.

Loss of the "Audacious."-On Oct. 26, whilst carrying out firing practices off Lough Swilly, the battleship "Audacious" struck a mine. In spite of endeavours to tow her into harbour, she sank some hours later, her crew being saved. The loss was a serious one and came at an unfortunate moment. On that day the Belgian army supported by Hood's flotilla were making their last grim stand upon the Yser and news of the Grand Fleet so far away might tempt the Germans to strike a blow at Hood before help could reach him. Also war with Turkey hung in the balance and news of a disaster to the Grand Fleet might have affected the issue Consequently the Government kept the loss secret until the necessity was past.

Lord Fisher.—On Oct. 29 Lord Fisher (*q.v.*) relieved the Marquis of Milford Haven as First Sea Lord. A conference was held at the Admiralty, which Admiral Jellicoe attended, to decide upon future naval policy. On Nov. 2 the British Government declared the whole of the North Sea a prohibited area and warned all neutrals that, unless they adhered to the routes prescribed by the British authorities, they used the area at their own risk. On Nov. 3 a German cruiser squadron appeared off the Suffolk coast in the morning mist, fired a few shells on to the beach at Gorleston and at the old gunboat "Hazard" and retired. The battle squadrons having left Lough Swilly on Nov. 2, remained in the north part of the North Sea whilst a search was made by the battlecruisers and light forces, and returned to Scapa Flow on Nov. 17. The German cruiser "Yorck," on her way home from the Gorleston raid, struck a mine off the Jade River and was sunk. The defences of Scapa Flow were now far enough advanced to give a certain sense of security to the fleet, but between Nov. 23–26, when the fleet was absent in support of aerial operations in the Heligoland Bight, six submarines were sighted close to the base and one ("U. 18") was sunk by the local defence flotilla. Nov. 26 was marked by the loss of the battleship "Bulwark," which blew up at Sheerness owing to accidental ignition of cordite and sank with great loss of life.

The Scarborough Raid.—The Grand Fleet returned to Scapa Flow on Nov. 27 and there followed a month of gales of exceptional violence which delayed the completion of the submarine defences. On Dec. 15 a German force was reported at sea and the 2nd battle squadron and battlecruisers were sent south. The weather was so heavy that some of the light cruisers and destroyers had to be left behind, and to this fact and to the mist, the German force that raided Scarborough and the Hartlepools on Dec. 16, owe their narrow escape. The two towns were bombarded, 120 civilians were killed and over 400 wounded and, after laying mines off the Yorkshire coast, the Germans retired. In the mist and heavy sea a short, indecisive fight took place between the light forces, but the heavy ships, although very close, did not sight one anpther. The Grand Fleet swept in full force into the Bight on that day and Dec. 17, but the enemy had retired behind his minefields. It returned to Scapa on Dec. 20 and on Christmas Day was again in the Heligoland Bight, supporting an air raid upon Cuxhaven, after which it returned to Scapa on Dec. 27 in a heavy gale.

THE TRADE ROUTES 1914

Germany's oceanic trade was brought to a standstill at the very outset of the war, the approaches to her Home Ports being closed by the British Fleet, and with the cutting of the German cables in the Dover Straits on Aug. 5, she was isolated from the ports of the world. At the outbreak of hostilities there were permanent British squadrons stationed in China, Australia, the East Indies, at the Cape and in the Mediterranean, while the Home fleet protected the all important trade routes of the Atlantic. In August 1914, there was one light cruiser in the South Atlantic and the 4th Cruiser squadron (Craddock), detached from the 1st fleet, was in the West Indies. The 5th Cruiser squadron (Stoddart) was at once dispatched to the mid-Atlantic, between Africa and Brazil. and the ships of the 6th Cruiser squadron were scattered on special escort duties on the Atlantic Routes. The 9th Cruiser squadron (de Robeck) operated between Finisterre-Azores-Madeira; the 10th Cruiser squadron (de Chair) formed the northern patrol with the Grand Fleet; the 11th Cruiser squadron was stationed off the west coast of Ireland and the 12th Cruiser squadron, supported by a French squadron, guarded the Channel approaches.

Germany was credited with the intention of arming merchant ships as commerce raiders and the small enterprise she displayed in this direction was one of the surprises of the early months of the war. Only five such ships appeared: the "Kaiser Wilhelm der Grosse," which evaded the Grand Fleet, the "Kronprinz Wilhelm" from New York, the "Cap Trafalgar" from the River Plate, the "Cormoran" and "Prince Eitel Friedrich" in China. The "Dresden" and "Karlsruhe," in the West Indies, were the only German cruisers in the Atlantic.

The British 11th and 12th Cruiser squadrons, besides protecting trade, were at first occupied in safeguarding the passage of the Expeditionary Force. De Robeck kept a close watch upon the Spanish ports where some of the 70 interned German ships were suspected of trying to get to sea and arm. None did so and on Aug. 26 the "Highflyer," of his squadron, found the "Kaiser Wilhelm der Grosse" coaling off the African Coast and sank her.

The North **Atlantic.**—The "Dresden" was at Port au Prince (Haiti) on July 26, and the "Karlsruhe" at Havana on July 28. Both sailed for unknown destinations and Craddock sent the "Berwick" and "Bristol" to locate them, following himself in the "Suffolk." On Aug. 6 the "Suffolk" came upon the "Karlsruhe" engaged in arming the "Kronprinz Wilhelm." The merchant ship made off and the "Suffolk" chased the "Karlsruhe" until dark, when she was headed off by the "Bristol." A short moonlight action ensued, but the German's superior speed enabled him to escape. The "Dresden's" whereabouts were unknown and Craddock, anxious for the safety of the North Atlantic trade, took his squadron to the northern area. Several German ships in New York were expected to attempt to get to sea and arm, but none ventured to move and by Aug. 13 the "Karlsruhe" had been located at Curaçoa and the "Dresden" off Pernambuco. The Admiralty on that day stated that British trade in the North Atlantic was proceeding as usual. Craddock, with his flag now in the "Good Hope," sailed south in search of the two German cruisers. Leaving two French cruisers to watch the West Indies, he searched the Pernambuco and mid-Atlantic areas and then joined hands with Stoddart. By the beginning of September, a number of armed merchant ships had joined the British Cruiser squadrons, which were also reinforced by four old battleships. By this time the North Atlantic was clear of enemy cruisers and owing to the movements of the squadron under von Spee, interest was transferred to the southern part of that ocean, to which Craddock's command was specially allocated.

The "Cap Trafalgar" which left the River Plate on Aug. 22 was found by the "Carmania" on Sept. 14 off Trinidada Island. After spirited action between the two armed merchant ships, the German ship sank and the damaged "Carmania" crawled back to Gibraltar for repairs. With the West Indian cruisers pre-occupied in matching the newly opened Panama Canal, the "Karlsruhe" was successful as a raider until she blew up at sea on Nov. 4; she had several narrow escapes and during her three months' career captured 17 ships.

THE FAR EAST AND PACIFIC 1914-15

When war was declared, Admiral Jerram was at Hongkong completing his mobilisation With his squadron concentrated on Aug. 12, he destroyed the German wireless station at Yap Island. By Aug. 20 he had established a close watch on Tsingtau. Admiral von Spee was at the Caroline Islands with the cruisers "Scharnhorst," "Gneisenau" and "Nurnberg." He left on Aug. 6 for Pagan Island, where he was joined on the 12th by the cruiser "Emden," which had slipped out of Tsingtau, on Aug. 7, with supply ships. At Pagan Island von Spee heard of the Japanese ultimatum to Germany. Japan commenced hostilities against Germany on Aug. 22 and Jerram was thus freed to co-operate with the Australian squadron (Admiral Patey) in preventing von Spee from breaking through to the Indian Ocean.

The Fall **of Tsingtau.**—The primary objective of the Japanese was the German stronghold at Tsingtau. As soon as war was declared the port was blockaded by the Japanese Fleet and H.M.S. "Triumph" and Japanese troops were landed on Sept. 2. By Sept. 21 the fortress was invested by land and sea and on the next day, British troops having joined the Japanese, the general attack commenced. Tsingtau held out until Nov. 7 when it surrendered.

The Pacific Expeditions.—The Australian squadron, under Admiral Patey concentrated at Port Moresby on Aug. 7 and, on the 9th, appeared off Rabaul, the government centre of German New Guinea. No German ships were present and after destroying telegraphic communication the squadron sailed to meet the New Zealand Samoa Expedition at Suva. Von Spee's whereabouts being unknown, the presence of the battlecruiser "Australia" with this expedition was necessary. Samoa surrendered on Aug. 30 and Patey sailed to escort the Australian expedition against Rabaul. Little resistance was made to the landings on Sept. 11 and German New Guinea, with the Bismarck Archipelago, capitulated on Sept. 15. Patey's force was thus freed to attend to the Australian and New Zealand convoys, as by this time it was certain that von Spee's destination was South America.

The "Emden."—On Aug. 28 the German light cruiser "Emden" entered the Indian Ocean by way of the Molucca Strait and after being nearly found by the British cruiser "Hampshire" on Sept. 4 she made her dramatic appearance off the River Hoogly on Sept. 14. She ranged the Bay of Bengal until Sept. 25, bombarding Madras on the 22nd. Then for a month she cruised in the western approaches to Ceylon, coaling at Diego Garcia. On Oct. 21, after a narrow escape from the "Hampshire" and the armed merchant cruiser "Empress of India," she crossed the Indian Ocean, appearing off Penang on the 28th. There she sank the Russian cruiser "Zhemchug" and the French destroyer "Mousquet," and doubled back round the north of Sumatra. Unable to find her storeships, which had been sunk by the "Yarmouth," she made for the Cocos Islands. There on Nov. 9th, she was brought to action and sunk by H.M.A.S. "Sydney," so ending her remarkably successful raiding career in which she had sunk 15 ships.

Von Spee in the Pacific.—With Japan's entry into the war, von Spee's position in Chinese waters became untenable, and he decided to make for South America. After despatching the "Emden" on her memorable cruise, he sailed east, passing through the Marshall Islands on Aug 22. Here he detached the "Nurnberg" to Honolulu and sailed himself for Christmas Island. Arriving on Sept. 6, the "Nurnberg" rejoined next day, having cut the British cables at Fanning Island. On Sept. 14 von Spee appeared off Samoa and finding the place already in British hands, again sailed east. By this date Craddock had taken over the command of the South Atlantic and was coming south in search of the "Dresden." Von Spee, after bombarding Tahiti on Sept. 22, visited the Marquesa Islands on Oct. 1 and arrived at Easter Island on Oct. 12. Here he was joined by the light cruisers "Leipzig" from North America and "Dresden" from the Atlantic. On Sept. 15 Craddock was ordered to concentrate his force upon the Falkland Islands and was promised reinforcements. He heard on Sept. 26 that the "Dresden" was off Chile and it was by then certain that South America was von Spee's destination. By Oct. 22 Craddock had collected his ships at the Falkland Islands and he then searched round the Horn, leaving the old and slow battleship "Canopus" to join him through the Magellan Straits. Meanwhile von Spee had arrived off Valparaiso and was cruising off the coast.

Coronel and the Falkland Islands **Battles.**—Craddock, after rounding the Horn, continued his search to the north and sent the light cruiser "Glasgow" into Coronel. Von Spee hearing of her at that port on Oct. 31, turned south to cut her off. Craddock, having heard the "Leipzig's" wireless, was searching for her on his way north. Neither admiral was aware of the proximity of the other until they met on the evening of Nov. 1, and the battle of Coronel (*q.v.*) was fought. The cruisers "Good Hope" and "Monmouth" were sunk and the other British ships made their escape and returned to the Falkland Islands. Von Spee, after his victory, paid a visit to Valparaiso and then sailed south to St. Quintin Bay, about 300 miles north of the Magellan Straits.

The news of the Coronel defeat created consternation in England and immediate steps were taken to retrieve the position. The battlecruisers "Invincible" and "Inflexible," from the Grand Fleet, were placed under the orders of Admiral Sturdee, who was given a wide commission to seek out and destroy von Spee, wherever he might be, in the South Atlantic or Pacific Oceans. Sturdee left Plymouth on Nov. 11 and concentrated his force at the Abrolhos Rocks on Kov. 26, the same day that von Spee left St. Quintin Bay for the Falkland Islands. Now that von Spee's position was better known four other squadrons were quickly concentrated in order to deal with him. Patey, in the battlecruiser "Australia," with a squadron of British and Japanese ships watched the middle Pacific; a Japanese squadron was concentrated at the Galapagos Islands and the Battlecruiser "Princess Royal" was sent to the West Indies, in case von Spee should attempt to pass the Panama Canal. De Robeck on the African Coast and Stoddart off Montevideo were reinforced with armoured ships, in case von Spee should escape Sturdee, who, after searching the South American Coast, arrived at Port Stanley on Dec. 7 Von Spee rounded the Horn on Dec. 2, delayed for three days to coal from a prize in the Beagle Channel, and arrived off Port Stanley on the morning of Dec. 8. Sturdee put to sea and there followed the battle of the Falkland Islands (*q.v.*) in which the German squadron was destroyed, only one ship, the "Dresden," escaping.

The End of **the** Cruiser Campaign.—Despite the incessant demands for the protection of troop convoys and support for military expeditions that had so hampered the Admirals in their first duty of commerce protection, the British Navy in the first eight months of the war cleared the German flag from the outer seas. By the end of 1914, only one of the thirteen German cruisers abroad was unaccounted for and of the five armed merchantships only two remained at large. The "Dresden," escaping from the Falkland Islands battle, was hunted and helpless until she was sunk by the "Glasgow" and "Kent" at Juan Fernandez on Mar. 14. The "Kronprinz Wilhelm" (April 8) and "Prinz Eitel Friedrich" (Mar. 12) were interned at Newport News, and the "Konigsberg," having been discovered in hiding in the Rufiji River was destroyed on July 11. By the end of Mar. 1915, the Canadian, Australian, New Zealand and Indian armies had been carried overseas, garrisons abroad had been replaced by territorial troops, without the loss of a troopship and naval support had been given to six considerable military operations. This was accomplished with the loss to the Navy upon the outer seas of three cruisers ("Good Hope," "Monmouth" and "Pegasus") and of 62 merchant ships. The German cruisers had caused a loss amounting to less than two thirds of 1% of British seaborne commerce during the period.

THE MEDITERRANEAN 1914

The Goeben and **Breslau.**—The first duty of the British Mediterranean squadron was to watch the movements of the German cruisers "Goeben" and "Breslau." On Aug. 3, their whereabouts being unknown, Admiral Milne stationed the 1st Cruiser squadron (Troubridge) with destroyers to prevent them entering the Adriatic and sent the battlecruisers "Indomitable" and "Indefatigable" towards Gibraltar to stop them interfering with the transport of Algerian troops or escaping into the Atlantic. At 10.30 A.M. on Aug. 4 the German cruisers, who that morning had bombarded Phillipville, were sighted by the British battlecruisers and were shadowed by them into Messina. On Aug. 5, the situation was complicated by the Italian declaration of neutrality and by Austria not yet being at war with Britain, while the information received by Milne was conflicting. Expecting the Germans to break westward, he placed his force to prevent them escaping from the north of Messina, leaving Troubridge to deny them the Adriatic. On the evening of Aug. 6th the Germans sailed from the south of the Straits, gallantly and skilfully shadowed by the "Gloucester." Troubridge did not bring them to action and when they passed Cape Matapan, the "Gloucester" was recalled from her precarious position. Milne followed into the Aegean on the 9th but was too late to prevent the two German ships entering the Dardanelles on Aug. 10. Their escape was unfortunate as it had a far-reaching effect upon subsequent events in the Near East.

After the safe passage of the Algerian troops the security of the Mediterranean was undertaken by the French fleet, which, using Malta as its base from Aug. 16, established a blockade of the Adriatic. Admiral Carden was appointed to command the reduced British force in the Mediterranean and with it he established a blockade of the Dardanelles. On Nov. 3rd, on Turkey declaring war, he bombarded the outer forts of the Dardanelles as a demonstration. The watch upon the Dardanelles was kept with few ships for the cruisers were called upon to guard the Malta–Port Said route during the passage of troop convoys. It was uneventful, except for the daring exploit of Submarine "B. 11," which on Dec. 13 dived through five rows of mines in the Dardanelles, torpedoed and sank the Turkish battleship "Messudieh" and returned safely.

OVERSEA CAMPAIGNS 1914–15

Togoland and the Cameroons.—A stroke by the Gold Coast forces on the outbreak of war led to the occupation of Togoland and the destruction of the important German wireless station at Kanima. Before the end of August the colony had surrendered and an attack was launched upon the German Cameroons. On Aug. 25 the British cruiser "Cumberland" and the gunboat "Dwarf" left Sierra Leone to attack Duala, followed by the cruiser "Challenger" and the Niger flotilla with a British and French military force. A base was established in the Cameroon estuary and after a month of flotilla warfare, in which the "Dwarf" played a prominent part, the river was cleared of mines and obstructions. The "Challenger" then entered and on Sept. 27 Duala surrendered to a combined naval and military attack. Nine large German steamers, a floating dock and two railway termini were captured. River warfare in support of the military advance inland then developed. The "Cumberland," "Challenger" and French cruiser "Bruix," being required elsewhere, were relieved by the cruiser "Astraea" from the Cape and with the arrival of the old cruiser "Sirius" and the sloop "Rinaldo" in April 1915 a blockade was established to prevent supplies reaching the enemy from the Spanish island of Fernando Po. The colony was, by this time, in Allied hands, but fighting in the hinterland continued for two years.

German South West Africa.—The attack upon this colony, started in Aug. 1914 by the South African Government, was delayed by the Boer revolt, but, the revolt having been suppressed, it was resumed early in 1915. The Union Army, escorted by the battleships "Albion," the "Astraea" and two armed merchant cruisers occupied Walfisch Bay and Swakopmund in January. The "Albion" was then sent to the Dardanelles and the "Astraea" to the Cameroons and, with the exception of some naval armoured cars the campaign became a purely military one. It was brought to a successful conclusion in July 1915 by the surrender of the colony.

German East Africa.—The German cruiser "Königsberg" was at sea on the outbreak of war and on Aug. 6 she made her only prize in the Gulf of Aden. Two days later, the "Astraea" and "Pegasus" appearing off Dar-es-Salam, the Germans blocked the entrance to the port, but agreed that the ships there should be considered British prizes, and the wireless station was destroyed. The "Königsberg," her base closed against her, was not heard of until Sept. 20, when she appeared off Zanzibar and finding the "Pegasus" with engines disabled in the roadstead, sank her at her moorings. Admiral Charlton, with the Cape squadron, was, by now, on the "Königsberg's" trail and she took refuge amidst the swamps of the Rufiji River, where she was located by the "Chatham." On Nov. 1 the East African Expeditionary Force, escorted by the battleship "Goliath" and cruiser "Fox," arrived from India. On Nov. 2 the troops landed at Tanga, under cover of the "Fox," but the attack made two days later was repulsed and the troops were re-embarked.

Following this reverse no serious military operations against the colony were undertaken until early in 1916. The 600 miles of coastline, with its many harbours, remained in the hands of the Germans and it was not until March 1915 that ships could be spared to establish an efficient blockade. Meanwhile a strict watch had to be kept upon the "Konigsberg" in the Rufiji River and several relief ships slipped through with arms and stores for the colony. On Dec. 14, boats sent in to Dar-es-Salaam to take possession of the prizes, were fired upon and the town was then bombarded and the ships sunk. In the Rufiji River a ship was sunk to block the "Konigsberg" in, but the cruiser was unapproachable until the arrival of shallow draught ships and aeroplanes. On June 3, 1915 the small monitors "Severn" and "Mersey" arrived with four seaplanes, and a month was occupied in preparing these craft for their work. On July 6 the first attack was made, the "Konigsberg" was damaged but the monitors were forced to retire. On July 11 the attack was renewed and pressed home by the monitors, and the "Konigsberg" was destroyed.

Persian Gulf and Mesopotamia. — An Indian Division, escorted by the "Ocean," and the sloops "Espiitgle" and "Odin" arrived at Bahrein late in October and on the 30th received orders to commence hostilities against Turkey. On Nov. 6, after bombarding Fort Fao at the entrance of the Shatt-al-Arab, the troops landed. Advancing against considerable opposition, supported by the "Espiegle" and "Odin," an entrenched position was established at Abadan by Nov. 10. The force pressed forward supported by the two sloops and Basra was entered on Nov. 22, and a further advance ended on Dec. 9, in the occupation of Kurnah, at the junction of the Tigris and Euphrates. By this rapid and well planned stroke the command of the Persian Gulf and of the outlet from the Persian oilfields was assured.

In December the "Ocean" was withdrawn to the Dardanelles and the flotilla consisted of the "Espiitgle" and "Odin," the vessels of the Royal Indian Marine and a number of armed river steamers and launches. In March of 1915 the "Clio" and four armed boats arrived from Egypt and in the late autumn the first of the new "Fly" class gunboats arrived from England.

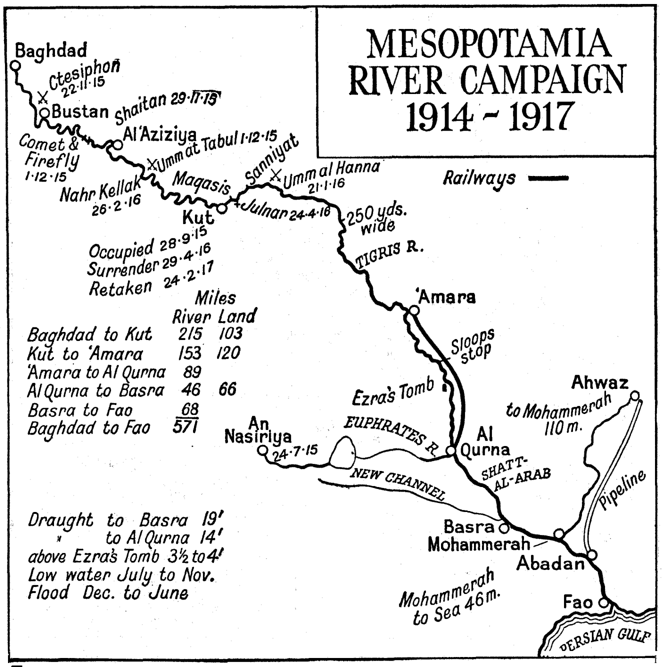


FIG. 1.— MESOPOTAMIA RIVER CAMPAIGN, ENDED ON MARCH 11, 1917

Throughout 1915 the flotilla formed the spearhead of the advance of the Army. It protected the oil pipe line by patrolling the Karun River and in April the Euphrates flotilla assisted in defeating the Turkish attack upon Basra. The remarkable amphibious battle north of Rurnah on May 31, was followed by the dash up the river by the flotilla after the retreating Turks, with General Townshend on board, and the capture of Amara. With the flotilla reinforced by four seaplanes from the Rufiji River, Townshend captured Kut and continued his pursuit of the Turks until he was brought up at Ctesiphon on Oct. 5. The political and military situation in the Near East then led to the illfated attempt upon Baghdad. The naval flotilla consisted of the gunboat "Firefly," the "Comet," two armed launches and four armed horse boats. After the repulse of the army at Ctesiphon, the withdrawal of the river transport was covered by the flotilla with the loss of "Firefly," "Comet" and "Shaitan," which grounded and were abandoned. Townshend reached Kut on Dec. 3, but by the 9th that place was invested and the flotilla was withdrawn down river.

Egypt. — By mid-November 1914, the careers of the "Emden" and "Konigsberg" being ended the Indian Ocean was secure. The British cruisers were ordered homewards and Admiral Peirse, in the battleship "Swiftsure," reached Suez on Dec. 1 and detained in the Canal enough ships to meet the threatened Turkish attack upon Egypt. During December the "Doris" and the Russian cruiser "Askold" made a series of successful raids in the Gulf of Iskanderun and. on the Syrian Coast. At the end of January 1915, when the Turkish attack developed, a strong naval force under Peirse's command took up its position in the Canal. The Turks made their attempt on the Canal on February 2 and 3 and were easily repulsed, the Canal traffic being but little interfered with. By Feb. 11, all threat to the Canal having disappeared, Peirse was able to send most of his ships to reinforce Carden's forces at the Dardanelles. A further threat to the Canal in April 1915 was frustrated by the presence of strong British and French naval forces.

HOME WATERS AND THE BALTIC 1915

The Battle of **the** Dogger Bank. — The year opened with the loss of the battleship "Formidable," which was torpedoed by "U. 24" off the Start on the morning of Jan. 1. In the North Sea the first weeks of January passed quietly, but on the 19th reports of German activity brought the British battlecruisers into the Heligoland Bight. Nothing was seen, but a Zeppelin raid on the East Coast indicated a repetition of the Scarborough raid. The battlecruisers remained concentrated in a position south of the Dogger Bank, supported by the Grand Fleet battleships to the northward. On the morning of the 24th the Germans were sighted and there followed the battle of the Dogger Bank (*q.v.*). The German squadron was driven back to its base with the loss of the cruiser "Bliicher" and two battlecruisers badly damaged. Beatty's flagship "Lion" was severely damaged but returned safely to Rosyth. After the Dogger Bank action a change was made in the command of the High Sea Fleet and a policy of extreme caution was initiated. The German fleet put to sea only to cover minelaying operations and always retired behind its minefields on the approach of the enemy. Four of these "one day out and one day back" sorties in March, April and May were threatened by the Grand Fleet in force and the Germans retired.

The Baltic. — In the Baltic the Russian fleet, assisted by a few British submarines, was successful in holding the older ships of the German fleet in check. In June a German attempt to land troops in Courland in support of their army was defeated by the Russian destroyers and on July 2 the German minelayer "Albatross" was driven ashore by the Russian cruisers and the cruiser "Prinz Adalbert" was torpedoed and seriously damaged by the British submarine "E. 9." In August a part of the High Sea Fleet made a serious attempt to force the Gulf of Riga, but on Aug. 19 the battlecruiser "Moltke" was badly damaged by a torpedo from submarine "E. 1." The operations were abandoned and for some time the Baltic was the scene of only minor operations, but, in the closing months of 1915, the German iron trade with Sweden was harassed by British submarines, which sank 14 steamers engaged in the trade and the cruisers "Prinz Adalbert" and "Bremen" and a destroyer.

The **Grand** Fleet. — Improvements in the British intelligence, especially in directional wireless, gave timely warning of any movements of the German Fleet. By the end of the first quarter in 1915, the Allied flank in Flanders was stabilized, supplies to the army were ensured by the grip of the Dover and Harwich forces upon the narrow seas while the northern bases had been made practically submarine proof. These factors led to a general redistribution of the British fleet. The Channel fleet was broken up and most of its ships were sent out to the Dardanelles. The Grand Fleet battle squadrons remained at Scapa Flow and Cromarty and the battlecruisers at Rosyth. During the year the Battle fleet swept down the North Sea to the Heligoland Bight no less than 17 times and many other searches were made of the Danish and Norwegian coasts by the battlecruisers and light forces. During one of these cruises "U. 29" was rammed by the "Dreadnought." The British Navy was short of destroyers until the autumn, when the new vessels began to appear. Until then constant calls were made upon the Grand Fleet for destroyers to assist the auxiliary patrol in hunting submarines. The work of the destroyers was incessant and arduous and due to their efficiency the Germans gained no major success with submarine or mine against the British fleet during the year. The northern blockade was maintained with increasing efficiency by the 10th Cruiser squadron, now composed entirely of armed merchant cruisers. The fleet base at Scapa Flow developed into a great training establishment for new personnel. A system of gunnery and other training was organised which brought the many new ships joining the fleet to a state of fighting efficiency in minimum time and new officers and men were trained for the ancillary services all over the world. This year of strenuous work was marked by no outstanding event after the Dogger Bank action and it closed with the disaster to the armoured cruiser "Natal," lost by internal explosion at Cromarty on New Year's eve. During August and September, Zeebrugge and Ostend were several times bombarded by the monitors and other ships of the Dover Patrol, in support of the Allied offensive. The results were inconclusive owing to the difficulties of fire observation and to the fact that the ships, finding themselves outranged by the heavy German shore guns were forced to keep at extreme range.

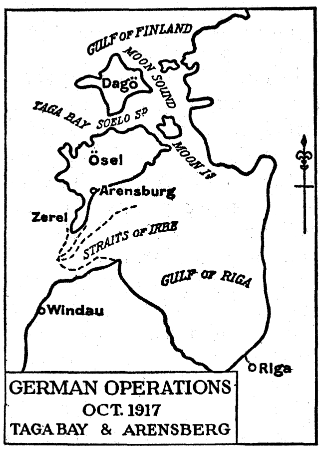


FIG. 2.— MAP SHOWING GERMAN OPERATIONS AT TAGA BAY AND ARENSBERG, OCTOBER, 1917

Submarine Warfare.— By the beginning of 1915 the ocean high-ways had been made safe for commerce, but the narrow seas around the British Isles were becoming unsafe for any traffic. On Feb. 17, 1915, Germany declared these waters to be a "War Zone" and announced her intention of using submarines to sink merchant-ships. Thus commenced the submarine campaign (*q.v.*). In the first quarter of 1915, 38 British ships were sunk by submarines and by Dec. 31 this number was swelled to 259. In the same period 48 ships were sunk by mines and the tonnage loss for the year approached 900,000 tons. For these two forms of warfare against trade Britain was unprepared and the submarine and minelaying tactics of the enemy produced a situation beyond the capacity of the weak and scattered coastal patrol and minesweeping flotillas. Trawlers, drifters, yachts and small steam and motor vessels of all kinds were armed to reinforce the flotillas. By the beginning of 1915, no less than 750 of these craft were in commission and their numbers were rapidly swelled at the opening of submarine warfare. By August 1915 the auxiliary patrol was a complete organization and the coastal waters were divided into twenty-one patrol areas. In each area destroyers and auxiliary craft were employed in submarine hunting, minesweeping, guarding channels, guiding traffic, rescue work and in many other duties. The auxiliary ships were manned by seamen, yachtsmen and fishermen, enrolled in the Royal Naval and Royal Naval Volunteer Reserves. As in days of old, the seafaring population of the country, of all classes, came forward in the hour of need and in its ceaseless watch around the coast until the end of the war, the auxiliary patrol paid a heavy price and rendered to the country service of incalculable value.

THE DARDANELLES CAMPAIGN

Early in 1915 political complications in the Balkans and the Russian wish for an open Dardanelles to ensure munitions supply, made imperative some demonstration of the Allied power in the Eastern Mediterranean. It was decided to attack the Dardanelles, where, since September, Admiral Carden had been keeping a close watch. In the redistribution of the British fleet, after the Falkland Islands battle, Carden was strengthened with a number of the older battleships and cruisers. The French Government offered a squadron and both naval and military aid was promised by Russia in the Black Sea. By the end of February, Carden's force consisted of the battlecruiser "Inflexible," the new battleship "Queen Elizabeth," 16 old battleships (4 French), 20 destroyers (6 French), a flotilla of 35 minesweeping trawlers and a seaplane carrier were on their way, and a varying number of cruisers and submarines were under his orders. Admiral de Robeck was appointed second in command. The Greek Government handed over the Island of Lemnos as an advanced base and Admiral Wemyss was appointed to command it.

From the first the naval view was that any attack upon the Straits by ships could be only a diversion unless it was backed by a strong military expedition. Steps were accordingly taken to send troops to the Aegean, but the situation on the eastern and western fronts caused delay and it was not until Feb. 20, after the first bombardment, that the decision was made to send out five divisions (4 British and 1 French).

The First Bombardment.— Bad weather in January made reconnaissance of the Straits difficult, but enough was done to enable Carden to recommend, on Feb. 15, that a naval bombardment was not a sound operation without a strong military force to consolidate the work of the fleet. But the political situation was critical and Carden was pressed by the War Council to commence operations. Pointing out that no progress could be expected until the minesweepers and seaplanes arrived, Carden decided to bombard the outer forts on the first opportunity. Owing to bad weather this did not occur until the 19th and at 10 A.M. on that day the battleship "Cornwallis" fired the first shot of the campaign at Fort Orkaniye. The forts were hit repeatedly and made no reply, but when the "Vengeance" (flying de Robeck's flag), closed to moderate range she received a hot fire from all guns. Thus early it was proved that long range bombardment of modern earthworks was ineffective unless the

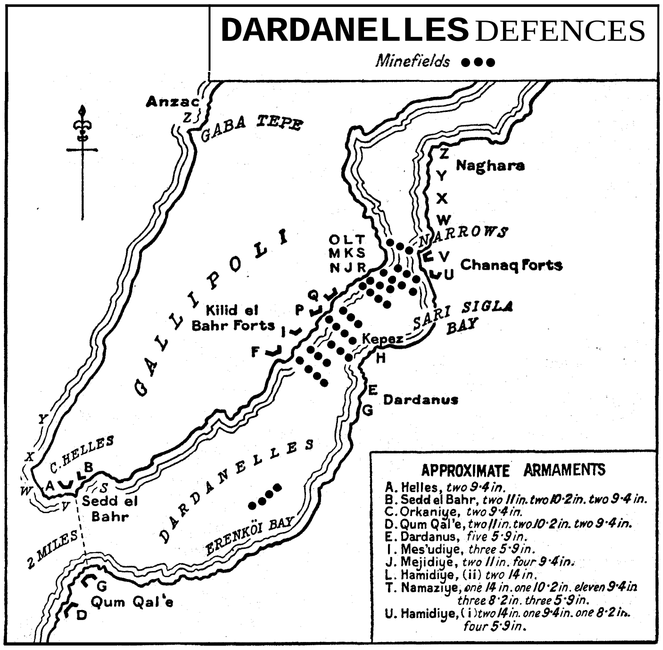


FIG. 3.— MAP OF DARDANELLES DEFENCES. SHOWING APPROXIMATE ARMAMENTS AND POSITION OF MINEFIELDS

ships can close to decisive range and knock out each gun by direct hits.

Carden was now informed that he was expected to force the Straits without military assistance. On February 25, after a four days gale, a bombardment, commencing at moderate range, was intensified by British and French ships closing in towards the shore. The four outer forts were silenced and the minesweepers began clearing the Straits. Next day, demolition parties, supported by marines landed to complete the destruction of the forts, and the fleet, going as far up the Straits as had been swept, bombarded the inner forts at long range. As before the forts made no reply when hit, but the ships were badly worried by mobile howitzers on each shore, which could not be located. Gales delayed operations for two days and on March 1 and 2 the Narrows were again attacked, with similar results, the ships being constantly hit by an increasing number of hidden howitzers. Each night the minesweepers were driven off by gunfire as they attempted to sweep the minefields off Kephez. On March 3 de Robeck reported that the Straits could not be forced unless one shore or the other were occupied and that no progress was possible without military assistance. This was emphasized on March 4 by the repulse of the demolition parties, showing that the time was past for employing small forces onshore.

As yet, no definite decision had been made as to the scope of any military operations. In spite of the Admiralty's reiterated demands for troops and the doubts of General Birdwood on the spot, that the fleet could force a passage unaided, Lord Kitchener, at the War Office, in his instructions to General Sir Ian Hamilton, on the latter's appointment as commander-in-chief, only contemplated "the employment of military force on any large scale . . . at this juncture. . . . in the event of the fleet failing to get through after every effort has been exhausted." *(See* W. S. Churchill, *The World Crisis.)* Mr. Winston Churchill, as First Lord, continued to urge the fleet to new efforts and on March 11, Admiral Carden was told "the results to be gained are . . . great enough to justify loss of ships and men if success cannot be obtained without it."

A naval attack was, therefore, planned for March 18, by which time General Sir Ian Hamilton would have arrived. Meanwhile daily bombardments of the forts produced indefinite results and desperate attempts were made nightly without success to sweep up the Kephez minefields. All experience proved that until the mobile guns were suppressed they could prevent minesweeping operations, and until the minefields were cleared ships could not approach to decisive range at which alone they could destroy modern earthworks. On March 16 Admiral Carden's health broke down and he was forced to hand over his command to Admiral de Robeck, who at once proceeded to carry out the attack planned.

The Naval Attack of March 18.—The plan of attack arranged for the four modern ships ("Inflexible," "Queen Elizabeth," "Lord Nelson" and "Agamemnon") to engage the inner forts at 14,000 yards, whilst a British and French division, of four old ships each, alternately pressed home the attack to 10,000 yards, which was the limit of the swept area. Two old battleships on each side were to attempt to keep down the fire of the small guns onshore. The action commenced at 11.30 A.M. on the 18th. Little reply came from the forts, but unseen guns opened a heavy fire. The "Agamemnon" was frequently hit and the "Inflexible" forced out of the line with her forebridge burning. At noon the French division passed through the British line, closed to 10,000 yards and received a hot fire from the forts. The "Gaulois" was forced out of action and the "Bouvet" was heavily hit, but the squadron gallantly held its place and by 1.45 the fire of the forts was slackening. De Robeck then sent the British division in to relieve the French and ordered the minesweepers up to clear the channel. At 2 0 P.M. as the French squadron was steaming out the "Bouvet," struck a mine, blew up and sank in a few minutes, with nearly all hands. The British division engaged the forts with apparent success until 3 0 P.M. when the "Irresistible" struck a mine and sank, her crew being saved. The fire from the forts now became intermittent, but at 4.5 P.M. the "Inflexible" was mined and ten minutes later a similar fate befell the "Ocean." The "Inflexible" reached Tenedos and was beached, but the "Ocean" was abandoned and sank. The ships withdrew just after 6 P.M. and as they did so the forts opened a heavy but inaccurate fire; the attempt to force the Straits thus ended in failure. The forts had been damaged but were not put out of action and the minefields were still intact. The loss to the Allies had been severe: three battleships sunk, three heavy ships badly damaged and others severely handled.

The First Landings.—For political reasons the campaign had to be continued and the failure of the fleet to force the Straits necessitated the landing of an army upon the Peninsula. For this operation the transports were unprepared and the army was concentrated in Egypt to reorganise, a valuable month thus being lost. *(See* DARDANELLES CAMPAIGN.) Meanwhile the fleet reconnoitred and prepared for the landing and, when the weather permitted, harassed the Turkish reinforcements now crowding on to Gallipoli. Smyrna was strictly blockaded and the Russian fleet was active off the Bosphorus.

By April 23, the transports had reassembled at Mudros and the work of getting into position for the landings commenced. The weather favoured the operation and early on the morning of the 25th, landings were effected on five beaches around Cape Helles and Gaba Tepe (Anzac). At the same time, French troops gained a footing on the Asiatic side and a demonstration was made in the Gulf of Xeros; 18 battleships, 12 cruisers, 29 destroyers, 8 submarines and a host of small craft supported the landing. At each beach, the covering ships went close inshore in support, whilst the attendant ships carried the troops and aided by small craft and boats suited to the particular beach, landed them. Opposition was severe and losses very heavy but by sunset the army was established ashore and the naval parties had the work of organising the beaches well in hand. Thenceforward the campaign became mainly a military one in which the rôle of the Navy was to support the troops by gunfire, to evacuate wounded and to ensure the supply of food, water, stores, munitions and reinforcements to the beaches. This task was an arduous and dangerous one and casualties on the beaches were heavy. The old battleships "Albion" (April 28) and "Prince George" (May 5) were so damaged by gunfire that they had to be docked and on May 13, the "Goliath" was torpedoed by a Turkish destroyer and sank with great loss of life. The appearance of German submarines in the Mediterranean now rendered the position of heavy ships employed off the Peninsula precarious. The "Queen Elizabeth" was ordered home to join the Grand Fleet and the replacement of battleships by monitors and old "bulged" cruisers commenced, but two more battleships were lost: the "Triumph" on May 25 and the "Majestic" on May 27, both torpedoed by "U. 21."

Lord Fisher Resigns.—The War Council decision on May 14 to continue the campaign led to the resignation of Lord Fisher (*q.v.*). This was followed by the reconstruction of the Government and the removal of Mr. Winston Churchill from the office of First Lord of the Admiralty. Throughout the summer months the navy supported and supplied the army on the peninsula, and more troops being sent out, a successful landing was made at Suvla Bay on the night of Aug. 6–7. But neither here nor at the other positions was any appreciable progress made onshore and all idea of forcing the Straits with the fleet was consequently abandoned. Submarines alone could pass the Narrows and of the 12 boats (9 British and 3 French) which made the adventure, 7 were lost. The presence of these vessels in the Marmora, however, produced such alarm as greatly to interfere with the Turkish supplies to the Peninsula.

The Evacuation.—By the end of October the defeat of the Serbian Army and the opening of the Salonika Campaign hastened the decision to withdraw from Gallipoli, and preparations for this difficult operation commenced. Night by night, the vast accumulation of stores were removed and on the night of Dec. 18–19 the troops were withdrawn from Suvla Bay and Anzac under cover of the fleet. So successful was the operation that the Turks knew nothing about it and awoke to find that their enemy had vanished. The more difficult evacuation of the Helles Beaches was accomplished on Jan. 8–9, 1916, without the loss of a man. Little of value was left in the hands of the enemy and with these two wonderful examples of naval and military co-operation the ill-fated campaign was brought to a close.

HOME WATERS 1916

Heavy weather in January hampered the work of the 10th Cruiser squadron on the northern patrol and caused damage to the submarine defences of Scapa Flow and on the 6th the battleship ('King Edward VII.," struck a mine off Cape Wrath and was lost. Scheer succeeded von Pohl in command of the High Sea Fleet in January and he at once adopted more energetic tactics. On Feb. 10 German destroyers appeared on the Dogger Bank and sank the sloop "Arabis," whilst minesweeping. A sweep by the Grand Fleet followed with the usual barren result. During the dark February nights the raider "Moewe" slipped homeward through the blockade after her successful cruise and the "Greif," another raider, in attempting to break out was brought to action by the armed merchant cruiser "Alcantara" on Feb. 29 and both ships were sunk. Cruising constantly during March the Grand Fleet saw nothing of the enemy until March 24–25 when the Harwich Force met a Division of enemy destroyers at night. The German "G. 194" was rammed and sunk by the light cruiser "Cleopatra" and a British destroyer was lost by collision. On April 23 the German fleet put to sea, the battlecruiser "Seydlitz" being forced to return after striking a British mine. Zeppelins raided the East Coast on the night of April 23–4 and at daybreak Yarmouth and Lowestoft were bombarded by the German battle-cruisers. The Harwich Force engaged them and the light cruiser "Conquest" received heavy damage from their fire as they hurriedly retired eastward, reaching their minefields just in time to escape Beatty's battlecruisers. The 3rd Battle squadron (7 King Edward's) was stationed in the mouth of the Thames at the end of April to deal with the coastal raids and on April 26 a heavy mine and net barrage was laid in the Straits by the Dover Patrol. On May 4–5 an aerial attack, supported by the Grand Fleet, was made upon the Zeppelin sheds at Tondern. One Zeppelin was destroyed at sea. Mines were laid off the Horns Reef and Borkum before the fleet returned north.

The Battle of Jutland.— At the end of April, in deference to protests from the United States and other neutrals, the German submarines received orders to cease sinking merchant ships without warning. Scheer thereupon determined to use the submarines thus released in an attempt to trap the British fleet. By May 23, 22 submarines were stationed off the British bases, and the High Sea Fleet was to put to sea on that day in the hope of enticing the Grand Fleet over them. The plan had to be modified as the weather delayed the German fleet until May 30. On that day, following upon reports of unusual activity by the enemy, the Grand Fleet sailed on one of its periodical southerly sweeps. On May 31, after a preliminary action between the rival battle-cruiser forces in which the British suffered heavy losses, the two main fleets met and the battle of Jutland (*q.v.*) was fought. The German fleet after sustaining severe damage and being skilfully extricated from a very dangerous situation, eluded the British fleet at night and retired behind its minefields at daylight on June 1. The Grand Fleet returned to its bases on the 2nd and 3rd of that month.

June 5 was marked by the tragic loss of the "Hampshire," with Lord Kitchener on board, after striking a mine on the Orkney coast.

There were no large fleet movements during June as the High Sea Fleet was repairing its damage after Jutland. All the damaged British ships rejoined the Grand Fleet by the middle of July when a number of exercise cruises took place. In the second week in August, just as before Jutland, an unusual number of submarines were reported in the North Sea. Expecting another move on the part of the High Sea Fleet, Jellicoe swept south in force on August 18. Next morning ten Zeppelins were located stretched across the North Sea. By noon a fleet action appeared imminent, the battle fleets being only 42 miles apart, but warned by the Zeppelins, Scheer turned and made for home, and was soon beyond pursuit. The German battleship "Nassau" was twice torpedoed by a British submarine as the fleet put to sea; the cruisers "Nottingham" and "Falmouth" were torpedoed and sunk; and two submarines were accounted for by the British flotillas during the operation.

During the autumn British squadrcns were constantly at sea on observation cruises, while regular British cruiser patrols were established in the North Sea and a submarine patrol was maintained off the German ports. But the German fleet made no move until the night of Oct. 26, when two German destroyer flotillas, working from Zeebrugge, made their first raid on the Dover Straits, sinking two British destroyers and seven drifters and escaping unscathed. On Nov. 5 a division of the German fleet put to sea to help a stranded submarine. The British submarine "J. 1" was waiting and succeeded in torpedoing and damaging the battleships "Kronprinz" and "Grosser Kurfiirst."

Jellicoe, First Sea Lord.— The long winter nights at the end of November enabled the raiders "Moewe" and "Wolf" to break through the blockade. This was annoying but not serious, for it was the submarine which had now become the menace to shipping and exceptional measures were called for to deal with it. At the end of November, therefore, Admiral Jellicoe was appointed First Sea Lord to take over this great task. Admiral Beatty succeeded him in command of the Grand Fleet.

In September war against merchant ships was renewed with ever increasing vigour. During 1916, 436 British merchant ships were lost, totalling 1,250,000 tons. Of these 322 were sunk by submarines, 88 by mines and 26 by raiders, etc. During the year a further 218 merchant ships had been attacked by submarines and had escaped.

THE MEDITERRANEAN 1915–16

The French fleet based upon Malta blockaded the Straits of Otranto watching for the Austrian "Dreadnought" squadron. The latter made no move but the Austrian submarines were active and the battleship "Jean Bart" (Dec. 1914) and the cruiser "Leon Gambetta" were torpedoed and sank. The French admiral withdrew his heavy ships to Malta and kept watch upon the narrow waters of the Adriatic with cruisers and destroyers. In May 1915, after prolonged negotiations as to the distribution and command of the Allied fleets in the Mediterranean, Italy declared war against Austria. The Italian fleet, reinforced by 4 British battleships and 4 light cruisers and by 12 French destroyers and 7 submarines became responsible for the Adriatic blockade. The French Admiral remained nominally in command of the Mediterranean, controlling the western basin, whilst naval operations in the Levant were under British control. The Italian battle squadron was based upon Taranto, but it was upon the cruisers, working from Brindisi, that the principal burden devolved. The cruisers "Dublin" (June g) and "Giuseppe Garibaldi" (July 18) were torpedoed by Austrian submarines and the latter sank. In September a barrage of British net drifters was placed across the Straits of Otranto, but owing to the depth of water it was not very effective.

The Dardanelles campaign dominated other events in the Mediterranean during 1915 and, with the appearance of German submarines in that sea during the summer, the task of protecting the stream of transports and supply ships became very difficult. In the autumn the almost simultaneous decision to evacuate Gallipoli and to commence the Salonika Campaign (*q.v.*) made demands upon the British transport service which all but stressed its powers to breaking point, and the losses caused by submarines became very serious.

Dedeagatch was bombarded on Oct. 21 and a British squadron was constantly operating at Salonika and on the Bulgarian coast until the end of the war. The collapse of Serbia in November 1915 was followed by an Austrian naval raid upon Durazzo. The raiding force was engaged by the "Dartmouth," "Weymouth" and "Nino Bixio" (Italian), the Austrians escaping with the cruiser "Helgoland" badly damaged and a destroyer sunk. Corfu was occupied as a base for the Serbian army in Jan. 1916 but the subsequent vacillating conduct of Greece did much to hamper the Allies during the Salonika campaign (*q.v.*).

The year 1916 in the Mediterranean was a continual struggle with the German and Austrian submarines, whose use of the

Greek ports and islands called for constant British and French activity around that coast. In December after an Allied force, landed from the fleet, was treacherously fired upon at Athens, a strict blockade of Greece was declared and enforced by the Allies. The British Aegean squadron, which was reinforced at the end of the year by four battleships, kept a close watch upon the Dardanelles and the Syrian coast during 1916.

Overseas Campaigns.--On Feb. 28, 1916, the final surrender of the colony brought the Cameroon Campaign to an end. In East Africa, although the coast was blockaded by the Cape squadron, the coast towns remained in German hands until September 1916. By this time all were occupied and the colony was cut off irom the sea. The command of Lake Tanganyika was established by two British motor boats, carried 2,000 miles overland from Capetown, but fighting in the interior continued until after the Armistice. In Mesopotamia, 1916 was a year of pause and preparation for the next campaign. Kut surrendered on April 29 after a gallant naval attempt to relieve the town had failed five days previously.

UNRESTRICTED SUBMARINE WARFARE 1917

After the refusal of the Allies to consider her proffered peace terms at the end of 1916, Germany saw that her fate was sealed unless she could by some means, break the Allies' sea power (*q.v.*). The German High Naval Command was granted its wish and it was proclaimed that, after Feb. 1 submarines would sink all merchant ships on sight and without warning. The commencement of this ruthless campaign was followed by the severance of diplomatic relations between the United States and Germany and on April 6 the United States entered the nar against the Central Poners The German aim was to strike a fatal blon by bringing the Allied. and more especially the British, seaborne trade to a standstill by sinking so many ships as to reduce seriously available tonnage and to make the merchantmen refuse to face the risk of sailing. To some extent this latter was successful at first, in the case of neutral shipping, but British merchantmen continued to put to sea in spite of the heavy toll taken by the submarines. During February and March a weekly average of 23 British ships were lost and in April. the darkest month for British shipping, 196 vessels of nearly *600.000* tons were sunk. These losses were so serious, that, had they continued, success must have ultimately renarded the German effort.

The Convoy System.—Every known method of protecting shipping at sea was adopted: camouflage (*q.v.*), defensive gun armaments, zig-zag courses in submarine waters and directing traffic along routes patrolled by craft armed with every anti-submarine device were all tried; but still the toll of losses grew. In spite of constant changing of the patrolled routes, by the end of March this system had definitely broken down and the Convoy System (*q.v.*) was adopted. To this there was, at first, much opposition, both from the fleet and from merchant owners and ship masters, and the difficulties appeared insuperable. Chief amongst these was the finding of sufficient escort ships, mainly destroyers, for the convoys. The destroyers from the Grand Fleet and Harwich could not be spared, as the High Sea Fleet was still in being and a menace, and there were but few others. The arrival of an American flotilla at Queenstown and of a Japanese one in the Mediterranean eased the situation: the Admiralty under Jellicoe persevered and by the end of May the Convoy System was in full swing. Its effects were immediate. In the second quarter of 1917 the weekly average losses amounted to over 30 merchant ships: in the third quarter this was reduced to just over 20 and in the last quarter to well below that figure, whilst in 1918 the average weekly loss was under 15. In all, 88,000 ships sailed under convoy during the war with a loss of only one half of 1%. During 1917, 1,134 British ships were sunk by submarines, whilst 841 others were attacked and escaped: 137 were sunk by mines, mostly laid by submarines and 38 by surface craft. The total tonnage loss for the year was over 3,500,000 tons and as a counter to this great loss *75* German submarines were sunk.

VARIOUS OPERATIONS 1917

The Dover Raids.—The German submarine and destroyer bases at Zeebrugge and Ostend were frequently bombarded by the monitors of the Dover Patrol but, although much damage was done, the lock gates and basins were not hit. The mine and net barrage in the Straits was constantly patrolled by destroyers and drifters and German destroyers made several attempts, by night raids on the patrols, to open a way for their submarines into the Channel. On the night of March 17 a German flotilla attacked the patrol, sank the destroyer "Paragon" and damaged the "Llewellyn." On April 20, they were not so successful, for the raiding flotilla was met by the "Swift" and "Broke" and, in the spirited hand-to-hand fight that ensued the German destroyers "G. 42" and "G. 45" were sunk. Thereafter, except for ineffectual sorties on April 26 and May 2, no raid was made upon the Dover Straits for nearly a year. Further north the Harwich Flotilla was constantly on the alert and on Jan. 23, in a night melée with a flotilla off the Dutch coast, the German leader was forced into Ijmuiden badly crippled, another boat was driven back to Zeebrugge and the British destroyer "Simoon" was sunk.

The Scandinavian Convoy.—Although to a great extent covered by the Grand Fleet cruisers and escorted by destroyers, the Scandinavian convoy was open to bold attack by the German surface craft and two such attacks were successful. On Oct. 17 two German light cruisers met this convoy of nine vessels, sank the escorting destroyers "Strongbow" and "Mary Rose" and the ships of the convoy without warning and escaped unscathed. Again on Dec. 12 a German flotilla attacked the convoy and sank the destroyer "Pellew" and four armed trawlers, most of the merchant ships escaping. These two mishaps led to a reorganization of this convoy route and to the strengthening of the escorts.

The Action of November **17.**—Owing to delays in the production of mines, the British policy of intensive mining off the entrances to the German ports was not put in force until October. This was followed by a great increase in the German minesweeping service, some of the flotillas having to work as far as 150 miles from Heligoland. In November the Grand Fleet cruisers constantly raided the Bight and the Cattegat and on Nov. 2 the decoy ship "Kronprinz Wilhelm" was sunk in the latter area. On Nov. 17, two British light cruiser squadrons, supported by battlecruisers, attacked the German minesweepers and their covering force in the Bight. **A** long range action followed, the Germans retiring under smoke-screens to the minefields, when two battleships appeared in support and the British force withdrew. In this indecisive affair the light cruiser "Konigsberg" was heavily hit and one German outpost vessel was sunk and on the British side the light cruiser "Calypso" was hit and her captain killed. On Dec. 23 three destroyers escorting the Dutch convoy steamed into a German minefield off the Maas Lightship and were sunk in quick, succession. The Grand Fleet suffered a heavy loss when the battleship "Vanguard," on July 9, was lost at Scapa Flow with nearly all hands, owing to an internal explosion.

At the end 'of the year Admiral Wemyss relieved Admiral Jellicoe as First Sea Lord and Vice-Admiral Keyes took over the command of the Dover Patrol, in succession to Vice-Admiral Sir Reginald Bacon.

The Baltic in **1917.**—A few British submarines operated in the Baltic throughout the year, being employed mainly on reconnaissance work by the Russian Admiral. In October, after Riga was captured by the German Army, an attempt to open up the Gulf of Riga was made by the High Sea Fleet, and a military force was successfully landed on Osel Island. The Straits of Irben were swept but the battleships "Bayern," "Grosser Kurfiirst" and "Markgraf" all struck mines. The Russian battleship "Slava" was sunk but after three German battleships had been attacked by British submarines the naval force was withdrawn, leaving Osel Island in military occupation.

Mesopotamia, **1917.**—After many months of preparation, General Maude commenced his advance up the Tigris in Feb. 1917. The army was supported by a flotilla of eight new river gunboats and a number of armed river steamers. Kut was retaken on Feb. 24 and in the heavy fighting that followed the naval flotilla played a prominent part. The 6-inch and 4-inch guns of the gunboats did much to convert the Turkish retreat into a rout and the British flag was hoisted over Baghdad on March 11. (See MESOPOTAMIA, OPERATIONS IN.)

The Mediterranean, **1917.**—Allied naval strategy was centred in the Adriatic during the year, for the French and Italian battle squadrons had to keep a watchful eye upon the Austrian dreadnoughts. But the enemy submarines and not the battleships became the dominating factor and, using the Austrian bases, they operated all over the Mediterranean. Their target was a vast one consisting of the great volume of trade to the East, swelled by troop and supply ships feeding the armies at Salonika (*q.v.*), in Egypt, in Syria (*q.v.*) and in Mesopotamia. The 40-mile Otranto Straits were too deep for mining and were patrolled by 50 British North Sea drifters, supported by British and Italian cruisers and destroyers. Stopping the passage of enemy submarine was a difficult task and the patrols were always open to sudden raids. On May 15 Austrian cruisers and destroyers descended upon the patrols and sank 14 drifters before they were chased back to Cattaro by the cruisers "Weymouth" and "Dartmouth." The latter ship was torpedoed during the action but did not sink.

Owing to separate commands in the different areas, difficulties arose in the co-ordination of the methods of protecting merchant ships from submarines and by the middle of the year the losses in the Mediterranean became very serious. In August a British commander-in-chief was appointed to Malta as the single authority responsible for trade protection in that sea. A convoy system was started, under the escort of British and Japanese destroyers and the toll of losses was gradually reduced. A further co-ordination of naval effort followed the meeting of the Allied Naval Council at Malta in November. During the year a British squadron of two battleships and a number of cruisers cruised in the Levant, watching the Dardanelles and co-operating with the Salonika force. On the Palestine coast, a flotilla of monitors, destroyers and gunboats took an active part in the battles of Gaza (*q.v.*), which led to the fall of Jerusalem (Nov. 11).

THE NORTH SEA AND CHANNEL 1918

During 1918 the mine became predominant as a counter to the submarine and a duel developed between the two weapons. The mine barrage in the Dover Straits was strengthened and with the patrol craft armed with every known anti-submarine device nine submarines were accounted for in that area during the early weeks of the year and it became evident to the German naval command that the passage of the Straits was virtually closed to them. They made two attempts to reopen the Straits. On Feb. 15 a destroyer flotilla raided the patrols at night, sank seven drifters and a trawler and escaped without being brought to action. On March 21 a similar raid was not so fortunate, the German flotilla being met by British destroyers. One German destroyer was rammed and cut in half by the "Botha," another was sunk by gunfire and the Germans were chased into Ostend. The "Botha" was torpedoed but reached Dover safely.

Zeebrugge and **Ostend.**—This proved to be the last German attempt upon the Straits, but as long as their bases at Zeebrugge and Ostend remained in being, raids were to be expected. As early as 1914, Jellicoe had proposed an attempt to block these places, but it was not until the last months of his time at the Admiralty that active steps were taken to put the plan into execution. Admiral Keyes was appointed to Dover to carry it out. After weeks of secret preparation, the mixed force selected sailed on the afternoon of April 22 to attempt to block the entrances at Zeebrugge and Ostend. The flotilla returned to Dover next morning, its mission at Zeebrugge accomplished.

At Ostend the blockships failed to find the entrance, but this was remedied a fortnight later, when a volunteer crew took the "Vindictive," of Zeebrugge fame, into Ostend and sank her in the entrance. 'These two brilliant actions did not entirely block the Flanders Coast bases. but their moral influence was great and they acted as an added inducement to the German submarines to shun the waters of the Dover command and to confine their efforts to gain the open sea to surmounting the lesser perils of the northabout route.

Last Sortie of the German Fleet.—The Scandinavian convoy remained a bait for the High Sea Fleet and on April 23 it put to sea, for the last time in full strength, to try to intercept it. The date was an unfortunate one for the German enterprise for on that day both outward and homeward bound convoys were in the vicinity of the Forth. The British intelligence system failed to warn Beatty that enemy were at sea and the German battlecruisers reached the Norwegian coast at Lat. 60 N. before they were reported. Here the "Moltke" broke down and had to be taken in tow. The German fleet made for home at its best speed; the "Moltke" was torpedoed by Submarine "E. 42" on her way south, but managed to reach her base.

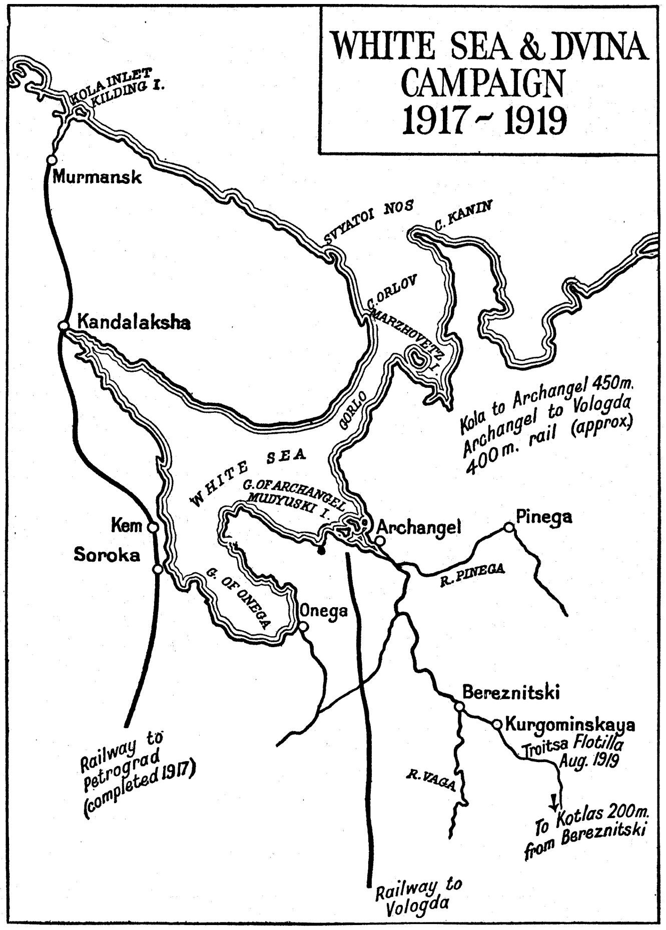
The Northern Barrage.—Frequent raids were made by the British cruisers and destroyers upon the flotillas engaged in clearing ways for the German submarines through the minefields and on April 15, during a raid into the Cattegat, 14 German trawlers were sunk. From the commencement of the British intensive mining policy in the autumn of 1917 until Feb. 1918 over 16.000 mines had been laid in the Heligoland Bight. On Feb. 15 a deep minefield was laid in the Cattegat and the following month saw the beginning of the greatest minelaying operation of the war, the laying of the Northern Barrage. (See MINES [NAVAL] .)

This vast undertaking. the closing by mines of the northern entrance to the North Sea from the Orkneys to the Norwegian coast, involved the laying of over 70,000 mines. The mines were made in the United States and were laid by British and American vessels, escorted by the squadrons of the Grand Fleet, with which for some time an American battle squadron had been working. The Northern Barrage was successful both as a moral deterrent and by the number of submarines destroyed in it.

The End of the Submarine Campaign.—By the middle of 1918 the mastery of the Allies over the submarine was in sight, both from the number destroyed and from the lessening toll they took of merchant ships. In the first nine months of the year over 60 submarines were sunk by the Allied naval forces: the average weekly loss of British merchant ships was over 17 in the first quarter of the year and by the third quarter this figure was reduced to under 11. During 1918, 1,108 submarine attacks were made upon British merchant ships: of these 581 were sunk and 527 escaped, a far higher percentage than hitherto. During 1918 only 8 British ships were lost by mines, a figure that attests the efficiency of the Auxiliary Patrol and Minesweeping services.

On July 19 a naval air raid, supported by the Grand Fleet, was made upon Tondern and a Zeppelin shed was destroyed. In another raid on August 11 made into the Heligoland Bight by cruisers and coastal motor boats, a Zeppelin was brought down and destroyed, but the motor boats suffered heavily from the enemy air craft. These proved to be the last two important operations of the Grand Fleet during the war.

The White Sea, 1918–19.—The closing of the Black Sea and the Baltic brought the northern route to Russia into prominence and vast quantities of munitions and fuel were, in 1917, sent to the ice free port of Murmansk (connected by rail to Petrograd in 1917) and to Archangel, which was open from July to October. When Russia collapsed in 1917 the old battleship "Glory" and the cruisers "Cochrane" and "Amiral Aube" (Fr.) were sent to Murmansk and were followed in May 1918 by the cruiser "Attentive," the seaplane carrier "Narana" and a force of 9,000 troops (2,100 British). The object of the expedition was to prevent Germany using these ports as submarine bases, to keep open supplies and give support to the anti-Bolshevik forces under Kolchak (*q.v.*). Archangel was occupied in August after a spirited duel between the "Attentive" aided by the Narana's seaplanes and the forts, and an advance was made along the railway towards Vologda and up the Dwina river towards Kotlas, the latter being supported by a flotilla, which included a British monitor and a number of local river steamers fitted out as gunboats and motor launches, mostly manned by British crews. Troitsa, 250 miles from Archangel, was occupied in September, when the flotilla had to retire before the river began to freeze. In April 1ǐ9 a British flotilla, which eventually included 6 monitors, 6 river gunboats, minesweepers, and coastal motor boats, 18 seaplanes and a kite balloon, assisted in the attempt to advance to Kotlas, but Kolchak's effort failed and political influences caused the Allied Governments to order a withdrawal from North Russia. The flotilla successfully covered



the re-embarkation with the loss of two small monitors. By the end of Sept. 1919 the evacuation was complete.

The Baltic, 1918.—The British submarine flotilla, working under the orders of the Russian commander-in-chief, was stationed at Helsingfors during the winter of 1917–18. After the break-up of Russia, the Germans advanced upon Helsingfors, and on April 3, 1918, the flotilla of seven boats was taken to sea through the ice and sunk to avoid falling into the hands of the enemy.

The Mediterranean and Black Sea, 1918.—Early on the morning of Jan. 20, the "Goeben" and "Breslau" suddenly reappeared in the Mediterranean. Shadowed down the Dardanelles by two British destroyers, they made for Imbros Island, where they found the monitors "Raglan" and "M. 28" at anchor. The two British ships were soon set on fire and sunk but in rounding the south of the island the Germans met disaster. The "Breslau" struck a mine and sank and the "Goeben" shortly afterwards struck two mines in quick succession. In a sinking condition she crept back into the Straits and was beached in the Narrows. Continuous attacks upon her from the air failed to do material damage and a desperate attempt to torpedo her, made by "E. 14," resulted in the loss of the submarine. Eventually the "Goeben" was towed off and once more made her escape to Constantinople.

The loss of merchant tonnage on the congested traffic lanes of the Mediterranean remained severe and although the unified control of Trade Protection gradually reduced this loss the Mediterranean was one of the chief danger areas on the trade routes until the end of the war. The Otranto barrage, though a deterrent, was unable to close the passage to the German and Austrian submarines and its patrols were always open to sudden raids. On April 22 Austrian destroyers made a descent upon the patrols but were driven off and in June the Austrian dreadnought squadron at last moved out of Pola and sailed for Cattaro with the intention of attacking the barrage. The squadron was attacked by Italian torpedo boats, the dreadnought "Svent Istvan" was sunk, the attack was abandoned and the Austrians returned to Pola. On Oct. 31 the defences of that port were pierced by the Italian mosquito craft and the battleship "Viribus Unitis" was torpedoed and sunk. During the closing months of the war a flotilla of British monitors and small craft were employed on the northern shores of the Adriatic in co-operating with the flanks of the Italian Army in their final struggle with the Austrians.

The Black Sea.—Until the break up of Russia, sporadic fighting took place between the Turko-German naval forces and the Russian Black Sea fleet, in which the Russian dreadnoughts dominated the situation. After the mutiny of the Black Sea fleet, a danger arose that one or more of the battleships might fall into the hands of the Germans as potential fighting units. The Allied Aegean squadron was therefore strengthened in 1918 by 4 French battleships and 2 British dreadnoughts. It was one of the latter ("Superb") that on Nov. 12, 1918 led the Allied fleets up the Dardanelles and subsequently to Constantinople.

THE FINAL PRASE

As the months of 1918 drew on the menace of the submarine waxed less and less and during May, June and July over 600,000 American troops were safely carried across the Atlantic and landed in France. It was the beginning of the end. In August the German Western Front began to crack under the blows of the French and British armies: Austria was breaking up: September saw the Bulgarian front give way and, in October, Germany, racked by internal troubles, was forced to her knees.

Scheer, who had relinquished the command of the High Sea Fleet to von Hipper on being called to Headquarters in August as Chief of the Naval Staff, received orders late in September to be prepared to leave the Flanders Coast. In October the retirement began, hastened from the sea by the ships of the Dover Patrol. Ostend was clear of German troops on Oct. 17 and two days later they were in full retreat from Zeebrugge. Eighteen destroyers and torpedo boats escaped to the Bight but a number of submarines were left behind and blown up.

Mutiny in the German Fleet— After its futile sortie in April the High Sea Fleet made no move and signs were not wanting that its fighting spirit had departed. As early as May 1917 there had been unrest amongst the personnel and outbreaks of mutiny occurred in the battleships "Westfalen," "Kaiser," "Kaiserin" and "König Albert." In the spring and early summer of 1918 further outbreaks called for stern repressive measures. The continued inactivity of the fleet and the withdrawal of the best of its personnel for service in the submarines and in the flotillas, so undermined its morale that when called upon to make a final effort it failed.

Scheer had planned a last raid into the Channel by the whole High Sea Fleet, whilst a concentration of submarines in the North Sea attacked the Grand Fleet on its way south. The submarines were recalled from their war upon commerce at the end of October and were stationed off the Scottish coast, but, when, on Oct. 29, the signal was made to prepare for sea, open mutiny broke out and the fleet refused to sail. From that moment the High Sea Fleet ceased to exist as a fighting machine and the war at sea was over. Most of the crews of the destroyer and submarine flotillas remained loyal until the end and one of the latter inflicted the last casualty of the war upon the British navy when, on Nov. 10, the old battleship "Britannia" was torpedoed off Cape Trafalgar.

The Armistice.— Under the terms of the Armistice, Germany agreed to surrender 10 battleships, 6 battlecruisers, 8 light cruisers, 50 destroyers and all submarines. These terms were enforced without delay and two scenes followed that will be forever memorable in the long sea history of Britain. On Nov. 20, Rear-Admiral Tyrwhitt, with the Harwich flotillas, met the surrendering submarines off the Essex coast and escorted them into Harwich. Slowly, the long line of 129 submarines passed into the harbour, watched, in dead silence, by great crowds on either shore. Thus was the greatest menace to Britain's sea power laid to rest. The next day, Nov. 21, Admiral Beatty with the Grand Fleet, met the German Fleet off the Firth of Forth. Between two long lines of British ships the High Sea Fleet steamed to its anchorage below the Forth Bridge and there, at sunset, the German flag was hauled down and was not hoisted again. Thus the proud fleet of Germany surrendered to its enemy, who for over four years had watched and thwarted its every move.

The Peace Terms.—In June 1919 the naval conditions of the Peace terms were signed. They were drastic and reduced Germany at a blow from the position of a great sea power to that of a minor one. The maximum strength of the German navy was fixed at 6 small battleships, 6 cruisers, 12 destroyers, 12 torpedo boats and no submarines, with a personnel not to exceed 15,000 officers and men.

Within two months of the signature, the remaining 8 dreadnoughts with 8 light cruisers and 92 of the latest destroyers and torpedo boats were surrendered, disarmed but with their guns on board, and, within one month, all submarines, either built or building, were either surrendered or broken up.

The disposal of this great array of ships became the subject of delicate discussion between the Allies. Great Britain wanted to destroy them all but France and others wished to add their share to their fleets. The question was partially settled by the Germans themselves, when on June 21, the fleet interned at Scapa Flow, was scuttled. There were at anchor in the war base of the Grand Fleet, 11 battleships, 5 battlecruisers, 8 light cruisers and a number of destroyers. At 10 A.M., by preconcerted signal, the crews opened the valves and the ships began to sink. Only four, the "Baden" (the latest battleship) and three light cruisers remained afloat. This act cost Germany dear, for she had to surrender in place of the battleships, 300,000 tons of floating docks, her remaining five light cruisers and 42,000 tons of floating cranes, etc., in lieu of the destroyers.

Comparative Naval **Losses.**—The warship losses of the powers engaged are shown in the following table.

	Great Britain	France	Italy	Japan		Russia	Turkey	Austria	Germany	
									Losses	Surrendered
Dreadnoughts	2*	..	1*	1*	..	2*	..	2	..	18
Pre-dreadnoughts	11*	4	3	..	..	2	1	1	1	..
Battlecruisers	3	..	..	1*	..	..	..	..	1	6
Cruisers	13*	5	1	..	1	2	..	..	6	..
Light cruisers	12	..	2	2	..	..	1	3	17*	23
Destroyers	67	12	8	1	2	20	3	6	66	92†
Submarines	54	14	8	..	..	20	..	14**	199	All

*One lost by accidental internal explosion. †Also 50 of the newest torpedo boats.

**By the peace terms Austria was left without coast line and her navy ceased to exist.

In addition to those shown in the table, Great Britain lost 60 minor war vessels (torpedo boats, sloops, gunboats, monitors, coastal motor boats, etc.), her losses in this type being heavier in proportion than that of the other Allies. British losses of auxiliary vessels totalled 17 armed merchant cruisers and 828 other vessels. This latter figure included 288 colliers and oilers, 246 trawlers and 130 drifters. Submarines accounted for 35% of the loss amongst auxiliary vessels, 28% were sunk by mines and 9% were lost by wreck or fire.

Under the urgent stress of war, science brought about the rapid development of certain new weapons and new methods; the submarine and the mine and their countermeasures; the increased range of the great gun and in the power of explosives; the use of poison gas and the birth of aircraft as fighting machines. Reference to all these matters will be found elsewhere; they were common to all belligerents and did not alter the course of the war at sea. For, upon the sea, history was repeated. Like France and Spain in the wars of the 18th century, Germany found herself, at the outset, in the grip of the blockade of the British Fleet. Isolated from the world and cut off from oversea supplies, she attempted by her submerged blockade, like Napoleon with his Continental System (*q.v.*), to strike a vital blow at Britain's seaborne trade. Like the Continental System, the Submerged Blockade came near to success, but, in the end, under the steady pressure of the Allied navies, it failed. With supplies unlimited the wasteful struggles between the great armies might have been prolonged indefinitely, but with the Central Powers denied their wants by the Allied blockade at sea, whilst the Allied armies received their every need from overseas, there could be but one end.

Upon the British Merchant Navy fell by far the greatest burden of carrying the seaborne trade that kept the Allied armies in the field and fed the civilian populations; heavy indeed was the price it paid in the faithful performance of this duty. To the Royal Navy fell the lion's share of the fighting upon the sea: its great traditions were maintained and glorified and when the Armistice called a halt the two navies of Britain had once again carried the country in triumph to the end of a great war.

(S. T. H. W.)

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WORLD WAR II. The article which follows is divided into six broad sections which describe the principal political and military events of World War II. The military and air operations have been treated according to three main geographical divisions—Europe, Africa and the near east; China; and the war in the Pacific.' Naval operations are described in a separate section, although it is often impossible to draw a sharp line of demarcation between purely military and purely naval action in World War II, particularly in the Pacific.

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  - 2. The German Offensive
  - 3. The Russian Invasion
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  - 2. Mannerheim Line Crushed
- C. German Campaigns in Denmark, Norway
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  - 2. Egypt and Libya
    - (a) First Italian Offensive (Sept.–Dec. 1940)
    - (b) British Counteroffensive (Dec. 1940–Feb. 1941)
    - (c) Second Axis Offensive (March–April 1941)
    - (d) Second British Counteroffensive (Nov. 1941–Jan. 1942)
    - (e) Third Axis Offensive (Jan.–Aug. 1942)
    - (i) Final British Offensive (Oct. 1942–April 1943)
  - 3. Occupation oi Madagascar
- F. The Near East Campaigns
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- G. The Balkan Campaigns (1940–41)
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- H. The German–Russian War
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  - 5. Russian Reconquest of the Ukraine
  - 6. Russians Enter Poland and Rumania
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I. THE ORIGINS

The years between World Wars I and II covered another period in history wherein the struggle for world peace resulted in failure. It was a period during which those who had the power to enforce peace failed to act and during which the aggressors. encouraged by such failure and heedless of the destruction and human suffering entailed, again took up war and oppression as a means of accomplishing their objectives.

World War I had been sufficiently vast and destructive to induce mankind to search deeply for the means of avoiding another such convulsion. Many objective and high-principled leaders, who devoted all the energies they could summon to the establishment of a form of society which would bring security and peace, arose after that conflict. If there were also men of partisan approach and background, they did not dominate the scene; and it is safe to say that all were so gripped by the full sense of the destructive power of war as to seek honestly and energetically for security. Then, as at later times, there was divergence of opinion as to method.

Then, as after World War II, acute postwar problems arose which had to be dealt with even while discussion of the form of a world organization was taking place—problems in some instances very much like those which confronted the world after 1945. These problems frequently plagued the general will to set up a form of international organization which would become either a substitute for. or a moderation of. the old methods of achieving security; namely, by alliance. individual action and war.

It was the conflict, probably inevitable, between the concept of individual security and Pres. Woodrow Wilson's doctrine of collective security which compromised the settlement after World War I. It stalked across the entire period between the wars, and finally led to outright defiance of the League of Nations by the axis powers and to virtual abandonment of it by the western democracies. The establishment of the many new small nations had been tied in with the creation of the League as the fundamental basis of fostering European peace. With these new nations and the alterations of boundaries which were necessary to produce them, and without firm adherence to the League on the part of the victors, Germany was left a wide choice of European issues to exploit.

All the great Allied Powers, including the U.S.S.R., appear to have been guilty of the most painful blunders in their vacillation between collective and individual security as the aggressors began their exploitation of Allied disunity, weaknesses and indecision. That vacillation frequently nullified effective action toward peace. It was only in the face of black disaster and in the heat of actual armed conflict that unified action was forged.

Significance of **Versailles.**—It is to this persistent conflict between collective and individual security and the jockeying it produced among the powers, rather than to the harshness or the softness of the treaty of Versailles in respect to Germany, that one must look for the elements most useful to the aggressors during the decade preceding World War II.

The Versailles treaty attempted to put together French and Anglo-U.S. concepts of a stable world order. France, which sought drastic modifications of Germany's political boundaries, finally settled for military guarantees of the type with which for centuries it had been familiar. These it accepted from Great Britain and the United States of America in return for the abandonment of its claim to strategic frontiers and of its plan for the dismemberment of Germany.

The resultant treaty, at least in French eyes, presupposed the continuance of English and U.S. military support. which in the end was not forthcoming. France, as a result. never was induced by a basic sense of security to rest its full faith in the League of Nations.

Practically from the instant of the refusal of the United States to support France by a military alliance and the consequent loss of the British guarantee, the essential elements of the whole theory on which the treaty was drafted were removed. The United States' refusal to ratify the treaty was a body blow of almost fatal character in itself, considering the part which the assumed adherence of the United States had played in the treaty negotiations. Even France's proposal for an international police force was rejected. The representatives of Great Britain and the United States had been rather well satisfied with the geographical and military positions of their respective countries after World War I. They were disposed to be content with the formal creation of an organization to keep the peace without placing any great emphasis on the methods by which such an organization would be made potent and dynamic. The League without U.S. participation was thus doubly undermined. To make matters worse, after U.S. withdrawal, England quickly shifted to its old concepts of the balance of power and of restricted intervention in European affairs which effectively deterred it from supporting France's proposals to curb the first military gestures of the renascent reich. Instead of Anglo-French integration of policy, there ensued a sort of duel between the two countries resulting in the practically unilateral and highly unsuccessful occupation of the Ruhr by France and the consequent encouragement of Germany to flout the treaty.

The Germans, especially Adolf Hitler, made much of the harshness of Versailles; but in retrospect no serious contention can be held that the political burdens of Versailles were too great for it to bear. The boundaries in some cases were awkward. as for example the Polish corridor; but they left Germany a strong national state, with a chance for complete economic recovery. Considering the conglomeration of races in Europe and the acute sense of security need which German aggression had induced, the territorial solutions attempted at Versailles could not be said to have been unreasonable or vindictive. It is true that the reparations clauses of the treaty were unrealistic, and together with other factors—most of them of German origin—they played a part in inducing the distressful inflation which Germany underwent. The reparations clauses were moderated, however, by successive plans of adjustment; and in the end Germany failed to pay by way of reparations as much as was received by it in foreign loans on which it later defaulted. It is true that the inflation under which Germany suffered and the economic collapse of the country did serve to destroy the chief prop the German republic had in the way of political support, for it embittered the middle class against the government, and it enabled Hitler to gain ground with his joint denunciation of the republic's leaders and Germany's former enemies.

While the economic features of the treaty had serious consequences, the true defect of Versailles lay in the failure of the Allied Powers to move together in the enforcement of the settlement. even after their own moderation of its terms. The truth of the matter became apparent too late, but eventually, even to Anglo-U.S. apologists for the alleged harshness of the treaty, it became evident that Hitler was grossly overplaying Versailles as a justification for his depredations.

Primary German **Responsibility.**—Hitler, however, successfully utilized the treaty as a means of gaining power at home and of disseminating publicity abroad as to the sincerity of his purposes. It was only on the verge of war that the realization arose that something deeper than modifications of the treaty of Versailles stood between peace and war in Europe. Hitler's reiteration at each crisis he precipitated that he sought no further concessions in Europe finally lost its force.

Prior to World War II, the German standard of living had substantially improved—it was measurably higher than that of the first victims of Hitler's attacks. If there was discrimination displayed by contiguous states against German residents, none of it approached Hitler's charges nor faintly suggested the brutalities Hitler was himself exerting on minorities within his own borders. Yet these were the elements which his propagandists stressed and which readied the nation for another mar.

With all this, Hitler could not have made Germany march without another factor which underlay the whole German structure. This was a still deeply seated tradition and sense of superiority fostered by Germany's military philosophers and supported generally by the people. It arose from pride in Germany's many and important military successes in the past and a conviction of superiority which was never entirely dissipated by its really thorough defeat in 1918. The unconvincing character of that defeat in German minds, and the humiliations which defeat brought Germany, supplied the chief nourishment on which Hitler's propaganda could and did thrive.

Germany had no justifiable military, political or economic cause for war and it was always within its power to avert it; but the Allied Powers made the way easy for Hitler's ambitions, first, by their failure to enforce collectively the provisions of the treaty and the agreements made subsequent to the treaty, and, second, by their refusal to take united and timely action in the way of economic concessions which would have strengthened the republic. These concessions, which were never forthcoming in unified form, were belatedly urged on Hitler when they were of no further avail as a war preventive.

In condemning the shortsightedness and indecision of the Allied Powers, it must always be borne in mind that these factors did not cause the war. They only failed to prevent it.

The utter wantonness of Hitler and the willingness of the German people to support him and condone his depredations caused the European war, and in the disappointment caused by the weakness and indecision of the Allied leaders and peoples one should not lose sight of the primary and fundamental responsibility of Germany, Japan and Italy for the years of misery they inflicted on the world.

Futility of Disarmament.—Throughout the period between World Wars I and II, the western democracies clung persistently to the concept that disarmament in itself would bring peace. Indeed, this became almost the only continuing element of their policy Even in the face of the most significant acts of aggression on the part of Germany, Japan and Italy, the disarmament conferences went on. No disarmament agreements of any substance were concluded by the axis powers, a fact significant enough in itself; but all the while they went on arming. The democratic governments were informed of this rearmament, but they chose to ignore it. They fastened only the more firmly to the hope that the more convenient policy of disarmament would induce peace. Though no agreements were consummated, the two greatest of the democracies were actually disarming through their failure to maintain their military establishments at any stage which either Germany or the smaller nations, eventually to become Germany's victims, could recognize as a factor measurable in terms of time and effect in enforcing peace.

This tendency arose in large part from the expressions of great bodies of well-meaning people, in both Great Britain and the United States, who firmly believed that no arms meant no violence. It was combined with the ever-present reluctance of political parties in power to take the responsibility of imposing on the electorate the added tax and personal burdens which armament involves.

Whatever the motive, the result was clear. None of the axis powers felt that there was either a will or a capacity to enforce the peace on the part of the great democracies. This belief was transmitted to those countries which might have resisted the aggressions. It thus entered into the calculations of both aggressor and victim—the aggressor being convinced that he could make away with his gains before any retribution could overtake him and the victim being convinced that resistance was useless, since no help could or would arrive before he was overrun.

Locarno and London.—Two occurrences, rather characteristic of the trend of world politics in the interwar period, should be referred to before reciting the sequence of the direct and immediate events which led up to the actual outbreak of World War II. The first was the repudiation of the Locarno pact of 1925, and the second was the failure of the World Economic conference in 1933. During the period between the wars, as indeed in most periods of history, political and economic issues went hand in hand as parallel irritants to friendly relations. In the period referred to, the economic crazy quilt of high tariffs, reparations, foreign loans and strangulation of international trade constantly created international complications and demanded rectification.

A serious effort was made, and for a time seemed successful, to deal with the political issues at Locarno. The conclusion of the pacts ushered in a period of much good feeling. It followed the evacuation of the Ruhr and the acceptance of the Dawes plan as a settlement of the reparations problem and the stabilization of German economy. At Locarno, Franco-German and Belgian-German boundaries were guaranteed; the permanent demilitarization of the Rhineland was provided for; war was renounced and the principle of arbitration of disputes between the countries was established, except for cases in which self-defense, League action or German violation of the demilitarization provisions was involved. Great Britain and Italy joined in to promise assistance to the country which became the victim of another's aggression. Germany was elected to the League. Thus, all but Germany's eastern boundaries were dealt with. The Soviet Union naturally was disturbed, but in spite of Russian suspicions the Locarno pact established a basis upon which much might be built and even more hoped for. Here was an agreement entered into freely by Germany as a coequal. It had none of the aspects of the Diktat which Germany signed in the Hall of Mirrors at Versailles.

Hitler came to power in Jan. 1933; in 1936, not long after he had proclaimed his firm intention to observe the agreements which were made at Locarno, hardly more than ten years after the pacts had been signed, the new German leader marched his troops into the Rhineland in direct violation of the pacts. The great powers did no more than make formal protestations to this action.

The other significant event was the attempt made to solve the major economic problems then plaguing the world. To accomplish this, a great economic conference was called together to meet in London in June 1933. The conference was called by the League in a supreme effort to recognize the integral character of the world's economy. The economic dislocations brought on by World War I, and the continued nationalistic measures and countermeasures which were everywhere in force, were patently interfering with the political stability of the world. The conference was to deal primarily with the removal of trade barriers, the stabilization of currencies and the disposal of other restrictions impeding world trade.

Though having high hopes and possibilities, the conference at the very outset was blocked by the action of the United States in opposing any measure leading to the stabilization of currencies. Other restrictions on the power of the U.S. delegates, together with the force and manner in which their authority respecting currencies was taken from them by their own chief, turned the conference into something of a fiasco.

The political value of Locarno was destroyed by the determination of Hitler to prepare his way for outright aggression, whereas the attempt to deal with world economic problems was nullified at a critical time largely by a leader who had just come on the scene and who was to play such a vital part in the final overthrow of Hitler—Pres. Franklin D. Roosevelt. The president felt a compelling domestic need for higher prices and was prepared to place that consideration above the international need for stabilized world economic conditions. This event is stressed as a significant incident of the general trend of nationalistic action which tended to interfere with constructive plans for world peace. The event is the more significant in that President Roosevelt, who was later to become almost the personification of collective action and internationalism, was impelled to pursue this course. Whatever his motives, the failure of the London conference served to encourage the policies of economic nationalism. This encouragement unfortunately played into the hands of the nazi leaders of Germany. Other factors may have obstructed the possibilities of success at London, but the action of the United States made a spectacular contribution to its failure.

These two events stood out as typical of the halting and contradictory character of Allied action as against the unequivocal evidence of axis intention, particularly as such intention became manifest after Hitler's accession to power. They were only typical, however, for it would not be difficult to find similar instances of the operation of British, French and Russian self-interest or to locate as flagrant an example of axis provocation.

Failure to Check Aggression.—Thus, first one country and then another, the western democracies as well as the U.S.S.R. (for the record shows that all were sooner or later involved), took, or failed to take, action, which set the stage for the ever-present and unrelenting determination of Hitler to divide and conquer. This was the pattern which led to war, and one step after another followed, no one of which seemed sufficient at the time to induce the powers to undertake collective action or even courageous individual action. Some of the major incidents can be only briefly summarized, with consequent risk of oversimplification, but it is impossible to misinterpret the trend.

The Japanese aggression in Manchuria in 1931 apparently was the first of the definite steps toward doom. It is necessary at this stage to look at the state of affairs in the far east to judge the part Japan was to play in the drama.

Paralleling the nazi and fascist motives of Germany and Italy, another virulent and demoralizing force was steadily at work and steadily antagonistic to peace. Comparatively late in emerging from a deep tribal isolationism to become a member of the international community, and permeated with a strong militaristic tradition, Japan had persistently expanded its territories and areas of influence through opportunistic conquests before World War I; viz., China (1894), Russia (1904) and the German possessions in the far east (1914).

For a time, after obtaining the concessions for which it contended at Versailles, Japan gave evidence of participating with considerable good will in the international field. It had benefited greatly both territorially and otherwise by its intervention in World War I, at relatively little cost. Encouraged in addition by the spectacle of the weak support given by the great powers to the League and inspired by the opportunities it felt that a feeble China afforded it, Japan's materialist and militarist elements soon impelled the country to discard all inhibitions, seize Manchuria and subjugate Asia to exclusive Japanese interests. When the League rather feebly sought to remonstrate, Japan departed from that organization and from then on matched each self-serving protestation of peaceful intent with an act of the most barefaced aggression.

Its first step was, as has been indicated, in Manchuria. In Sept. 1931 a portion of the track of the South Manchurian railway was blown up with all the marks of a manufactured incident. The Japanese army immediately took possession of important strategic positions in Manchuria. Four months later Japanese forces landed in Shanghai, bombarding the town and engaging the Chinese forces located there. All of Manchuria was occupied. The foresighted warning of Henry L. Stimson, then United States secretary of state, who called for collective action, appealed neither to Great Britain, whose stake in the Pacific areas was, if anything, greater than that of the United States, nor to the United States. In spite of Secretary Stimson's prescience, the United States, as Great Britain well knew, was in no mood to take determined action. In retrospect, the failure to act in Manchuria becomes the first recognized signpost along the road of missed opportunities which led to war.

Ethiopia, the Rhineland, Spain.—The League was bluntly challenged by Japan and promptly collapsed before the challenge. It was only a relatively short time later, in Oct. 1935, that Benito Mussolini defied the League in his conquest of Ethiopia. France this time failed to support Great Britain, and it was not long before the shoe was on the other foot when in March 1936 Hitler marched into the Rhineland. As Pierre Laval had failed to support Great Britain over Ethiopia, so now Stanley Baldwin failed to join with France over the Rhineland, and again there was no firm individual or collective action.

These were portentous incidents, but more ominous than any of them was the outbreak of bitter armed conflict within Europe itself. The Spanish peninsula, so important to British and French interests, became in July 1936 the scene of a violent struggle which ended in a serious deterioration of British and French power in Europe. The Civil War moved from a left-*v.*-right domestic struggle to a sort of international proving match of strength and weapons, in which German and Italian forces became deeply involved; and the position of the democratic powers became increasingly weak as totalitarian forces were strengthened. "Nonintervention" became a watchword of Allied policy, and still the German and Italian reinforcements of men and arms grew. Soviet aid was given to the loyalists (left) but never on the scale of the axis assistance which was made available to Gen. Francisco Franco's rightist forces. Entire divisions were transported to the peninsula, and the fighting was on a fully organized scale. The war in Europe had in reality already started, but it was significantly obscured in western eyes by a fog of ideologies—communism v. the right and a stubborn refusal to face up to political and strategic realities. Refuge was taken in nonintervention pacts entered into after laborious exchanges between foreign offices but only unilaterally observed. When the fog had lifted with a Franco victory, English sea power all over the world was compromised by the weakened position of its fleet in the Mediterranean. France had another hostile European power with which to cope. The Soviet Union was more deeply isolated, and Hitler was better prepared for his impending excursions into middle Europe.

Japan again renewed its aggression by the seizure of Peiping in July 1937. Italy withdrew from the League. Through all this period the greatest potential power for peace had little to offer. The United States at this stage appeared to the world as isolationist, pacifist, neutral and disarmed, and its government had little influence upon the world situation. Others were to call the tune by which the world was to dance, and the attitude of the United States was ignored by the aggressor nations that were in a few years to be destroyed by a combination of powers of which the United States was to be the chief centre of strength.

Austria and Czechoslovakia.—While Hitler was already fighting in Spain, he was preparing at home his more ambitious plans of conquest and forging the means by which they were to be carried out.

By 1936 the paramilitary organizations of Germany were in full strength. The *Sturm Abteilungen* (SA), the *Schutzstaffel* (SS) and the *Reichsarbeitsdienst* (RAD) consisted of more than 1,500,000 men, disciplined as military organizations, yet intimately involved in the social and political life of the country. They were the select exponents of the nazi doctrine. Force was the keystone of their existence. Their intermittent spectacles of massed manpower with Teuton, if not barbaric, display of colour and music gave indication of the dangerous momentum of the country. At their head was the coterie of individuals which had followed Hitler to power. Strange mixtures of zealots and opportunists placed in positions of great and self-perpetuating authority, they came to feel no limit to their ambitions or the destiny of the state they ruled. Though Hitler seems to have had a design for all his conquests, the tremendous concentration of power in the hands of this relatively small group created a psychological impulse as well as a means to act promptly and drastically. With this fearful imperative it was not long before action was forthcoming.

Austria was marked as the first victim. Chancellor Engelbert Dollfuss had made an attempt at strengthening the government in Austria in 1933, but it was not the type of strength which Hitler sought, since it involved exclusion of nazis. After Dollfuss' assassination in 1934 by nazi storm troopers, Kurt von Schuschnigg became chancellor and under heavy external pressure in

July 1936 agreed to a friendship pact with Germany.

Not content with this arrangement and in accordance with plans laid far in advance, Hitler, with a modern modification of Canossa, first humiliated Schuschnigg at his Berchtesgaden hilltop and then forced Schuschnigg's resignation. This time full collaboration with the nazis was exacted, and on the night of March 11, 1938, German troops marched into Austria on the pretense that Arthur Seyss-Inquart, the new nazi chancellor, needed them to restore order.

Next in order was Czechoslovakia; nazi propaganda began its heaviest drumfire on this front in the summer of 1938. The world heard much during this period about Hitler's rages and his "patience." So great was the tendency toward appeasement, so firm the determination not to be embroiled over issues in "remote" countries, that the appeal of Pres. Eduard Benes for assistance brought only a blunt proposal by the French minister at Prague that either Czechoslovakia should agree to the Anglo-French plan for the surrender of the Sudetenland to Germany, with the abandonment of the highly prized border fortifications and the existing military alliance, or look elsewhere for help. It was quite clear that if Czechoslovakia refused, it had to face the rearmed might of Germany alone.

Munich. — Somewhere between Sept. 21 and Oct. 1, 1938, another opportunity for France, Britain and the U.S.S.R. to join and oppose was lost. The famous Munich agreement, from which the Soviet Union was excluded, was entered into on Sept. 30 and incorporated a drastic concession to Germany in the Sudeten issue. It was such an abandonment of Czechoslovakia that it represented a showdown on the one hand too humiliating for the great powers long to endure and on the other too successful for nazi politics not to exploit. Again great pressure was placed on the Czech government to conform to the Munich agreements, and just at this stage even Poland, soon itself to be engulfed, sped an ultimatum to demand the immediate cession to it of the Teschen area. Again came capitulation, and this time President Benes resigned and fled to London. Neville Chamberlain, Edouard Daladier and the Munich capitulation were much criticized. But individuals were condemned for a policy which was largely dictated by the people of the Allied nations themselves. Munich was generally applauded in France and Britain, and the representatives of those countries were met with welcoming crowds on their return. Prime Minister Chamberlain was following the overwhelming desire of the people of Great Britain to avoid a war which they sensed would be desperate if not worse in its consequences to them. Subconsciously, they may have sensed the significance of air power not only as a challenge to their long dominance of the seas but also as a weapon which could be employed perhaps disastrously against the homeland itself. The people of France were in a like mood. Czechoslovakia was not in the sphere of their vital interests. It was probably time, they reasoned, that such a maladjustment as the Sudetenland should be moderated. "If we have to fight it must be on larger issues than that," said Chamberlain, echoing the sentiments of the majority. A "quarrel in a far away country between people of whom we know nothing" was not a sufficient base on which to make a stand. But if Chamberlain was doing all he could to avoid a stand which might mean war, he was merely coping with a dilemma which Stanley Baldwin had had more timely opportunity to avoid. Daladier was but following a course toward which Camille Chautemps and the rationalizing spirit of France had directed him.

The illusion of "peace in our time" which it was hoped that truce had brought was soon to be dispelled. On the night of March 14, 1939, Pres. Emil Hacha of Czechoslovakia was called to Berlin, subjected to another of Hitler's set tirades and threatened with the destruction of Prague by air. In the face of these threats. and in approximately six months after Munich, all Czechoslovakia was overnight made a vassal state of Germany.

Poland and **the Russo-German** Pact. — Great Britain and France were belatedly aroused, if not to collective European action. at least to strong joint and individual action. Poland was so obviously the next victim that this time Great Britain made its position entirely clear in advance. An attack on Polish independence resisted by the Poles would mean active support to Poland from Great Britain, and in this action it was stated that France would join. At this point Mussolini attacked and on April 8, 1939, seized the weakest opponent at hand — Albania.

Events moved quickly. A firm military alliance was concluded between Germany and Italy on May 9, 1939. Maxim Litvinov, soviet commissar for foreign affairs, who had been an outspoken and consistent advocate of collective security, resigned on May 3, 1939, an ominous note if one had the foresight to interpret it; for shortly thereafter, and almost in the midst of protracted Allied-Soviet negotiations for collective action in the event of further German aggression, Moscow announced on Aug. 21, 1939, a ten-year treaty of nonaggression and neutrality with nazi Germany. Left out of the Austrian settlement and the Munich negotiations, suspicious of the western powers and desirous of a free hand in the Baltic states, the U.S.S.R. joined hands with Germany on the verge of battle. Its motives were destined to be debated and its conduct alternately supported and condemned at least until the time, if ever, when history might disclose definitive proof of their true character.

The great hope of the U.S.S.R. from the time of the treaty of Brest-Litovsk had lain in the spread of great revolutionary movements. It was Nicolai Lenin's thought that his action in withdrawing as a participant from World War I would be followed by revolutionary developments in Germany and the German army. Subsequently, it became a tenet of the soviet faith that such movements must occur throughout the world if the full concept of soviet philosophy were to develop. In the interval between World Wars I and II such upheavals were not forthcoming to the degree soviet concepts required. The soviet leaders set about implanting agents and propagating soviet doctrine in the countries and dependencies of the western democracies. This doctrine of revolution, mixed with some rather involved interpretations of its own self-interest, constantly ran counter to the soviet need for collective action to meet the recrudescence of German strength. There was inculcated in its people fear of the "imperialism" of the western democracies which rather outdid in rivalry, as the chief enemy concept, the strength of fascism or the growth of German industrial and military power. If the western European powers had been very slow to recognize the need for a soviet *rapprochement*, their reluctance could be understood when all the while soviet agents fomented destruction of their governments.

If Litvinov, a liberal diplomat of wide experience, did see the need and worked toward collective action, there were others in the Soviet Union who inspired actions which gave the democracies as much cause for suspicion as the exclusion of soviet representatives from important councils gave the Soviet Union.

Another strong element in Allied suspicions was the constantly recurring suggestion of soviet desire for continuing "imperialistic" wars. Indeed, until Hitler made it so unmistakably clear that the object of his chief animosity was the Soviet Union, Joseph Stalin seemed not to fear the nazi development in Germany. With this background it was not surprising that both British and Russian leaders should harbour the unexpressed hope that matters would so fall out that their respective countries could stand aloof while Germany became embroiled in war with the other.

After many unfortunate failures to co-operate in the solution of European problems, this conflict was put to the final test. The Soviet Union held out for guarantees which Britain did not feel it could give. Not receiving the price of its support, it spectacularly stood aside to permit Germany to have its way with Poland. Germany was not long in acting, and the failure of any combined Anglo-French-Russian policy to check the aggressor was to cost the Soviet Union unbelievable destruction and death, France utter defeat and bring England and the whole civilized world to the brink of ruin.

Hitler, with his border problems now in order, struck at Poland on Sept. 1, 1939. Great Britain and France, no longer hesitant, declared war on Germany two days after the attack; but no steps could be taken to save Poland from its fate. (J. J. McC.)

II. THE WAR IN EUROPE, AFRICA AND THE NEAR EAST

A. THE GERMAN CAMPAIGN IN POLAND

The German conquest of Poland in Sept. 1939 was the first demonstration in war of the theory of high-speed armoured warfare which had been conceived by the British tank exponents after World War I and adopted by the Germans when their rearmament began. Its adoption was mainly a result of the initiative of the young Gen. Heinz Guderian, a soldier of vision, who organized and trained the new armoured divisions. Although the senior German generals took a cautious view of the new technique and had developed the means for it in a measure much more limited than the tank exponents visualized, it sufficed to produce a startlingly quick victory. Poland was all too well suited for such a demonstration. Its frontiers mere immensely wide—about 3,500 mi. in all. The stretch of 1,250 mi. adjoining German territory had recently been extended to 1,750 mi. by the occupation of Czechoslovakia. This had also resulted in Poland's southern flank's becoming exposed to invasion as the north flank, facing East Prussia, already was. Western Poland had become a huge salient that projected between Germany's jaws.

1. Polish Dispositions.—It would have been wiser for the Polish army to assemble farther back, behind the broad river lines of the Vistula and the San, but that would have entailed the definite abandonment of some of the most valuable parts of the country. The Silesian coal fields were close to the frontier, while most of the main industrial zone, though farther back, lay west of the river barrier. It was difficult to conceive that the Poles could have maintained their hold on the forward areas even in the most favourable circumstances, but the economic argument for making the attempt, and delaying the German approach to the main industrial zone, was heavily reinforced by national pride and military overconfidence, as well as by an exaggerated idea of what Poland's western allies could do to relieve the pressure.

The Polish army at peace strength was as large as the French and not much smaller than the German. It comprised 30 infantry divisions and 12 cavalry brigades. But Poland's industry was insufficient to make full use of its manpower or even furnish an adequate scale of equipment for its active forces. On mobilization it could increase its number of divisions by only one-third, whereas Germany could more than double its divisions, except for the armoured and motorized ones; but this limitation on Germany's side was offset by Poland's almost complete lack of such modern-type forces. Poland had no armoured or motorized divisions, merely a sprinkling of light tanks, while only one of its cavalry brigades was motorized; and its old-style formations were very short of both anti-tank and anti-aircraft guns. Yet many of its leaders gallantly but absurdly clung to the double belief that their preponderance of horsed cavalry was an important asset and that they could take the offensive against the German mechanized forces. They also tended to discount the effect of Germany's vastly superior air force, which was nearly ten times as powerful as their own.

The unrealism of such an attitude was repeated in the Polish dispositions. Approximately one-third of the forces were concentrated in or near the corridor (Polish Pomorze), where they were perilously exposed to a double envelopment—from East Prussia and the west combined. This indulgence of national pride was inevitably at the expense of the forces available to cover the areas more vital to Poland's defense. For in the south, facing the main avenues of approach, the forces were thinly spread. At the same time nearly another third of Poland's forces mere massed in reserve north of the central axis. between Lodz and Warsaw, under the commander in chief, Marshal Edward Smigly-Rydz. This grouping embodied the offensive spirit; but its aim of intervening with a counterattack did not correspond to the Polish army's limited capacity for manoeuvre, even if this had not been cramped by German air attack on the rail and road routes of movement. The Poles' forward concentration in general forfeited their chance of fighting a series of delaying actions, since their foot-marching army was unable to get back to the positions in the rear, and man them, before being overrun by the invader's mechanized columns. In the wide spaces of Poland the unmechanized state of its forces was a heavier handicap than the fact that it was caught by surprise before all its reserves had been called up. By the same token, the 40-odd infantry divisions of normal pattern which the Germans employed in the invasion counted for much less than their 14 mechanized or partially mechanized divisions. These included six armoured divisions, four light divisions (motorized infantry with two armoured units) and four motorized divisions. It was their deep and rapid thrusts that decided the issue, in conjunction with the overhead pressure of the *Luftwaffe,* which wrecked the Polish railway system besides destroying most of the Polish air force before it could come into action.

2. The German Offensive.—The German forces crossed the frontier shortly before 6 A.M. on Sept. 1, 1939; air attacks had begun an hour earlier. In the north, the invasion was carried out by Gen. (later Field Marshal) Fedor von Bock's army group, which comprised the 3rd army under Gen. (later Field Marshal) Georg von Kuchler and the 4th army under Gen. (later Field Marshal) Giinther von Kluge. The former thrust southward from its flanking position in East Prussia, while the latter pushed eastward across the Polish corridor to join it in enveloping the Poles' right flank. The greater role was given to Gen. (later Field Marshal) Gerd von Rundstedt's army group in the south. This was nearly twice as strong in infantry and more in armour. It comprised the 8th army under Gen. Johannes von Blaskowitz, the 10th under Gen. (later Field Marshal) Walter von Reichenau and the 14th under Gen. (later Field Marshal) Siegmund List. Blaskowitz, on the left wing. was to push toward the great manufacturing centre of Lodz and help to isolate the Polish forces in the Poznan salient, while covering Reichenau's flank. On the right wing. List was to push for Cracow and simultaneously turn the Poles' Carpathian flank, using an armoured corps to drive through the mountain passes. The decisive stroke, however, was to be delivered by Reichenau, in the centre, and for that purpose he was given the bulk of the armoured forces.

The success of the invasion was helped by the way the Polish leaders, despising the defensive, had devoted little effort to the construction of defenses, preferring to rely on counterattacks—which they believed their army, despite its lack of machines, could effectively execute. Thus, the mechanized invaders had little difficulty in finding and penetrating open avenues of advance, while most of the Polish counterattacks broke down under the combined effect of a repulse to their forward movement and a deepening German threat to their own rear. By Sept. 3, when Britain and France entered the war, Kluge's advance had cut the corridor and reached the lower Vistula, while Küchler's pressure from East Prussia toward the Narew was developing. What was more important, Reichenau's armoured forces had penetrated to the Warta and forced the crossings there. Meanwhile, List's army was converging from both flanks on Cracow, forcing Gen. Antoni Szylling's army in that sector to abandon the city and fall back to the line of the Nida and the Dunajec.

By Sept. 4 Reichenau's spearheads had reached and crossed the Pilica, 50 mi. beyond the frontier. Two days later his left wing was well in the rear of Lodz, after capturing Tomaszow, and his right wing had driven into Kielce. Thus, the Polish Gen Juliusz Rommel's army, covering the Lodz sector, was outflanked, while Gen. Stanislaw Kutrzeba's army was still far forward near Poznan and in danger of being isolated. The other German armies had all made progress in fulfilling their parts in the great enveloping manoeuvre planned by Gen. Franz Halder, the chief of the general staff, and directed by Gen. (later Field Marshal) Walther von Brauchitsch, the commander in chief. The Polish armies were splitting up into unco-ordinated fractions; some of which were retreating while others were delivering disjointed attacks on the nearest German columns.

The German advance might have travelled still faster but for a lingering conventional tendency to check the mobile forces from driving far ahead of the infantry masses that were backing them up. But as newly gained experience showed that such a risk was offset by the opponents' confusion, a bolder course was pursued. Exploiting an open gap between Lodz and the Pilica, one of Reichenau's armoured corps raced through to the outskirts of Warsaw on Sept. 8; it had covered 140 mi. in the first week. By the following day the light divisions on his right wing reached the Vistula farther south, between Warsaw and Sandomierz. They then turned northward. Meanwhile, near the Carpathians, List's mobile forces had swept across the Dunajec, Biala, Wisloka and Wislok in turn, to the San on either flank of the famous fortress of Przemysl. In the north, Guderian's armoured corps (the spearhead of Kiichler's army) had pushed across the Narew and was attacking the line of the Bug, in the rear of Warsaw. Thus, a wider pincer movement was strongly developing outside the inner pincers that were closing on the Polish forces in the bend of the Vistula west of Warsaw.

On Sept. 10 Marshal Smigly-Rydz issued orders for a general retreat into southeastern Poland, where Gen. Kazimierz Sosnkowski was placed in charge, with the idea of organizing a defensive position on a relatively narrow front for prolonged resistance. But this was now a vain hope. While the big encirclement west of the Vistula was being tightened, the Germans were now penetrating deeply into the area east of the Vistula. Moreover. they had turned both the line of the Bug in the north and the line of the San in the south. Guderian drove southward in a wide outflanking thrust to Brzesc-nad-Bugiem (Brest-Litovsk). On the southern front Gen. (later Field Marshal) Paul von Kleist's armoured corps reached Lwow on Sept. 12. There the Germans were checked by Sosnkowski, but they spread northward to meet Kiichler's forces. Although the invading columns were feeling the strain of their deep advances and were running short of fuel, the Polish command system was so badly dislocated that it could not profit either by the Germans' temporary slackening or by the stubbornness that many isolated bodies of Polish troops still showed. These dissipated their energy in random efforts while the Germans were completing the encirclement.

3. The Russian Invasion. — On Sept. 17 the soviet armies crossed Poland's eastern frontier. That blow in the back sealed the country's fate, for there were scarcely any troops there to oppose this second invasion. Next day the Polish government and high command crossed the Rumanian frontier, the commander in chief sending back a message to tell his troops to fight on. Perhaps it was as well that it did not reach most of them, but many gallantly fulfilled its intention in the days that followed, although their resistance collapsed bit by bit. The garrison of Warsaw held out until Sept. 28, despite heavy bombardment from the air and the ground; the last considerable Polish fragment did not surrender until Oct. 5, and guerrilla resistance continued into the winter. About 80,000 escaped over neutral frontiers. The German and Russian forces had met and greeted each other, as partners, on a line running south from East Prussia past the Narew-Bug line and Przemysl to the Carpathians. That partnership was sealed, but not cemented, by the mutual partition of Poland.

B. THE RUSSO-FINNISH WINTER WAR

Following the partition of Poland, the soviet government made haste to underwrite its forward security policy by re-establishing strategic control of the U.S.S.R.'s former buffer territories on the Baltic. By Oct. 10, 1939, Estonia, Latvia and Lithuania were induced to allow soviet forces to garrison key points on their soil. On Oct. 14 similar demands were presented to Finland. Considered from the viewpoint of strategic safeguards — against Hitler's possible use of Finnish territory as a springboard for attack on the U.S.S.R.—they were moderate, and the small cessions of territory required of Finland were to be compensated by the U.S.S.R.'s giving up strips elsewhere. But national sentiment made it hard for the Finns to agree to a settlement on these lines. When they continued to argue the points, the soviet forces invaded their country on Nov. 30.

1. Early Finnish Successes. — The original advance ended in a check that astonished the world. A direct push from Leningrad up the Karelian isthmus came to a halt in the forward layers of the Mannerheim line.

An advance near Lake Ladoga did not progress. At the other end of the front the Russians cut off the small port of Petsamo on the Arctic ocean, as a means of blocking the entry of help to Finland by that route. Two more immediately menacing thrusts mere delivered across the waist of Finland. The more northerly thrust penetrated past Salla to Kemijärvi, halfway to the Gulf of Bothnia, before it was driven back by the counterattack of a Finnish division which had been switched up by rail from the south. The southerly thrust. past Suomussalmi, was interrupted in turn by a counterstroke, early in Jan. 1940. Circling round the invaders' flanks, the Finns blocked their line of supply and retreat, waited until their troops were exhausted by cold and hunger, then attacked and broke them up.

Sympathy with Finland as a fresh victim of aggression had rapidly developed into enthusiasm at the apparent success of the weak in repulsing the strong. This impression had far-reaching repercussions. It prompted the French and British governments to consider the dispatch of an expeditionary force to this new theatre of war with the object not only of aiding Finland but also of securing the Swedish iron mines at Gallivare from which Germany drew supplies, while establishing themselves in a position that threatened Germany's Baltic flank. Partly because of the objections raised by Norway and Sweden. this project did not materialize before Finland collapsed. France and Britain were thus spared entanglement in war with the U.S.S.R. as well as uith Germany at a time when their own powers of defense were perilously weak. But the obvious threat of an Allied move into Scandinavia precipitated Hitler's decision to forestall it by occupying Norway. Another effect of Finland's early successes was that it reinforced the tendency in western quarters to underrate the soviet military strength. The general view was epitomized in Winston Churchill's broadcast assertion of Jan. 20, 1940, that Finland "had exposed, for the world to see, the military incapacity of the Red army." His misjudgment was to some extent shared by Hitler—with momentous consequences the following year.

More dispassionate examination of the campaign, however, provided better reasons for the ineffectiveness of the original advance. There was no sign of proper preparation to mount a powerful offensive, furnished with large stocks of munitions and equipment. There were clear signs that the soviet authorities had been misled by their sources of information about the situation in Finland, and that, instead of reckoning on serious resistance, they imagined that they might have to do no more than back up a rising of the Finnish people against an unpopular government. The country cramped an invader at every turn, being full of natural obstacles that narrowed the avenues of approach and helped the defense. Between Lake Ladoga and the Arctic ocean the frontier appeared very wide on the map but in reality was a tangle of lakes and forests, ideal for laying traps as well as for stubborn resistance. Moreover, on the soviet side of the frontier the rail communications consisted of the solitary line from Leningrad to Murmansk, which in its goo-mi. stretch had only one branch leading to the Finnish frontier. This limitation was reflected in the fact that the "waistline" thrusts which sounded so formidable in the highly coloured reports from Finland were made with only one division apiece, while only two were employed in the outflanking manoeuvre north of Ladoga.

2. Mannerheim Line Crushed. — Much the best approach to Finland was through the Karelian isthmus, but this was blocked by the Mannerheim line, while the Finns' six active divisions were concentrated there at the outset. The Russian thrusts farther north, though they fared badly, served the purpose of drawing part of the Finnish reserves thither while thorough preparations were being made, and 14 divisions brought up, for a serious attack on the Mannerheim line. This was launched on Feb. 1, under the direction of Gen. Kiril A. Meretskov. Its weight was concentrated on a 10-mi. sector near Summa, which was pounded by a tremendous artillery bombardment. As the fortifications were pulverized, tanks and sledge-carried infantry advanced to occupy the ground, while the soviet air force broke up attempted countermoves. After little more than a fortnight of this methodical process a breach was made through the whole depth of the Mannerheim line. The attackers then wheeled outward to corner the

Finnish forces on either flank, before pushing on to Viipuri (Viborg). A wider flanking operation was carried out across the frozen Gulf of Finland by troops who advanced from the icebound island of Hogland and landed well in the rear of Viipuri. Although an obstinate defense was still maintained for several weeks in front of Viipuri, Finland's limited forces had been worn down in the effort to hold the Karelian isthmus. Once a passage was forced, and their communications menaced, eventual collapse was certain. Capitulation was the only way in which it could be averted, since the proffered Anglo-French expeditionary force had not arrived, though almost ready to sail.

On March 6, 1940, the Finnish government sent a delegation to negotiate peace. Beyond the earlier soviet conditions, Finland was now asked to cede areas in the communes of Salla and Kunsamo, and also the Finnish part of the Fisher peninsula. They were also asked to build a railroad from Kemijarvi to the frontier (which was not yet established). On March 13 it was announced that the Soviet terms had been accepted. (B. H. L. H.)

C. GERMAN CAMPAIGNS IN DENMARK AND NORWAY

The German conquest of Norway and Denmark was the first of Hitler's aggressions which was not long premeditated. Reluctantly, he was induced to embark upon it. The chief instigator probably was the commander in chief of the navy, Grand Adm. Erich Raeder, who first broached the problem to Hitler on Oct. 10, 1939. Various intelligence reports indicated British designs on Norway and Raeder held that enemy control of that country was synonymous with the loss of the war. Sweden would fall completely under enemy influence; the supply of Swedish ore, on which the German war economy was so dependent, would be cut off. The danger appeared aggravated by the Russo-Finnish war; the British might get a foothold in Norway as a result of giving aid to Finland. Vidkun Quisling visited Germany and conferred with Raeder on Dec. 11. 1939. He advised Raeder that there was imminent danger of Britain's gaining a foothold in Norway and expressed the view that the National party. which he represented, desired to anticipate any possible British step in this direction by placing the necessary bases at the disposal of the German armed forces. The next day Raeder obtained Hitler's approval of the proposal that the armed forces high command be permitted to make plans with Quisling for preparing and executing the occupation either by friendly methods, *i.e.,* the German *Wehrmacht* called in by Nonvay, or force.

Admiral Raeder envisaged certain military advantages accruing to Germany as a result of gaining Norwegian bases but he was quite aware that the occupation would be accompanied with extremely great risk for the navy in view of the heavy superiority of British sea power. Consequently he continued to hold that the maintenance of Norway's neutrality was the best solution but under no circumstances must Nonvay fall into British hands. Hitler was in agreement with this view. But in early 1940 signs and even overt acts appeared to force his hand. On Feb. 16 the British destroyer "Cossack," on orders from the admiralty, pushed up Josing fjord and forced the German tanker "Altmark," which had taken refuge in Norwegian territorial waters, to hand over about 300 prisoners. Since the Norwegian torpedo boats present on that occasion did not intervene, the Germans concluded that Norwegian territorial waters would henceforth not afford sure protection for German shipping and that Norway probably would not contest further overt acts on the part of the British, and they hoped this might also apply in the event of a German occupation. The British attack on the "Altmark" infuriated Hitler and it is likely that he then made the decision to execute the planned undertaking. On Feb. 21 Hitler appointed Gen. Nikolaus von Falkenhorst head of the planning and operations staff for *Weserübung,* the code name for the operation, and the future commander in chief of the army of occupation in Norway. On March 1 Hitler issued his top secret directive for implementing *Weserübung*, but no date of execution was set. Finland's capitulation to the U.S.S.R. on March 13 temporarily eased the situation but not for long. Intelligence reports gave the Germans definite reason to believe that the western powers were contemplating action against Scandinavia and incidents of German shipping being molested by British forces in Norwegian territorial waters multiplied. Yet on March 26 Raeder advised Hitler that in his opinion "the danger of a British landing in Norway is no longer acute" but "sooner or later Germany will be faced with the necessity of carrying out operation *Weserübung*. Therefore it is advisable to do so as soon as possible, by April 15 at the latest, since after that date the nights are too short; there will be a new moon on April 7." Hitler agreed to the operation on X-day, around the period of the new moon. On April 2 D-day was ordered for April 9 with the time for landing at 5:15 A.M.

When the Germans later captured the French archives they found evidence of how narrowly they had forestalled the Allies in the race for Norway. These documents showed that: (1) the Allied supreme council in Paris on Feb. 5 had determined to prepare French-British forces in Great Britain for transport to Norway; (2) on Feb. 6 the British foreign minister had informed the Norwegian minister in London that Great Britain wished to have certain bases on the Norwegian coast "in order to interrupt the German ore transport from Narvik"; (3) the Allied plans had projected aid to Finland, seizure of the Swedish iron-ore mines at Gallivare and occupation of the northern ports. Even though peace had meanwhile been concluded between the U.S.S.R. and Finland, the final decision to undertake Operation "Scandinavia" was made on March 28; the departure date of the first transports was set for April 5. At the last minute the sailing of the transports was postponed to April 8. Therewith the Allies had lost the "race for Norway." German naval forces were then under way for all those places which the Allies had selected for their landings.

German Invasion.—The landing places for the blitz occupation and the forces assigned to each were as follows: Narvik, battleships "Scharnhorst," "Gneisenau" and 10 destroyers, the latter with 2,000 landing troops; Trondheim, cruiser "Hipper" and 4 destroyers with 1,700 landing troops; Bergen, cruisers "Koln," "Konigsberg," "Bremse," 2 torpedo boats and torpedo motorboat flotilla I with 1,900 landing troops; Kristiansand and Arendal, cruiser "Karlsruhe," 3 torpedo boats and torpedo motorboat flotilla II with 1,100 landing troops; Oslo, cruisers "Blucher," "Liitzow," "Emden" and 3 torpedo boats with 2,000 landing troops; Egersund, 4 mine sweepers with 150 landing troops. Since the loading capacity of the warships was very limited, the heavy weapons, equipment and ammunition had to be loaded in transports scheduled to arrive simultaneously at the ports of destination. They had to be sailed ahead of the warships because of their slower speed. Stavanger was occupied solely by air-borne troops on the morning of April 9. The German air force assisted in the capture of Oslo, Kristiansand and Bergen with parachute and air-borne troops. The invasion of Denmark proceeded apace with Norway; the former had to be occupied to safeguard the lines of supply by sea and by air and to provide air bases for the operations to the north. Little Denmark fell with little resistance being offered; the country was hardly defensible against a powerful attack with modern weapons.

The navy had to carry the fight to capture the Norwegian ports with strong assistance from the air force. At 9:48 A.M., and again at 2:25 P.M., April 7, the combined Narvik-Trondheim task forces were sighted and reported by British air reconnaissance. The royal air force made an unsuccessful attack on the German force before the weather closed in. The British high command recognized that a German naval operation to the northward was in progress and certain important decisions were made. Britain's own landing operation was abandoned, the troops then on board were disembarked and all measures were geared to the interception of the German force. On the evening of April 7 the British home fleet under Adm. Sir Charles Forbes put to sea. At 8:20 A.M., April 8, the first action between German and British naval forces took place north of the Bergen-Shetland Islands line. The British destroyer "Glowworm," which had lost contact with its force in heavy weather, ran into the destroyer "Bernd Von Arnim" and the cruiser "Hipper" and was sunk by gunfire. At 2:20 P.M. the former Polish submarine "Orzel" sank the transport "Rio De Janeiro" loaded with troops for Bergen. It was a disastrous blow, for the landing of the survivors and the dead in German army uniform necessarily revealed the German intentions and gave warning to the Norwegians. Upon arrival off Vest fjord, the ten Narvik destroyers were detached and, by a lucky circumstance, they found the approach to Narvik unguarded by the British. However, the Norwegian armoured coastal ships "Eidsvold" and "Norge" engaged them at short range until both were sunk by torpedo fire. The commander of the landing troops, Maj. Gen. Eduard Dietl, took over the town without resistance from the Norwegian Col. Konrad Sundlo, one of Quisling's friends. The Bergen group was fired on by coastal batteries; the "Konigsberg" took three hits and the "Bremse" one. The debarkation of troops was accomplished without interference. British planes attacked the "Königsberg" at Bergen on April 10 and scored two direct hits; the ship burned out and capsized. Trondheim, Kristiansand, Arendal and Egersund were occupied with little or no resistance. At Oslo, however, the navy was stopped. In attempting to pass the strongly fortified narrows leading to Oslo, the van ship, the heavy cruiser "Blucher," was only from 500 to 600 yd. away when the coastal batteries opened fire. Within a few moments the ship took two 11-in. hits, at least twenty 5.9-in. hits and finally two torpedoes irom a shore torpedo battery. Fires within the ship touched off a magazine explosion; it capsized and sank. The "Liitzow," steaming astern of the "Blücher," also received three hits but the fighting effectiveness of the ship was not seriously impaired. The attempt to iorce the narrows was then abandoned; the troops were landed outside and the capitulation of the fortifications was acconiplished the same day by a combined land, sea and air attack. Meanwhile Oslo itself had been taken by the air iorce; Fornebu airfield had been seized by parachute troops during the morning; at noon six companies oi air-borne troops landed there and occupied important points of the city. The political situation was confused; Quisling got nowhere in getting Piorwegian support to form a new government, while the king and the government leaders fled to the northward with a view to rallying resistance. Meanwhile, the German air force had been busy operating against the British naval forces off the Norwegian west coast. Though the damage inflicted did not come up to German expectations and was in fact much below the claims made by the attacking planes, nevertheless the deterrent effect on British operations was great. Actually, the German planes sank only one ship, the destroyer "Gurkha," scored one hit on the battleship "Rodney," and near misses inflicted light damage to the cruisers "Southampton" and "Glasgow."

In faraway Narvik, beyond the effective reach of the German air force, the British navy reacted speedily. During the early morning of April 10 the Germans were taken completely by surprise when the shells and torpedoes of five British destroyers suddenly rocked the harbour. A mutually damaging action was fought but in the balance the loss was definitely German. What was left of the German naval iorce at Narvik was finished off on April 13, when the British struck again with the battleship "Warspite" and nine destroyers. The loss of ten destroyers was a staggering blow to Germany, but the addition of more than 2,000 men irom their crews was a welcome accretion to General Dietl's defenses.

Allied Landings in Norway.— Speed was particularly important ior the Allied counterattack to retake at least central and northern Norway before the Germans could reinforce and consolidate their positions. The transports and troops for their own landing operations were readily available, but it was not until April 12 that the first convoy sailed from the Clyde. It was decided to retake Trondheim and Narvik but, since their troops were equipped ior only an unopposed landing, a direct attack could not be considered. It was decided to capture Trondheim by a pincer attack commanded by Lt. Gen H. R. S. Massy; north arm irom Namsós with about 6,000 men under Maj. Gen. Sir Adrian Carton de Wiart; south arm from Andalsnes with about 6,000 men under Maj. Gen. Sir Bernard Paget. The prospects looked good since the Germans had landed only 1,700 troops at Trondheim. The German air force had not been able to prevent the Allied landings but it did hit hard and continuously in the subsequent operations. Carton de Wiart's forces moved south slowly, plagued by deep snow, smaii enemy detachments and especially by enemy air attacks, to Steinkjer and then were iorced to retreat. Carton de Wiart suggested evacuation and this was done shortly thereafter. Paget's iorces reached Dombas in the Gudbrand valley on April 19 but, instead of being able to wheel north on Trondheim, they had to iace the German vanguard pushing north irom Oslo, while being threatened in the rear by the Trondheim occupation force. If the *Luftwaffe* could have been checked, the Allies might have held on but their own air support was lacking. Evacuation was directed and in the first days oi May the last Allied troops in the Trondheim area were re-embarked. At this time Allied troops were landed at Mosjoen, Mo and Bodo in order to block the movement of German troops to the relief of Narvik. However, these iorces slowed General Feuerstein less than did the difficult mountainous terrain. On May 11 and 18 he took Mosjoen and Mo respectively; the British withdrew to their principal base at Bodo, where they held on to the end of the month.

Narvik Episode.—To recapture Narvik, the British landed at Harstad and Salangen on Vaags fjord. The operation began on April 14 and the Allied forces were built up until they finally numbered about 24,000. When the attempt to capture Trondheim was abandoned, it was decided to hold iast at Narvik where British sea power was in firm control of the line of supply and where the Germans were cut off irom support. Progress had been slow, for General Dietl with his 2,000 mountain troops plus more than 2,000 sailors skiliully fought a defensive action. On May 24 the Allies decided to liquidate the whole Norwegian undertaking; the Germans had meanwhile driven deep into France and it appeared advisable to draw in their scattered forces. However, the plans ior a concentric attack on Narvik were so far advanced that it appeared desirable to capture that port prior to the evacuation. By the evening of May 28 the Allies had uncontested control; General Dietl withdrew into the mountains east of Narvik. The Allies pressed in pursuit and enveloped the flanks; the situation was becoming more difficult ior the Germans from day to day. In the first week of June, however, the Allies began their evacuation. On June 8 Dietl reported to the German high command that Narvik had again been occupied by his own so recently hard-pressed troops. The next day the Norwegian iorces also ceased hostilities; the king and government left Norway for England. On June 8 the Germans scored a naval victory over the Rritish naval forces off northern Norway. The battleships "Scharnnorst" and "Gneisenau" nad been sent north in an attempt to relieve the situation at Narvik. The Germans took a final thrust at the withdrawing foe, sinking the aircrait carrier "Glorious," the auxiliary cruiser "Orama" and the tanker "Oil Pioneer," while "Scharnhorst" took a torpedo hit from a destroyer.

Evaluation.—The surprise attack on Norway mas the first great combined operation of army, navy and air force. Norway, however, should have been a more difficult operation ior the Germans No order for mobilization was given until the iateiul night of April 8–9, despite the warnings irom the Norwegian minister in Berlin and urgings from the chief of the general staff. The German navy never recovered irom the heavy sacrifices made in the landing operations. It had numerous other losses, but the loss of the ten Narvik destroyers alone represented exactly half of the German strength in this type.

The Franco-British counterblow was ill-starred from the beginning because it was undertaken with inadequate iorces and underestimation of the German potentialities. The counterattack had prospects of success only ii the line of supply from Germany to Norway had been promptly and effectively cut. This was not done. Allied submarines pinpricked the main line of supply on the waters from Germany to Oslo but only large means could avail in this situation; *i.e.,* the extension of British naval supremacy into the Skagerrak and Cattegat. The German air force would have exacted a price and the British high command must have considered the probable price too high. This represented a new development in sea power; with the advent of air power, conditions had developed which made it possible to overcome enemy naval superiority in limited waters without a fleet of equal strength.

Had Germany bided its time and allowed the Allies to move into Norway first, it would have been saved the stigma of an attack on a neutral nation. To deiend their positions in Norway would have cost the Allies dearly; the Germans would have had control of the long arm of the lever since they could have taken immediate counteraction via Denmark and southern Sweden. In view of German air superiority it would have been extremely difficult for the Allies to supply their iorces in Norway. Moreover, had the Allies gone into Norway on their own initiative, it would have been a matter of national prestige to hold their ground there, and more and more blood and treasure would have been expended. (R. E. K.)

D. THE WESTERN FRONT, FIRST PHASE

1. The "Phony War."—When the Germans invaded Poland on Sept. 1, 1939, they left only 23 divisions in the west. The French mobilized nearly five times as many divisions. The German generals themselves felt that their western front was dangerously underinsured, but they could see no way of increasing the insurance without forfeiting their chance of a quick victory over Poland. Their anxiety proved excessive. The French had hardly dented the foremost layers of the defense before the Germans had overrun Poland and returned in force to the nest. The French advance was confined to the 100-mi. stretch of the common Franco-German frontier between the Rhine and the Luxembourg border, and any pressure was limited to narrow sectors of this stretch. At the end of the month. following the collapse of Poland, the French command decided to withdraw its divisions to the shelter of its own Maginot line. Then stagnation settled on the western front for the next seven months.

The German command felt that the French had never seriously tried to attack and had thereby let slip a great opportunity. The first assumption was true; the second more doubtful. The French army was a ponderous machine, with a tactical doctrine to match, and thus had little capacity for rapid action. Even if the French army had been fitted for manoeuvre, room for manoeuvre was lacking as long as Belgium remained neutral. On Sept. 1 Gen. Maurice Gamelin, the French commander in chief, addressed a memorandum to his government which argued that the only way of success would lie in "extending our front of attack" from the Moselle to Maastricht, for an advance through Belgium and Dutch territory to the lower Rhine. If Belgium and the Netherlands would not agree to this. and the French government was unwilling to override their neutrality, the prospect was dim. As this wider alternative was ruled out, Gamelin did not see any point in courting heavy loss and wearing down the French army's morale by pressing the attack on the Rhine-Moselle sector.

While Germany clearly benefited from the neutrality of Belgium and the Netherlands at this stage of the war, it was doubtful whether the alternative that Gamelin desired would have made any important difference to the fate of Poland. For the mobilization of the French army was not completed until Sept. 20, and the leading British army corps arrived at the front only in the first week of October, whereas most of Poland was overrun by the third week of September. But the prospects of subsequent resistance to a German offensive in the west might have been greater if the French armies had been permitted to advance into Belgium in Septeniber. The situation was radically changed with the collapse of Poland. The scales of forces in the west now tilted heavily to the German side, and the primary problem of the French was to assure their own defense. In these different circumstances, however, they still favoured the idea of an advance into Belgium, even if it could be carried out only after a German invasion of Belgium. That was a more questionable decision. Their o n army was not well fitted to execute such a racing manoeuvre and establish itself firmly on a fresh line at short notice.

The widespread view that the French leaders were too defensive minded is a fallacy. During the months that followed the fall of Poland, Gamelin showed a hankering for the offensive and mooted various provocative moves to threaten Germany's flanks, even though he had to admit that the means were lacking. That urge to do something, however unpromising the chances, was stimulated by political criticism of Gamelin's "caution," particularly from Paul Reynaud, whose cry for bold and early action brought him growing political influence, as usually happens in a democracy at war. The pressure of such tendencies could be traced in the development of the French plan to meet a German invasion of Belgium. The first idea was that the two armies on the extreme left, the French 7th army and the British, should advance a short distance across the frontier and occupy a position along the Escaut river as far as Ghent, there linking up with the Belgian army, which was expected to fall back on the line Antwerp-Ghent. This was extended by November into plan D, which embraced a 60-mi. advance to the line of the Dyle, east of Brussels, and a general wheel forward of the French left centre to correspond. In March a third development in the plan gave it a still more venturesome turn. The French 7th army was to dash up the Belgian coast past Antwerp into the Netherlands, so that it could not only buttress the joint between the Belgian and Dutch armies, but strike at the flank of the Germans advancing into Belgium.

The plan and the distribution of forces expressed the twin convictions of the French high command. One was that the Germans would make their main effort in the plain of Belgium, north of Namur, as in 1914. The other was that no serious stroke could be delivered south of Namur, through the Ardennes, because of the difficulties presented by that hilly and wooded belt of country. This proved a fatal delusion. Yet if the German offensive had been launched when Hitler intended, in November, Gamelin's plan might well have succeeded in checking it on the Dyle, while at the worst a decisive defeat of the French would have been unlikely. But Hitler's desire was repeatedly postponed by the weather, coupled with the hesitation of his generals. And when at last the German offensive was delivered. six months late, its plan had been so changed as to profit decisively from the nature of the French plan.

The centre of gravity was shifted from Gen. Fedor von Bock's army group B on the right, facing the main plain of Belgium, to Gen. Gerd von Rundstedt's army group A, facing the wooded hill belt of Belgian Luxembourg. The change was suggested by Gen. (later Field Marshal) Erich von Manstein, Rundstedt's chief of staff, who argued that the tank forces could be effectively used in the Ardennes, contrary to orthodox ideas, and that the risk of a check would be less than if they met the main mass of the Allied forces head-on in the centre of Belgium. Manstein's proposal was regarded as too hazardous by the heads of the German army; but its boldness appealed to Hitler, who, in March, secured its adoption. The French advance into Belgium now played into the hands of the Germans in the same way that the French advance of 1914 into Lorraine and the Ardennes had done. It was, however, the employment of fast-moving armoured vehicles, instead of foot-marching infantry masses, that made the vital difference to the result in 1940 compared with 1914.

The period that popular opinion christened the "phony war" was far from being such in reality. It was a period when the Allies were projecting offensive schemes which they lacked the power to execute, and when Hitler was repeatedly mounting an offensive, only to be compelled to defer it, contrary to his desire, but to his advantage.

2. German Conquest of the Low Countries and France.— Following the dramatic success of his April coup in Norway, Hitler became more eager to attempt the deferred stroke in the west. But it was not until May 7, 1940, that the first warning order since January was actually issued. On May 8 Hitler was "very agitated" by reports that the Dutch were accelerating their precautions and might allow the British to reinforce them. The invasion was launched in the early hours of May 10. Under the remodelled plan, Bock's army group B comprised two armies instead of the former three. The 18th army, under Gen. Georg von Kiichler, invaded the Netherlands with the aid of an armoured division and air-borne forces, while the 6th army (Gen. Walter von Reichenau) advanced along the main avenue into Belgium, with the aid of an armoured corps. These two German armies had to deal with the Dutch and Belgian armies, the British expeditionary force (now grown to 13 divisions, of which 9 were available there) and two of the best-equipped French armies. Lacking superiority of numbers there, the Germans depended on surprise and superior skill. Rundstedt's army group A covered the stretch between the middle Meuse (Maas) and the Moselle. It advanced with 46 divisions, of which 7 were armoured, while a further 27 divisions of the general reserve backed it up. Once it had brushed aside the screen of Belgian troops in the Ardennes it had only to deal with two French armies consisting of 12 infantry divisions—half of them low-grade—and 4 horsed cavalry divisions. Against this weak hinge of the Allied wheel forward into Belgium were massed nearly two-thirds of Germany's forces in the west and nearly three-quarters of its armoured punch. Along the Franco-German frontier, between the Moselle and Switzerland, stood Gen. (later Field Marshal) Wilhelm von Leeb's army group C, comprising two armies. Its task mas merely to threaten an attack on the Maginot line and thus pin down the excessively large proportion of the French forces that were arrayed there. For 41 divisions were posted in and behind that well-fortified sector, compared with 39 on the longer sector between the Maginot line and the channel coast, while the larger part of the French general reserve was also on this flank. The responsibility for those fatal dispositions lay more directly with Gen. Alphonse Joseph Georges, the commander in chief of the armies on the northeast front, than with Gamelin. For the moment that danger was obscured by the dramatic opening of the campaign in the Low Countries.

(a) Conquest of the Netherlands.—The Dutch army comprised ten divisions and the equivalent of a further ten in smaller formations. It should thus on paper have had a very good chance of withstanding the German invasion, since its front was covered by successive rivers, while the attacking army comprised only seven divisions, apart from the air-borne forces. But the Dutch had a wide front, very sensitive and densely crowded rear, poor equipment in modem weapons and no experience of modern war. Apart from air superiority, the German offensive depended for its success primarily on the air-borne forces under Gen. Kurt Student. Contrary to popular imagination after the event, these forces were on a small scale. Four parachute battalions were used, together with a regiment of air-transported infantry. to seize the bridges at Moerdyk, Dordrecht and Rotterdam, on the main road artery from the south into the heart of the Netherlands, with the aim of opening the way for the mobile ground forces. One parachute battalion, followed by two air-transported regiments, descended on the airfields around The Hague with the aim of capturing the main government buildings. The attack on the capital did not succeed, though it caused a lot of confusion and thus aided the invader's purpose. But the bridges were captured with very slight loss, and the defense was too disorganized to dislodge the troops who had dropped out of the sky before they were reinforced by forces arriving overland.

While the invasion could hardly have triumphed without this capture of the back door, the air-borne coup would have mattered little if the Dutch front had not broken down at a specially vulnerable spot.

Gen. Hendrik Gerard Winkelman, the Dutch commander in chief, was mainly concerned to cover the direct approach into the heart of the Netherlands. Out of his four army corps, two were massed on the Geld valley position, between the Maas (Meuse) and the Zuider Zee, while another was in reserve behind them. The remaining corps had held the Peel line south of the Maas; but, just before the invasion came, the Dutch command came to the conclusion that it would be safer to concentrate on holding the central part of the Netherlands, covered by the great rivers. So the army corps in the south was withdrawn, leaving the Peel line to be held by a screen composed of lower-grade troops who lacked anti-tank and anti-aircraft guns. Nothing could have been better designed to suit the German aim of bringing quick reinforcement to the air-borne troops near Rotterdam.

On May 10 the Germans penetrated the Peel line. The next day the defenders retreated due west past Tilburg toward Breda, thus leaving a clear road by which the solitary German armoured division could drive northwestward to the Moerdyk bridge. That same afternoon the leading mobile troops of Gen. Henri Giraud's French 7th army reached Tilburg, after a remarkable 140-mi, dash from the French frontier. Disconcerted by the Dutch retreat and German air attack, they fell back on Breda. By May 12 they had been reinforced but made no serious attempt to advance over the farther 10-mi. strip to the Maas and bar the German armoured division's passage to Moerdyk. This reached the outskirts of Rotterdam soon after midday. Meanwhile, the main German forces had spent t o days in closing up to the Geld valley line. On May 12 they made a narrow breach in it. Lacking reserves on the spot for effective counterattack, the Dutch command decided to abandon this line and fall back on the "fortress of Holland" line, just in front of Amsterdam and Utrecht. Its defense was never tested; for by the time the Germans closed up to it, late on May 14, the campaign had been brought to an end.

The Germans had made no progress at Rotterdam on May 13, and their situation there might have again become precarious since it formed a narrow wedge thrust far forward between the Dutch and French forces. But it was difficult for the Dutch to see the situation in such a light. They were more conscious that most of their country had been swiftly overrun and that the roar of German aircraft filled their ears. The queen and the government sailed for England on May 13, leaving the country in charge of General Winkelman. By the next afternoon he had decided to surrender. That decision was produced not only by the blackness of the outlook but by the threat of bombing the cities of Rotterdam and Utrecht if resistance continued. Such action was in accord with the old laws of warfare governing the bombardment of besieged places, since both cities were now in the fighting zone. But its technical legality did not diminish its inhumanity as a means of moral pressure. Rotterdam was actually bombed, through a fault in signal communications, after the Dutch had yielded to the threat. The horror it produced was shown in the way the statement that this bombing, by a mere 30 planes, had killed 30,000 people was credited, and continued to be believed long after bombings oi ten times such a scale had been found to kill only a fraction of the number.

(b) Conquest *of* Belgium, First Phase.—The direct invasion of Belgium was made with stronger forces than were used against the Netherlands, but with only a handful of air-borne troops. Reichenau's 6th army deployed four army corps abreast on the 30-mi. Roermond-Aachen front and also included Gen. Erich Hoeppner's armoured corps. The air-borne troops consisted of a mere 500. To compensate for the shortage, dummy parachutists were dropped over a wide area, thus accounting for the reports that "thousands of parachutists" were descending on the country. At the start of the invasion of the west, the main weight of the German air force, of the dive bombers in particular, was concentrated on the gateway into Belgium, before being switched south to help in the passage of the upper Meuse around Sedan. That concentration of air bombardment was the invaders' biggest asset in gaining an ascendancy over the Belgian defense. The tiny element of air-borne troops, however, counted for almost as much. For it was they who secured the keys to the gate.

The most delicate point of the Belgian forward position lay north of Liege, where the Maastricht "appendix" of Dutch territory protruded between the Belgian and German frontiers, forming an indefensible strip that could mask an approach to the Albert canal, which there formed the Belgian frontier line. The invaders' chances turned on gaining the bridges at that point before they could be blown up, and preventing the guns of Eben Emael, Belgium's most modern fort, from dominating them subsequently. Early on May 10, before it was light, a platoon in gliders landed at the back of each bridge and captured each intact. Other gliders landed on the top of Eben Emael and dropped explosives into the guns and the exits unobserved by the garrison inside—which was thus helplessly imprisoned in its now useless fort. By the morning of May 11 sufficient German troops had accumulated beyond the canal to burst through the Belgian line. The leading armoured division now drove through to the west, while part of the infantry wheeled south and entered Liege from the rear. That evening the Belgian command (King Leopold III, commander in chief; Gen. F. F. O. Michiels, chief of staff) ordered a general withdrawal to the Antwerp-Namur (or Dyle) line, where the leading Allied divisions had just arrived—the French 1st army (under Gen. Georges Blanchard) occupying the sector from Namur to Wavre, the British (under Viscount Gort) occupying the sector from Wavre to Louvain, while the Belgians wheeled back to hold the sector from Louvain to Antwerp.

In view of the imminent collapse of the Belgians' forward position, the French advance to the Dyle line had been accelerated on May 11, and from there Gen. René Prioux's cavalry corps (of two light mechanized divisions) pushed on eastward to meet the Germans. It was too late to check the break-through on the Albert canal, but it helped to cover the Belgians' retreat from Liege. Falling back by stages, Prioux checked a series of German tank thrusts on May 12–13. During the second night his corps withdrew to an anti-tank obstacle a few miles in front of the main position. On May 14 the Germans made a powerful effort to break through in the direction of Gembloux, and a big tank battle developed. Although Prioux prevented a complete break-through, his corps was so badly mauled by the afternoon that it had to be withdrawn to reorganize behind the main position, which mas now solidly occupied by the rest of the 1st army. When the Germans attacked the next morning, they were checked. Immediately afterward, Hoeppner's armoured corps was sent south to join Rundstedt's army group. Its disappearance appeared to increase the French prospects of holding this end of the Dyle line, while no pressure at all had yet developed on the British sector. But on the evening of May 15 Gamelin ordered its abandonment. For by then Rundstedt's armoured forces, which had crossed the Meuse at Sedan on May 13, were driving deep into France. It had now become a question for the Allies, not whether they could hold out in Belgium, but whether they could escape being cut off there.

(c) Thrust into France.—The break-through from the Ardennes across the Meuse turned more on the approach march than on the battle. The passage of such great forces through such a difficult belt of country as the Ardennes was an amazing feat of staff work. Rundstedt's army group comprised, from right to left, the 4th army (Gen. Gunther von Kluge), the 12th army (Gen. Siegmund List) and the 16th army (Gen., later Field Marshal, Ernst Busch), while the 2nd army (Gen., later Field Marshal, Maximilian von Weichs) was in reserve. But its thrust was provided by two armoured groups: a large one under Gen. Paul von Kleist and a smaller one under Gen. Hermann Hoth. Guderian was put in charge of Kleist's principal spearhead, and delivered the decisive thrust, at Sedan. The solution of the approach march problem was both bold and ingenious. While the armoured divisions used such roads as were available through that hilly and wooded belt, infantry divisions started alongside them by using field paths and marched so fast across country that the leading ones reached the Meuse only a day after the armoured divisions.

Early on May 10 Kleist's leading troops crossed the frontier of Luxembourg, where they met only road obstructions. In three hours they reached the frontier of Belgian Luxembourg, 30 mi. beyond. There they found bridges blown up and met opposition, first from the Belgian *chasseurs ardennais* and then from French horsed cavalry. The French paid forfeit for pushing old-fashioned cavalry divisions deep into the Ardennes in face of armoured divisions. By the next evening they were driven back across the Semois in disorder and had suffered such losses as to ease the Germans' task in forcing the difficult passage of that river. Georges now ordered reinforcements to that sector, but their arrival was too slow to match the German rate of movement.

By the evening of May 12 the Germans were across the French frontier and overlooking the Meuse. The blow was about to fall not only on the hinge of the French advance into Belgium but on the joint between two armies: Gen. Charles Huntziger's and army and Gen. André Corap's 9th. Huntziger's left wing, from Sedan eastward, was composed of two reserve divisions of oldish men. Corap's right wing, west of Sedan, was of similar composition. The defenses were rudimentary; it was the least-fortified stretch of the whole French front. Worse still, they had hardly any anti-tank guns and no anti-aircraft artillery. Such was the measure of the trust placed in the unlikelihood of an armoured thrust through the Ardennes.

On May 13 Kleist's forces achieved a threefold crossing—by Guderian's corps at two points near Sedan, and by Gen. Georg Hans Reinhardt's corps at Monthermé. At Sedan, wave after wave of dive bombers swooped on the defenders of the south bank. These could not stand the nerve-racking strain, and the German troops were able to push across the river in rubber boats and on rafts. The tremendous air bombardment was the decisive factor in the crossings A thousand aircraft supported Kleist's forces while only a few French aircraft intervened in a gallant but hopeless effort to aid their troops on the ground. Next day, after the tanks had been brought across, Guderian widened the Sedan bridgehead and beat off French counterattacks. On May 15 he broke through the defenses into open country, turning westward in the direction of the channel coast. On May 16 he swept on west for nearly 50 mi. His superiors tried to put on the brake, feeling that such rapid progress was hazardous. But the pace of the drive upset the French far more, and their collapse spread as Reinhardt's corps joined in the pressure.

There was no "battle of the bulge," such as was vividly described in the Allied reports at the time. It was a procession in quick time along an almost empty corridor behind the backs of the Allied armies in Belgium. Meanwhile, further crossings had been made to the west, between Givet and Namur—one by Maj. Gen. (later Field Marshal) Erwin Rommel's armoured division. Thus, the breach had widened to 60 mi., and any French positions remaining had become mere islets lapped and left behind by the waves of the armoured torrent that was now sweeping through the corridor between the Sambre and the Aisne. Giraud had been sent to replace Corap and reinforcements followed. But there again the measures were inadequate and taken too late. When he arrived, on May 15, he drew up a plan for a counteroffensive to block the corridor on a line 25 mi. W. of the Meuse. But a day later he found that the forces were not available, while the Germans had advanced in strength far beyond their line. So he now decided to withdraw to the line of the Oise, 30 mi. farther back, and block the Germans there. Once again he was too late, for the German armoured divisions outran his retreating troops and were across that barrier on May 17. Even if the French had been able to mount a counter-offensive. they would not have found it easy to crush the invaders' flank. For Kleist's southern flank was progressively lined by his motorized divisions, which in turn were relieved by the infantry corps that were marching on as fast as possible. This lining of the Aisne had an important indirect effect, by playing on the most instinctive fear of the French. For on May 15 Gamelin received an alarming report that the Germans were crossing the Aisne between Rethel and Laon. He told the government that he had no reserves between that sector and Paris and that he could not guarantee the security of the capital for more than a day. After Gamelin's startling message the French premier. Reynaud. hastily decided to evacuate the government from Paris to Tours. By evening more reassuring reports came from the Aisne, and Reynaud went to the radio to broadcast a denial of "the most absurd rumours that the government is preparing to leave Paris." At the same time he seized the opportunity to replace Gamelin, and for that purpose summoned Gen. Maxime Weygand from Syria. Weygand did not arrive until May 19, and thus for three critical days the supreme command was in a state of mental, though not actual, suspense.

While the Allied statesmen, like their peoples, were still dreaming of an attack that should cut off the "bulge," the German armoured forces raced on to the sea and cut off the Allied forces in Belgium. The remaining obstacles that could have blocked the tanks were not manned in time on an adequate plan. After crossing the Oise on May 17, Guderian's advanced troops reached Amiens two days later. On May 20 they swept on and reached Abbeville, thus blocking all communications between north and south. By the next day the motorized divisions had taken over the line of the Somme from Péronne to Abbeville, forming a defensive flank barricade. Guderian's corps then turned north up the coast in a drive for Calais and Dunkirk on May 22, while Reinhardt's, swinging south of the British rear position at Arras, headed for the same objective—the last escape port that remained open for the British.

(d) Conquest of Belgium, Final Phase.--After abandoning the Dyle line on May 16 the Allied armies in Belgium had wheeled back to the line of the Escaut (or Scheldt). By the time they arrived there, the position had been undermined by the cutting of their communications. On May 19 Gort began to consider the necessity of evacuating the British expeditionary force by sea, and the preparatory steps entailed. Next day, however, orders came from the cabinet that the B.E.F. was to march south on Amiens. Gort argued that such a long-range drive in reverse was not practicable, either tactically or administratively. All he could manage was an attack by two divisions, which had just been rushed south to Arras for the purpose, led by a brigade of infantry tanks, the only armoured troops he had. When this riposte was launched on May 21. it comprised no more than two tank battalions backed by two infantry battalions, while elements of one French light mechanized division covered its flanks. Nevertheless, this small drive into the corridor momentarily shook the nerve of the German higher command. The effect showed that if two or three armoured divisions had been available for a concentrated counterstroke, the German advance might have been dislocated.

After this flash in the pan the Allied armies in the north made no further effort to break out of the trap, while the belated relieving push from the south was so feeble as to be almost farcical. The prevailing confusion was increased by Weygand's arrival to take over supreme command. This veteran of 1914–18 was better in expounding theory than in grasping reality, and even his theory was out of date. His grandiloquent orders had no more chance of being translated into practical terms than those of Reynaud and Churchill. While the governments and commanders got into a tangle of divergent views and orders, the cut-off armies in the north fell back on a slant closer to the coast under increasing pressure from Reichenau's advance through Belgium. More dangerous still was the backdoor approach of Guderian, whose armoured forces were sweeping north past Boulogne and Calais. So three of Gort's divisions were pulled out of the front and sent south to strengthen the line of canals that covered Dunkirk and the Allies' rear. Two more were allotted for Weygand's renewed project of a Franco-British drive down into the German corridor. But then the Belgians' extended right flank, adjoining the British, gave way under Reichenau's pressure; so these two divisions were rushed north again. By the time they arrived, on May 27, the Belgian centre had cracked. and there were no reserves to fill this fresh gap. With their country overrun and their backs to the sea, in a small strip cronded with refugees, the Belgians were driven to sue for an armistice that evening; and the cease-fire was sounded early next morning.

Even before the Belgian capitulation, the British government had decided to evacuate the B.E.F. by sea from Dunkirk, and the admiralty had been collecting every kind of small craft to help in taking away the troops. The retreat to the coast now became a race to re-embark before the German pincers closed. As many of the troops had to be taken off from the beaches, it was a slow and difficult process, extending from May 26 to June 3. In the end 233,039 British troops were taken away, as well as 112,546 Allied troops, mainly French, though most of the equipment had to be left behind. The evacuation could not have been achieved but for the air cover provided by fighter aircraft from the English coast, the indomitable efforts of the seacraft and the good discipline of the troops. It was Hitler, however, who did most to make their escape possible. For the German armoured forces had reached and crossed the canal defense line close to Dunkirk as early as May 23, when the bulk of the B.E.F. was still far distant from the port. But they were halted by Hitler's order on May 24, and actually pulled back to the canal line, just as Guderian was expecting to drive into Dunkirk.

That "miraculous" intervention, which brought salvation to the British, was prompted by several factors. Kleist and Kluge contributed to it by the anxiety they expressed about the British tank counterattack at Arras and by overestimating its scale. Rundstedt contributed by the way he impressed on Hitler the need to conserve the armoured divisions for the next stage of the offensive. Goring contributed by insisting that the Luftwaffe could deliver the coup de *grâce* at Dunkirk and prevent any escape by sea. Hitler himself was greatly influenced by his memories of marshy Flanders in World War I, and thus became needlessly fearful of his tanks' becoming bogged if they drove any further north. But some of his generals who talked with him felt that his halt order was also the result of a belief that Britain would be more willing to make peace if its pride was not wounded by seeing its army surrender.

'Three days passed before Brauchitsch, the army's commander in chief: persuaded Hitler to withdraw his veto and allow the armoured forces to advance. But they now met stronger opposition, and almost immediately Hitler stopped them again, ordering them to move south ready for the attack on the Somme-Aisne line. Reichenau's army followed, leaving Küchler's to clear up things in the north, where more than 1,000,000 prisoners had been taken in the three weeks' campaign, at a cost of 60,000 German casualties.

(e) Collapse of France. — The new French front along the Somme and the Aisne was longer than the original one! while the forces available to hold it were much diminished. The French had lost 30 of their own divisions in the first stage of the campaign, besides the help of their Allies. (Only two British divisions remained in France, though two more that were not fully trained were now sent over.) In all, Weygand had collected 49 divisions to cover the new front, leaving 17 to hold the Maginot line. The Germans, by contrast. had brought their 10 armoured divisions up to strength again with relays of fresh tanks, while their 130 infantry divisions were almost untouched. For the new offensive the forces were redistributed, two fresh armies (2nd and 9th) being inserted to increase the weight along the Aisne sector (between the Oise and the Meuse) ; Guderian was given command of a group of two armoured corps that were moved to lie up in readiness there. Kleist was left with two corps, to strike from the bridgeheads over the Somme at Amiens and Péronne respectively, in a pincer move aimed to converge on the lower reach of the Oise near Creil. The remaining armoured corps was to advance between Amiens and the sea.

The offensive was launched on June 5, initially on the western stretch between Laon and the sea. Resistance was stiff for the first two days, but on June 7 the most westerly armoured corps broke through on the roads to Rouen, with Rommel leading. The defense then collapsed in confusion, and the Germans met no serious resistance in crossing the Seine on June 9. Kleist's pincer stroke did not, however, go according to plan. The left pincer, from Péronne, was hung up by tough opposition north of Compiègne. The German supreme command then decided to pull back Kleist's group and switch it east to back up the break-through that had been made in Champagne. The offensive there did not open until June 9, but then the collapse came quickly. As soon as the infantry had forced the crossings, Guderian's tanks swept through the breach toward Châlons-sur-Marne and then eastward. The drive continued at racing pace, over the Langres plateau to Besançon and the Swiss frontier, cutting off all the French forces in the Maginot line.

On June 10 Italy declared war. An Italian offensive, however, was not launched until ten days later and was then easily held in check by the weak French forces. On June 11 Churchill flew to Tours in a vain effort to encourage the French leaders. Next day Weygand addressed the cabinet, told them the battle was lost, blamed the British for both defeats and then declared: "I am obliged to say clearly that a cessation of hostilities is compulsory." There was little doubt that he was correct in this estimate of the military situation, for the French armies were now splitting up into fragments. The cabinet was divided between capitulation and a continuance of the war from North Africa but decided only to move itself to Bordeaux.

The Germans entered Paris on June 14 and were driving deeper on the flanks. Two days later they reached the Rhône valley. Meanwhile Weygand had continued his pressure for an armistice, backed by all the principal commanders. Reynaud resigned, whereupon a new cabinet mas formed by Marshal Henri Philippe Pétain, and the request for the armistice was transmitted to Hitler on the night of June 16. Hitler's terms were delivered to the French envoys on June 20. The German advance proceeded beyond the Loire while discussion continued, but on June 22 the German terms were accepted. The armistice became effective at 1:35 A M. on June 25, after an accompanying armistice with Italy had been signed the day before.

3. The Siege of Britain. — No plans had been made for the invasion of Britain when the Germans launched their offensive. Nor were any made even when the collapse of France was assured. It is clear that Hitler counted on the British government's agreeing to a compromise peace on the favourable terms he was disposed to offer and had no desire to press the conflict to a decisive conclusion. The German army was given to understand that the war was over, leave was granted and part of the Luftwaffe was shifted to other quarters. Even when Churchill's determination to continue the war was manifest, Hitler still clung to the belief that it was merely a bluff. feeling that Britain must recognize "her militarily hopeless situation." That hope of his was slow to fade. It was not until July 2. 1940, that Hitler even ordered a consideration of the problem of invading England, and he still sounded a note of doubt about its necessity when at last. on July 16. he ordered preparations to begin for such an invasion, christened Operation "Sealion." But he said that the expedition must be ready by mid-Aug. 1940.

The German army was in no way prepared for such an undertaking. The staff had not contemplated it, the troops had been given no training for landing operations and nothing had been done to build landing craft for the purpose. So all that could be attempted was a hurried effort to collect shipping, bring barges from Germany and the Netherlands and give the troops some practice in embarkation and disembarkation. It was only the temporary "nakedness" of the British forces, after losing most of their equipment in France, that offered such an improvisation the possibility of success. The main operation was entrusted to Rundstedt's army group A, which was to use the 9th and 16th armies, comprising 2j divisions. Starting from the various harbours between the Scheldt and the Seine estuaries, they were to converge on the south coast of England between Folkestone and Worthing, while air-borne troops were to capture the cliff-covered Dover area. According to the plan, ten divisions were to be landed in the first four days, to establish a wide bridgehead After about a week the main advance inland would begin, its first objective being to gain the high ground along an arc from the Thames estuary to Portsmouth. In the next stage, London was to be isolated from the west. If opposition were stiff, the 6th army (from army group B) might be landed west of Weymouth for a push northnard to the Severn.

The German generals were very apprehensive of the risks that their forces would run in crossing the sea. They had little confidence in the capacity of either their own navy or the *Luftwaffe* to keep the passage clear. The German admirals were even more frightened about what would happen when the British navy appeared on the scene. They had no confidence in their own power to stop it and insisted that the responsibility must be placed on the Luftwaffe. Goring, however, expressed assurance that the Luftwaffe could check British naval interference as well as drive the British air force out of the sky. So it was agreed that he could try his preliminary air offensive, which did not commit the other services to anything definite, while the time for the invasion attempt was postponed to mid-September.

During July and early August a rising stream of air attacks was delivered against Britain's convoys and ports. Then on Aug. 13 the main offensive was unleashed, initially against air bases. Although targets and tactics were changed in different phases, the underlying object was always to wear down Britain's air defense, and the effort was maintained far into September. Although it severely strained the limited resources of fighter command, under Air Chief Marshal Sir Hugh Dowding, the German losses in both bombers and fighters were disproportionately heavy. Aug. 15 and 18, Sept. 15 and 27 were the *Luftwaffe's* days of greatest loss in the long series of air battles over Britain. As the expensiveness of the daylight attacks came to be impressed on the Luftwaffe, the offensive effort was increasingly diverted into the channel of night raids on Britain's industrial centres. Although the nightly "blitz" imposed a great strain on the civilian population, besides impairing war production and food supply, it contributed little to the main purpose that had prompted the air offensive. (See Battle of Britain, below.)

The evident inability of the Luftwaffe to dominate the sky increased Hitler's hesitation to take a decision on Operation "Sealion." Orders he issued on Aug. 16 hinted at further delay. On Sept. 3 the date of invasion was deferred to Sept. 21, and then on Sept. 19 he ordered the shipping to be dispersed. On Oct. 12 he announced that the operation was off for the winter, though a pretense of preparations was to be kept up. Long before the spring came he had decided to turn eastward against the U.S.S.R., and plans for the invasion of Britain were definitely discarded. Rundstedt and other generals had doubted all through whether his intentions were serious, in view of the apparent lack of interest and impetus on his part compared with the way he had spurred on the preparations for other offensives. The campaign against Britain thenceforth became purely a blockade of its sea approaches, conducted mainly by the German submarines, supplemented by the Luftwaffe.

4. British Amphibious Raids.—The number of operations carried out by the commandos during World War II was small, but they had a tonic effect on British national morale during the depressing period of isolation and siege that followed the enforced evacuation of the continent by the British forces in 1940. They helped to show that the German hold on the continental coast line was not completely secure, and they gained valuable experience for future amphibious operations on a larger scale. While the German command had reason to welcome these occasional raids as a help in keeping its own troops alert, it became uncomfortably impressed by such evidence of the excessive stretch of coast it had to cover as a result of its conquests. The commando operations were also valuable as a school in the application of irregular tactics to regular warfare, correcting the normal tendency of armies to develop formal habits and stereotyped methods.

The earlier raids had as their main target the fish-oil plants in Norway that were used in the making of glycerine for explosives; destruction of shipping was one of the subsidiary aims. The first raid was carried out—by British commandos, light naval forces and Korwegian marines—at the head of the Vest fiord off Narvik, on March 7, 1941. The next was a purely Norwegian raid, at Oksfiord, between Tromso and Hammerfest on the night of April 11. On Dec. 27 a larger raid, mainly by British forces, was delivered against the island of Vaagsoey. In 1942 commando operations were switched to the Atlantic shores of occupied France. The first was on the night of Feb. 27 at Bruneval, near Le Havre, where the secrets of the radar station formed the main objective. Some parachute troops co-operated in this very successful small operation. A more ambitious one was attempted at St. Nazaire on March 28 and did considerable damage to the harbour works, though at a rather high cost. On April 22 there was a small raid near Boulogne.

A much bigger operation was attempted at Dieppe on Aug. 19, 1942. Officially described as a reconnaissance in force, it furnished useful lessons for the future in the problem of invading a well-defended coast. Although the cost was very high, it showed the possibility of achieving a large-scale landing under modem conditions, while bringing out mistakes that were to be avoided. In this operation, the commandos played only the preparatory role, in the form of a dual flanking move. The right-hand thrust was successful in disabling the coastal guns on its sector, but the left-hand thrust miscarried; it unluckily ran into a German flotilla before the landing. The main assault was carried out on the beaches of Dieppe, by a mainly Canadian force of about 7,000 men, and tanks were employed to help it, though their efforts were seriously obstructed by the sea wall. Kearly half the assaulting force was lost, largely as prisoners. Losses in landing craft and aircraft were also heavy, though in the air a compensating toll was taken by the great Allied "umbrella" of about 1,000 fighters.

(B. H L. H.)

5. Air Warfare over Western Europe, Germany, Mediterranean and Italy.—Germany used its air force from 1939 to 1944 mainly as an adjunct to offensive military and naval operations; but by the beginning of 1944 it was forced to switch to the defensive because of the Allied air campaign against its industrial area. Thereafter, German offensive action was largely limited to mechanical weapons, first the flying bomb or V-I and later the big rocket or V-2. Allied air strength in the earlier period had been built up from a condition of numerical inferiority to an overwhelming preponderance. Victory in the long run depended largely on the Allies' success in expanding and deploying their air forces and on the failure by Germany to prevent this. If the German air force could have smashed the British aircraft industry between 1940 and 1942 or the Russian aircraft industry after 1941, or stopped the flow of U.S. aircraft to Britain after 1941 or prevented the movement of air forces to North Africa, the eastern Mediterranean and the Soviet Union, it could have changed the course of the war. It achieved none of these tasks; as a strategical weapon, German air power failed.

Allied air effort, whether its strength warranted it or not, always took account of strategical as well as tactical needs until the two merged into one with the invasion of Germany. By that time it had disorganized German production and transport, safeguarded Allied bases and given vital support to the ground forces in a series of campaigns.

This continuous and mounting attack on the sources of axis power formed the background to the campaigns. It went on in retreat and in advance. It rose at last to an intensity never before imagined. While the armies of Germany and Italy were being forced back, the whole economy of their homelands was being destroyed. High on the program of destruction were the aircraft industry and the oil needed by the axis air forces. When finally the Allied armies crossed the Rhine in the last stages of the war, there was practically no interference from the German air force.

(a) The Success of the Blitzkrieg.—Most of the nations Germany attacked between 1939 and 1941 were in a position similar to that of Germany at the end of the war. The one exception was the U.S.S.R. When Germany invaded Poland in Sept. 1939 it had about 5.000 first-line aircraft. Nearly 2,000 of these were used in the campaign. Poland could muster at most 600 aircraft; the German aim was to put these out of action first. In two weeks this purpose had been achieved, and German air units could concentrate on turning retreat into confusion and on spreading terror among civilians. The entire campaign cost Germany only about 200 aircraft. When the Germans invaded Norway in April 1940 the air defense was equally inadequate, and it was impossible for the British to reinforce the Norwegian army.

Ship-based aircraft, few in numbers, backed up by only two land-based fighter squadrons, could not compete with the German land-based aircraft of superior performance. Thus, a second campaign was decided in the air.

When the main thrusts were delivered into the Netherlands, France and Belgium, the German air operations resembled those of the Polish campaign, with some innovations. Again the resistance was weak. About 3,500 aircraft were used by the Germans. Against these France had a total of 2,500, but never many more than 1,000 aircraft in its first-line strength. The British air strength in France did not exceed 500 aircraft. Heavy air fighting took place, and the Germans suffered serious losses, especially among their dive bombers; but they were too well supplied with aircraft to be checked.

In the Netherlands, parachute troops were used in force for the first time. About 20,000 were dropped, chiefly in the neighbourhood of Rotterdam; this action was preceded by an intense bombing of the dock area of the city. On other parts of the 250-mi. front, German aircraft attacked airfields and communications, broke down resistance in front of their troops, put up a defensive umbrella over their advancing columns, bombed and fired at refugees on the roads and took every opportunity to create chaos in the rear of the opposing armies. By way of breaking the spirit of the French, there were raids on certain towns, including one by 120 bombers on military objectives around Paris. Meanwhile the relatively small force of the royal air force continued to cover the British retreat to Dunkirk and to oppose to the limit of its powers the advance of the Germans. The bombing of towns by the Luftwaffe had released the British from their inhibitions concerning targets where civilians might be involved. During the German advance there were frequent attacks on railway yards, oil supplies and road junctions in western Germany. In the air fighting near Dunkirk, the Germans had a taste of the opposition they were thenceforth to meet. British victories in the air made the evacuation possible but could not impede the collapse of France. The German air force lost 2,000 aircraft in six weeks of fighting, yet after six weeks' refitting it was ready for the next venture, to prepare the way for the invasion of England.

(b) The Battle of Britain.—The Germans had available for this task about 3,000 aircraft. The British could put against them a fighter force about 800 strong; but this force was extremely well armed with eight-gun fighters, its aircraft carried armour over vital parts, its pilots were well trained and, perhaps most important of all, it was equipped with radar which had been brought secretly to a high state of efficiency. This apparatus detected formations at a distance of 50–60 mi. and revealed their strength, height and direction.

The Germans opened the battle of Britain on Aug. 8, 1940, with attacks on shipping and on south coast ports. For ten days they kept up this onslaught. From Aug. 12 they combined their campaign against shipping with raids on airfields, aircraft factories and radar stations in southeast England. On the whole they used about 500 aircraft a day; on some days, the figure reached 1,000. Throughout, losses were heavy. Failing to obtain the success they had expected, the Germans tried out various plans—night attacks on industrial towns in the Midlands, raids on the airfields of the home counties.

Early in September came attacks on London itself. The first was made by more than 400 aircraft; of these, nearly a quarter were brought down. So heavy were the losses of the Germans in their daylight assaults that they turned to night bombing. Daylight raids continued, but they were more a nuisance than a threat; the night raids were to trouble Britain for two years. Meanwhile an invasion fleet of barges had been assembling on the French and Belgian coasts and British bombers had been attacking it. Many barges were destroyed, but the danger of invasion remained an influence in British policy for many months and, together with the German campaign against shipping, curtailed British activity in other theatres of war. (See also Siege of Britain.)

(c) The Defensive Phase.—When Italy entered the war in June 1940 there were fewer than 400 British aircraft in the whole middle east command; these had to look after the defense of Malta, the Suez canal and the Sudan and to undertake offensive operations in Libya, Eritrea, Italian East Africa and Ethiopia. The Italians, on the other hand, had a front-line strength of about 1,500 aircraft. Reinforcements from the air forces of Australia, New Zealand, South Africa and Rhodesia soon arrived in North and East Africa. Under the "cash-and-carry" arrangement a certain number of U.S. aircraft, chiefly fighters and long-range reconnaissance types, were taken in British ships to Britain and thence to Africa. Later, under the lend-lease scheme, the flow was greatly increased.

The Italian air force was roughly handled wherever the British forces came into conflict with it. Axis ports on both sides of the Mediterranean were bombed. The British air units made up in dash what they lacked in numbers and equipment. Ship-borne aircraft had one outstanding success in Nov. 1940, when British planes caught some ships of the Italian navy at anchor in Taranto harbour and torpedoed seven, including three battleships. In the following April they took a major part in the battle of Cape Matapan. But for the most part, the British forces were at a disadvantage, especially in protecting convoys and in preventing the movement of traffic from Italian ports.

These difficulties came to a climax with the advance of the Germans through Yugoslavia to the Greek coast in April 1941 and with the capture of Crete by an air-borne force in May. This was the first example of an entirely air-borne campaign; it was preceded by intense bombing of the three airfields from which the small British fighter force operated. The latter became so reduced in size as to be ineffective against a raiding force about 500 aircraft strong and had to be withdrawn. Then the Germans dropped paratroops and glider troops, so that by the end of a week they had nearly 23,000 men on the island.

This evidence of German skill in air-borne invasion increased the anxiety felt in Britain. Night bombing had meanwhile grown in strength. Sometimes as many as 450 bombers attacked London in a night. A large part of the City had been destroyed by fire at the end of 1940. There had been heavy raids on other towns such as Coventry, Bristol, Birmingham, Liverpool and Birkenhead. Defense against night attacks was having little success mainly because single-seat fighters were being used and there was no room in them for an air-borne radar set and its operator. The possibility of an air-borne invasion by night was acknowledged. Home defense then remained a priority and alongside it stood the need to give more attention to the Atlantic battle.

German submarines were now working in packs, guided by scouting aircraft from advanced bases. Some of these aircraft made bombing attacks on merchant ships approaching Europe. With coastal bases all the way from Norway to the Spanish border in Its hands, the German air force came near to making good the claim that air power could neutralize sea power. In the end, air power from British bases held down the German aircraft and checked the operations of the German submarines as well. Small escort carriers—converted merchant ships—came to be used in addition to naval escorts, and the R.A.F. steadily increased its long-range patrols until they were not only locating but fighting the submarines. By the end of the war, 415 out of the total of 781 submarines accounted for had been destroyed by air action. In this defense of Britain as a base, operations began near the shores of Britain and were gradually extended into the oceans until air cover was provided along all the convoy routes.

In the Mediterranean in 1941 there was a parallel situation in which the Germans held the majority of bases for controlling traffic in that sea, and the British were even less well equipped than they were at home. The Germans failed to knock out Malta and they paid heavily in every attempt they made to do so. Although the British were unable to prevent the transport of German troops from Italy to Africa, they did destroy the ships supplying these forces.

(d) The Offensive Phase.—The process of building up a British striking force in the middle east was slow and laborious. For two years the bulk of the fighting strength was in Britain and had to be used from Britain. Bombers and fighters went out whenever the weather was fit, by day and by night, to hamper German production and communications and to challenge the German air force in France. The daylight raids were intended to tie down units in France which might otherwise have been moved to the

Mediterranean and the U.S.S.R. Most British scruples were removed by the German incendiary attacks and so with the night raids began the campaign of systematic widespread destruction which was afterward to make Germany the most devastated area in Europe.

Strategic bombing, aimed at Germany's power to feed the war machine, was gathering weight by the end of 1941. The first of the four-engined bombers had gone into action. Mounting production in Britain was adding to the numerical strength of the attack building up; new ideas in technique were also being introduced. The raid by 1,000 British bombers on Cologne on the night of May 30–31, 1942, introduced the "saturation" attack; the 1,000 aircraft delivered more than 2,000 tons of bombs within a period of 90 min. There was a repetition at Essen the following night and again at Bremen on June 25. This time the attack was completed in 75 min. It was the last 1.000-bomber raid, but all this was the prelude to the series of heavy night raids which the R.A.F. continued right up to the end of the war. These were based on the "pathfinder" technique, by which radar was used to enable a specially trained advance party to locate the target and mark it with distinctive ground or sky markers, flares so powerful that their light could often be seen through clouds. On those marker flares the main body dropped its bombs.

During this period bigger and bigger bombs were used. At the end of June 1942 the 4,000-lb. bomb was introduced. By September the 8,000-lb. bomb was in use and a year later there was first a 12,000-lb. bomb and then a 22,000-lb. bomb for the uprooting of particularly difficult structures such as viaducts. Another important development in the early part of 1942 was the arrival of heavy bomber units of the United States army air forces and of fighter units to escort them on daylight attacks. The B-17 four-engined bombers specialized in precision bombing, and this was a consideration in deciding that the U.S. heavy bombers should undertake the day bombing while the British Lancasters and Halifaxes should continue their night campaign. From Sept. 1942 the daylight campaign of the Americans, continually growing in volume, was carefully co-ordinated with the mounting night offensive of the R.A.F. It was also supplemented by high-speed, unprotected attacks in daylight and in darkness by R A.F. Mosquito bombers, each capable of carrying one 4,000-lb. bomb or a selection of smaller bombs.

While these developments were taking place in the west, Germans and Russians were both using their air forces to help their armies, much in the way that Germany had applied air power in its earlier campaigns. Air losses on both sides were heavy. The Russians, for instance, admitted the loss of 4,500 aircraft in the first two months of the fighting in 1941. German losses in the same period were nearly 2,000. That winter and in subsequent winters, Germany withdrew some of its best air units from the Soviet Union to the western and Mediterranean fronts to be used against Britain.

On both these fronts, however, by the beginning of 1942 the British were beginning to assert superiority in the air. On the French front, this was shown in a series of provocative sweeps by day bombers and fighters, which were later amplified by the addition of U.S. army air forces and which cleared the way for the Normandy landings of June 1944. In the Mediterranean, the Allied air superiority expressed itself first in a close co-operation with the army and later also in the complete isolation of the axis forces in Tunisia from their sources of supply in Sicily and on the Italian mainland. It also amounted to air supremacy during the Allied crossing from Tunisia to Sicily, a crossing in which paratroops and glider troops were used in large numbers.

The technique of close co-operation with the army had been carefully worked out during the seesaw battles of the desert campaign. Both strategical and tactical operations had been planned by the air force to serve the general military scheme. Soon after the opening of the British offensive at El Alamein, the Anglo-U.S. landings in Morocco and Algeria took place Nov. 1942, and the limited axis air forces in Africa had to serve two fronts. They were already outnumbered in Egypt. and such was the spirit of the Allied air forces that they were outfought as well. As the Allied air forces moved up always within a few miles of the forward troops, their effectiveness against the axis line of supply from Italy was improved until neither reinforcement nor escape was possible for the troops in Tunisia. The process of making the front too hot for the axis air forces was repeated in Sicily, so that within a fortnight of the Allied landings not a single axis aeroplane was based on the island.

In the African campaign, the air operations of the Allies differed from those which the Germans had applied to their offensives in the sense that they stretched out farther beyond the battlefields and that they dealt with air opposition which, on occasions, was strong. In supporting the armies the Allied air forces employed fighter bombers which gave better help than the axis dive bombers and made successful use of rocket projectiles against armour and against shipping. As the Allies advanced northward through Italy, the Germans experimented with radio-controlled bombs in attacks on ships; but the strength of Allied air cover soon made these of little consequence.

British and U.S. air forces were now working together. The performance of the British air forces in the advance from El Alamein and of the united air forces in Sicily and Italy set the standard for subsequent operations in western Europe, where the numbers of aircraft were greater and where powerful forces of heavy bombers could be fitted into the strategic plan. Before the Allied landings were made in Normandy, the German air force had been bombed out of its forward bases, its radar had been disorganized and its sources of supply and reinforcement had been attacked. Railways in the whole of northwest France had been reduced by attacks on junctions and on rolling stock. Coastal fortresses were smothered. A regular patrol of aircraft in the English channel kept submarines out of the course the invasion fleet was to follow. The whole scheme of air protection and preparation was co-ordinated and directed toward the threefold end of pushing back the axis' air defense, of preventing air or sea interference and of isolating the battlefield chosen by the supreme commander.

It succeeded beyond expectations, although Germany had had two years in which to convert its air force from an offensive into a defensive weapon. Its success undoubtedly owed much to its comprehensiveness. It brought Germany's production to a standstill, and it crippled German communications; at the same time, it provided effective cover for Allied strategy and close tactical support for the ground forces. In the Mediterranean, the method had been evolved and tested. In France and on through Belgium to the Rhine and beyond, it was applied with the full weight of the Allied resources and with the skill derived from experience.

The one factor which tended to divert and dissipate part of the Allied air effort was the introduction by the Germans of mechanical air weapons. Launching sites of the flying bombs and the rockets had to be attacked, and fast fighters had to be used to intercept the flying bombs. When the armies advanced far enough to put these weapons out of action, the war was nearly over, and Germany's air power had been largely destroyed by air action. (E. C. SD.)

6. The German Occupation of Western Europe.——Under the terms of the Franco-German armistice, the northern half of France together with the whole of its Atlantic seaboard remained in German occupation. "Unoccupied France" was economically the poorer part, and at the time of the armistice its problems were complicated by the fact that its population had been swollen by several million refugees from the north and from Belgium. The French government under Marshal Pétain, which was established at Vichy, retained a nominal independence but was naturally subject to German control and interference. It was permitted to retain an army similar in size (100,000) to that which Germany had been allowed under the Versailles treaty, and also its navy, as well as its colonial empire. This concession, which proved of great importance for the future, was prompted not only by a desire to secure French co-operation but by the Germans' naval weakness and consequent difficulty, when faced by the royal navy, in extending their tide of conquest to the French territories overseas.

The other conquered countries of western Europe were completely occupied, but the Germans sought, for their own convenience, to get the administration carried on by officials of these countries, subject to German control. A policy of conciliation was at first pursued. It corresponded to the ideas of the German military chiefs, who had learned the drawbacks of repression from the experience of World War I, while it also represented Hitler's desire to get these countries to accept their intended place in his "new European order." At first, that policy made considerable progress — largely because of the way the German troops fulfilled the high command's instructions to behave with restraint and courtesy in the conquered countries. This polite behaviour, combined with the German efforts to restore normal conditions, began to win over a much larger proportion of the peoples than merely the instinctive collaborators. Its prospects, however, were frustrated by the combination of Britain's continued defiance with nazi impatience and intolerance. Overbearing demands provoked resistance in occupied Europe, leading to more drastic measures and thus to more widespread resistance, in a rising spiral. This resistance became increasingly organized, with British support, and caused the occupying forces more and more trouble as the war went on. Besides the more active forms, sabotage and guerrilla (*q.v.*) warfare, there was a much more general passive resistance which had on the whole greater effect, without the legacy of licensed violence that in the former case often complicated the restoration of order after liberation.

In France, where the resistance eventually became strongest, it started with the handicap imposed by the Vichy government's tendency to avoid any such direct opposition to the conquerors as might worsen the plight of the French people. At the same time, prior to June 1941, the leaders of the large Communist party advocated collaboration with the Germans against Britain, as the last European stronghold of "western plutocracy." After the German invasion of the U.S.S.R. its attitude changed, and it started its own resistance movement. Others were also doing so on separate lines — Radical, Socialist or Catholic. The disunity of these movements hampered their effectiveness, and in their discords they often played into the hands of the occupying forces, until a later stage.

Outside France, Gen. Charles de Gaulle had started his "Free French" (later "Fighting French") movement as early as June 18, 1940. But he was able to collect only a few hundred in England, at Morval camp near Aldershot, and support for him elsewhere was at first small. The censure of the Vichy government was a deterrent to many, while confidence was shaken by the fiasco of De Gaulle's July attempt, under the protection of a British fleet, to seize Dakar, on the West African coast. But his prospects gradually improved as German impositions and the Vichy government's subservience brought an increasing flow of converts to his cause. The British entry into Syria in 1941 and Madagascar in 1942 paved the way for extension of his authority. Still more decisive was the U.S.-British occupation of French North Africa. in reply to which the Germans rushed to occupy the whole of France (Nov. 11, 1942) and turned the French people more definitely against them. Although the French fleet at Toulon did not escape to join the Allies, it was scuttled rather than allow it to fall into German hands (Nov. 27). Henceforth, there was a great development of the resistance in France, which was now better coordinated, while being more plentifully equipped with arms dropped by air. All the different bodies were now unified under the C.N R. (Conseil National de la Résistance), while the guerrilla sections were combined in a single organization entitled the F.F.I. (Forces Françaises de l'Intérieur), though the Communist partisans retained a measure of autonomy.

At the same time the regular forces under De Gaulle were growing fast. A brigade under Gen. Joseph Marie Pierre Koenig played a gallant part in the British campaign of 1942 in Libya. Larger forces mere employed in the Tunisian campaign. The following year an army corps under Gen. Alphonse Juin went to Italy and achieved the decisive manoeuvre through the mountains in the Allied offensive of May 1944 that led to the capture of Rome. Meannhile Koenig had taken over command of the F.F.I., which severely harassed the German communications in France before and during the Allied invasion of Normandy. On **Aug.** 18, as the Allied armies approached, the people of Paris rose in arms to liberate their city, and a French armoured division was hurried thither to support their efforts. In the same week a French army under Gen. Jean de Lattre de Tassigny formed part of the Allied landing in the south of France. It later achieved striking successes in the Rhine campaign. (B. H. L. H.)

E. THE BRITISH AFRICAN CAMPAIGNS

1. East Africa. — When Italy declared war on France and Great Britain Gen. Sir Archibald (later Field Marshal Lord) Wavell, commander in chief, British land forces in the middle east, was faced with the problem of disposing pitifully small resources in manpower and material to meet the numerically superior enemy ready, from favourable strategic positions, to launch a concentric offensive against Egypt and the Sudan. The fall of France rendered the position of the British in the Nile valley still more desperate, and success seemed likely for Mussolini in his new African venture. Although the British were particularly vulnerable in this nodal strategic area, the Italians were overcautious; they lacked daring, they lost precious time and they missed an opportunity which never again presented itself.

(a) Italian Conquest of British *Somaliland.*—The campaign in East Africa was opened by three limited Italian offensives: emerging from the Eritrean plateau they took Kassala in the Anglo-Egyptian Sudan and stopped there (270 mi. from Khartoum); they took Moyale in the north of Kenya; finally they occupied British Somaliland. This vast desert country was defended by a force of 5 battalions with one battery of howitzers and limited air support from Aden against the whole Italian eastern army amounting to 24 battalions with four groups of pack artillery, two groups of medium artillery, 30 tanks and adequate air support. The Italians crossed the frontier of British Somaliland on Aug 5, 1940, progressing along the main Jijiga (Giggiga)-Berbera highway. The British — under Maj. Gen. A. R. Godwin-Austen— fought a gallant rear-guard action toward Berbera, where in the night of Aug. 17–18 almost the whole force was embarked.

(b) British Conquest of Somaliland, Eritrea and Ethiopia. — During the autumn of 1940 General Wavell was under constant pressure by Winston Churchill to reduce to the minimum the troops in Kenya and the Sudan and to send all available forces to Egypt. He resisted and was authorized to start small-scale offensive operations against the Italians in East Africa. At a meeting in Cairo on Dec. 2, 1940, on the eve of the offensive against Marshal Rodolfo Graziani's forces in the western desert, General Wavell instructed Lieut. Gen. Sir William Platt, general officer commanding, Sudan, to prepare to recapture Kassala and Lieut. Gen. Sir Alan Cunningham, general officer commanding, East Africa, to conquer Chisimaio (Kismayu). It was also ordered that the rebellion in Ethiopia was to be encouraged by all possible means, and to this end Lieut. Col. O. C. Wingate was appointed staff officer for patriot forces toward the end of November and flown to Ethiopia, where Brig. D. A. Sandford had preceded him. By this time General Platt had at his disposal one Indian division and General Cunningham two African divisions and one South African.

Early in Jan. 1941 the Italians evacuated Kassala, and General Wavell therefore ordered an advance on Asmara and Massawa; in the meantime General Platt's small army was reinforced by another Indian division and moved to Eritrea from the battlefield of Sidi Barrani. General Cunningham was told that if successful in capturing Chisimaio he should advance on Mogadiscio. The emperor Haile Selassie, under the protection of the "Gideon force" of Wingate, crossed the frontier of Ethiopia on Jan. 20, 1941, and the subsequent operations of this small force cleared the Gojjam area of large Italian forces.

In Eritrea the Italians made a seven-meek stand on the naturally strong position of Keren (Cheren), which, honever was taken by storm on March 27. Asmara was occupied on April 1 and seven days later General Platt's army was in Massawa. In the south, General Cunningham started his offensive against Italian Somaliland on Feb. 11, three days later was in Chisimaio. and on

Feb. 24 entered Mogadiscio. Instructed by General Wavell to advance on Harrar to cut communications between Addis Ababa and Jibuti (Djibouti), General Cunningham pressed forward and on March 17 was in Jijiga, 744 mi. N. of Mogadiscio. The previous day Berbera had been recaptured by a combined operation from Aden under Air Vice-Marshal G. R. M. Reid. Harrar fell on March 25, Diredawa four days later and on April 6 the 1st South African division entered Addis Ababa. Emperor Haile Selassie, coming from the west, made his formal entry into the capital on May 5, five years to the day after its occupation by the Italians.

After his rapid advance General Cunningham wished to deploy his forces to the west in order to reduce the enemy centre of resistance in the Jimma (Gimma) area; General Wavell, however, anxious to get the South African division and the large quantity of transport as quickly as possible to Egypt, ordered a northward advance along the new Italian-built highway from Addis Ababa to Asmara. At the same time General Platt was ordered to advance south with the 5th Indian division (the 4th returned to Egypt after the fall of Keren). The two British divisions met the Italians at Amba Alaji, 235 mi. S. of Asmara and 424 mi. N. of Addis Ababa. The combined attack resulted in the surrender on May 17, 1941, of a large Italian army under Prince Amedeo di Savoia, duke d'Aosta, its commander in chief. This decisive victory was not the end of the campaign; the Italians continued to resist in two other redoubts until the surrender of Gen. Pietro Gàzzera in the Jimma area on July 8 and of Gen. Guglielmo Nasi at Gondar on Nov. 27, 1941.

The conquest of Italian East Africa had been accomplished by five British divisions and the small guerrilla force of Lieutenant Colonel Wingate (50 British officers, 800 Sudanese and 300 Ethiopians), helped by irregular patriot forces. The Italians had a numerical superiority of four to one over the British and their armies totalled 220,000 men. Discouraged by their defeat in the western desert, they exhibited a low morale throughout and felt uneasy in a country which they had occupied five years earlier but of which the population had remained unconquered.

When General Wavell began operations against Italian East Africa he did not expect such an easy and quick and so complete a victory. The ultimate pattern of the British offensive was a pincer movement on the largest scale through Eritrea in the north and Somaliland in the south converging on Amba Alaji, combined with a direct thrust through western Ethiopia by the patriot forces. "It looks Teutonic in conception and execution, but the result was not foreseen in the original plan," wrote Lord Wavell in his dispatch on "Operations in East Africa" (supplement to the London Gazette of July 9, 1946). It came about gradually through the development of events. "It was in fact an improvisation after the British fashion of war rather than a set piece in the German manner." (K. SM.)

2. Egypt **and** Libya.—These campaigns were dominated by three gifted commanders whose careers overlapped but whose ascendancy fell into three periods: Gen. Sir Archibald Wavell (until Feb. 1941), Field Marshal Erwin Rommel (March 1941–Aug. 1942) and Gen. Sir Bernard (later Field Marshal Viscount) Montgomery (from Sept. 1942).

Between El Agheila, near the Tripolitanian frontier, and El Alamein, about 60 mi. W. of Alexandria, there was no naturally defensive position which could not be readily turned. There was only one road, along the coast. There were several small, but, with the exception of Benghazi, only two large ports, Tripoli and Alexandria (each at the end of the respective lines of communication), by which to maintain major forces. Water supplies were, in parts, sparse. Apart from the Jebel Akhdar, the "bulge" of Cyrenaica which the Italians had attempted to colonize and which was outflanked regularly throughout the campaigns, the terrain was, in the main, flat and arid desert. Between El Agheila and El Alamein there was ample room for manoeuvre, particularly for mechanized forces; airfields were readily confected; moreover, save a small number of Arabs and, at first, a few Italian settlers, there were no civilians. The nature of the country with its solitary coastal road and the dispersion of its small ports gave the campaigns their pattern: a series of mechanized turning movements, outflanking "hooks" from inland while infantry hugged the coast, to secure a port which would nourish a further advance. "North Africa," said Gen. von Ravenstein, the commander of the 21st pnnzer division, "is a tactician's paradise and a quartermaster's hell."

(a) First Italian Offensive *(Sept.–Dec. 1940)*.—When Italy declared war on June 10, 1940, it had more than 200,000 troops in Libya and a considerable numerical superiority in aircraft. Thenceforward, British reinforcements had to reach Egypt via the Cape of Good Hope. With a detachment of the 7th armoured division on the Cyrenaican frontier, the main British positions were at Mersa Matruh, 120 mi. farther east. From June 11, small British columns established an early dominance by harassing raids over the frontier. but on Sept. 13 after a heavy artillery program against the deserted escarpment above Sollum, the Italians invaded Egypt on a narrow front along the coast with two divisions up, two in rear and a further division and the Maletti group in reserve. Sidi Barrani was reached by Sept. 16. These forces, subsequently increased by two additional divisions to a strength of 80,000 men, then distributed themselves, to remain for more than two months with ill-assured supply, in a series of fortified camps from Maktila, on the coast east of Sidi Barrani, to the escarpment about Sofafi, about 50 mi. away, in echelon from the left flank. Their defenses lacked both depth and mutual support. A gap of more than 20 mi. lay between Sofafi on the right and the next camp at Nibeiwa.

(b) British Counteroffensive *(Dec. 1940–Feb. 1941)*.—After an approach march by night over open desert, two highly mobile British divisions (7th armoured and 4th Indian) advanced on the gap. Complete surprise resulted in the rapid capture of Nibeiwa early on Dec. g, and by nightfall the Tummar camps, immediately north, had almost entirely fallen. Next day Sidi Barrani was retaken, and the ragged road to the west had been cut. In quick pursuit, the 7th armoured division intercepted a long Italian column between Buq Buq and Sollum, making its way back to the frontier. "Something is wrong with our Army," wrote Count Galeazzo Ciano on Dec. 11, "if five divisions allow themselves to be pulverized in two days." By Dec. 15 all Italian troops had been driven from Egypt, leaving nearly 40.000 prisoners in British hands, and the majority of the Italian army remaining in Cyrenaica had withdrawn within the invested 17-mi. perimeter of Bardia. There was a pause for maintenance and reliefs and to utilize the port of Sollum, before Bardia fell, after a naval bombardment and a heavy attack from the west, to the 6th Australian division (which had relieved the 4th Indian division) on Jan. 5. About 45,000 prisoners and 460 guns were captured.

By the next day, the 7th armoured division had cut the road Tobruk-Derna and the track Tobruk-Mechili while the Italians were abandoning their airfields at Gazala, Tmimi and Bomba. The southern face of the 28-mi. perimeter of Tobruk was attacked by the Australians on Jan. 21, with effective air and naval support, to capture the road junction Sidi Mahmud 8,000 yd. inside the perimeter. The town capitulated next day with 38,000 more prisoners.

The remaining Italian forces in Cyrenaica fell into two main elements: the majority of the infantry east of Derna and a mechanized group about Mechili. the nodal point of the tracks south from the Jebel Akhdar and the direct westward route to Benghazi. While the Australians pushed into the Jebel, the 7th armoured division moved on Mechili. By Feb. 3 it was evident that the Italians were abandoning the "bulge," and great risks offered complete victory. The 7th armoured division was therefore swiftly directed on Msus with a tight maintenance margin, to cut off the Italians south of Benghazi by moving northwest on Soluch or southwest on Agedabia as required. By Feb. 5, after a gruelling approach across unreconnoitred desert, detachments were astride the main routes southwest of Beda Fomm, blocking escape into Tripolitania. Eighty-four Italian tanks were put out of action next day by the British pincers closing from Soluch and Beda Fomm. After an abortive attempt by 30 Italian tanks to break through at dawn on Feb. 7, Gen. Annibale Bergonzoli surrendered unconditionally. The Italian 10th army had thus been wiped out, and Cyrenaica was in British hands. During the two months following Dec. 7 the army of the Nile advanced about 500 mi. It had destroyed an Italian army comprising nine divisions and part of a tenth and had taken 130,000 prisoners, 400 tanks and 1,300 guns. In these operations Gen. Sir Richard O'Connor, Wavell's tactical commander, had never employed more than two divisions at a time, the 7th armoured division, "the Desert Rats," being engaged throughout. British casualties totalled 1,928 men. The bombardment and supply work of the royal navy had been outstanding, while the royal air force, though most inferior in numbers, had gained complete superiority over the Italian air force.

(c) Second Axis Offensive (March–April *1941*).—Wavell was compelled to gamble on a strategic shoestring. Uncertain when German ground forces would reach Africa (where their aircraft were already operating) and pledged, although Keren and Chisimaio had still to be taken, to send to Greece what he could scramble together, he risked leaving the newly gained Cyrenaica with an understrength armoured brigade covering its western approaches and a new Australian division forming in the Jebel. British and German armoured cars first met on Feb. 20 and, before the month was out, German aircraft had made the port of Benghazi unusable. The maintenance of the slender British forces had therefore been thrown back on the long line to Tobruk when Rommel recaptured El Agheila on March 24 and advanced in force through Marsa Brega on March 31 with the 5th light division (an experimental German formation subsequently converted into the 21st panzer division) and two mobile Italian divisions.

The British attempts to delay, first around Agedabia, to cover Benghazi, then on the line Derna-Mechili to cover Tobruk, were foiled by the faster and more powerful German tanks on the open flank. The Germans thrust in two main groups, one forcing its way through the Jebel on Derna, the other dashing via Msus across the open desert on Tobruk. Having captured a British divisional headquarters at Mechili on April 8 and driven a small delaying force back from El Adem to the Egyptian frontier, Rommel launched an ill-prepared attack on Tobruk on April 10–11, which was worsted after three tense days by the British gunners and Australian infantry who had withdrawn within the perimeter.

Their tanks requiring overhaul, the Germans, with Italians in attendance, settled down to prepare a less impetuous assault while the 15th panzer division moved up from Tripoli. The renewed attack went in on the night of April go—May 1, but the Germans narrowly failed in their purpose, and Tobruk settled down to the rhythm of its long siege.

The escarpment running southeast from Sollum was generally impassable to vehicles for about 50 mi. inland save at Sollum itself and at Halfaya. While Tobruk remained besieged, operations on the Egyptian frontier developed into battles for possession of the two passes. Sollum and Capuzzo were captured by the British on May 1j, only to be regained by the Germans next day. On May 27 the Germans took Halfaya in an operation ("Scorpion") beginning as a diversion for the battle of Crete. As a result of political pressure to relieve Tobruk, Wavell ordered an attack ("Battleaxe") over the frontier on June 15 designed to defeat the German armour in detail before advancing on El Adem. Capuzzo fell, but Halfaya and Sollum remained in German hands, and by the evening of June 16 additional German armour had arrived from outside Tobruk. Following an armoured battle south of Sidi Omar that night, the British began to withdraw after heavy tank losses, particularly from the German 88-mm. gun.

Rommel had already revealed the qualities which were to stamp his desert career: a forceful and inspiring personal leadership, disdaining either risk or advice, the requirements of maintenance and of his allies alike; a roughshod capacity to take advantage of his opponents' mistakes as rapidly as he recovered from his own; a tendency to improvise and to repeat his tactics; a liability to obsession.

Preoccupation with Tobruk conditioned the reorganization and accumulation of strength to which both sides devoted the long hot summer: one to capture, the other to relieve, the fortress. While eight Allied battalions in the front line dominated the four Italian divisions and three German battalions besieging the perimeter, the Allied naval and air forces tackled with redoubtable success the double task of keeping Tobruk alive and hamstringing the build-up and maintenance of the axis forces preparing to assault its mettlesome garrison. The Italian navy was not risking another Matapan; and between May and November no single axis convoy reached Tripoli or Benghazi unscathed; no single axis formation arrived in Africa complete. Meanwhile, Gen. (later Field Marshal) Sir Claude Auchinleck succeeded the sagacious Wavell (who had been involved in six campaigns between February and July) and steadily built up his striking force (which became the 8th army), undisturbed in the desert itself save by an abortive raid to investigate his preparedness by the 21st panzer division over the frontier as far as Rabia on Sept. 14, and by the urgent and political need to change the personnel holding Tobruk.

The Italian forces under Gen. Ettore Bastico's supreme command (for the North African littoral as an Italian domain was perforce also in name an Italian theatre) totalled eight divisions, of which three (Ariete, Trieste and Trento) were formed into a mobile corps. The axis frontier defenses were strengthened by the fortification of Halfaya and Sidi Omar to increase the difficulty of frontal assault and to extend any turning attempt. To release the 1jth and 21st panzer divisions for their proper role, the 90th light division was created from positional battalions about Tobruk. Rommel proposed to hold off the British at the frontier while he attacked Tobruk on Nov. 23.

(d) Second British Counteroffensive (Nov. 1941–Jan. *1942*).—The British attack ("Crusader") at dawn on Nov. 18, 1941, achieved complete surprise. Swinging an armoured corps wide across the frontier from Maddalena, the British sought to bring the German armour to battle, while on the inner flank another corps, having masked the frontier defenses, attacked northward to isolate Sollum and Bardia. The Tobruk garrison was to break out approximately southeast to join the relieving armoured corps. By Nov. 19 the British had seized the vital area of Sidi Rezegh southeast of Tobruk. Rommel replied by ordering the junction of the 21st panzer and Ariete divisions west of Bir el Gobi for attack eastward, while the 15th panzer division moved west from Sidi Omar.

By Nov. 23 the British plan had gone agley. Sidi Rezegh had been retaken, the sortie from Tobruk was stuck and the spearhead of the corps which had attacked north over the frontier was held at Gambut. While uncertainty existed in the British command, a mood relieved by Auchinleck's decision to take over personally, Rommel threw away his opportunity in a characteristic gamble to finish the battle quickly. Collecting all the armour he could muster on Nov. 24, he led a "dash to the wire," a raid over the frontier through the British lines, then swept north on a wide, incoherent front. His disruptive columns, having failed to unseat the British from their essential purpose, swung back on Nov. 26 against the rear of the New Zealanders, who had by then pushed beyond Gambut to retake Sidi Rezegh. Next day the Tobruk garrison captured El Duda, making junction with the relieving forces on Nov. 27. The 21st panzer and Ariete divisions were therefore east and the 1jth panzer division west of the corridor, the reverse of their dispositions when Sidi Rezegh had first been captured and some measure at once of the disruption which Rommel had created for himself and of the whirligig of desert warfare.

By Dec. 1, however, the 15th panzer and the 90th light divisions managed to break through the corridor to join the 21st panzer division at Zaafran. Rommel then again overreached himself and had to pull in his horns by abandoning the area east of the general line Bir el Gobi-El Adem. He began to withdraw from Tobruk on Dec. 7–8 and by Dec. 12, after expensive rear-guard actions, the Germans had reached a line running southwest from Gazala with an open right flank. A heavy battle for disengagement ensued, but by Dec. 15 it was evident that Rommel's lines were both pierced and turned. He retreated to Agedabia, picking up a delivery of tanks from Benghazi en route. The British failed to cut him off and, after another enveloping attempt about Agedabia on Dec. 28–30, tried to contain the main axis forces in western Cyrenaica while they proceeded methodically to eliminate the isolated axis positions masked in the rear: Bardia, Sollum and Halfaya. Refreshed by the arrival of a convoy at Tripoli and by two

Italian divisions, Rommel then withdrew into the strong El Agheila position to refit: back where he had started.

(e) Third Axis *Offensive* (Jan.–Aug. *1942).*—Nearer to his base, Rommel was ready first. Having probed British strength astride the coastal road on Jan. 21, he seized his advantage next day and rapidly captured Saunnu and Antelat. By Feb. 4 he had retaken Benghazi and driven the Allied forces back to their chosen line of resistance south from Gazala. He did not press home his attack on Feb. 14–15, and both sides settled down to prepare again for further advances while the race for supply was run, a phase demonstrating yet again the immense significance of Malta, the "unsinkable aircraft carrier."

The Allied defenses were a straggle of irregularly spaced strong points, "boxes" linked by mine fields. Most important was that at "Knightsbridge," a track junction where the Trigh Capuzzo running west from El Adem crossed the north-south track between two other "boxes," Acroma and Bir Hacheim. South and east of Bir Hacheim the left flank lay open. Rommel planned a swift drive round this flank to capture Bir Hacheim and roll up the Allied positions from south and rear. Tobruk was to fall on May 30.

The attack began on May 25, the German armour swinging round Bir Hacheim, one division making for Acroma, another for El Adem. By May 28 it was obvious that rapid success had escaped Rommel, and the slim margin of supply which he had allowed himself might be turned to Allied advantage. To ensure his continued maintenance, or if necessary his retreat, he had to cut a corridor back westuard through the British mine fields. A fierce four-day armoured battle about Knightsbridge resulted. Within an ace of victory, the 8th army failed to prevent Rommel from keeping open, indeed widening, his feed pipe to the "cauldron." Instead of his enforced withdrawal, Rommel regained the initiative with a modification of his original plan by regrouping his main strength in a salient east of his corridor while he proceeded to eliminate Bir Hacheim, which extended and hobbled his southern supply line, While the Free French hung on tenaciously against repeated attacks on Bir Hacheim from June 2 to 10, farther north the British nere trying unsuccessfully to pinch out the axis salient. The evacuation of Bir Hacheim on the night of June 10–11 offered Rommel the opportunity to destroy the remaining positions piecemeal. A series of heavy armoured battles, in which once again the inferiority of British tanks was revealed, covered the fighting withdrawal of the exposed Allied infantry. The British then attempted to repeat 1941 by holding Tobruk and delaying on the Egyptian frontier. But Tobruk, so long the symbol of British resistance to Rommel, fell with unexpected suddenness on June 21. With the forces thus released and the booty thus secured, Rommel could be stopped at the frontier neither by Allied arms nor by Italian advice. Once again Auchinleck rose to the crisis and assumed personal command. He decided to pause at Mersa Matruh while the last ditch was manned, the El Alamein line which Wavell had reconnoitred and Auchinleck himself had made ready.

By June 26 Rommel had reached Matruh, where he attempted to repeat the enveloping manoeuvre which had just gained him Tobruk. He was foiled by the remarkable rear-guard action of the New Zealanders at Minqar Qu'aim and because the British, who had retreated hundreds of miles under the magnificently offensive protection of the desert air force, despite the loss of 80,000 men, were still full of fight. Although Matruh and Daba fell before the end of June, by the time the Germans reached El Alamein their drive was almost spent. The first few days of July saw desperate fighting, but by July 5 the Germans had begun to establish a defensive screen. Both sides set about developing their defensive layout, and the heavy fighting which continued throughout July centred upon possession of the key ridges of Tel el Aisa in the north and Ruweisat, the backbone of the British defenses in the central sector.

The El Alamein line was the organization of a naturally defensive position about 60 mi. W. of Alexandria between the sea coast and the Qattara depression 35 mi. S. Like the Gazala position, it had been originally laid out as a series of mutually supporting boxes, but with the significant difference that the southern flank was closed by a sand sea generally impassable to large forces. Astride the coastal road lay Rommel's obsession, the El Alamein box itself, upon which the remaining defenses pivoted.

Once again the battle of supply bulked foremost. Rommel was now at the end of a long and frequently punctured pipe line (although an Allied combined operation to take Tobruk failed in September), whereas the Allies were defending their very base. While the toll of axis shipping mounted rapidly, the Allied build-up was for the first time swifter. Nevertheless, Rommel attacked first.

The 8th army, now under Montgomery's command, knew how the battle was to proceed. When Rommel advanced in strength on Aug. 31 to complete the "final annihilation," he was met on the strongly held Alam Halfa ridge, which dominated the southern sector, by massed artillery and tanks which refused to react to his design but fought a model defensive battle on ground of Montgomery's choosing. Close air support was employed as never before. As in May, Rommel had impulsively disregarded his maintenance in the rapid hope of a glittering prize: this time Egypt itself. Far in the rear, the coup de *grâce* was delivered by Air Bfarshal Sir Arthur (later Lord) Tedder's Wellingtons, which sank the fuel convoy in Tobruk which was Rommel's last hope of effective resupply. On Sept. 3 he began to withdraw. Montgomery had become a power in the sand, and the 8th army had acquired the morale and the master it needed for the battle of El Alamein.

(f) *Final* British Offensive (Oct. *1942–April 1943).*—To ensure the safe passage of the last convoy which could renew Malta's almost exhausted aviation spirit, the Allies needed possession of the Martuba group of airfields in the Jebel Akhdar by mid-November. Moreover, the North African landings ("Torch") were to take place early in the month. These requirements and the state of the moon and of Allied readiness set the date for Oct. 23.

By then the axis defenses were deeper and stronger. In the northern sector any Allied attack was intended to lose both force and direction within the system itself; in the south, where the defenses were less intricate, they were sited to canalize Allied penetration. Five Italian divisions were held in position by thick mine fields and a corset of German infantry. In the rear were four armoured divisions and the 90th light division. A further Italian infantry division stood on the frontier. Montgomery's design ("Lightfoot") was to feint in the south while he cut two corridors through the northern axis positions in a moonlit break-in operation with massed artillery support; to hold off the German armour during the "crumbling" operations which would ensue; and, in this dogfight, lasting perhaps ten days, to destroy the axis infantry and thus leave Rommel's armour without firm bases from which to manoeuvre or within which to refurbish. Then only did Montgomery purpose to release his own armour.

Before Oct. 23 the desert air force had conclusively won the air battle and thereafter devoted its full and successful attention to the close support of the land forces shown so effective at Alam Halfa. By Oct. 25 Montgomery had established a bridgehead in the northern axis positions and the dogfight was going well. He then developed his northern thrust by a series of fierce attacks, mainly by the 9th Australian division, the veterans of Tobruk, into a salient which menaced the coastal road and railway. Misled about his ultimate line of advance, the German Africa corps steadily congregated, not without severe losses, in the northern sector about Sidi Abd ur Rahman. Switching his thrust line swiftly, Montgomery, who by shrewd regrouping since Oct. 26 had been accumulating reserves as steadily as Rommel had been committing his. early on Nov. 2 (Operation "Supercharge") cut south of the German strength into the Italian positions. A quickly improvised axis anti-tank screen prevented the immediate break-through, but by Nov. 4 the 51st highland and the 4th Indian divisions had forced back the screen, and the Sherman tanks with which the United States had equipped the British armoured divisions (even at the expense of their own divisions in training) swept with the motorized New Zealanders out into open country. Heavy rain on Nov. 6 and 7 saved the axis forces from annihilation; but four German and eight Italian divisions had been drastically defeated, and 30,000 prisoners were taken.

The pursuit was rapid. The Martuba group of airfields was in Allied hands by Nov. 15, in time to support the convoy which left Alexandria next day. Benghazi fell on Nov. 20 and by Nov. 23 Rommel was back once more at El Agheila. The capture of El Agheila was psychologically important to the 8th army, with its memories of the annual retreat of the past. and as the gateway to Tripoli, its perennial target. In the event, Rommel partially false-fronted the British attack, and the remarkable December outflanking march of the New Zealanders over inland desert never before traversed by large forces failed to entrap many of the Germans who retreated to the Buerat position covering Tripoli. The main Allied difficulty was now administrative, and the size of the force which could be maintained as far as Tripoli was small. By the morning of Jan. 16, however, the "left hook" was beyond the Wadi Zem Zem, the main natural obstacle, and on Jan. 23, exactly three months after the El Alamein battle had begun, the 8th army entered Tripoli.

The next objective was the Mareth line, but first Tripoli had to be "uncorked." Only light forces advanced therefore into southern Tunisia. Between Feb. 28 and March 4, the 8th army was accordingly not well disposed for axis counterattack, yet it was increasingly evident that Rommel, having broken off his Tebessa attack against the 1st army, was turning south to deal the 8th army a blow before the united weight of Gen. Dwight D. Eisenhower's command could be brought against him. He was too late, for when he attacked on March 6 at Medenine with the 10th. 15th and 21st panzer divisions, Montgomery had made ready. In Rommel's last attack in Africa, he was decisively defeated in a single day in an engagement which again demonstrated Montgomery's mastery of the defensive battle.

The Long Range Desert group, a remarkable body of military explorers, had already found a way through the uncharted desert west of the Matmata hills which closed the western end of the Mareth line which the French had originally prepared. Behind the screen provided at Kasr Rhilane by Gen. Jacques Leclerc's Free French (who had joined Montgomery after their astounding march from Lake Chad), a large outflanking force was built up with Gen. Sir Bernard Freyberg's New Zealanders as a nucleus. A heavy frontal attack on the Mareth line proper was launched across the water-filled Wadi Zigzaou on March 20, but the German reaction was heavy. Montgomery straightway reinforced his left hook and by March 26, with the most effective close support by aircraft ever till then employed, he was able to force the axis switch line west of the hills before El Hamma and release an armoured division by moonlight through the disorganized axis forces. German reinforcements were too late; the 52 tanks they had lost at Medenine on March 6 were badly missed at El Hamma. The Mareth line had been turned, and only the axis forces holding the Wadi Akarit position (the "Gabès gap" between the Shott el Fejaj and the sea) stood between the 8th army and its U.S. comrades. The position was stormed in the dark early morning of April 6. The Germans held on throughout the day, but on April 7 British armoured cars made contact with tanks of the U.S. 2nd corps on the Gabès-Gafsa road. (For the rest of the Tunisian campaign, see *The North African Campaign, Nov. 1942–May 1943,* below. (E. T. Ws.)

3. Occupation **of** Madagascar. — The British had reason to believe that the Japanese, after the capture of the Andaman Islands, would seize the island of Madagascar either by force or through Vichy collaboration and thus cut off the last supply route to the middle east. In order to forestall a Japanese invasion, a British naval and military force under the command of Adm. Sir James F. Somerville attacked Diégo Suarez on May 6, 1942. The next day Diégo Suarez surrendered. After the occupation of this important naval base in the Indian ocean it was hoped that some degree of collaboration with the French administration would supervene which would enable the British to secure certain military objectives while still maintaining the machinery of French government in the island. By July it became obvious that the governor general, Armand Annet, although toying with the idea of collaboration, was really playing for time until the rains began in October, and that no sincere *rapprochement* could be expected from him. Lieut. Gen. Sir William Platt, who since July 1, 1942, had been in command of all British troops in Madagascar, therefore advised the chiefs of staff that further operations were essential. The plan proposed by General Platt, Admiral Somerville and Air Commodore M. L. Taylor was accepted. The offensive began on Sept. 10, and the same day the port of Majunga was conquered after slight resistance. Eight days later Tamatave surrendered; on Sept. 23 the British entered Antananarivo, the capital, where they were enthusiastically received by the population. Annet, however, and the pro-Vichy French forces withdrew southward, blocking all roads heavily as they went. At the end of September the British advance from Antananarivo was resumed. Antsirabe was occupied on Oct. 2 and Fianarantsoa on Oct. 29. On Nov. 4 Annet sent a plenipotentiary to obtain terms for an armistice. The British terms were accepted and hostilities ceased on Nov. 5. Annet was interned at Durban, and on Jan. 8, 1943, General Platt handed over the responsibility for the administration of Madagascar to Gen. Paul Legentilhomme, a representative of Fighting France under Gen. Charles de Gaulle. (K. SM.)

F. THE NEAR EAST CAMPAIGNS

1. Iraq. — Influenced by axis successes during 1940, the Iraqi government continued to maintain diplomatic relations with Italy, whose legation became the centre of axis intrigue and propaganda. Early in 1941, Rashid Ali el Gailani became prime minister; backed by four Iraqi generals, known as the Golden Square, he began to collaborate openly with the axis.

On March 31, 1941, the regent of Iraq took refuge on a British warship at Basra to evade arrest by his government. The British government, in accordance with its treaty rights, ordered an Indian brigade to Basra which arrived on April 18. Rashid Ali, on hearing that additional troops were coming from India, ordered the Iraqi army to attack the British air base at Habbaniya, 40 mi. W. of Baghdad. The Iraqi forces consisted of more than 9,000 troops with 50 guns while the garrison of Habbaniya numbered 300 British infantry (flown up from Basra), 1,000 royal air force personnel, 1,000 levees (mainly Assyrians) and no artillery.

On April 30 the Iraqi forces occupied a ridge overlooking Habbaniya and commenced bombardment by air and artillery. Until May 7 the position was critical; then the garrison, supported by British air forces from Egypt, drove the Iraqi forces, which had been reinforced by the German air force, back to Al Falluja on the Euphrates. Meanwhile, the Indian brigade advancing from Basra was delayed by floods and demolitions.

On May 18 a mechanized column consisting of British cavalry and the Arab legion of the emir of Trans-Jordan reached Habbaniya after marching about 560 mi. from Haifa, mostly across desert. This force secured Falluja bridge on May 19 and continued its advance, reaching the outskirts of Baghdad on May 30. The government of Rashid Ali, disheartened by the lack of adequate support from the Germans, thereupon fled the country. Resistance ceased and the regent was able to return and form a new government.

2. Syria. — During May 1941 Gen. Henri Dentz, the French (Vichy) commander in chief, had assisted the passage of German air forces to support Rashid Ali in Iraq. After the evacuation of Crete, the strategical importance of Syria increased; if occupied by the axis, it would constitute a threat against Turkey or Egypt. The Allies decided therefore that the country could not be left open to German infiltration and should be occupied. The degree of resistance to be expected from the French (Vichy) could not be assessed, but the presence of Free French forces with the Allies was expected to have a stiffening effect. The garrison of Syria consisted of about 30 battalions with 90 tanks. The Allies had available for this operation about 15 battalions made up of British cavalry, the 7th Australian division, 5th Indian infantry brigade and Free French forces, but no tanks. On June 8 the Allies crossed the frontier in three columns. The right column (Indian and Free French brigade), moving via Deraa on Damascus, was checked on June 10 ten miles short of that city. The centre (Australian) column captured Merjayoun on June 9, while the left column (Australian), moving up the coast, captured Tyre and forced the passage of the Litani river. Resistance to the advance stiffened thereafter, and Merjayoun was recaptured by a French counterattack. Only along the coast was slow progress maintained.

On June 21 a bold night attack by the 5th Indian brigade reached the outskirts of Damascus and captured the airfield, causing the French (Vichy) to evacuate the city. By the end of June the coastal column, supported by fire from a cruiser squadron of the royal navy, had taken Sidon and faced a strong position covering Beirut. The Allied force in the meantime had been augmented by a British infantry brigade from Egypt and farther east by forces released from the Iraq operations. The British mechanized column from Baghdad turned back across the desert and took Palmyra after hard fighting, while an Indian column moved unopposed up the Euphrates valley to capture Deir ez Zor.

On June 7 the 7th Australian division on the coast launched an attack to secure Beirut and was closely supported by effective fire from the cruisers. in the face of which resistance began to crumble, causing the French (Vichy) to ask for an armistice on July 11. This armistice was signed at Acre on July 14, and Syria passed into Allied occupation.

3. Iran. — During June and July 1941, reports began to reach the Allies of axis activity in Iran and of the infiltration of Germans described as "tourists." By the end of July. German activities had increased to an extent that compromised the neutrality of the Iranian government. After previous warning, on Aug. 16 the British and Soviet governments asked the government to expel all Germans. This request mas answered on Aug. 16 by an assertion on the part of the Iranian government of strict neutrality together with a denial of German subversive activities.

As a result of this unsatisfactory reply, British and Soviet troops moved into Iran on Aug. 25. British columns starting from Iraq were directed in the south on Abadan and Ahwaz and farther north on Kermanshah and Hamadan, while soviet columns advanced south on Tabriz and Pahlevi. After slight initial resistance, the Iranian army ceased fighting. A new government was formed in Tehran, and by Sept. 2 the basis of a settlement with the Allies had been reached.

On Sept. 16 the shah abdicated in favour of his son and on the same day British and soviet troops arrived at Tehran. All axis nationals. with the exception of 80 Germans who had disappeared into the mountains, were evacuated.

G. THE BALKAN CAMPAIGNS (1940–41)

1. The Greek-Italian War. — The occupation of Albania by Italian forces on April 7, 1939, caused a reorientation of the defense plans of the Greek government, which hitherto in accordance with previous Balkan agreements had been implemented for facing Bulgaria as a possible adversary. The distribution of troops was altered to deploy, for defensive purposes on the Albanian front, eight infantry divisions and two infantry brigades. The timing for concentration on this front was 22 days. The Greek air force comprised about 156 planes for all purposes, many of them of an obsolescent type.

In early Aug. 1940 Mussolini discussed in Rome the possibilities of an attack on Greece. The Greek light cruiser "Helle" was torpedoed by an unknown, "alleged Italian," submarine on Aug. 15, the day of the Feast of the Assumption. The Greek government, on advice from Berlin, acted with caution over this incident, but the event had an important psychological effect on the Greek people and added a religious zeal to the prosecution of the coming war against Italy.

On Oct. 12, 1940, and subsequent days Mussolini held conferences in Rome planning the attack on Greece. The date was fixed for Oct. 28. The Italian forces taking part were on a war footing, while the Greek army had not mobilized. The main Italian thrust, consisting of two infantry divisions and an armoured division, was directed through Epirus and was successful in forcing back Greek forces of one infantry division and one infantry brigade to the river Kalamas. In the centre on the Pindus mountains, an Italian mountain division drove in initially through two Greek battalions and almost reached the Metsovo pass but was unable to hold the ground gained in face of counterattacks. In the northeast, in the vicinity of the Prespa lakes, two Italian divisions attacked a Greek force consisting of one infantry division and one infantry brigade with similar results.

After two weeks of fighting, the Italian invasion had been checked and held by the Greek forces, whose divisions had concentrated on their respective battle fronts and gone straight into action. The mountainous nature of the terrain, with its lack of communications, made their supply difficulties acute. Greek peasants, men, women and children from the villages adjacent to the lines, carried up ammunition and rations to the forward troops. The Greek air force, which by this time was reduced to low numbers, was reinforced by five British squadrons from the middle east.

After Nov. 14, 1940, the initiative passed to the Greek forces. On the northeast front, in a hard battle in which five divisions were engaged on each side, the Greek forces captured the town of Koritsa (Korce, Kortcha); on the Epirus and central fronts, the Greeks forced back the Italians toward the frontier and by Nov. 16 had retaken Konitsa. At this juncture Gen. Alexandros Papagos, the Greek commander in chief, was faced with having to decide whether to continue the defensive in the northeast, where the greater successes had been achieved but where they were faced with very mountainous terrain and no definite objective, or to concentrate on the Epirus front for a thrust against the port of Valona. The maintenance of communications for such an operation could be assisted by using sea transport. The latter course was decided upon and resulted in the capture of the port Santi Quaranta (Aghioi Saranta) and the town of Gjinokaster (Argyrocastro) by Dec. 8, while on the rest of the front parallel advances were made in the course of heavy fighting through mountains. In the centre progress had been made in the Aoos valley and Premeti was captured. Additional attempts to reach Valona secured the port of Chimara on Dec. 28, but further offensive was brought to a standstill by heavy snow conditions. The strength of the forces engaged at the end of the year was as follows: Italians, 16 divisions; Greeks, 11 divisions, 2 infantry brigades and 1 cavalry division.

In Jan. 1941 the Greek command transferred the axis of attack to the centre sector. The offensive, initially successful, came to a halt by the end of the month after the capture of Boubessi but short of Tepelini, where it encountered many divisions freshly arrived from Italy. During February the Italians were still further reinforced and between March g and 25 launched a counteroffensive on a narrow front between Trebesina mountain, east of Tepelini and Boubessi, employing 12 divisions. This attack was stopped with heavy losses and no appreciable gain by six Greek divisions, while spasmodic fighting flared up all along the front. The forces engaged at the end of March were: Italian, 26 divisions; Greek, 14 divisions, 2 infantry brigades and 1 cavalry division.

The hard fighting, combined with bitter conditions prevailing in the Pindus mountains during the winter, had taken its toll of Greek manpower in casualties from battle and frostbite. Throughout the campaign, because of the lack of communications in the mountainous country, the maintenance of front-line troops imposed a great strain on all transport resources as well as on the troops themselves, who frequently had to resort to manhandling supplies.

The Italians were better situated in this respect, as the port of Valona and the communications radiating from it were not seriously disrupted. It was this background of conditions that the Greek command had to face when, at the end of March, the Germans were ready to strike from Bulgaria and the action of Yugoslavia was uncertain.

2. German Occupation of Rumania and **Bulgaria.**—During 1940 the occupation by the U.S.S.R. of the two Rumanian provinces of Bessarabia and Bukovina in June and the Italian attack on Greece on Oct. 28 disposed of any German intention of avoiding a commitment in the Balkans.

The joining of the axis by Rumania on Nov. 23, 1940, followed shortly by the infiltration into 'that country of German troops, secured the oil supply from the Ploesti fields and was a preliminary to the occupation of Bulgaria.

On March 1, 1941, Bulgaria joined the axis and the following day German troops commenced to cross the river Danube. In the occupation of Bulgaria the German forces found themselves in contact with two states, Yugoslavia on the west and Turkey to the southeast, whose attitude was so far undetermined. Forces therefore had to be detailed to cover these frontiers and had to be in sufficient strength to overawe the respective governments and prevent their taking action.

The German forces which entered Bulgaria consisted of 17 divisions (including 5 panzer), of which 8 were intended for the operations in Greek Thrace. Their deployment was completed within approximately a week of crossing the Danube, but the build-up of air forces and supplies necessitated a pause; the stage was thus set for carrying out the occupation of the northern Aegean coast line at the end of March.

3. German Conquest of Yugoslavia and Greece.—The attitude of the Bulgarian government to the German infiltration into Rumania, which was nearly completed by the end of Jan. 1941, left no doubt that the German armies would be granted a free passage through that country for an attack on either Turkey or Greece. The Greek armies at that time were heavily engaged in Albania, where 300,000 troops were deployed on the front between Lake Ohrid and the Adriatic.

To replace heavy casualties in the Albanian fighting, the Greek garrisons of the fortified line in eastern Macedonia, covering Salonika against an attack from Bulgaria, had been heavily drawn upon. Faced with the possibility of a German attack from this direction, the Greek government on Feb. 8, 1941, asked the British government what help could be afforded to it in case of such a development. As a result it was agreed that a British force would be sent to Greece to hold a position west of Salonika, which included the Aliakmon river and the Vermion range. This force mas to be augmented by the Greek garrison from Thrace and eastern Macedonia, considered strategically indefensible in view of the forces available. This plan envisaged Yugoslavia, whose attitude was in doubt, either acting as an ally or a strict neutral, to cover the northern flank. In face of the menace of a German attack from Bulgaria, the soundest strategical course would have been to withdraw the Greek armies on the Albanian front to a shorter line and thereby produce reserves which could be used as required for operations in northeast Greece. The Greek commander in chief, however, had to discard this plan in view of the disastrous effect it might have on the morale of the Greek soldiers.

The force for holding the Aliakmon-Vermion line was altered subsequently to three Greek divisions and seven independent battalions. The eastern Macedonia defenses were held by three divisions. On March 7 the first British contingent (1st armoured brigade group) began to arrive in Athens and moved to an area west of the river Vardar, where it completed its concentration by March 21.

Meanwhile, heavy pressure was being brought to bear by the Germans on the Yugoslav government to join the Tripartite pact which, after much vacillation, was signed in Berlin on March 25. The Yugoslavs considered this agreement an infringement of their sovereignty. On March 27 a coup d'état organized by Gen. Dushan Simovich expelled the regent and overthrew the government. A new government was formed in Belgrade, but a paralysis of indecision descended on it, and several days were lost while a state of uncertainty existed as to what courses should be adopted politically or strategically. Meanwhile, the German high command had ordered an attack on Yugoslavia to be ready in eight days. The Yugoslav armies were in a state of semimobilization, ill equipped and lacking in modern weapons, tanks, anti-tank and anti-aircraft guns.

On April 6 the axis attack started with heavy bombing attacks on Belgrade, while land operations took the form of thrusts inward from all round the perimeter. These thrusts were successful in dividing the Yugoslav army and eliminating it in detail. The German columns which moved through Stip were directed on Skoplje and Bitolj with the object of getting in touch with the left flank of the Italian armies in Albania and isolating the Yugoslav forces from Greece. The head of these columns reached Bitolj on April 8 and by April 9 had completed its task of cutting off the Yugoslav forces, which, by this time, were no longer capable of organized resistance. The inevitable result was that Yugoslavia passed under German domination on April 17, within 11 days of being attacked.

The German column moving via Strumica bypassed the Greek defenses in eastern Macedonia and erupted down the Vardar valley into the Salonika plain, where it came into contact with British troops on April g.

The collapse of Yugoslav resistance and the occupation of Bitolj by German forces threatened the Anglo-Greek army in process of occupying the Aliakmon-Vermion position, as any advance down the valley running from Bitolj to Kozani would take that position in flank and reverse, the terrain offering easy movement for armoured fighting vehicles except for a gap with poor facilities for defense near Florina.

The imperial forces had meanwhile been augmented by the arrival of the New Zealand division and two-thirds of the 6th Australian division, which enabled a hastily improvised flank guard to be collected and established to watch the Florina gap. This detachment was in position by April g and in touch with the 20th Greek division on the Vermion range on the right, and a Greek cavalry division with one Greek infantry brigade under command detached from the Albanian front on the left, about Nymphaion.

A heavy bombing attack by the German air force on Piraeus harbour on April 7 caused considerable dislocation to the working of the port, which never regained its former capacity. From April 8 to 11, air operations were on a small scale because of bad weather.

The collapse of resistance in Yugoslavia placed the Anglo-Greek army in a difficult situation. Its flank was threatened by a force of one armoured and one infantry division from the direction of Bitolj, while on its front a German corps was west of the river Vardar and in contact. The Aliakmon-Vermion position was held too lightly for its length of front to offer protracted defense, and it was doubtful how long the detachment guarding the Florina gap could hold on in face of the superior forces opposed to it. It was decided therefore to fall back to a line running from Mt. Olympus through Servia and then northward along the mountain ridge east of and parallel to the upper section of the Aliakmon river.

The German advance from Bitolj crossed the frontier on April 10 and became heavily engaged with the flank guard. A two-day battle was fought in a snowstorm in which the Germans were able to make some slight progress. While this fighting was taking place, the withdrawal from the Aliakmon-Vermion position started on the night of April 11–12 and was completed by the morning of April 13; the flank guard covered by the 1st British armoured brigade thereupon fell back on Kozani.

During these three days' operations, the forecast of General Papagos as to the effect a withdrawal would have on the morale of the Greek army became manifest. His divisions had not been trained to carry out such a complicated manoeuvre as a retreat, and signs of disintegration were beginning to appear. In consequence it was decided to withdraw all forces east of the upper Aliakmon river to its western bank.

Up to April 14, except for the heavy bombing of Kozani, the activity of the German air force was limited while the small British air force engaged German columns. With the improvement of weather conditions, the German air force came into operation again; and its attacks became continuous, widespread and intense, directed mainly on road and rail communications.

Though the Anglo-Greek army in central Macedonia still presented an intact front, the general situation was far from satisfactory. The weakness of the left of the Greek forces in the upper Aliakmon valley and the gap between the left of the Greek cavalry division and the armies in Albania were being exploited by the Germans and would shortly become a menace. To meet this situation it became necessary to withdraw all Allied armies to a shorter line in order to retain an intact front.

On April 14, General Papagos approved the further withdrawal of the Anglo-Greek army to a line through Thermopylae to which the armies in Albania would conform. He suggested at the same time that the British forces should withdraw from Greece to save the country from devastation.

On April 15, fighting developed in the Mt. Olympus area, in which Australian and New Zealand troops were engaged. The withdrawal commenced on April 17 and was largely carried out by night to avoid German air attacks. By April 20 the occupation of the new position was complete, with the New Zealanders holding the famous Thermopylae pass and the 6th Australian division the Brailos pass farther inland.

On April 18 Alexandros Korizis, who had succeeded Ioannis (John) Metaxas as prime minister, committed suicide, and King George II became acting head of the government. As a result of conferences following this crisis it was decided with the full approval of the Greek king and government that the evacuation of the imperial forces was essential, and the first night for embarkation was fixed for April 28. Events in Epirus, however, caused the evacuation to be advanced four days; on April 21 the German Adolf Hitler division had reached Ioannina (Janina) and the local commander, without reference to the high command in Athens, had ordered the capitulation of the whole of the Greek army in Epirus. The embarkation was set therefore to commence on the night of April 24–25 and to be completed in three nights. The port of Piraeus was unusable but still remained a target for German bombing. Nine embarkation points, consisting of small ports and open beaches, were selected on the coast line between Marathon to the north, east of Athens, and Kalamati in the south of the Peloponnesus.

The rearward movement to the beaches began on the night of April 22–23 and was carried out without interference until April 24, when a German attack in force with tanks along the coast on Thermopylae was repulsed by the 6th New Zealand infantry brigade.

The royal navy with the light forces of the Mediterranean fleet carried out the embarkation and transport of troops by sea. By using fast warships for the journey to and from Crete, rigidity in the plan could be avoided and embarkation points altered to suit the tactical situation on land. The movement by sea was subjected to continuous attacks by the German air force by day and cost the loss of some warships and transports. The destruction of the remaining British fighters on an airfield at Argos gave the Germans complete superiority at this time.

The evacuation was completed by April 28–29, but at Nauplion and Kalamati the Germans were successful in cutting off certain detachments which could not be embarked.

The number of British Commonwealth troops sent to Greece was approximately 57,660. Of these, 43,000 were taken off, but all equipment had to be jettisoned. Of those embarked, 27,000 were landed in Crete and the remainder transported to Egypt.

The inability of the Italian forces in Albania to achieve success over the Greeks, the Yugoslav coup d'état and the presence of British forces in central Macedonia forced the German high command to a commitment considerably in excess of its original concept. In all, 27 German field divisions (including 7 panzer divisions) became involved in the campaign against Greece and Yugoslavia, in terrain which precluded rapidity of movement, thereby causing difficulties when it came to extrication.

By April 21, information had reached Athens through Balkan railway sources that a comprehensive and carefully worked out railway movement of troops from southeast Bulgaria to Galicia had been dislocated by the diversion of these troops to the Greek and Yugoslav fronts. That such a concentration was contemplated could portend only that a German attack on the U.S.S.R. was imminent. It could be assessed that in the extrication of their divisions from the Balkans the German high command lost from four to five weeks before completing its preparations for the attack on Russia, which took place on June 22. This delay, if studied in conjunction with the German attempt to take Moscow before the end of 1941 and the advent of an early winter, played no inconsiderable part in the final outcome of World War II.

4. The Conquest of Crete.—The capture of Crete became necessary to the German high command after the occupation of Greece in order to secure sea communications in the Aegean and to provide fields for air action against the middle east and Mediterranean shipping routes. Crete, a mountainous island 160 mi. long by 40 mi. broad, offered poor facilities for defense against an attack from Greece since its one lateral road, harbours and airfields were all located along its northern shore. All Allied shipping therefore had to pass through the narrow waters between either Greece or Rhodes, held by axis forces.

The imperial garrison consisted of 28,000 troops, most of whom, having been evacuated from Greece, were short of equipment and supporting weapons. The defense was disposed along the northern coast to cover the airfields of Malemi and Rethymnon (Retimo), the port and harbour of Heraklion and the naval base at Suda bay. The German air force was in such superiority in attacking shipping and airfields that all British aircraft were withdrawn before the main operation. The main attack started with the heavy bombing of Malemi aerodrome in the northwest corner of the island at dawn on May 20 and was followed by parachutists and gliders. In the afternoon similar tactics were employed against Rethymnon and Heraklion. In all about 7,000 troops were landed during the day. Casualties were extremely heavy, and only at Malemi had the attack established itself. At night counterattacks by New Zealand troops were at first successful, but at dawn they were compelled to abandon ground because of heavy bombing.

During May 21–22, heavy fighting took place around Malemi aerodrome, while German forces were continually landing from troop carriers. This enabled a sufficient force to be built up at Malemi to advance toward the town of Canea (Khania).

During the nights May 21–22 and 22–23, German attempts to reinforce by sea, using a large number of small craft, were frustrated by the royal navy, which caused considerable casualties but at the same time suffered losses itself from bombing after daylight.

Heavy fighting continued through May 24–25, the German attacks on Canea continuing to make progress; at Heraklion two British battalions landed on the south coast, marched overland and eased the pressure. German detachments, however, isolated the Rethymnon garrison by cutting the road east and west of the airfield.

On May 27 the Germans succeeded in breaking through the Allied defenses covering Canea and thereby rendered Suda bay untenable. The continuous fighting and uninterrupted air bombing were beginning to exhaust the power of the defense with the result that on that day the decision was made to evacuate. The losses suffered by the royal navy from axis bombing made it imperative that the evacuation should take place in the shortest possible time, and it was decided that all should be completed by the night of May 31–June 1. The imperial forces in the Canea area, consisting of Australian and New Zealand brigades, British marines and commandos with tank and artillery units, withdrew over the mountains to the small port of Sphakia on the south coast, where embarkation started on the night of May 28–29 and was carried out without undue interference. At Heraklion the evacuation was completed on the night of May 28–29 from that port in warships, thereby avoiding a German attack which was in preparation. The isolated Australian and Greek garrison at Rethymnon, having received no orders to withdraw, continued fighting until May 31, when it was overwhelmed.

There were 27,550 imperial troops in action at the commencement of the attack; of these, 14,580 were evacuated. The German losses were estimated at between 12,000 and 15,000, which included a very high percentage of killed.

The German success was attributable to the manner in which a completely superior air force was handled in conjunction with air-borne troops. The defenders had many difficulties to contend with as most of the troops had been evacuated from Greece, having left behind their supporting arms, while communications on the island were limited to one road parallel to the north coast, connecting the two harbours. The German air-borne troops suffered such casualties that they could not be reconstituted before the autumn. It also had the effect that an operation on such a scale was never again attempted. (H. M. Wn.)

H. THE GERMAN-RUSSIAN WAR

The course of history was changed when Hitler invaded the U.S.S.R. on June 22, 1941, a day ahead of the anniversary of Napoleon's invasion. That move ultimately proved as fatal for him as it had for Napoleon. The effect was most immediate on Britain's situation. Until then its prospects had appeared hopeless in the eyes of most people except its own, for its situation was far worse under modern conditions of war than it had been in Napoleon's time. Its government's decision to continue the struggle after the fall of France and reject Hitler's peace offers could spell only slow suicide unless relief came from one or other of the two remaining great powers. Otherwise, even if a German sea-borne invasion failed, the concentrated development of submarine and air pressure on Britain's sea communications was bound to produce eventual collapse.

Hitler brought Britain relief by turning east, just as the strain was becoming severe. That eastward turn was influenced by Britain's stubborn resistance but had deeper promptings. He had always contemplated the overthrow of the Soviet Union. Though he had brought himself to make the 1939 pact as a matter of expediency, antibolshevism was his most profound emotional conviction. arising from fear even more than from ambition. It had been stirred up afresh before he even considered the question of invading Britain. For early in June 1940, while he was still engaged in the French campaign, Stalin had seized the opportunity to occupy the three Baltic states. Then on June 26, again without notice to Hitler, Russia addressed a 24-hr. ultimatum to Rumania demanding the restoration of Bessarabia, together with the surrender of northern Bukovina. The Russian forces poured in immediately, as Rumania yielded. That placed them ominously close to the oilfields on which Germany depended. Hitler became acutely suspicious of Stalin's intentions and began to feel that he could not afford to wait to complete the subjugation of the west before dealing with Russia.

A provisional plan for a stroke against Russia was worked out in the late summer of 1940 and elaborated in the autumn. The doubts of his generals merely served to give the new turn of his mind a more definite bent. Their doubts suggested that they still distrusted his military judgment; he must prove them wrong once again, and more strikingly. When they argued that it meant war on two fronts, he retorted that to overcome Britain would require an expansion of the air force and navy at the expense of the army, and that this could not be risked while Russia remained a menace. In that mood he did not share his diplomatists' moderate satisfaction over the result of the November discussions with Vyacheslav Molotov in Berlin, but only noted the Russians' hesitation to join the axis. On Dec. 18 he issued "Directive No. 21, Case Barbarossa." which opened with the statement: "The German armed forces must be prepared to crush soviet Russia in a quick campaign before the end of the war against England."

On Feb. 3, 1941, Hitler approved the final draft of the plan and had it presented to a conference of his chief soldiers. Their anxieties were not diminished by the balance sheet, which showed that the invasion would have to be made with an inferiority of numbers, in tanks as well as men, and must trust to an offsetting superiority of quality. That deficiency of strength became a handicap even before the offensive was launched. For Hitler was anxious to safeguard his Balkan flanks before striking at the U.S.S.R. and had hoped to secure this by power diplomacy alone, without fighting. That hope was impaired, to his annoyance, by Mussolini's independent aggression against Greece, which opened up the prospect of a British army's being landed there. This threat led Hitler to decide that he must overcome Greece and clear out the British before he could proceed with his eastern plan. But the effort entailed was much increased when Yugoslavia's adhesion to the axis was upset by a military coup d'etat in that country on March 27. Larger forces had now to be sent south to crush Yugoslavia simultaneously with Greece. Both nations were quickly overrun while the British were hustled back into their ships. But Hitler's decision, on April 1, to mount this double offensive had entailed the postponement of the Barbarossa plan from the middle of May to late June. By the swiftness of his Balkan victories he was able to keep to this revised timetable, but the five weeks' delay shortened the time for carrying out his attempt to conquer the U.S.S.R., and that delay proved the more serious because in 1941 the Russian winter arrived earlier than usual. But spring was late that year, so that the rivers were still in flood and the ground soft until nearly the middle of June. It would thus have been practically impossible for Hitler to have launched his invasion of the U.S.S.R. more than a week or so earlier than he did. A greater hindrance to his chances of victory was that the German intelligence service underestimated the reserves that Stalin could bring up from the depths of the U.S.S.R. It correctly estimated that there were about 150 divisions in western U.S.S.R. and reckoned that a further 50 might be produced. But the Russians actually brought up more than 200 fresh divisions by the middle of August, making a total of 360. The consequence was that although the Germans (who launched their invasion with 120 divisions only) succeeded in shattering the original Russian armies by superior technique, they then found their path blocked by fresh armies. The effects of the miscalculations were increased because much of August was wasted while Hitler and his chief advisers were having long arguments as to what course they should follow after the initial victories.

1. To the Outskirts of Moscow.—The German offensive was delivered on June 22, 1941, by three army groups under the same commanders as in the 1940 invasion of the west. Field Marshal Gerd von Rundstedt was on the right, in southern Poland. Field Marshal Fedor von Bock was in the centre, north of the Pripet marshes. Field Marshal Wilhelm von Leeb was on the left and drove through the Baltic states. But this time the main weight, and the decisive role, was committed to Bock's army group. Two armoured groups (later rechristened "armies"), under Gen. Heinz Guderian and Gen. Hermann Hoth, were allotted to Bock's front, compared with only one, under Kleist, to Rundstedt's front. Once again the issue turned, not on the infantry masses, but on the armoured forces. These had now been increased from 10 divisions to 20, but only by halving the number of tanks in each division.

The invasion profited at the start from the way the Russian position in Poland formed two salients, which lent themselves to pincer strokes. The German command hoped, by these means, to wipe out the Russian armies before reaching the Dnieper, and then have a clear path. The northern salient was quickly pinched off by Guderian and Hoth. Piercing its Brest-Litovsk (Brzesc) flank, Guderian drove 50 mi. deep on the first day, and on June 27 reached Minsk (200 mi. inside the frontier), where he joined hands with Hoth. But Bock's infantry armies, following on, were not quick enough to complete the encirclement. About 300.000 prisoners were taken, but a large part of the enveloped Russian armies forced their way out of the trap. Although these were clumsily handled and frittered their tank strength away in piecemeal action like that of the French in 1940, the isolated troops fought with a stubbornness that the French had not shown, and their resistance imposed a brake by the way it continued to block road centres long after the German tide had swept on.

The German armoured groups now drove on eastward. Guderian crossed the Dnieper on July 10 and reached Smolensk on July 16. There another big encirclement was achieved, in conjunction with Hoth. But the ring was not completely closed, as the foot-marching infantry was still far behind. Although a further 200,000 Russians were captured, a sufficient number escaped to help the newly arriving reserves from the east in building up a fresh resistance along the Desna.

In this latest German hound a series of rainstorms also came to the aid of the Russians, turning the sandy roads into clogging mud. Even when the tanks could have pushed on they were held back because their transport—composed of heavy, wheeled vehicles—was bogged. The Germans had owed their success to the measure in which they were mechanized, but from now on they paid forfeit for not being fully mechanized. If their striking force had been equipped entirely with tracked vehicles they would have suffered fewer checks from the combination of bad weather and the Soviet Union's primitive roads.

Nevertheless the Germans had advanced more than 400 mi., and come within 200 mi. of Moscow, by mid-July. They still had ample time to gain a decisive result before the winter, but lost it primarily because Hitler wasted several weeks in making up his mind about the direction of the next move. He hesitated whether to swing north for Leningrad, south for Kiev or to drive on to Moscow, as Bock and Guderian wished. Brauchitsch was not strong enough to impose a clear-cut decision on Hitler.

Meanwhile, Rundstedt's army group had been driving forward through southern Poland with little difficulty despite the greater strength of the Russian armies there. These mere thrown off their balance by the invasion and fell back eastward in confusion. In the next phase, Rundstedt's advance was delayed by flank counter-attacks from the Pripet marshes. But at the end of July, Kleist's tanks broke through Gen. (later Marshal) S. M. Budenny's front south of Kiev and made a scythelike sweep down through the Ukraine toward the Black sea. The mouths of the Bug and the Dnieper were reached by mid-August, trapping a large part of the southern Russian armies which were opposing the advance from Rumania. Hitler now decided to shift his centre of gravity and carry out another great encircling manoeuvre near the junction of Bock's and Rundstedt's army groups. Kleist was ordered to wheel northward again, and Guderian southward, to close the pincers behind the Russian armies assembled around Kiev. This trap succeeded, and 600,000 prisoners were taken. But it was late in September before the victory was completed, and winter was approaching.

Elated by this great success, Hitler decided to resume the advance on Moscow, while Kleist was again sent south, to form the spearhead of a continued advance southeastward by Rundstedt, from the Dnieper to the Don, on the road to the Caucasus. Leeb's advance through the Baltic states had reached the outskirts of Leningrad, but Hitler cancelled the intended assault, fearing to become entangled in city fighting. Rightly, he deemed it wiser to rely on the German superiority of manoeuvre in the open, but he had lost the best two months of the summer, when the open country was good going. He also handicapped his chances by splitting his effort in divergent directions.

The renewed advance on Moscow began on Oct. 2. Its prospects looked bright when Bock's armies brought off a great encirclement round Vyazma, where an additional 600.000 Russians mere captured. That left the Germans momentarily with an almost clear path to Moscow. But the Vyazma battle had not been completed until the end of October; the German troops were tired, the country became a morass as the weather got worse, and fresh Russian forces appeared in the path as they plodded slowly forward. Some of the German generals wanted to break off the offensive and take up a suitable winter line. But Bock wanted to press on, believing that the Russians were on the verge of collapse, while Brauchitsch and Halder tended to agree with his view. As that also accorded with Hitler's desire, he made no objection. The temptation of Moscow, now so close in front of their eyes, was greater than any of the topmost leaders could resist. On Dec. 2 a further effort was launched, and some detachments penetrated into the suburbs of Moscow; but the advance as a whole was held up in the forests covering the capital.

2. Russian Winter Counteroffensive.—This was the signal for a Russian counteroffensive of large scale, prepared and directed by Gen. (later Marshal) G. K. Zhukov. It tumbled back the exhausted Germans, lapped round their flanks and produced a critical situation. From generals downward. the invaders mere filled with ghastly thoughts of Napoleon's retreat from Moscow. In that emergency Hitler forbade any retreat beyond the shortest possible local withdrawals. His decision exposed his trcops to awful sufferings in their advanced positions facing Moscow, for they had neither the clothing nor equipment for a Russian winter campaign; but if they had once started a general retreat it might easily have degenerated into a panic-stricken rout.

In the south, Kleist's drive had reached Rostov. near the mouth of the Don, on Nov. 23; but it had exhausted its fuel in plowing through the mud. The glamour of attaining this "gateway to the Caucasus" impelled Hitler to insist on staying there, although Rundstedt tendered his resignation rather than commit such a folly. Within a week the Germans were thrown back by a Russian counterstroke there. For a moment their situation looked grave, but they managed to hold on to the defensive line of the Mius river, which Rundstedt had chosen before his removal.

The soviet army's winter counteroffensive continued for more than three months after its December launching, though with diminishing progress. By March 1942 it had advanced more than 150 mi. in some sectors. But the Germans maintained their hold on the main bastions of their winter front—such towns as Schlüsselburg, Novgorod, Rzhev, Vyazma, Briansk, Orel. Kursk, Kharkov and Taganrog—despite the fact that the Russians were often many miles in the rear. In retrospect, it became clear that Hitler's veto on any extensive withdrawal worked out in such a way as to restore the confidence of the German troops and probably saved them from a widespread collapse. Nevertheless, they paid a heavy price indirectly for that rigid defense. Its success encouraged the belief that it could be as successfully repeated in the more adverse conditions of the following winters. A more immediate handicap was that the strength of the *Luftwaffe* was drained in the prolonged effort to maintain supplies by air, under winter conditions, to the garrisons of these more or less isolated bastion towns. The tremendous strain of that winter campaign, on an army that had not been prepared for it, had also a serious delayed effect in other ways. Before the winter ended, many divisions were reduced to barely a third of their original strength. They were never fully built up again. The unfavourable aspects of the situation were realized by the German general staff, but its heads now had less power to influence Hitler's decision. Hitler's pressure was too strong for them to resist, and the pressure of events was too strong for Hitler. He was compelled to go on and on. The weight of military opposition was weakened by the changes in the higher commands which followed the miscarriage of the 1941 campaign. When the failure of the whole campaign was plain to the world. the removal of Brauchitsch was announced. That act served the dual purpose of furnishing Hitler with a scapegoat and opening the way for him to take over direct command of the army.

3. German Advance to the Caucasus.—The plan to launch another great offensive crystallized in the early months of 1942. Hitler's decision was influenced by pressure from his economists. They told him that Germany could not continue the war unless it obtained oil supplies from the Caucasus, a view that was proved mistaken by the fact that Germany failed to secure the Caucasus oil yet managed to continue the war for three more years. But Hitler was the more responsive to such economic arguments because they coincided with his urge to do something positive and offensive. He was led, however, to recognize the limitation of Germany's resources to the extent of admitting the necessity of limiting the scope of his new offensive. The main effort was to be made on the southern flank near the Black sea.

The most effective factor in clearing the path for the German advance mas a Russian offensive toward Kharkov. which began on May 12. This was a premature effort, beyond the powers of the soviet army at this stage in face of the Germans' defensive skill. The prolongation of this Kharkov offensive played into the Germans' hands, absorbing too large a part of the Russians' reserves. Moreover, although the Russians succeeded in parrying the immediate counterstroke which the Germans launched against the southern flank, this gained a valuable leverage for the future by reaching the Donetz river near Izyum. On June 3, preliminary to the main offensive, a siege assault was launched against the fortress of Sevastopol though it was not until July 3 that the fortress, and with it the whole Crimea, was completely in German hands. On June 10 the Germans exploited their Izyum wedge by forcing the passage of the Donetz and gaining a bridgehead on the north bank. This created an invaluable flanking leverage to assist the easterly thrust of their main offensive, which was launched on Tune 28.

The 4th panzer army broke through in the sector between Rursk and Byelgorod and swept rapidly across the 100-mi. stretch of plain to the Don near Voronezh. It then wheeled southeastward into the corridor between the Don and the Donetz, followed by the 6th army, which had the mission of taking Stalingrad. These operations tended to cloak the menace that was developing on the right wing. For a more dangerous thrust was being delivered'by Kleist's 1st panzer army from the Kharkov sector. After achieving a quick break-through, it drove toward the lower Don at and above Rostov. There it gained a crossing, with little opposition, on July 22, after an advance of about 250 mi. from the starting line. The German armies now forked on divergent courses: part for the Caucasus oil fields, and part for the Volga at Stalingrad. After crossing the lower Don, Kleist's right column drove southward through Armavir to the great oil centre of Maikop, zoo mi. beyond Rostov, which it reached on Aug. 9. On the same day the van of his centre column swept into Pyatigorsk, 150 mi. to the east of Maikop, on the outskirts of the Caucasus mountains.

The pace of this early August onrush beyond the Don was terrific. But it slowed down almost as suddenly as it had developed. The prime causes were a shortage of fuel and an abundance of mountains. That dual brake was subsequently reinforced by the distant effect of the struggle for Stalingrad, which drained off a large part of the forces that might have been used to give a decisive impetus to the Caucasus advance. The first serious check occurred on reaching the Terek river, which covered the approaches to the mountain road over to Tiflis. Kleist then tried a manoeuvre to the east, downstream, and succeeded in forcing a passage near Mozdok in the first week of September. But his forces were held up again in the densely wooded hills beyond the Terek. Throughout September and October, Kleist went on trying to push south from Mozdok, by surprise attacks at different points. At each attempt he was blocked. The front was then stabilized, with the Germans still facing the mountain barrier which they had vainly tried to pierce. This final repulse in the central Caucasus coincided with the opening of the great Russian counteroffensive at Stalingrad.

4. Turning Point at **Stalingrad.**—The German command might have captured Stalingrad with little difficulty at the end of July if it had not overestimated the capacity of the Russians to hold Rostov and the lower Don. For the 4th panzer army was temporarily diverted southward to help the 1st, which, in fact, needed no such help. When the postponed thrust to Stalingrad developed a fortnight later, the Russians had gathered just sufficient forces to check the advance. Another fortnight passed before their resistance was loosened by the advance of the German 6th army, under Gen. (later Field Marshal) Friedrich Paulus, eastward across the Don bend. The last week of August had thus arrived before the Germans were ready to begin the final stage. The tenseness of the situation was manifested in the tone of the call to the Russian troops to hold on at all costs to the last man. They responded to the call with wonderful endurance. Attack followed attack in seemingly endless succession, with frequent changes of site and method, but with only slight progress to compensate for the attackers' cost. The more closely the Germans converged on the city, the more their own power of manoeuvre became cramped, whereas the narrowing of the frontage helped the defender in moving his reserves more quickly to a threatened point on the diminished arc. At the same time, the Germans' concentration at Stalingrad increasingly drained reserves from their flank cover, which itself was already strained by having to stretch so far, nearly 400 mi. from Voronezh along the Don to the Stalingrad "isthmus," and as far again from there to the Terek.

On the surface, the defenders' position came to appear increasingly perilous, or even desperate, as the circle contracted and the Germans came closer to the heart of the city. The most critical moment was on Oct. 14. The defenders now had their backs so close to the Volga that they had little room left in which to practice shock-absorbing tactics. But beneath the surface fundamental factors were working in their favour. The attackers' morale was being sapped by heavy losses, a growing sense of frustration, and the coming of winter, while their reserves were so fully absorbed as to leave the overstretched flanks without resiliency. They were thus becoming ripe for the counterstroke which the Russian command was preparing. It was launched on Nov. 19 and was well timed. It started in the interval between the first strong frosts, which hardened the ground for rapid movement, and the heavy snows, which clogged manoeuvre. A pair of pincers, each composed of several prongs, was inserted in the flanks of the Stalingrad attack, so as to isolate the 6th army and 4th panzer army. The pincers were driven in at places where the flank cover was largely provided by Rumanian troops. The plan was devised by a brilliant triumvirate of the Russian general staff, Zhukov, Gen. (later Marshal) Alexander M. Vasilevsky and Gen. (later Marshal) Nikolai N. Voronov. By Nov. 23 the encirclement was completed. It was welded more firmly in the days that followed, enclosing about 250,000 Germans.

Meanwhile, another powerful Russian force had burst out of the Serafimovichi bridgehead and spread over the country west of the Don bend. This outer-circle movement was of vital importance, for it dropped an iron curtain across the more direct routes by which the relieving forces might have come to the aid of Paulus. Thus, the German reply, in mid-December, was delivered from the southwest, beyond the Don, up the line from Kotelnikovo to Stalingrad. But this hastily improvised advance was checked a long way short of the beleaguered army and then gradually forced back by Russian pressure on its own flank. With the frustration of this attempt any hope of relieving Paulus passed, for the German command had no reserves for another attempt.

Hitler was at last brought to realize the inevitability of a disaster greater even than the Stalingrad encirclement if he persisted in his dream of conquering the Caucasus and compelled the armies there to cling on while their flank was exposed for 600 mi. back. So, early in Jan. 1943, the order was sent that they were to retreat. The decision was taken just in time for them to escape being cut off. Their successful extrication prolonged the war, but it preceded the actual surrender of the Stalingrad armies in making clear to the world that the German tide was on the ebb. Paulus' army at Stalingrad surrendered on Feb. 2, 1943, at the same time as Kleist's army from the Caucasus recrossed the Don at Rostov. The latter could hardly have escaped if Paulus' army had yielded any time during the first seven weeks after its encirclement. Its sacrifice detained Russian forces that could otherwise have poured down upon Kleist's line of retreat and swamped the improvised army group under Field Marshal Erich von Manstein which was covering Kleist's rear. Even as it was, those two held off the Russians' outflanking pressure by the narrowest of margins. In terms of time, space, force and weather conditions that Xenophonlike retreat was an amazing performance.

5. Russian Reconquest of the Ukraine.— After Kleist's army had passed safely through the Rostov bottleneck, it had still to ward off dangers that were developing farther back on its line of retreat. In the last half of Jan. 1943 Gen. Nikolai F. Vatutin's armies had struck southward from the middle Don to the Donetz. At the same time Gen. Filip I. Golikov's armies, farther west, broke through the front of the Hungarian 2nd army, and within a week drove forward 100 mi., halfway from the Don to Kharkov. Before the end of the month the Russians struck westward from Voronezh, across the upper Don, and advanced on Kursk, the starting point of the last German summer offensive, which they captured on Feb. 7. Two days earlier Vatutin's troops had crossed the Donetz southward at Izyum and then spread westward to capture Lozovaya junction on Feb. 11. Besides undercutting the German position at Kharkov, which fell into the Russians' hands on Feb. 16, these advances came near to intercepting the armies of Manstein and Kleist. Their retreat became a race, with the odds against them.

But a dramatic change came over the scene in the last half of February. An early thaw intervened to hamper the Russians in bringing up supplies and reinforcements to maintain their momentum. Thus, the retreating armies gained time to get back to the Dnieper, with the help of the better communications in the coastal strip, and mount a counteroffensive just as the Russian advance had lost its impetus. This counteroffensive, directed by Manstein, snapped off the Russian wedges southwest of Kharkov and recovered the line of the Donetz. If the Germans could have crossed the river quickly and cut astride the rear of the soviet armies that were pushing westward, they might have produced a Russian disaster comparable to their own at Stalingrad. But they were baulked in the attempt, lacking the strength to storm such a barrier. Although they squeezed the Russians out of Kharkov, their own drive petered out in the slush of the spring thaw.

Further evidence of their shrinking strength was seen in the withdrawal they were now compelled to carry out in the north. Gen. Kurt Zeitzler, who had succeeded Gen. Franz Halder as chief of the general staff, persuaded Hitler that it was no longer possible to maintain their advanced position facing Moscow. So in March the Germans abandoned their salients there and fell back to a straighter line close to Smolensk. What the Germans gained by this shortening of their front was, however, more than offset by the fresh extension caused by the success of their counteroffensive in the south. Although its results had been limited, it had secured a promising set of offensive springboards that looked all too tempting to a leader who clung to the hope that an of-. fensive success in summer might still turn the war in his favour. By recapturing Byelgorod and retaining Orel the Germans had suitable flank positions for a pincer stroke against the big salient in which the Russians were left around Kursk.

Following this line of thought, Hitler concentrated all efforts on that offensive without regard to the risk that the cost of an unsuccessful attack would leave him without reserves to maintain any subsequent defense of his long front. He would not agree to Manstein's suggestion of letting the Russians advance first and then delivering a riposte from the flank. At the same time, Zeitzler tended to encourage Hitler's hopes of another brilliant success. But the increasing difficulty in building up the forces, with fresh drafts of men and equipment, was reflected in the increased delay that year in opening the summer offensive. Three months' pause followed the close of the winter campaign.

By contrast, the soviet army had improved much since 1942, both in quality and quantity. The flow of new equipment had greatly increased as well as the number of new divisions, and its numerical superiority was now about four to one. Better still, its leadership had improved with experience. Generals and junior commanders alike had become more skilled tacticians. That was foreshadowed in the way the Russians, in the summer of 1943, waited to let the Germans lead off and commit themselves deeply, while they themselves kept well poised to exploit the Germans' loss of balance in lunging.

The German offensive was at last launched on July 5, and into it Hitler threw 17 armoured divisions, almost all he had. The pincers got entangled in the deep mine fields which the Russians had laid, forewarned by the long preparation of the offensive, and failed to secure any large bag of prisoners since the Russians had withdrawn their main forces out of reach. After a week of effort the German armoured divisions were seriously reduced.

On July 12, as the Germans began to pull out, the Russians launched their own offensive, which thus had the recoil-spring effect of a counterstroke. The Germans just managed to check the northern thrust from cutting their communications behind Orel, and they were not squeezed out of that city until Aug. 5. The southern thrust began more gradually but then quickened into a deep drive past Byelgorod. The danger of a general collapse was narrowly averted by the arrival from the south of the Germans' one remaining armoured corps, though Kharkov had to be abandoned. In the second half of August the Russian offensive was more widely extended; and though it did not make headway very fast, its alternating strokes kept the scanty German reserves scurrying from sector to sector.

In September the shrinkage of German reserves was reflected in an acceleration of the Russians' advance. Skilful commanders like Vatutin, Gen. (later Marshal) Ivan S. Koniev and Gen. (later Marshal) Konstantin K. Rokossovski were quick to exploit thin stretches of the broad front. Before the end of the month they had reached the Dnieper and established a wide range of bridgeheads beyond it. While attention was focussed by Vatutin's threat to the famous city of Kiev, Koniev burst out of his bridgehead at Kremenchug and went halfway to severing the great bulge formed by the Dnieper bend. Although Manstein rushed reserves there in time to stem the advance and extricate the imperilled garrisons, it was at the price of a breakdown between the Dnieper bend and the sea. The Russians' fresh stroke there reached the mouth of the Dnieper early in November, closing the exits from the Crimea and isolating the German forces there.

At the same moment Vatutin advanced from his bridgeheads near Kiev, broke into the city from the rear and drove 100 mi. westward in a week to capture the junctions of Zhitomir and Korosten, not far from the Polish frontier. Manstein was left without reserves to meet this crisis, but ordered one of his best young generals, Hasso von Manteuffel, to scrape together such armoured fragments as he could find for a flank counterattack. This light stroke profited by the Russians' overstretch and tumbled them out of both junctions. Manstein tried to develop the opportunity by organizing a larger counteroffensive when reinforcements arrived from the west; but although it pushed the Russians back toward Kiev it was never so dangerous as it appeared on the surface, and early in December it petered out in the mud.

Hitler's chief consolation that autumn was that his northern armies, after falling back from Smolensk in September to a line covering the upper Dnieper, succeeded in repelling five successive Russian offensives between October and December. The assaults there were mainly delivered astride the Moscow-Minsk highway. As they came along an obvious line and on a narrow front, the well-knit defense proved superior despite a numerical inferiority of about one to six. It showed how Hitler might have spun out the war if his strategy had been wiser and less self-exhausting.

6. Russians Enter Poland and Rumania. — The dominant factor in the campaign of 1944 was that the German front remained as wide as ever, while the German forces were shrinking. As a natural result the Russian advance continued with little check except from its own supply problem; and, because of the Russians' simpler requirements, that problem was less of a handicap than in any other great national army. On Dec. 24, 1943, Vatutin's armies, now reinforced, burst out of the Kiev salient and within a week had regained Zhitomir and Korosten. On Jan. 4 they crossed the prewar Polish frontier. Scraping up reserves, Manstein produced another inner flank counterstroke that checked Vatutin's progress, but only at the price of thinning the line both north and south. The Russians soon profited by the opportunity. On the north, they drove forward and captured Luck, 100 mi. beyond the frontier, by Feb. 5. On the south, Vatutin's left wing converged with Koniev's right wing to pinch off a force of ten weak German divisions that was still clinging, by Hitler's order, to the Dnieper line near Korsun. This produced a miniature Stalingrad. The effort to bring help to this trapped force entailed, in turn, the abandonment of Nikopol, in the Dnieper bend, and its valuable manganese ore.

Early in March 1944 the Russians started a new combined manoeuvre of still wider scope. It began with a thrust toward Tarnopol that outflanked the defensive line of the upper Bug. This was delivered by Zhukov, who had taken charge of Vatutin's armies when the latter was stricken with a fatal illness. Meanwhile, at the southern end of the front, Gen. (later Marshal) Rodion Y. Malinovski's armies pushed forward across the mouths of the Dnieper and the Bug. Between these two horns, Koniev drove suddenly forward to the central stretch of the Bug, crossed it, drove on to the Dniester 70 mi. beyond and crossed this difficult river by seizing pontoon bridges intact in the confusion caused by his swift onrush.

Before the end of March, Koniev's spearheads had penetrated to the line of the Pruth near Jassy, in Rumania, while Zhukov had crossed the upper reaches of that river. This advance brought them close to the foothills of the Carpathians, the ramparts of Hungary. Hitler promptly reacted to the danger by occupying Hungary. The preservation of this mountain barrier was essential, not only to check a Russian surge into the plains of central Europe but also to ensure any continued hold on the Balkans.

On April 1 Zhukov's advance reached the entrance to the Tartar pass, and it looked as if he might repeat Sabutai's exploit of 1241, when the Mongols swept through the Hungarian plain to the Danube in a few days. But his spearhead failed to penetrate the pass, and there was not sufficient weight behind it to renew the impetus. His forces were feeling the effects of their prolonged advance, while the Germans benefited by falling back on their supply lines. The following week they succeeded in mounting a flank counterstroke from the Lwow area that broke off the tip of Zhukov's spearhead and enabled them to extricate a part of their forces which had been trapped by the Russians' rapid advance. After this the front in southern Poland was stabilized from April to July. Koniev, also, was halted in his effort to penetrate the northern stretch of the Rumanian frontier. But his left wing wheeled south down the Dniester, toward the Black sea, thus threatening the rear of the German forces that were facing Malinovski's advance toward Odessa. This leverage squeezed the Germans out of that great port, which was regained by the Russians on April 10.

April also saw the liberation of the Crimea, to which Hitler had insisted on clinging. Gen. (later Marshal) F. I. Tolbukhin attacked southward, from the mainland, and unhinged the defenses of the Perekop isthmus by a crossing of the Siwash lagoon. Then Gen. A. I. Yeremenko struck westward from his foothold on the Kerch peninsula. The Germans were thrown into confusion, and most of the Crimea forces were quickly overrun, up to the outskirts of Sevastopol. Hitler still believed that the fortress itself could be maintained, though he let the Rumanians be evacuated by sea and relied on the stubbornness of the German garrison. But when the Russians breached the southeast approaches, between Inkerman and Balaklava, the garrison abandoned Sevastopol on April 10 and fell back into the Khersonese peninsula. The Germans' resistance there, with their backs to the sea, was as brief as on the Cape Bon peninsula in Tunisia the year before.

On the other flank of the eastern front, a January offensive broke the Germans' encircling grip on Leningrad. There, however, they achieved an orderly withdrawal, at the end of which they stood fast on the line of lakes from the Gulf of Finland to Pskov. This straightening and shortening of their front much improved their situation for the moment. But it left the Finns in isolation and prompted them to approach the Russians for an armistice in February. Although the Finns baulked at accepting the Russian conditions and did so again after the renewed negotiations that followed a Russian advance to Viipuri in June, it was only a postponed capitulation. Moreover, Finland's attempted breakaway set an example that Germany's other satellites soon followed. The general stabilization of the eastern front that the Germans apparently achieved in May 1944 was unstable, both politically and militarily, under the surface.

7. The Russians on the Vistula.—The Russians' main summer offensive was launched two and a half weeks after the Anglo-U.S. invasion of Normandy. Contrary to general expectation, the offensive began, not from the Russians' great wedge in southern Poland, but from their relatively backward line north of the Pripet marshes, in White Russia. This was the best-fortified sector of the German front and had withstood repeated assaults in 1943; but for that very reason it was less likely to be reinforced, now that the German reserves were so scanty. Moreover, the German communications there were long stretched and suffered much interference from the Russian partisans, whereas the Russian communications were shorter there than in the south, so that their offensive could have greater momentum. Four groups of armies were massed there for the Russian offensive. Realizing the danger, the German commanders wanted to carry out a withdrawal before the blow fell, to the line of the Berezina, which would have thrown the Russian advance out of gear; but Hitler forbade it.

The offensive opened on June 23, 1944. Exploiting wedges driven in the previous autumn, the right wing began by pinching out the famous bastion town of Vitebsk and then swung south across the highway from Moscow to Minsk. On the other flank Rokossovski's armies broke through just north of the Pripet marshes and then drove 150 mi. deep. in a week, to cut the highway farther back on the stretch from Minsk to Warsaw. Minsk itself fell on July 3. Although a large part of the enveloped armies managed to find a way back by secondary routes, the Russian mechanized spearheads raced ahead, bypassing any attempted blocks. By mid-July they had overrun half of northeast Poland and pressed deep into Lithuania.

On July 14 the Russian armies south of the Pripet marshes joined in the offensive, and within a fortnight were across the San, besides capturing Lwow. This multiple pressure at so many points gave Rokossovski's mobile columns an opening to slip through the centre, past the end of the marshes, and reach the Vistula. On July 31 one of them penetrated to the suburbs of Warsaw, and the Polish underground leaders there were encouraged to give the signal for a rising.

It was a moment of general crisis for the Germans. In the west their front in Normandy was collapsing, while their rear was shaken by the repercussions of the plot to kill Hitler and the purge that followed. But an astonishing rally came in August, beginning at Warsaw. Three SS armoured divisions arrived at the crucial moment and delivered a counterstroke which threw back the Russian advanced forces. This gave the Germans a breathing space in which to suppress the Polish rising. But the change was not confined to that sector, for by the end of the first week of August the Russians were held up almost everywhere. They had advanced up to 450 mi. in five weeks—the longest and fastest advance they had yet achieved. They were now suffering the natural effect of overstretching their communications and had to bow to that strategic law. Six months were to pass on the Vistula before they were ready to mount a fresh drive.

8. The Hungarian Plain Reached.—The reprieve which Hitler obtained on the main front, however, was offset by the advent of a fresh menace on his Balkan flank. On Aug. 20, 1944, Malinovski and Tolbukhin launched a converging attack on the German salient that still projected into Bessarabia. Aug. 23 saw a change of government in Rumania, which thereupon made peace and simultaneously changed sides as a sequel to negotiations that had been proceeding for some time. With their passage thus cleared, the Russians pushed through the mountain barrier into Transylvania and, more quickly, up the Danube valley to the Yugoslav frontier. At the same time they occupied Bulgaria, where they met no resistance.

The autumn of 1944 saw the gradual development of a great wheel, by the Russian left wing, through the vast spaces of southeastern and central Europe. All that the Germans could do was to put a brake on it, by holding the successive communication centres as long as possible, and gain time to extricate their forces from Greece and Yugoslavia. Belgrade was liberated on Oct. 20. Meanwhile, the inner flank of the wheel had reached the edge of the Hungarian plain. From there the Russians made a strong spurt, which reached the suburbs of Budapest on Nov. 4. But, like other cities that had been stubbornly defended, Budapest proved a hard nut to crack. It was still unconquered at the end of the year, though by then deeply enveloped, and did not fall until Feb. 13, 1945.

The autumn of 1944 also saw a similar flank-sweeping process at the northern end of the eastern front. Finland capitulated early in September, and the Russians then concentrated on clearing the Baltic states and, if possible, cutting off the German army group which still clung there. Although it managed to evade several dangerous scythe strokes, the remains of it were cornered, by mid-October, in the Courland peninsula. The Russians then tried to break into East Prussia, but their attacks there were repelled and deadlock ensued.

The year 1944 had seen a tremendous shrinkage in Germany's Lebensraum. Yet it had avoided the total collapse that seemed almost certain at the end of the summer. Its subsequent rally—in the east and in the west and the centre of Europe—was proof of the combined effect of its contracted defensive front and the attackers' extended communications. It also showed how the Allies' demand for unconditional surrender had helped Hitler to stiffen the Germans' resistance. That might have continued longer, gaining time for the development of his new weapons, if he had planned a strategy of elastic defense instead of insisting on the rigid defense of untenable positions.

9. From the Vistula to the **Oder.**—The year 1945 opened

with a German counteroffensive to relieve Budapest. This did not succeed in its local aim, and it was made with armoured divisions that had formed the main reserve available to meet a renewed Russian offensive in Poland. Yet Hitler, while dictating this abortive effort in Hungary, would not permit any withdrawal from the Vistula line, to forestall the expected Russian offensive there. He thus, in a double way, played into the hands of Stalin.

After nearly six months' interval for preparation, the Russians had built up their communications in Poland and assembled abundant resources for a long drive. Besides a numerical superiority of nearly five to one, they had greatly increased the output of their new heavy Stalin tanks, while the inflowing stream of U.S. trucks enabled them to motorize many more of their infantry brigades. to back up the armoured thrust.

The offensive was initiated on Jan. 12, 1945, by Koniev's three armies, from the Baranow bridgehead. A breach was soon made, and armoured corps poured through it, some driving westward, while others threatened the rear of the Germans who were facing Zhukov. On Jan. 14 both Zhukov and Rokossovski joined in the offensive, and the breach became zoo mi. wide. Warsaw was isolated and fell on Jan. 17, by which time Zhukov's spearheads were close to Lodz. Two days later Koniev's spearheads crossed Germany's Silesian frontier besides driving into Cracow, while Rokossovski reached the southern frontier of East Prussia. Too late, Hitler allowed German divisions to be rushed north from Slovakia; they were too few to fill such an immense gap.

Rokossovski entered East Prussia by the same route, toward Tannenberg, that Gen. Alexander Samsonov had taken with fatal results in 1914, but Tannenberg was to be reversed this time, for Rokossovski swept on past that battlefield and reached the Baltic on Jan. 26, thus isolating all the German forces east of Danzig. Meanwhile, Koniev had already reached the Oder, isolating the industrial area of Upper Silesia.

Between these two far-stretched wings, Zhukov's armoured columns drove through the corridor between the Vistula and the Warta, bypassed the great fortified communication centres of Torun and Poznan, which were thus surrounded by the motorized forces following on, and on Jan. 30 crossed the Brandenburg frontier, 220 mi. from Warsaw and barely 100 from Berlin. Next day one of his spearheads reached the lower Oder near Kiistrin, only 40 mi. from Berlin.

10. Fall of Berlin.—But the advance had gone so far and so fast that it no longer had the momentum needed to overcome the defense of this great river, which was aided by a sudden thaw. Although Zhukov gained footholds near Kiistrin and Frankfurt in the following week, his advanced forces lacked sufficient weight to burst out. Koniev then sought to develop a flanking leverage by a push down the west bank of the Oder from Breslau, but his forces in turn were held up on the Neisse, which there provided the Germans with a convenient switch line. The Germans were much helped at this stage by the fact that their front had been forcibly contracted to only a fraction of its former extent. That contraction went far to balance their losses for the moment, giving their defense a better proportion of force to space than it had enjoyed since the tide of the war had turned and thrown them on the defensive. Although the Russians were baulked, it was the menace of their imminent approach to Berlin that led Hitler to decide that most of his fresh drafts must be sent to reinforce the Oder, whatever the risk to the defense of the Rhine. The way was thus eased for the passage of the Rhine by the U.S. and British armies.

Early in March 1945 Zhukov enlarged his bridgehead over the Oder but did not succeed in breaking out. Russian progress on the far flanks continued, and Vienna was entered early in April. Meanwhile, the German front in the west had collapsed, and the Allied armies there were driving eastward from the Rhine with little opposition. They reached the Elbe, 60 mi. from Berlin, on April 11. There they halted. On April 16 Zhukov resumed the offensive, in conjunction with Koniev, who forced the crossings of the Neisse. This time the Russians burst out of their bridgeheads and within a week were driving into the suburbs of Berlin, where Hitler chose to remain for the final battle. By April 25 the city had been completely isolated by the encircling armies of Zhukov and Koniev, and Koniev's forces joined hands with the American forces on the Elbe river. But in Berlin itself desperate street-by-street resistance was put up by the Germans and mas not completely overcome until the war itself ended, after Hitler's suicide, with Germany's unconditional surrender.

(B. H. L. H.)

I. THE NORTH AFRICAN CAMPAIGN, NOV. 1942–MAY 1943

From the summer of 1941 to June 1942 the tide of war set most strongly against the Allies. Japan's rapid expansion of its initial successes had brought it to the shores of Australia and to the eastern frontier of India. Sinkings of Allied shipping were mounting alarmingly in number. The U.S.S.R., having borne the full brunt of terrific German onslaughts during the summer and autumn of 1941, was showing signs of exhaustion and insistently demanding Allied action to ease the pressure. Finally, in June 1942, the British forces in Libya suffered a major defeat, being driven back to El Alamein, on the edge of the Nile delta.

Faced with the possibility of a complete Russian collapse, Great Britain and the United States were forced to come to its aid. Both had previously agreed that the European theatre was decisive and that any relieving action must be taken there. In April 1942 an American project for an invasion of continental Europe in the spring of 1943 was discussed but was rejected as being too tardy and incapable of achievement in the time available. Thus, in July, it was decided, as an alternative, to launch the North African campaign, under the code name of "Torch," not later than Oct. 30; this left little more than three months for the preparation of this vast expedition.

The object of the operation was to clear the northern coast of Africa (thereby opening the short sea route through the Mediterranean to the far eastern theatre of operations) and to secure a base from which a subsequent attack on Italy could be launched.

This necessitated the occupation of French Morocco, Algeria and Tunisia, the last being strategically the most important, since its proximity to Italy and the facilities provided by the modem ports of Tunis and Bizerta made it eminently suitable as a base for the subsequent operations. Its very proximity, however, made it easy for the axis to reinforce it rapidly.

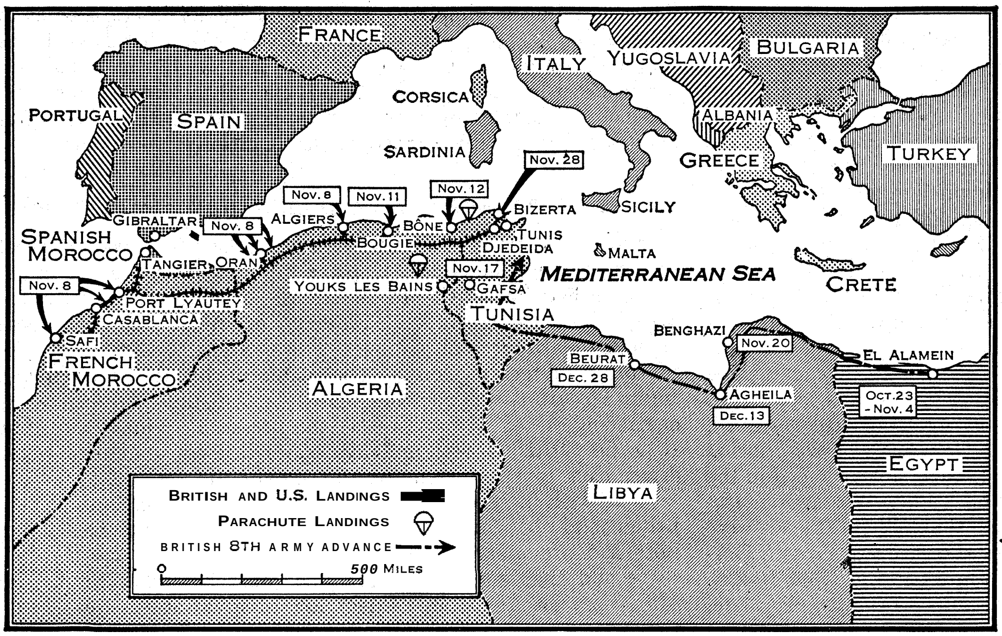
The plan, in outline, was to occupy French Morocco and Algeria, to guard against any possible reaction from Spanish Morocco by neutral Spain and then to advance with all possible speed into Tunisia and to occupy at least the important northeastern corner, before the axis could reinforce it in sufficient strength. This phase of the operations was, therefore, likely to develop into a race between the Allies and the axis.

The French political situation further complicated the plan, as the Vichy government, which still controlled French North Africa, would most probably oppose any attempt to occupy it. It was known, however, that there existed throughout the area a strong element of opinion bitterly opposed to Vichy and ready to welcome the Allied landings; but, despite searching diplomatic investigations by the United States, its strength was unpredictable. One thing was certain: the Vichy government was bitterly antagonistic to Great Britain; so that, if the operation was to stand any chance of winning support from those in authority in French North Africa, it would have to be American in character.

Accordingly, in July 1942 Lieut. Gen. Dwight D. Eisenhower, then in command of the U.S. forces in Great Britain, was appointed supreme commander of Operation "Torch." With a combined Anglo-U.S. staff, he began the preparation of this venture, which was to require the use of no fewer than 650 ships.

1. Plan and Composition of the Forces.—General Eisenhower was to establish his headquarters at .Gibraltar, and the operation was to consist of three groups of landings, each group being allocated to a separate task force.

(a) Western Task Force: French Morocco.—This force, of a total strength of about 34,000, was to capture Casablanca, linking up with the central task force at Oran. and to be prepared to deal with any interference from Spanish Morocco. It was to be an entirely U.S. force, prepared and trained in and dispatched directly



FROM WINSTON CHURCHILL'S "THE HINGE OF FATE'

NORTH AFRICAN CAMPAIGN. 1942

from the United States, 3,000 mi. distant.

(b) Central Task Force: Western Algeria.—This force was to capture Oran, linking up with the task forces on its flanks, and to be ready also to deal with any interference from Spanish Morocco. The army component (about 31,000) was to be entirely American, but the naval and air components were predominantly British, and this force was to be trained and dispatched from the United Kingdom.

(c) Eastern Task Force: Algeria and Tunisia.—This force was to capture Algiers and then to advance into Tunisia with all possible speed, to secure the vital northeastern region. The army component was to be a joint Anglo-U.S. force of about 32,000, the naval and air components being provided by Great Britain; and this force was also to be trained and dispatched from the United Kingdom. To allay French susceptibilities, an American general was to command during the landing operations, but subsequently a British commander, Lieut. Gen. K. A. N. Anderson, was to carry out the advance into Tunisia.

2. Landings **in North** Africa.—By the end of October, everything was ready for the launching of "Torch"; and in Egypt, though few then appreciated it, the door to final victory had already been pushed ajar by the British 8th army's attack at El Alamein on Oct. 23. From now onward the tide of battle was to set ever more strongly in favour of the Allies.

By Oct. 26 the leading elements of "Torch" were en route for North Africa. Eisenhower established his headquarters at Gibraltar on Nov. 5, and the landings were to commence on Nov. 8.

At this point two Frenchmen who were to become deeply involved in the subsequent course of events entered the scene. Adm. Jean Darlan, whose authority as successor to Marshal Pétain, head of the Vichy government, was paramount in North Africa, arrived unexpectedly in Algiers. To Eisenhower's headquarters came Gen. Henri Giraud, a bitter enemy of Vichy, upon whose influence over the French forces in North Africa great faith had been placed. He had been smuggled out of France by submarine, as a potential commander of those French forces, after the landings had been effected.

At 1 A.M. on Nov. 8 President Roosevelt broadcasted an assurance to the French people that the Allies sought no territory, and the Spanish government was informed that no operations were contemplated against Spanish Morocco.

Simultaneously British and U.S. landings began east and west of Algiers. Initially surprise was complete, though opposition stiffened as the leading troops approached the city, and an American raid, transported in two British destroyers to capture the dock area, was very severely handled, one destroyer being sunk. By 5 P.M., however, a firm lodgment was held in the city.

Immediately before the landings Admiral Darlan was informed of their imminence, and many hours of indecisive negotiation and telegraphing to Pétain in Vichy followed. Finally, at 7 P.M., realizing that further resistance was hopeless, he authorized the French commander to negotiate a surrender and to resume control of the French garrison under Allied direction.

Likewise at 1 A.M. on Nov. 8 the main landing began in the Bay of Arzieu, east of Oran, with two subsidiary landings to the westward. Moderate opposition was encountered, but the troops were soon firmly established ashore. An air-borne expedition, flown directly from England to capture the airfields outside Oran, miscarried because of bad weather, and a sea-borne attempt to seize Oran harbour before the port installations could be sabotaged also met with disaster. French naval vessels from Oran put out to sea, but were overpowered by the British naval supporting ships. The coastal batteries remained active, though under heavy bombardment, throughout; and fighting continued in and around Oran till Nov. 11, when the French capitulated

When the western task force landed at 4 A.M. on Nov. 8, it found the French troops on the alert. This had arisen from a mishandling of the political situation as between the French resident-general and the army commander, whose loyalties differed. Eventually the resident-general was placed under arrest. The main landing was made at Fedala, near Casablanca, and subsidiary ones at Port Lyautey in the north and at Safi to the south. At sea, a fierce naval action took place in which the French lost seven ships and three submarines and suffered heavy casualties. Except at Port Lyautey, initial opposition was light; but as the U.S. troops fought their way inland it gradually stiffened. Fighting continued throughout Nov. 8 and g. Finally, on the morning of Nov. 10 the resident-general, now released from arrest, informed Admiral Darlan in Algiers that further resistance was useless; then, on the latter's orders, he surrendered.

On Nov. g Giraud, with Gen. Mark W. Clark (acting as Eisenhower's personal deputy), arrived in Algiers, where the situation among the French high authorities was naturally tense. From his icy reception, it was obvious that Giraud's authority would not be accepted by anyone of importance, yet the early issue of a general cease-fire order to all the French troops was of vital importance, so that the Tunisian advance could be begun without delay. Darlan was the one man who could issue such an order with a reasonable hope of its being obeyed, and with him Eisenhower decided to deal. Knowing that its issue would probably result in the occupation of the remainder of metropolitan France by the Germans, Darlan vacillated; but finally, on Nov. 11, after being given half an hour to make up his mind by General Clark, he issued the cease-fire order "in the name of the Marshal." He himself assumed complete authority in French North Africa—which he maintained till his assassination on Dec. 24. Giraud was to assume command of all French troops, under Eisenhower's orders.

The Allies had gained Morocco and Algeria, but in Tunisia the axis, reacting immediately to the Allied landings, began on Nov. g to bring in reinforcements with all speed, by sea and by air. The French authorities took no action to oppose this move; finally the army commander withdrew his garrisons westward, surrendering valuable territory to axis occupation, and placed himself at General Giraud's disposal. The Allies' chances of success in the race to occupy the northeastern corner of Tunisia had already been jeopardized.

3. Capture **of Tunisia.**—Once Algiers was secured, Anderson assumed command, and the 1st army began the advance to Tunisia. Bougie was captured on Nov. 11 and Bône (Bona) the next day; and by Nov. 16 the advance had reached Béja, where axis forces were encountered. U.S. air-borne forces, after capturing Youks les Bains airfield, reached Gafsa on Nov. 15.

By their advance, the Allies had gained airfields in eastern Algeria from which air support for further operations could be provided; but, though reinforced with every available U.S. unit and joined by the considerable yet poorly equipped Tunisian French forces, the 1st army could not achieve its object. By the end of November the axis forces numbered 15,000 men, supported by tanks and artillery and backed by an ever-increasing air force. The supply problem was also being aggravated by axis air attacks on Algiers, by the lack of road transport and shipping and by the fact that no more than one single-line railway and two roads, all poor, existed throughout the 650-mi. line of communication.

On Nov. 25 General Eisenhower moved his headquarters to Algiers; and on Nov. 28 a combined Anglo-U.S. force reached Djedeida, only 12 mi. from Tunis. This was the climax of the advance, for now heavy winter rains set in, turning the improvised Allied airstrips into quagmires and grounding their aircraft, while axis aviation, operating from all-weather strips in Tunisia, went unhindered. Sections of the supply routes through the mountainous country became impassable, and only the barest necessities could reach the forward area.

On Dec. 1 the Germans attacked at Djedeida, driving the Allies back to Medjez-el-Bab. After a further period of three days' continuous rain, Eisenhower decided to halt on the line then reached. This ran generally along the eastern edge of the mountainous country of western Tunisia from Medjez-el-Bab in the north, through Ousseltia and Faid, to Gafsa.

These adverse factors, together with the initial indecision of the French in Tunisia, served for the time to hold the Allies from their goal—Tunis and Bizerta. But the pause in operations was used for reorganization and for preparing a renewal of the offensive to take place when ground and weather should permit. In this offensive the sea and air forces were to protect the Allies' lines of supply and disrupt those of the axis.

By Dec. 28, meanwhile, the British 8th army had reached Buerat, about 700 mi. from its starting point in Egypt, and the Allied net was beginning to encircle the axis forces. On Jan. 18 a sharp axis attack up the Bou Arada valley, at the junction point of the British and French forces, caused both to fall back several miles, with the loss of Ousseltia. The weaknesses shown by this setback caused Eisenhower to vest complete operational control of all forces in the forward area in Anderson. These forces were regrouped into three corps, the British 5th in the north, the French 19th in the centre and the U.S. 2nd to the south.

By Feb. 2 the British 8th army had crossed into Tunisia and was approaching Ben Gardane. The situation was now causing Gen. Erwin Rommel, recently promoted to command all axis forces in Tunisia, grave concern; to gain time and space for the merging of those forces, he began a series of attacks on his western front. On Feb. 14 he thrust strongly at the thinly held U.S. 2nd corps's front, from Faid and Gafsa. This corps suffered heavily, retiring in considerable disorder, and the axis, following up the success, captured Sbeitla, Kasserine and Feriana. Thereafter, Rommel struck north but was halted by British and U.S. reinforcements hurried forward to restore the situation. On Feb. 22, after fierce fighting, the axis forces began an orderly withdrawal, though under heavy air attack; and by March 3, Allied forces had reoccupied their original positions. Meanwhile, on Feb. 26, Rommel struck another blow at the British jth corps, driving its northern flank back about 20 mi. to Djebel Abiod. The fighting was bitter and cost the axis dearly in tanks which could ill be spared; but it left the Allied northern flank dangerously exposed.

After this period of axis activity, far-reaching changes were made in the command and organization of the Allied forces in North Africa. The 8th army was placed under command of Eisenhower and, with the 1st army, became the 18th army group. Gen. H. R. L. G. Alexander, lately commander in chief of British middle east forces, became the army group commander and deputy commander to General Eisenhower. All Allied air forces operating in the Mediterranean were unified under the command of British Air Chief Marshal Sir Arthur Tedder; under him U.S. Lieut. Gen. Carl Spaatz commanded the Northwest African air force, comprising a strategic, a coastal and a tactical air force. The latter was subsequently most closely associated with the operations of the 18th army group and was in great measure responsible for its successes during the final stages of this campaign.

By now the net was drawing tight about the axis forces. To the west, the 1st army's line had been dented but not broken, and to the east, the 8th army was approaching Medenine. On March 6 Rommel, in a despairing effort to halt its advance and to retain his hold on the Tunisian beachhead, launched his picked Afrika Korps in four successive attacks against the 8th army. All failed, and the axis forces, hotly pressed, fell back to the strongly prepared Mareth line. On March 20, after a heavy air and artillery bombardment, the 8th army attacked; eight days of bitter frontal assaults followed. Finally, on March 28, after an outflanking movement through difficult country to the westward, carried out by an armoured and a New Zealand infantry division, the position was turned, and a further axis withdrawal to Wadi Akarit took place. At this point, Rommel was recalled to Germany and was succeeded by Gen. D. J. von Arnim.

On the western front, on March 17, the U.S. and corps had attacked, capturing Gafsa and thrusting farther east, and this threat contained at least one axis armoured division from the vital Mareth line battle. On March 27–28 the British 5th corps attacked to restore the position on its northern flank; after a few days of stiff and costly fighting, it recaptured Sedjenane, removing the threat to Medjez-el-Bab. The 8th army drove the enemy from the Wadi Akarit position on April 7, gaining contact with the U.S. 2nd corps near Gafsa the same day. On this day also, an Anglo-U.S. attack was launched through the Fondouk pass to cut off the axis forces retreating before the 8th army, and on April 11 it entered Qairwan. By now, however, the axis forces were racing for the last position, covering their beachhead, in the mountains north of Enfidaville, and the 8th army, in hot pursuit, occupied Sfax and Sousse in quick succession, regaining contact with Arnim's forces north of Enfidaville on April 14. Appreciating the strength of the axis position here, General Alexander decided to switch his main attack from the 8th to the 1st army's front and ordered the U.S. and corps, now freed by the contraction of the front, to take over the British 5th corps's front from Béja to the coast, while an armoured division from the 8th army was moved across to the 1st army.

On April 22 the main attack was launched on a two-corps front astride the Medjerda river; but so strong was the opposition that five days of fighting brought little progress, though the effort wore the axis forces down, costing them dearly in material. In the central sector, the French 19th corps advanced and captured Djebel Fkirine; and on April 23 the U.S. 2nd corps, attacking on the northern flank over very difficult country, made good progress toward Mateur. An attack by the 8th army on the Enfidaville position merely confirmed its strength; three more divisions were therefore transferred to the 1st army's front.

On May 6 the thrust astride the Medjerda river was renewed, under heavy air support, which proved to be the decisive factor; and on the next day the British entered Tunis, while the U.S. and corps entered Bizerta, thus trapping three axis divisions to the westward. Without pausing, a British force of an infantry and two armoured divisions swept eastward, and by May 10 one armoured division had reached Hammamet, while the infantry division drove unhindered round Cape Bon peninsula. This was the final phase of the battle. Thereafter all organized axis resistance ceased, and it remained only to round up the prisoners and collect the captured material. On May 13—after three days during which complete axis units drove themselves to the prisoner-of-mar cages in their own transport — Marshal Giovanni Messe, the Italian commander in chief in Tunisia, ordered all units to lay down their arms. More than 250,000 prisoners were taken, and very little of the enormous quantities of material escaped to Italy. (By April 22, Allied air power had disrupted the axis air supply route, and a tight sea blockade of the Tunisian coast prevented any shipping from leaving.)

Thus ended the campaign which opened the Mediterranean to Allied shipping and set the stage for the next phase of operations, the invasion of Sicily and Italy.

4. Summary. — From a review of this campaign, four major points of interest emerge.

First, it was a campaign of bold conception: to launch a huge expedition, composed mainly of troops untried in battle, on that most difficult of operations, an amphibious landing, needed judgment and planning of a high order.

Second, under Eisenhower there was forged that smoothly working Anglo-U.S. staff and command organization which contributed so largely to the final victory.

Third, the use of close air support for the army became fully understood during this campaign, the technique of its control being so perfected that, during the later stages of the fighting, its effect was often decisive.

Finally, the retarding influence of supply upon operations was clearly illustrated: the slowing down of the initial Allied advance into Tunisia, was, to a great extent, due to the weakness of the attenuated line of supply.

J. THE SICILIAN CAMPAIGN, MAY-AUGUST 1943

The decision to invade Sicily, after the completion of the Tunisian campaign, was taken at the Casablanca conference in Jan. 1943. Sicily was chosen because its capture would help to clear the Mediterranean for Allied shipping and provide a suitable springboard for the invasion of Italy. Tactically, however, it subsequently forced upon the Allies an extended land advance right up the Italian peninsula through very difficult country, which landings further north might have avoided. "Husky," as this operation was called, was to be launched about July 10, and the considerable pause between the end of the Tunisian campaign and the launching of "Husky" was a result of the difficulty of collecting enough landing craft.

Although widely dispersed assaults on both Palermo and Catania were considered initially. it became evident that the early capture of the airfields in the southeastern corner of Sicily was vital to the future success of the operation. This, together with the shortage of landing craft and available troops, led to the acceptance of a single expedition composed of two task forces operating within supporting distance of each other, against the 100–mi. coast line from just south of Syracuse westward to Licata. This plan involved taking the risk of landing a considerable force without the prospect of early capture of a major port through which it could be supplied and so of having to maintain it over open beaches. It created a precedent that was to be employed successfully later, notably in the landings in Normandy. The British 8th army, with the 13th and the 30th corps of approximately five divisions, under Gen. Sir Bernard Montgomery, formed the eastern task force; the U.S. 7th army with the 2nd and a provisional corps of approximately four divisions, under Gen. George Patton, Jr., formed the western.

In command was Gen. Sir Harold Alexander, acting as General Eisenhoner's deputy. Adm. Sir Andrew Cunningham dnd Air Chief Marshal Sir Arthur Tedder commanded the supporting naval and air forces, respectively.

In the third week of May, Pantelleria Island, midway across the Sicilian narrows, was attacked with sea and air bombardment of maximum intensity until it surrendered on June 11. Lampedusa Island, lying go mi. southwestward, surrendered the next day. The Sicilian channel was now clear.

Air attack in support of the Tunisian operations against the axis air forces, supply routes and bases in Sicily and Italy, begun in April, had achieved such success by the end of that campaign that the Allied air forces enjoyed a two-to-one superiority. On June 12 the attack was switched to the destruction of the airfields in Sicily. Most of them had been made unserviceable before "Husky" was launched.

On the night of July g, as the task forces were approaching the Sicilian coast, winds of near-gale force sprang up, jeopardizing the safety of the mighty armada of 600 big ships and 2,100 small craft that was transporting the expedition. However, they abated considerably before the hour of landing, having, moreover, put the defenses off their guard.

At 11 P.M. on July 9 a brigade of the British 1st air-borne division was dropped by parachute and glider to seize a vital road bridge and other objectives south of Syracuse. The high winds seriously hampered this operation (many gliders, released offshore, fell into the sea), but the objectives mere captured. Simultaneously, in the U.S. sector, four battalions of the U.S. 82nd air-borne division were dropped to clear routes for the advance of the ground forces to the airfields. Here also the high winds caused considerable scattering, but the paratroops prevented axis reinforcements from reaching the landing beaches.

Landings began at 2:45 A.M. on July 10 and met with little opposition. Licata was seized and opened to shipping that day, Syracuse was opened two days later and Augusta was occupied by July 14. The axis airfields were occupied on July 10, and from these the Allied tactical air force was able to maintain effective close support, flying as many as 1,200 sorties a day.

The Allies were confronted by 2 German and 11 weak coastal and field Italian divisions but maintained satisfactory progress. A German counterattack northeast of Gela became threatening, but the situation was saved by naval bombardment. The advance continued, until the 7th army struck northward through the hills toward Palermo, while the 8th army approached the critical area about Catania.

Problems of supply were acute during the first few days, when adverse weather conditions and occasional axis air attacks made difficult the unloading and handling of stores over open beaches or in small improvised ports. The situation was saved, however, by the new $2\frac{1}{2}$-ton amphibious DUKW (Duck) trucks, which enabled more than 80,000 men, with 7,000 vehicles and 300 tanks, to be landed during the first two days.

Advancing through the hills of western Sicily, the U.S. 7th army captured Palermo on July 22 and then turned east along the northern coast, turning the axis defenses by amphibious operations on three occasions. Between Aug. 1 and Aug. 6, in hard fighting on the slopes of Mt. Etna about Randazzo, it gave valuable support to the 8th army in its struggle to open the eastern coastal road north of Catania. On Aug. 17 it entered Messina from the west.

Approaching Catania, the British 8th army was faced with a hard task. Mt. Etna, with its defensively strong lower slopes, dominated the coastal route northward to Messina, and there the Germans concentrated all their divisions. General Montgomery, appreciating that the key to the position was Adrano, on the western face, transferred the weight of his attack there; hard fighting continued in this area with but little progress until Aug. 7, when, thanks to the pressure of the 7th army, Adrano was occupied. On Aug. 13 Randazzo, the road junction to the north, was captured. and this forced the Germans to carry out a general withdrawal. Immediately the 8th army pushed northward, along the coastal road, and on Aug. 17 its advance patrols entered Messina from the south — simultaneously with the advanced troops of the 7th army.

The campaign was now over. Under heavy anti-aircraft protection the Germans contrived to withdraw more than 40,000 men, with much equipment, over the Straits of Messina. Nevertheless the loss of Sicily was a severe blow to the axis, costing them 165,000 casualties, of whom 37,000 were German. together with considerable losses in tanks, guns and vehicles.

The shock of the invasion, combined with the heavy bombing of the Italian mainland, notably of the marshalling yards in Rome, sounded the death knell of the Fascist regime. On July 25, 1943, Mussolini resigned, to be succeeded by Marshal Pietro Badoglio.

K. THE ITALIAN CAMPAIGN, SEPT. 1943–MAY 1945

During the closing stages of the Tunisian campaign in May 1943, with the preparations for the invasion of Sicily well advanced, a top-level conference was held in Washington, D.C. This conference directed General Eisenhower to plan such operations in exploitation of the conquest of Sicily as would be best calculated to eliminate Italy from the war and to contain the maximum number of German divisions. Available to him would be 19 British and other Allied (including 3 Polish) with 4 U.S. and 4 French divisions, though a considerable proportion of the total would be required for internal security duties. Moreover, plans for the invasion of Normandy were taking shape, and seven U.S. and British divisions were to be returned to the United Kingdom by Nov. 1 for this operation.

The invasion of Italy offered certain notable advantages. The collapse of a major partner would have a tremendous effect on the axis powers, especially on the satellites. Italian air bases, particularly those in the Foggia region, would be of considerable use for the general Allied air offensive. In addition, the Allies could more effectively support the Yugoslav partisans and seriously threaten the axis positions within the Balkans, thereby assisting the Russians.

The risks to be accepted were numerous and serious. The demands of security in North Africa would reduce the forces available. In this first attack upon the European continent, the axis could be expected to exert every effort to maintain its prestige. The demand on shipping to supply the expedition would be heavy; and, granted success, the Allied lines of communication would be ever lengthening, requiring a heavy proportion of administrative troops. Conversely, the axis lines of communication would be entirely land-borne and would be ever shortening. Most important of all, an advance from the southern tip of Italy would have to traverse easily defensible country. The Apennine range, running down the centre of the peninsula, with its successive foothills and deep ravines stretching out to the coast, offered a series of natural defensive positions. These were further strengthened by countless streams, flooded in winter, and by coastal marshes, which would restrict the fuil exploitation of the expected Allied superiority in artillery and armour. As in the Sicilian operations, the acute shortage of landing craft presented a serious problem. No replacements from the United Kingdom or from the United States were forthcoming, and even the small stocks available were being drawn upon for other theatres. This chronic shortage was to dominate the whole strategy of the Italian campaign; it nearly stultified the initial landings and it limited the scope of the subsequent conduct of the operations. Despite this, on June 5, three months before the deadline date and one month before Sicily was invaded, the 15th army group was directed to plan for an assault across the Straits of Messina to capture the ports of Reggio di Calabria and San Giovanni, subsequently seizing the airfield at Crotone.

1. The Italian Surrender.—On Aug. 19 Marshal Badoglio established contact with General Eisenhower to negotiate a surrender, without the knowledge of the Germacs. Eisenhower was instructed to accept an unconditional surrender and to obtain the maximum military advantage thereby. Responding to Badoglio's plea that Rome should be seized to safeguard the king and the government from possible German reactions, Eisenhower offered to fly an air-borne division in, if the Italians would guarantee the use of the necessary airfields and silence the anti-aircraft batteries.

Meanwhile the Allied air offensive against axis marshalling yards, airfields and military installations was intensified. Pisa, Benevento, Salerno, Foggia and even the Brenner pass being heavily attacked. Field Marshal Albert Kesselring's headquarters at Frascati, south of Rome, was entirely bombed out, and axis fighter opposition decreased progressively.

The Italian unconditional surrender was signed at Cassibile in Sicily on Sept. 3 and announced on Sept. 8. The Germans evidently had been prepared for such an eventuality, for on the day of the announcement Badoglio informed Eisenhower that he could not guarantee the airfields for the landing of the Allied division, and on the next day the Germans occupied Rome. Unfortunately Sept. 9 was the day on which the Allied invasion was to land; but it was too late to change the objectives of the air-borne division destined for Rome, which was thus rendered inactive at a critical moment. On Sept. 9 also the Italian battle fleet vacated Taranto, just as the Allies were steaming in to occupy it, while a considerable force of battleships, cruisers and destroyers left Spezia and Genoa to surrender. This force was spotted and bombed by German aircraft, the battleship "Roma" being sunk, but the remainder sailed on via the Balearic Islands and Bône to Malta, where it joined the remaining units in surrender. The Italian army made only an apathetic resistance to the Germans, surrendering to them wholesale; and only 320 aircraft of the total Italian air force complied with the terms of surrender by flying over to the Allies.

The surrender had removed the Italian fleet from the war and left the Allies to face only the German army fighting in a country with a cowed but hostile population. With more decisive Italian leadership, Rome might have been occupied and the campaign shortened by many months.

The fall of Mussolini's regime, foreshadowing the collapse of Italy, opened new prospects for the Italian operations. An early assault upon the Naples area now appeared feasible; but a direct assault upon the city would certainly meet stiff German opposition, as it was the focal point covering their withdrawal routes from the south. North of the city the coast was unsuitable for landings and was beyond the range of Allied fighter aircraft; but to the south the Gulf of Salerno offered possibilities; surrounded inland by high mountains (2–10 mi. away) and crossed by routes to Naples running through narrow defiles, it possessed a 20-mi. stretch of excellent beach. It was estimated that, for the first few days, until an airstrip could be captured, Allied fighter aircraft. with detachable tanks, could maintain a continuous daylight patrol of 36 aircraft over the area. This was considered adequate, and Gen. Mark Clark with the jth army was ordered to plan Operation "Avalanche" for a landing in the Gulf of Salerno with Sept. 7 as the target date. General Montgomery, with the 8th army, was to carry out the landings previously planned across the Straits of Messina, called Operation "Baytown," several days earlier, with the object of containing as many German formations as possible to the south of Naples, so that "Avalanche" could cut them off. Moreover, the shortage of landing craft necessitated their employment for each landing successively.

2. The Landings.—Following heavy air preparation against axis airfields, batteries and communications in the "toe" of Italy, the 13th corps with the Canadian 1st and British jth divisions landed at 4:30 A.M. on Sept. 3, meeting negligible resistance. Inland, demolitions in the mountainous and easily defensible country slowed down the rate of advance of the forward troops, and this factor was to have a serious effect upon Operation "Avalanche." On Sept. 9, as the Italian fleet was steaming out to surrender, the 1st air-borne division landed and occupied Taranto. On Sept. 12 Crotone with its airfield was in Allied hands.

Early on Sept. 9 the 5th army landed at two points in the Gulf of Salerno. The northern force, sailing from Sicily and Bizerta and consisting of the British 10th corps, assaulted with the 46th and 56th divisions; the southern force, from Oran, consisting of the U.S. 6th corps, assaulted with the 36th division followed by the 45th. U.S. rangers landed to seize the defiles through the mountains leading to Naples, and British commandos to capture Salerno.

Expecting an Allied landing there, the Germans reacted swiftly and vigorously, and a series of strong counterattacks severely tested the Allied beachheads. Honever, by nightfall, these beachheads were 4 mi. deep. though a dangerous 5-mi. gap at the Sele river separated them (this was closed on Sept. 10). It had been estimated that eight German divisions were available in the area—two around Naples, two around Rome and four to the south facing the 8th army—and their proportion of armour was heavy. Shortage of shipping prevented the landing of any Allied armoured formations until Sept. 14, when the British 7th armoured division began to land; but by that time picked German troops had penetrated in places to within a mile of the beach, and the situation looked serious. At this point the Allied air force struck at the Germans and their communications with every available aircraft from the strategical and tactical air force. By Sept. 12 an airstrip was in operation within the beachhead, and on the three preceding days 3,000 fighter sorties had been flown from Sicily or from carriers. On the nights of Sept. 13 and 14 air-borne troops were flown in to reinforce the critical portions of the beachhead, and by Sept. 15 the crisis had passed. It is worthy of consideration whether, had it been able to land even a week earlier, the 8th army would have advanced to within closer supporting distance, in which case this crisis would never have arisen.

On Sept. 12 Capri and other islands in the Bay of Naples surrendered, and on Sept. 18 patrols of the 5th and 8th armies met at Vallo, 40 mi. S.E. of Salerno. The axis evacuated Sardinia to French 'occupation on Sept. 18.

3. Advance to the Gustav Line, Sept. 20–Dec. 10, 1943.—The 5th and the 8th armies now began to advance up the peninsula abreast. Bari fell on Sept. 13 and the 5th army occupied Naples and its harbour on Oct. 1. Repairs to the demolished port structures were begun immediately, and on Oct. 14 the unloading of stores over the Salerno beaches ceased (during the period Sept. 9–26, 108,000 tons of stores, 30,000 vehicles and 200,000 troops had been landed there).

With the Foggia airfields in their hands, the Allies' hold on the mainland was confirmed, as adequate close air support for the ground troops could now be provided by aircraft based close to the battle area. In addition, heavy bombers could easily strike at the German communications through the passes over the Alps and assist in the over-all air offensive against Germany and also disrupt industry and communications in the Balkans to assist the Russians.

As the Allies advanced, German resistance gradually stiffened, and progress became slow and painful. New divisions arrived to join the Allied forces, but concurrently the Germans hastily reinforced their own defenses. To avoid a costly frontal attack on Termoli, the 8th army by-passed it with an amphibious landing; but the town held out until Oct. 6. At 4 P.M. on Oct. 13 Italy declared war on Germany, which saved the Allies from the manpower drain necessitated by the establishment of military government in captured territory. On the night of Oct. 12–13 the jth army crossed the Volturno river after hard fighting; and the Germans withdrew to their winter line, known as the Gustav line, destroying every bridge and culvert en route. This line, which the Germans had been preparing since the Allies first landed, ran athwart the peninsula following generally the courses of the Sangro and Liri (Garigliano) rivers and was defensively very strong. The 5th army found the latter river an even stiffer obstacle than the Volturno, and costly attacks to cross the lower reaches began on Nov. 6. On Nov. 28 the 8th army launched an attack to cross the Sangro, and after repeated attacks it achieved its object. Nevertheless, it proved impossible to reach the Pescara-Popoli-Rome highway, thereby turning the defenses of Rome. By now, moreover, winter had set in, and heavy rains and snows limited offensive operations.

Though the Allied artillery was hastily reinforced with guns of the heaviest calibre in an attempt to blast a way through the Gustav line, it was without avail.

The jth army continued to fight its way into the entrance to the Cassino corridor, leading to Rome; but though it bent the German line did not break, and a period of stalemate descended upon the operations.

In December the first of the French divisions equipped by the U.S. arrived in Italy, and early in Jan. 1944 a complete corps under Gen. Alphonse Juin took over the 5th army's right sector. At the same time the Polish 2nd army corps, urider Lieut. Gen. Wladyslaw Anders, comprising two infantry divisions and one armoured, arrived from the middle east and was incorporated with the 8th army. But, although the Adriatic ports were handling 70,000 tons and Naples 80,000 tons weekly, the build-up of the Allied forces was considerably delayed because, apart from the shipping and land transport required to maintain the expeditionary force with its air force, a considerable volume was required to provide food to keep the liberated Italian population from starvation.

On Dec. 10 there were changes in the high command. Eisenhower, appointed supreme Allied commander of the projected invasion of Normandy, returned to the United Kingdom, being succeeded by Gen. Sir Henry Maitland Wilson. Montgomery returned with Eisenhower, and the whole hierarchy of the command underwent considerable changes.

4. Anzio and Cassino, January–May 1944.—In the third week of January, offensive operations were reopened on the southern flank. The British secured a bridgehead over the Garigliano at Minturno but were held there, while the 5th army, on Jan. 20–21, unsuccessfully attempted to force the Rapido river. Meanwhile, east of Cassino, the French corps made considerable gains.

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These operations were intended to divert German attention from a landing carried out by the U.S. 6th corps in the rear of the German forces at Anzio and designed to disrupt German communications in the Cassino area. The landing was a complete surprise, and a bridgehead 18 mi. long and 9 mi. deep was secured. Instead of driving straight to the Alban hills (a key area overlooking the German communications) the force consolidated its bridgehead. The German commander adjusted his dispositions accordingly, concentrated his forces against this threat and delivered a series of heavy counterattacks. By the end of January he had sealed off the bridgehead, and for four months kept 50,000 troops pinned within it under the most severe conditions. Meanwhile, the 5th army had been halted before the strong defenses at Cassino, blocking the southern entrance of the Via Casilina, the highroad leading northward. Around this position, particularly about the monastery, raged some of the bitterest fighting of the whole campaign. Week after week the Allies assaulted it without success; even after a combined air and artillery bombardment of such intensity that bulldozers had to be used to clear a way for the passage of tanks it still held out. Eventually, in the third week of March, the assault was given up.

5. The Summer Offensive, May–September **1944.**—During the early months of 1944, the Allied air offensive systematically destroyed all the axis rail nerve centres south of Florence, while the 5th and 8th armies regrouped their forces, concentrating their main weight to the west of the Apennines. Then, on May 11, Alexander delivered on the Gustav line a co-ordinated offensive. On May 18 units of the Polish 2nd corps took Monte Cassino.

In five days the Gustav line had been overrun, and the U.S. 6th corps, breaking out from the Anzio bridgehead on May 23, joined hands with the troops advancing over the mountains west of the Liri river. The Germans now decided to withdraw, and the Allied air forces took a heavy toll of their choked communications; yet their stubborn stand southeast of Rome delayed capture of the latter until June 4. Both armies took up the pursuit northward, and two days later the invasion of Normandy (Operation "Overlord") started (see below). In mid-June the French recaptured Leghorn and reached the river Arno. By this time, however, Alexander had had to surrender three first-rate U.S and seven French divisions to mount Operation "Dragoon," a landing on the French south coast designed to clear southern France, in support of the main "Overlord" operation. In their place the 15th army group received a Brazilian division and a Greek brigade that were not so battle-tried, with the result that its offensive power was lowered and its rate of advance slowed do n, which enabled the Germans to occupy their next prepared position, the Gothic line, running approximately from Pisa to Rimini. Despite their loss, the Allies captured Florence on Aug. 13 and breached the western end of the Gothic line with the capture of Pisa on Sept. 2. Then the 8th army, passing northward through the Apennines, captured Rimini on Sept. 21, thus breaching the eastern end of the Gothic line. Nevertheless, the Germans managed to seal off the two breaches, and their line held till the weather intervened, precluding any further offensive operations.

6. The Winter Pause, Oct. 1944—April **1945.**—During the winter, General Wilson, supreme commander in the Mediterranean, moved to Washington to join the combined chiefs of staff, being replaced by General Alexander. Gen. Mark Clark took over the 15th army group.

Early in January the Allies advanced their line to the south bank of the river Senio and, by their over-all action, managed to pin down the German 10th and 14th armies. But during this month three more divisions, two Canadian and one British, were transferred to France to reinforce "Overlord." Throughout the winter, the Allied air forces continued their attack on the German communications through the Alps, including oil and rail targets in Austria and southern Germany.

7. The Final Phase, **April–May 1945.**—By April, the general collapse of Germany had started. The Allied armies were running over western Europe, and the Russians were driving forward into eastern Germany. On April 9 the 15th army group opened its offensive to break into the Po valley. The 8th army, on the east, opened the attack across difficult swamp country intersected by many small rivers and had captured Imola in the Po valley by April 15. On April 14 the 5th army attacked and, after a week of heavy fighting, captured Bologna, advancing northward to the Po, over which bridgeheads were established southwest of Mantua on April 23. Bridgeheads were also established on the 8th army's front, and the German forces in the centre were faced with complete envelopment. Both armies now raced northward toward the foothills of the Italian Alps; the 5th army entered Verona on April 26 and Milan three days later. Part of the 5th army swept westward along the coast, capturing Spezia and Genoa, and then drove on to join the French. Everywhere effective support was received from the Italian anti-Fascists. On April 28 these patriots captured Mussolini and several other leaders who were trying to escape to Switzerland and summarily executed them.

By May 1 the 8th army troops, advancing on Trieste, had made contact with Yugoslav partisans at Monfalcone. On May 2 the German commander in chief signed the general surrender at Alexander's headquarters; under its terms nearly 1,000,000 Germans laid down their arms. On May 4 patrols of the U.S. 88th division met those of the 7th army moving down from Austria, south of the Brenner pass, and the Italian campaign was over.

8. Summary.—A review of this campaign discloses three major points of interest.

First, the objects laid down at the Trident conference were achieved: by pressure maintained throughout 20 months, the 15th army group, though frequently being drained of its battle-tried divisions, had made a major contribution to the over-all Allied effort, pinning down substantial forces which the Germans desperately needed to reinforce both their eastern and their western fronts in Europe. The cost was heavy, casualties and missing amounting to nearly 350,000; but the Germans paid more dearly.

Second, the plan of campaign had necessitated a land advance through terrain almost universally favourable to the defense.

Third—and with reference to the second point—the shortage of all types of landing craft precluded the Allies from exploiting their command of the sea by the use of large-scale amphibious operations; the Italian peninsula, with its extensive coast line, was peculiarly vulnerable to such a form of attack, and it is interesting to consider whether, had it been possible to land in strength, initially, nearer the base of the peninsula (perhaps in the rear of the Gothic line), the objects might have been achieved more quickly and at less cost. (A. W. LE.)

L. BALKAN OPERATIONS (1942–44)

1. Resistance in Yugoslavia and Greece.—With their mountains and lack of modern means of communication, with their populations having age-long traditions of conspiring against and resistance to the invader, Yugoslavia and Greece were ideally fitted for guerrilla warfare. Unfortunately, in neither did the political situation favour a unified underground movement. In Yugoslavia, particularly, the resistance was divided first by the Serbo-Croat feud and second by the tendency of the Communist party to pursue its aims without compromise. The German advance in April 1941, in its very swiftness, left in its rear tens of thousands of Yugoslav soldiers who hid with their arms. A month later Col. (later Gen.) Dragomir Mikhailovich started to organize *chetas* (companies) to fight the enemies of Yugoslavia. For the Chetniks, however, the enemies were not only the Germans but also the *ustaše* (insurgents) of the Croat quisling Ante Pavelic. From the outset, therefore, Mikhailovich, who had a unique chance to be a national Yugoslav leader, appeared in the narrower role of a Serbian patriot.

This situation was skilfully exploited by the leader of the rival underground movement, Josip Broz, called Tito. A Moscow-trained Communist, Tito organized his partisans and started guerrilla operations only after the German attack on the U.S.S.R. A meeting between Tito and Mikhailovich in Oct. 1941 was fruitless. Although at first Chetniks and partisans sometimes united against the Germans, their relations now became strained and they even fought each other. Mikhailovich was anxious to avoid reprisals against the civil population; he also considered the menace of communism at least as great as that of naziism or fascism. For this, after Aug. 1942, he was denounced as pro-German by the "Free Yugoslavia" radio broadcasting from Tiflis. In Nov. 1942 in the small Bosnian town of Bihac, Tito convened an Antifascist Assembly of National Liberation of Yugoslavia (AVNOJ, or Antifašističko Veće Narodnog Oslobodjenja Jugoslavije), which proclaimed that the Yugoslav national army of liberation was fighting for a "truly democratic and federal Yugoslavia in which equal national rights not only of Serbs, Croats and Slovenes, but also of Macedonians and Montenegrins would be recognized."

The first British officer sent into occupied Yugoslavia was Col. D. T. Hudson. Landed in Sept. 1941 by submarine on the Dalmatian coast, Hudson was instructed to co-ordinate the sabotage operations of Chetniks and partisans. but soon discovered how difficult was his assignment. The British, however, continued to help only Mikhailovich with money and munitions until March 1943 when a first British emissary to Tito, Lieut. Col. F. W. D. Deakin, was parachuted into the country. He reported that the partisans had both a political and a military organization on a large scale; he also recognized that Tito's soldiers were really fighting the Germans, despite setbacks and the sufferings of the civilian population. In Sept. 1943 a larger mission headed by Brig. Fitzroy Maclean was parachuted into Bosnia, and soon after came important material help to the partisans. By this time the Allies had established a special base near Bari, in southern Italy, so that it was no longer necessary to fly supplies from Egypt. The British mission to Mikhailovich was withdrawn in May 1944 and entire support was transferred to Tito. Speaking in the house of commons on Feb. 22, 1944, Winston Churchill stated that the partisans were the only people who were doing any effective fighting against the Germans and that they were checking no fewer than 14 German divisions out of the 20 in the Balkan peninsula.

In Oct. 1944 all southern and eastern Yugoslavia was liberated by the joint effort of Russians (Marshal Tolbukhin's army), Bulgarians (14 divisions now fighting with the Russians) and partisans of Tito. In April 1945 all Yugoslavia was free, and although many Chetniks took refuge in Allied-occupied Italy, Mikhailovich remained in his Serbian mountains. (He was arrested on March 13, 1946. condemned to death by a partisan court on July 16 and executed the next day at dawn.)

Compared with that of Yugoslavia, the situation in Greece was simpler in one respect; there was no feud similar to the Serbo-Croat. The political divisions, however, were serious enough not only to endanger the national unity but also to paralyze any large-scale operations against the axis. It must be remembered that Greece before the war had a dictatorship opposed by all Greek political parties. But while the royalists were ready to forgive the king for supporting General Metaxas if they were given power, the liberals and socialists were against both the dictatorship and the monarchy. After the occupation of Greece by the Germans and Italians the Communist party exploited this situation by sponsoring an underground national liberation front (E.A.M. or Ethnikon Apeleftherotikon Metopon) which proclaimed the necessity, after the war, of a Greek republic allied with the U.S.S.R. and other Balkan republics. The E A.M. organized its own national popular liberation army (E.L.A.S., or Ethnikos Laikos Apeleftherotikos Stratos), the commander in chief of which was Gen. Stefanos Sarafis.

When the first British military mission, under Brig. E. C. W. Myers and Col. C. M. Woodhouse, was parachuted into Greece during the night of Sept. 30, 1942, they found that both E.A.M. and E.L.A.S. were firmly established, capably organized, not badly armed and entirely controlled by the Communist party. The general headquarters, middle east, decided to support them with gold, arms and ammunition in the hope that they would start a large guerrilla campaign against the axis powers. In actual fact they were mainly fighting the non-Communist guerrilla bands such as that of Col. Demetrios Psaros, who was murdered by the E.L.A.S., or the more important E.D.E.S. (Ellinikos Dimokratikos Ethnikos Stratos, or Hellenic democratic national army) led by Col. Napoleon Zervas. In the house of commons on Jan. 18, 1945, Churchill said that the E.L A.S. leaders "were simply taking our arms, lying low and awaiting the moment when they could seize power in the capital."

2. British Reconquest of Greece.—There was no large-scale fighting for the liberation of Greece; it was not necessary. With two Allied armies north of Florence in Italy, with the Russians holding Rumania and Bulgaria, Hitler gave Field Marshal Maximilian von Weichs, commander in chief, Balkans, the order to abandon Greece. At the beginning of Oct. 1944 small British forces under Maj. Gen. Sir Ronald MacKenzie Scobie started the liberation of the country. On Oct. 18 the legal Greek government returned to Athens from Cairo. (K. Sm.)

M. ALLIED RECONQUEST OF WESTERN EUROPE

In March 1941, before the United States even entered the war, British and U.S. staff conversations had been held in Washington, D.C., to consider what should be the broad outline of the combined British Commonwealth and U.S. strategy in the event of the United States' being forced into it. It had been agreed that the paramount object must be the defeat of Germany and that, with this achieved, the destruction of any remaining enemies would be a much less formidable task.

In April 1942, after the United States' entry into the war, the combined chiefs of staff met in London and agreed that plans for a major invasion of western Europe in 1943, to be known as Operation "Round Up," should be studied. They reaffirmed that, provided the necessary measures be taken to hold the front against Japan, all resources were to be concentrated upon the defeat of Germany. But as at that time the Soviet Union was bearing the full brunt of the German offensive and was becoming exhausted, a proposal was considered for an invasion of northwestern Europe, on as large a scale as possible, by late summer or early autumn of 1942. Given the code name of "Sledgehammer," it would be launched only if the Russian situation so deteriorated as to render it imperative. In June 1942 the British prime minister, Winston Churchill, with the chief of the imperial general staff, Gen. Sir Alan Brooke, went to Washington for further discussions. The situation now was more serious: there was a possibility of a complete Russian collapse, and the British forces in Libya were falling back before Rommel's fierce offensive. Studies had shown that Operation "Sledgehammer" was impracticable in 1942 because resources, particularly landing craft, were insufficient and troops could not be trained in time. Something had to be done urgently, however, and the North African campaign, Operation "Torch," was born. In July Gen. George C. Marshall and Adm. Ernest King went to London to amplify the project and to discuss details, and the launching date was fixed for the end of October.

In Jan. 1943, with the tide of war in North Africa setting in favour of the Allies, it was decided at the Casablanca conference that the build-up for a full-scale invasion of northwestern Europe should be resumed and that, concurrently, the bombing of Germany should be intensified. Submarine construction yards and critical industries sustaining the German war effort were selected as initial objectives.

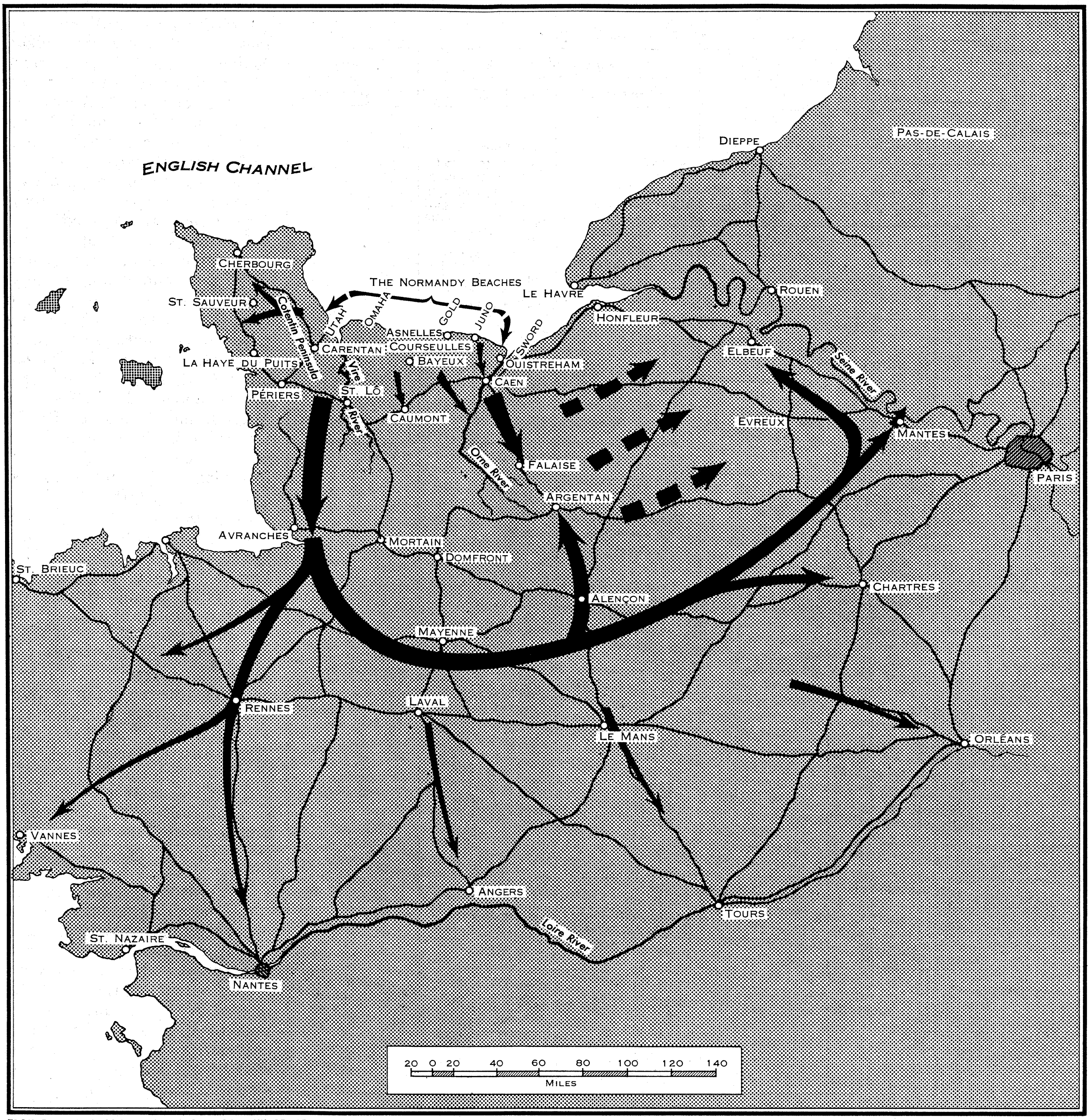
In May 1943 the Trident conference in Washington set May 1, 1944, as the target date for Operation "Overlord," the new code name given to the northwestern European invasion. In September, at the Quadrant conference in Quebec, it was directed that the air attack on Germany from the United Kingdom should be supplemented by strategic bombing from Mediterranean bases. Lieut. Gen. Sir Frederick E. Morgan had been appointed chief of staff to supreme Allied commander ("Cossac"), and his outline plan was now approved in principle.

In Nov. 1943 the Sextant conference in Cairo decided to supplement Operation "Overlord" with an invasion of southern France, named Operation "Dragoon"; and these two were to be given overriding priority in the combined Allied war effort. At Tehran, in Dec. 1943, Stalin agreed to these plans.

Meanwhile the Allied air offensive against Germany was reaching its climax with an all-out 24-hr. attack, the U.S. bombers carrying out high-level daylight attacks and the British royal air force continuing with night attacks to undermine the morale of the German workers. The former concentrated mainly against aircraft and ball-bearing plants, aerodromes and communications, while the latter destroyed industries in the Ruhr and Rhineland. Under this hammering the German fighter command was progressively weakened by the destruction of the industries that maintained it and by air combat.

On Dec. 10, 1943, Eisenhower, appointed supreme commander of the Allied expeditionary forces, returned to England and set up his headquarters, known as S.H.A.E.F., into which he absorbed Cossac's planning staff. In February the following year he received his directions, which read:

> Enter the Continent of Europe, and, in conjunction with the other United Nations, undertake operations aimed at the heart of Germany, and the destruction of her armed forces. The date for entering the Continent is the month of May 1944. After adequate Channel ports have been secured, exploitation will be directed towards securing an



FROM PAMPHLET ISSUED BY BRITISH 21ST ARMY GROUP

BATTLE OF NORMANDY

area that will facilitate both ground and air operations against the enemy.

1. Plans for "Overlord." — Experience gained in the Mediterranean theatre caused the plan as proposed by Cossac to be expanded, the assault force being increased from three to four divisions, and the assault beaches being extended from the Caen area so as to include part of the eastern coast of the Cotentin peninsula. These beaches a stretch of about 50 mi., were selected after detailed study of the coast line from Denmark to Brittany. They possessed the advantage of being less obvious places to choose than those in the strongly defended Pas-de-Calais area, nhile being within supporting range of fighter aircraft based in England. Their disadvantage was that their angle of slope was so shallow as to expose a wide expanse of foreshore at low tide, which might not stand up to the passage of many vehicles and tanks. They included no major port, but the plan envisaged the early capture of Cherbourg. To ease the constricted exits from the Cotentin beaches, which were isolated by floods, two air-borne divisions were to be dropped inland, and a third was to seize the bridges over the Orne river and the Caen canal and to protect the left flank.

Selection of the date for the assault was based upon a combination of tidal, moonlight and daylight conditions. The tide had to be low enough to enable the initial assault troops to land and to clear gaps through the beach obstacles. some of which were covered except at low tide. This tide condition had to coincide with a time and date giving light enough to permit visual bombardment by aircraft and naval vessels. Finally, moonlight was

TABLE *I.—Allied Forces in Europe*

	U.S.		British, Canadian, Polish		French
	On continent	In U.K.	On continent	In U.K.	On continent
June 6, 1944					
Armies	1st	3rd	2nd	1st Canadian	
Corps	5th, 7th	8th, 12th, 15th, 19th, 20th, 23rd	1st, 30th	2nd, 8th, 12th, 2nd Canadian, 1st Polish	
Divisions	1st, 4th, 29th infantry 82nd, 101st air-borne	2nd, 5th, 8th, 9th, 28th, 30th, 35th, 79th, 83rd, 90th infantry; 2nd, 3rd, 4th, 5th, 6th, 7th armoured	3rd, 50th infantry; 6th air-borne; 3rd Canadian	15th, 38th, 43rd, 45th 47th, 51st, 52nd, 53rd 55th, 49th, 59th, 61st infantry; 7th, 9th, 11th, 79th, guards armoured; 1st air-borne; 2nd Canadian infantry; 4th Canadian armoured; 1st Polish armoured; 2nd Polish grenadier armoured	
Sept. 30, 1944					
Armies	1st, 3rd, 7th, 9th	0	2nd, 1st Canadian	0	1st
Corps	3rd, 5th, 6th, 7th, 8th, 12th, 15th, 18th, 19th, 20th	13th, 16th	1st, 8th, 12th, 30th; 1st air-borne; 2nd Canadian	2nd	1st, 2nd
Divisions	1st, 2nd, 3rd, 4th, 5th, 8th, 9th 26th, 28th, 29th, 36th 35th, 36th, 44th, 79th, 80th. 83rd, 90th, 94th, 95th, 102nd, 104th infantry; 82nd, 101st air-borne; 2nd, 3rd, 4th, 5th, 6th, 7th, 10th armoured	95th infantry; 17th air-borne; gth ar-mowed	3rd, 15th, 43rd, 49th 50th, 51st 52nd, 53rd, 59th) infantry; 1st, 6th air-borne; 7th, 11th, 79th, guards armoured; 2nd, 3rd Canadian infantry; 4th Canadian armoured; 1st Polish armoured	38th, 45th, 47th, 52nd, 55th, 61st infantry; 2nd Polish grenadier armoured	1st, 2nd armoured; 1st motorized; 2nd Moroccan; 3rd Alg., 9th Col.
Dec. 31, 1944					
Armies	1st, 3rd, 7th, 9th, 15th	0	2nd, 1st Canadian	1st, Allied air-borne	1st
Corps	3rd, 5th, 6th, 7th, 8th, 12th, 13th, 15th, 16th, 18th, 19th, 20th, 21st.	22nd, 23rd	1st, 8th, 12th, 30th, 2nd Canadian	and, 1st air-borne	1st, 2nd
Divisions	1st, 2nd, 3rd, 4th, 5th, 8th, 9th, 26th, 28th, 29th, 30th, 35th, 36th, 44th, 45th, 75th, 78th, 79th, 80th, 83rd, 84th, 87th, 90th, 94th, 95th, 99th, 100th, 102nd 103rd, 104th, 106th 'infantry; 17th 82nd, 101st air-borne; 2nd, 3rd, 4th, 5th, 6th, 7th, 9th, 10th, 11th, 12th, 14th armoured	66th, 69th, 76th infantry; 8th armoured	3rd, 15th, 43rd, 49th, 50th, 51st, 52nd, 53rd infantry; 6th air-borne 7th, 11th, 79th, guards armoured: 4th Canadian armoured; 1st Polish armoured	38th, 45th, 47th, 48th, 55th, 61st infantry; 1st air-borne; 2nd Polish grenadier armoured	1st, 2nd, 5th armoured; 1st motorized; 2nd Moroccan; 4th Moroccan mtn.; 3rd Alg.; 9th Col.; 27th Alp.
March 26, 194					
Armies	1st, 3rd, 7th, 9th, 15th, 1st Allied air-borne	0	znd, 1st Canadian	0	1st
Corps	3rd, 5th, 6th, 7th, 8th, 12th, 13th, 15th, 16th, 19th, 20th, 21st, 22nd, 23rd; 18th air-borne		1st, 8th, 12th, 30th; 1st, 2nd Canadian	znd, 1st air-borne	1st, 2nd
Divisions	1st, 2nd 3rd 4th, 5th 8th', 9th', 26th, 28th, 29th, 30th, 35th, 36th, 42nd, 44th, 45th, 63rd, 65th', 66th', 69th, 70th, 71st, 75th, 76th', 78th, 79th, 80th, 83rd, 84th, 86th, 87th, 89th, goth, 94th, 95th', 97th: 99th, 100th, 102nd, 103rd, 104th, 106th infantry, 13th 17th, 82nd, 101st air-'borne; nnd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 16th, 20th armoured	0	3rd, 15th, 43rd, 49th, 51st, 52nd 53rd infantry; 6ih air-borne; 7th, 11th, 79th, guards armoured; znd, 3rd Canadian infantry; 4th, 5th Canadian armoured; 1st Polish armoured	38th, 45th, 47th, 48th, 50th, 55th, 61st infantry; 1st air-borne; 2nd Polish grenadier armoured	1st, 2nd, 5th armoured; 1st motorized; 2nd Moroccan; 4th Moroccan mtn.; 3rd Alg.; 9th Col.; 27th Alp; Gironde
May 8, 1945					
Armies	Same as March 26, 1945	0	2nd, 1st Canadian		1st
Corps		0	1st, 8th, 12th, 30th; 1st, 2nd Canadian	1st air-borne	1st, 2nd
Divisions		0	3rd, 5th, 15th, 43rd, 49th, 51st, 52nd, 53rd infantry; 6th air-borne; 7th, 11th, 79th, guards armoured; 1st, znd, 3rd Canadian infantry; 4th, 5th Canadian armoured; 1st Polish armoured	38th, 45th, 47th, 48th, 50th, 55th, 61st infantry; 1st air-borne; 4th Polish	1st, 2nd, 5th armoured; 1st motorized; 2nd Moroccan; 4th Moroccan mtn.; 3rd Alg.; 9th Col.; 27th Alp; Gironde; 1st, 10th, 14th infantry—!for occupation duty)

required for the air-borne landings on the previous night. Mainly because of the shortage of landing craft, some of which had to come from the Mediterranean theatre, the date of the assault had to be postponed from early May to early June. On June 5, 6 and 7 the requisite conditions were expected; of these days, June 5 was selected.

For the initial assault, the Allied ground forces were placed under command of Montgomery. The British 21st army group comprised the Canadian 1st army (2nd corps) under Lieut. Gen. H. D. G. Crerar, the British 2nd army (1st, 8th, 12th and 30th corps) under Lieut. Gen. Sir Miles Dempsey and the British 1st and 6th air-borne divisions under Lieut. Gen. F. A. M. Browning. U.S. forces consisted of the 1st army (5th, 7th, 8th and 19th corps) and the 82nd and 101st air-borne divisions, under Lieut. Gen. Omar N. Bradley. For the landing, the U.S. 7th corps was to assault with the 4th infantry division just north of the Vire estuary ("Utah" beach), and the U.S. 5th corps with one combat team from the 29th and one from the 1st infantry division was to assault east of the Vire estuary on "Omaha" beach. The British 21st army group was to assault with the Canadian 3rd and the British 5th and 50th divisions on Ouistreham ("Sword"), Courseulles ("Juno") and Asnelles ("Gold") beaches, respectively.

The objective of the U.S. 7th corps and air-borne division was to cut the Cotentin peninsula and seize Cherbourg. The U.S. jth corps was to advance southward toward St. Lô and then, with the support of the 7th corps, to continue to Avranches and to hold a line facing eastward. Meanwhile, the build-up forces, consisting of the U.S. 3rd army under General Patton, was to land and to be prepared to capture the Breton ports.

The British 21st army group was to gain ground about Caen and to protect the left flank against an expected German counterattack. This area mas favourable to armoured action, and it was there that the first strong German reaction was expected.

By June 1944 there were in the United Kingdom 47 divisions (26 British, Canadian and Polish, 21 U.S.); each, with its anti-aircraft, tank and tank-destroyer elements, amounted to approximately 17,000 men. This gives an idea of the quite unprecedented size of this expeditionary force; but by May 1945 their strength had increased to more than 4,000,000 men, of which the U.S. provided about 2,585,000, the British Commonwealth 1,073,000, France 413,000 and the other Allies collectively 67,000. Table I shows the progressive build-up of the forces in the European theatre until the German surrender in May 1945.

The Allied naval component was commanded by Adm. Sir Bertram Ramsay and was composed of two task forces, the western task force being U.S., the eastern British. Each was subdivided into a bombarding force and an assault force to land the assaulting troops on the five beaches. The total strength of this component exceeded 5,000 ships; viz., 4,000 assault and "ship-to-shore" craft, 6 battleships, 2 monitors, 22 cruisers and 93 destroyers, together with other miscellaneous craft.

Air Chief Marshal Sir Trafford Leigh-Mallory commanded the Allied air component of the expedition, which amounted to 4,900 fighter and 5.800 bomber aircraft grouped into tactical air forces. The strategic air force under Air Chief Marshal Sir Arthur Harris, consisting of R.A.F. bomber command and the 8th and 15th U.S. air forces, remained directly responsible to the combined chiefs of staff, though Eisenhower was authorized to call upon it if needed.

Supplies for this colossal undertaking had been accumulating in the United Kingdom since 1942. By June 1944 the monthly import had reached a total of 1,900,000 tons, and for the invasion 2,500,000 tons were required additional to normal loads carried by the troops themselves. Delay in the acquisition of a major port to handle this tonnage had been foreseen, and to meet this need a novel expedient was devised: two artificial harbours, called Mulberries. with breakwaters, quays and piers, each with the capacity of a medium-sized modern port, were prefabricated in the United Kingdom. These mere to be towed across the channel (a major naval operation) and assembled at two sites on the landing beaches, one for the U.S. forces and one for the British.

Further to ensure secrecy during the preparatory stages for "Overlord," an embargo was placed upon the movement of diplomatic personnel and upon their communications with their several foreign offices.

2. Western Europe before Invasion. — In western Europe, by June 1944, the Germans had about 60 divisions, or about a quarter of their total field force, under Field Marshal Gerd von Rundstedt; and of this force, 36 infantry and 6 panzer divisions were located in the coastal area facing England. The German 15th army held the Pas-de-Calais, where the main Allied assault was expected, and this error of judgment, which the Allies sedulously fostered, was to prove a major factor in the German defeat in Normandy. The 7th army, under Rommel, was located in Normandy, where the Allies actually landed, and consisted of one panzer and nine infantry divisions.

Against an invasion, the Germans had built their "Atlantic wall," which, according to Hitler. consisted of "a belt of strong points and gigantic fortifications from Norway to the Pyrenees." Along the beaches were successive rows of varying obstacles, some lying under water and many with mines attached to them.

During the spring of 1944, the Allied strategic air force concentrated its effort against European synthetic fuel plants and crude oil refineries, reducing production by 95% by the summer. Subsequently, it began directly to pave the way for the invasion by attacking bridges over the Seine and the Loire on road and rail routes leading into the area of operations, thus isolating the area so that the Germans would not be able to reinforce it.

For several months before the invasion, however, the British government and chiefs of staff had been mystified by the appearance on the French coast, particularly in the Pas-de-Calais, of several unidentifiable erections. It was thought that they were connected with some form of missile to be used against targets in England. and they were heavily bombed. They were, in fact, launching sites for "Hitler's secret weapons." the jet-propelled pilotless aeroplane (V–1) and the rocket bomb (V–2). The heavy bombing of the sites undoubtedly delayed the initial launching of these weapons until June 13, without which delay they might have disrupted the British war effort by making London uninhabitable or at least have caused havoc to the invasion plans and postponed its launching for several months.

The Germans launched about 18,000 V–1s between June 13, 1944, and March 29, 1945, of which 7,840 were fired at England (4,260 of these being destroyed in the air) and the rest at targets on the continent. Between Sept. 8, 1944, and March 29, 1945, they fired 3,000 V–2 rockets, of which 1,250 were directed at England and 1,750 at Antwerp in Belgium. These weapons collectively caused about 31,600 casualties in England and at least as many on the continent.

3. Beginning of the Assault. — During the weeks preceding D-day (as the date fixed for the invasion was called), the vast Allied armada of ships and landing craft had been assembling at every port, great and small, along the south coast of England. Concurrently the massive assaulting forces had been approaching that coast. During the last few days, the complicated task of loading them began. The Allied air forces had done their work so well that practically no hostile aircraft appeared over the area.

On June 4, rough weather in the channel forced Eisenhower to postpone D-day to June 6. At 1:30 A.M. on June 6, then, parachutists of the U.S. 101st and 82nd air-borne divisions began to drop beyond Utah beach and others of the British 6th air-borne division to drop east of the Orne river. Shortly after midnight R.A.F. bombers started to unload 6,000 tons of bombs on coastal batteries between Cherbourg and Le Havre. As day broke, U.S. heavy bombers dropped 3,000 tons on the shore defenses during the half-hour preceding the landings. Then medium, light and fighter bombers swarmed in to attack individual targets among the defenses. Again because of what the air forces had done during the preceding months, the Germans reacted little in the air.

The first troops disembarked at 6:30 A.M. under a heavy supporting fire of naval guns as well as of tanks and artillery pieces firing from tank-landing craft. Although still heavy, the sea had moderated; but some of the craft mislanded. partly because of the force of the current. First came tanks, some with jettisonable flotation attachments, but most of this type were lost. Next came infantry to cover the engineers and naval crews who were to blast gaps through the beach defenses, and then came successive waves of the assault infantry with their supporting weapons. Heavy resistance at some points caused serious losses to the assault waves; but the attacking forces stormed their way through the defenses, and by nightfall the five sea-borne assaulting divisions were firmly ashore. Integrating their efforts with those of the ground and naval forces, aircraft of all types contributed in large measure to the success of this critical day.

Differences between the German commanders, Rundstedt and Rommel, on the conduct of the defense also contributed much to the Allied success. Rommel wanted to destroy the invaders on the beaches, Rundstedt to check and to contain them and then to deliver a series of well-prepared counterattacks. Rommel, however, had his way; but, pinning his faith on the coastal fortifications, he had prepared few inland defenses and used his immediate reserves piecemeal in an effort to kill the invasion in the forward area. Once the Allied troops breached the Atlantic wall, he could never collect a mobile reserve large enough to endanger the beachheads. Moreover the preliminary isolation of the battle area by the Allied air forces prevented his receiving any further reinforcements speedily.

Attacking through difficult hedgerow country, the British and Canadians pressed on toward Caen, taking Bayeux on June 7. The U.S. forces worked down to join up the beachheads about Carentan. By June 11, one solid front had been established.

There followed six weeks of gruelling fighting in which the Allies expanded the lodgment area and built up forces for their future break-out. The U.S. 7th corps cut the Cotentin peninsula on June 17 and, pushing northward, captured Cherbourg nine days later after heavy fighting; but the port's installations had already been thoroughly demolished by the Germans and unloading could not begin until July 19. Meanwhile the Mulberry harbours, having been towed across the channel, were being assembled on the beaches; but a heavy storm on June 19 completely wrecked the Mulberry serving the C.S. beaches, although that serving the British was repaired and kept in service until Antwerp became available in November. Throughout the summer months, the major passage of reinforcements and supplies was over the beaches or via this Mulberry; during the first six days of the invasion 326,000 troops, 54,000 vehicles and 100,000 tons of supplies passed along these routes, and by November the totals had reached 2,628,240 men, 549,664 vehicles and 4,522,192 tons.

During the latter days of June the British maintained their pressure toward Caen despite desperate but piecemeal efforts of German armoured units which revealed the German resolve to prevent, at all costs, a break-through up the Seine valley toward Paris. Caen fell on July 9, and after the capture of Cherbourg the U.S. 7th corps turned toward the south with the U.S. 8th and 19th corps and cleared the Cotentin peninsula. On July 18 St. Lô was taken. (A. W. LE.)

The moment had now arrived for a break-out from the lodgment area. Eisenhower decided to put to good account the German tenacity on the east flank by continuing to punch hard in that region and following with a smashing right-hand blow. Preceded by a powerful air assault by bombers and lighter aircraft, on July 18 British and Canadian forces renewed their drive in the Caen area. Dogged resistance was aggravated by bad weather, but on July 25, again preceded by a powerful air bombardment, the attack of Bradley's forces against the Germans beyond St. Lô was launched. Complete success was achieved; Coutances mas captured on July 28, parts of several German divisions being cut off to the north. Only now, too late, did the Germans recognize the Allied main effort and decide to bring reinforcements to this region from the army which had been retained in the Pas-de-Calais.

Patton's 3rd army officially came into existence on Aug. 1 when he took command of the U.S. 8th, 12th, 15th and 20th corps; the 5th. 7th and 19th corps remained with Lieut. Gen. Courtney H. Hodges' 1st army, both under Bradley's 12th army group. Crerar's Canadian 1st army had become operational on July 23, and Crerar now commanded the British 1st and Canadian 2nd corps on the east flank, which, with Dempsey's British 2nd army, formed Montgomery's 21st army group. On Sept. 1 Eisenhower was to assume personal direction in France of all operations, at which date the supreme headquarters, Allied expeditionary force (S.H A.E.F.), was established officially on the continent.

Pouring through the breach in the St. LB-Coutances line, the 3rd army seized Avranches on July 31 and, in a swift amputation of the Breton peninsula, reached Nantes on Aug. 10.

With the collapse of the Germans on the west flank, Eisenhower decided once more to adapt his plan to his opportunities and, despite his need for the Breton ports, to turn his back upon them and make a wide encirclement of the German 7th army and panzer group (west), which were still, with great obstinacy, holding their ground. Leaving to his 7th corps the task of reducing the Breton ports, Patton in a rapid advance overran Mayenne, Laval and Le Mans and on Aug. 13 reached Argentan.

As part of the manoeuvre, the U.S. 1st army and the British forces had maintained their pressure from the north and west. In a desperate effort to checkmate this offensive, on the express instructions of Hitler himself, Field Marshal G. von Kluge, who had succeeded Rundstedt, launched a major armoured attack. supported by infantry, from the Mortain area toward Avranches with the hope of cutting off Patton's army from the rear. Prepared for the blow, Bradley attacked the flanks of the moving German columns; and at the same time the Allied air forces blasted them from above

After this failure the Germans strove desperately to hold open the gap between Falaise and Argentan in order to extricate the forces caught in the pocket which the Allies were steadily squeezing; but by Aug. 22 the pocket was eliminated, the Polish 1st armoured division having distinguished itself in this operation. Although many were able to escape, the Germans lost 500,000 men (mostly captured) and a great proportion of their equipment, and their 7th army was virtually annihilated as an organization. An interesting feature of the rapid advance of the 3rd army was that the ground protection of its open right flank was carried out by the 19th tactical air command. Air power also played its part in the liquidation of the German 7th army by persistent attacks against its communications and by raking German columns as they retreated across the Seine.

4. Launching of Operation **"Dragoon."**—Meanwhile, on Aug. 15, Operation "Dragoon," the invasion of southern France, which had been agreed on at the Sextant conference in Cairo, Nov. 1943, had been launched. The demands of the operations in Italy, together with the necessity for transferring forces and landing craft for the cross-channel expedition, repeatedly overshadowed the plans for this invasion and finally occasioned its postponement from the originally planned date of early June. However, Eisenhower's needs for additional port capacity soon pointed to the desirability of the early capture of Marseilles. Moreover, such an operation would contain and destroy German forces which might otherwise oppose him and would also threaten the flank and rear of the main forces which already faced him.

Measures were taken to organize and arm large forces of French patriots who were to lend valuable support to Allied operations. On July 30, 1944, Lieut. Gen. Jacob L. Devers organized the 6th army group headquarters in Corsica; and Lieut. Gen. Alexander M. Patch was placed in command of the U.S. 7th army to carry out the landing.

After prolonged aerial attacks against the communications serving this region. on Aug. 15 at 8 A.M. the 7th army, escorted by a powerful fleet of British and U.S. warships and under their gunfire, landed on the beaches between Cap Cavalaire and Agay. the area which offered the most favourable approach to the RhBne valley. The assault forces consisted of the U.S. 6th corps with the 36th division on the right, the 45th division in the centre and the 3rd division on the left, Most of the U.S. forces had been loaded at ports in the Naples area, the French forces at Oran, Taranto and Brindisi. A British-U.S. air-borne task force jumped astride the Ardens river west of St. Raphael the night preceding the assault and seized the pass through which the Allied forces would debouch.

It had been estimated that there were 11 German divisions in southern France, 2 of them armoured, but that only 3 would be ready to oppose the landing immediately. Weak resistance was in fact encountered, the beachheads were promptly established and the main forces moved west toward the RhBne valley.

On the heels of the 6th corps, four divisions of Gen. Jean de Lattre de Tassigny's French 1st army went ashore. By Aug. 28 Toulon and Marseilles were in Allied hands and by Sept. 1 Nice had fallen. Meanwhile, part of the 36th division headed directly north, seized Grenoble and turned northwest to cut off the Germans who were retreating up the RhBne valley. This drive into the rear of the German 19th army, already under pressure from the south. together with the havoc caused by the air forces, caused it to fall back in confusion. On Sept. 3 Lyons fell.

On Sept. 15, after effecting a junction with Patton's forces at Sombernon (northwest of Dijon), the U.S. 7th and French 1st armies, forming Devers' 6th army group, passed to Eisenhower's command.

5. The Advance to the German Frontier.—In northern France, meanwhile, the Allied armies were hard upon the heels of the retreating Germans. As Allied strategy called for the main effort on the northern flank, the Canadian 1st army in a rapid sweep isolated the channel ports, reaching Bruges on Sept. 9 and so overrunning the majority of the flying-bomb sites in the Pas-de-Calais. The channel ports themselves were captured as separate operations, Le Havre falling on Sept. 12, Dieppe on Sept. 1, Boulogne on Sept. 23 and Calais on Sept. 30. The British 2nd army, advancing on the right of the Canadian 1st army, took Amiens on Aug. 31 and occupied Antwerp virtually intact on Sept. 4, though the Scheldt was still in German hands.

The U.S. 1st army crossed the Seine, east and west of Paris, capturing Soissons. Then, turning east, it freed Namur on Sept. 5, Liège on Sept. 8 and Luxembourg two days later. Eisenhower had left to the French 2nd armoured division the honour of receiving the surrender of Paris on Aug. 25. In its pursuit, the

1st army cut off and surrounded large pockets of Germans between Compiègne and Mons, taking 25,000 prisoners. Simultaneously, the U.S. 3rd army swept eastward, capturing Reims and Châlons; then, overrunning Verdun on Sept. 1, it gained a foothold beyond the Moselle on Sept. 7. On their right was the U.S. 7th army, which had made a remarkably rapid advance up the Rhône valley. A continuous front thus now ran from the Netherlands along the French frontier to Switzerland and thence to the Mediterranean.

The Germans were now withdrawing into the defenses of the Siegfried line, the "West wall" covering the German frontier; but large forces were still isolated in France, of which one block of 20,000 surrendered along the Loire. French ports along the western channel and Atlantic coast were still in German hands, but Eisenhower made no attempt to reduce them after the experience at Cherbourg and Brest, where the Germans reduced the port installations to ruins. The U.S. 9th army under Lieut. Gen. W. H. Simpson was created on Sept. 5, and its 8th corps (2nd, 8th and 29th divisions) finally reduced Brest on Sept. 18. On Oct. 3 the 9th army took over a sector of the line between the 1st and 3rd armies.

Not only was the German resistance stiffening as Allied troops closed up to the West wall, but the unprecedented speed of their advance had caused them to outrun their supplies; so that slowly the armies came to a halt. Herculean efforts were made to maintain the flow of supplies from the Normandy beaches and Mulberry harbour along the ever-lengthening lines of communication. Aircraft were employed, and the famous "Red Ball highways," which consisted of an almost continuous line of vehicles operating throughout 24 hr. over certain arterial routes, were established. Fuel pipes were laid from depots in England under the channel to points on the French coast and were carried forward behind the troops as fast as the engineers could lay them. Collectively, these measures saved the day.

The Allied forces were now up against the German West wall defenses. On Sept. 17 a brilliant large-scale air-borne attempt was made to turn the northern flank of this position by the establishment of a bridgehead over the lower Rhine, about 60 mi. in advance of the Allied line. The 1st air-borne army had been formed on Aug. 8 under the command of Maj. Gen. Lewis H. Brereton, consisting of the U.S. 17th, 82nd and 101st and the British 1st and 6th air-borne divisions. On three previous occasions it had been intended to use this army to drop in the rear of the retreating Germans so as to cut them off; but the speed of the Allied ground advance had rendered it unnecessary. Now it was decided to employ it, in conjunction with the ground forces, for this Operation "Market-Garden." In "Market," the air-borne operation, the British 1st division was to be dropped at Arnhem to establish the actual bridgehead over the lower Rhine; the U.S. 101st division was to be dropped north of Eindhoven to secure the crossings over the Scheldt-Meuse canal; and the U.S. 82nd division was to be dropped below Nijmegen to seize a crossing over the Meuse. The whole operation entailed the dropping of more than 20,000 men with their equipment and vehicles by parachute, as well as nearly 14,000 gliders. In "Garden," the ground forces' operation, the British 2nd army was to advance over the crossings seized by the 101st and 82nd air-borne divisions and to join up with the 1st air-borne division at Arnhem. Initially, all went well, the ground forces linking up with the two U.S. air-borne divisions and advancing jointly to capture the Waal river bridge at Nijmegen. Meanwhile, the 1st air-borne division at Arnhem was fighting for its life to hold the bridgehead; after desperate and costly efforts to hold on, the remnants of it, now only 2,400 strong, were forced to withdraw, on Sept. 25, before the ground forces could link up with them.

Montgomery (promoted to field marshal Sept. 1) now turned to opening the port of Antwerp. With naval and air support, Canadian and British forces attacked South Beveland and Walcheren Islands at the mouth of the Scheldt and completed their capture on Nov. 9. The estuary was swept and the first ship unloaded at Antwerp on Nov. 26. This important step materially eased the supply situation. Appreciating its importance to the Allies, the Germans for many months maintained a harassing bombardment of Antwerp with flying bombs and rockets but were unable to prevent, or even seriously delay, unloading operations.

The U.S. 1st army entered Germany near Trier on Sept. 11, breached the Siegfried line north of Aachen on Oct. 2 and captured that German city on Oct. 21. South of Metz, the 3rd army fought its way across the Moselle, taking Nancy on Sept. 15. In the Vosges the 7th army came up abreast of it. But with the approach of winter unusually heavy rains set in.

With Antwerp operating, Eisenhower could now complete his drive to the line of the Rhine. By Sept. 30 German casualties were approaching 1,000,000 in number; but rather than maintain a flexible defense, the Germans once more elected to contest every foot of the ground, with the result that they were decisively defeated west of what would have been for them a formidable natural defensive line. Conversely they yielded to the Allies that barrier behind which the latter could, with relative impunity, concentrate their forces at any point they desired for the final assault.

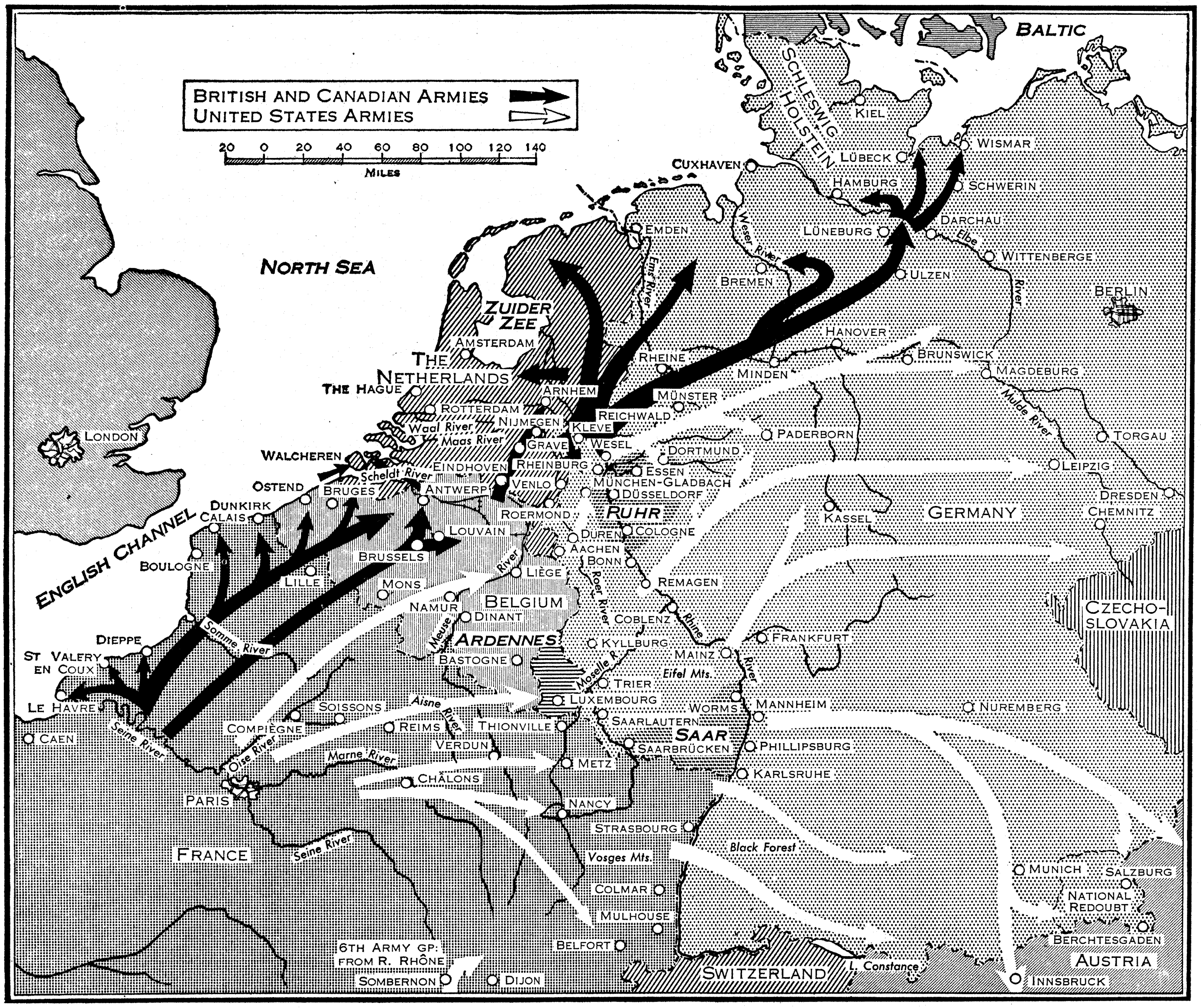
On Oct. 23 the 9th army was moved to the north flank of the 1st army and on Nov. 16 the 1st and 9th armies resumed their drive-toward the Rhine in the Aachen sector. Aided by powerful air support, U.S. troops in bloody fighting moved forward into Hiirtgen forest, and on Dec. 3 the 9th army reached the Roer (Rur) river. The Germans still held the series of dams higher up this river near Schmidt; and after air attacks had failed to destroy them, the 1st army on Dec. 13 undertook their capture lest the Germans, by releasing the waters, should flood the Roer at the moment of the 9th army's crossing.

East of Thionville the 3rd army had crossed the German frontier on Nov. 18 and reached the Siegfried line near Saarlautern. The last forts of isolated Metz finally fell on Dec. 13.

Belfort was captured on Nov. 22 by the French 1st army, which reached Mulhouse the same day; and the U.S. 7th army, which had reached the Rhine, took Strasbourg on Nov. 23. Between the prongs of the Allied advances at Strasbourg and Mulhouse the Germans were able to maintain a bridgehead west of the Rhine, known as the Colmar pocket, which was not liquidated until Feb. 1945.

6. The Counteroffensive in the **Ardennes.**—In order to make the powerful attacks in the Aachen sector and in the Saar, the Allied front had necessarily been left thin in some regions. This was the case in that sector of the Eifel hills between Monschau and the Moselle. It was there that Hitler decided to launch a desperate counteroffensive, presumably with the hope of capturing Liège and Antwerp and thus disrupting the Allies' supply system and severing their forces. Important, too, was the prospect of dampening the offensivedetermination of the Allied command. S.H.A.E.F. was alive to the possibilities of such an attack but felt that the German military leaders would hesitate to underlake a counteroffensive in this unfavourable terrain and with such faint hope of success. The Germans had taken meticulous precautions to ensure the secrecy of their preparations. Second-class Volksgrenadier divisions had gradually replaced panzer divisions in this sector, and the knowledge that the attack was to be made had been limited to a very few senior commanders.

On Dec. 16, aided by extraordinarily heavy fog, the Germans attacked. The first brunt of the assault was borne by the U.S. 4th, 28th, 106th infantry and 9th armoured divisions. Eisenhower at once alerted the army commanders to hold their free divisions ready for support if needed, and the 101st air-borne division was rushed into Bastogne, where it held out for five days. Eisenhower directed that the shoulders of the penetration be held, and all attacks elsewhere halted. Patton was to make a major counterattack in the direction Bastogne-Cologne. An attack by Montgomery from the north was to follow. A monumental piece of staff work was performed by the 3rd army, which, during a period of six days, broke off its general attack in the Saar region, faced to the left and mounted this new attack with six divisions, while Devers was instructed to extend his left flank to cover the front vacated by the 3rd army. By Dec. 19 the German penetration had become so deep as to impair Bradley's communications with



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SEINE TO THE BALTIC

his armies. Eisenhower therefore placed under Montgomery's command all U.S. troops on the northern face of the salient (the 9th and most of the 1st army), leaving to Bradley's control troops on the southern face.

The Germans in their attack used three armies, the 5th and 6th panzer and the 7th armies, including the 14th infantry and 10th panzer divisions. They also employed a panzer brigade using U.S. equipment with the mission of spearheading German combat units and spreading panic and confusion behind the U.S. front lines. Paratroops, dropped throughout the battle area as far to the rear as Paris, were to sabotage important bridges and headquarters. Although the penetration at its maximum reached a depth of about 50 mi. it never reached the Meuse; and since Bradley had not established any major installations east of the river in that region, this advance was not alarming. After the war it was learned from Rundstedt that the German high command privately conceded its failure when within 48 hr. it had failed to reach the Meuse. The prompt Allied measures proved successful, and by Jan. 25, 1945, the original front had been re-established. Simultaneously with this attack, Devers' 6th army group had also sustained a German assault. The net effect of the German effort was a delay in Allied operations of perhaps six weeks and a loss to the Germans of nearly 250,000 men, 600 tanks and assault guns and about 1,600 aeroplanes. The attack cost the Allies about 60,000 casualties. After this battle, the German 6th panzer army departed for the eastern front, taking seven panzer and three infantry divisions and virtually removing the last threat to the continuous advance of the Allied forces on the western front.

7. The Drive for the Rhine.—Eisenhower now resumed his manoeuvres to destroy the Germans west of the Rhine and to reach the banks of that river. These operations were performed in three successive steps: first, Operations "Veritable" and "Grenade," next, Operation "Lumberjack" and finally Operation "Undertone." On Feb. 8 "Veritable" was launched in difficult thaw and flood conditions resulting from the heavy January snows. Attacking from the Nijmegen area southeastward between the Rhine and the Meuse, the Canadian 1st army, in bitter fighting, forced its way through the Reichswald to the outskirts of Cleve and on Feb. 14 reached the Rhine at the site of the Allies' future major crossing. On Feb. 23, "Grenade" was launched. But before the U.S. 1st army captured the Roer dams (Feb. 10) as a preliminary to it, the Germans had opened the sluices of the Schwammenauer dam, causing the level of the Roer to rise about 4 ft. and thus delaying "Grenade" by 13 days. The 7th corps of the U.S. 1st army and the 19th and 13th corps of the 9th army crossed the flooded river, cleared Jülich and Düren on Feb. 24 and 25 and rapidly gained momentum. By March 1 the 9th army had cleared München-Gladbach and had reached the Rhine at

Neuss. This threat to ihe Germans' rear, coupled with frontal pressure, resulted in their withdra al across the Rhine of all units below Neuss.

The next operation was "Lumberjack," in which the 1st army advanced on the right flank of the 9th army; by March 7 it had captured Cologne. Farther south, on the same day; troops of the U.S. 9th armoured division seized an opportunity by crossing at Remagen the one bridge spanning the Rhine that the Germans had not yet demolished. Bradley mas ordered to put not fewer than five divisions promptly on the far bank. Despite the Germans' frantic efforts to retrieve their error, the 1st army on March 23, when the main crossings of the Rhine were begun, had three corps beyond Remagen in a bridgehead 25 mi. long and 10 mi. deep. On the right the 3rd army was pushing through the rugged Eifel hills, crushing the German front north of the Moselle; on March 9 it reached the Rhine just below Coblenz.

The third step was Operation "Undertone," a combined offensive by the U.S. 3rd and 7th armies. Instead of further exploiting the Remagen bridgehead. as the Germans might have expected, the 3rd army attacked southward across the hfoselle, behind them. in the Saar region; and on March 1j the Germans were attacked frontally by the 7th army. Zweibrucken and Saarbrücken were occupied by March 20, the Siegfried line defenses collapsed, and by March 22 Mainz had been occupied by the 3rd army. That night Patton sent his 5th division across the Rhine, and by March 25 all organized resistance ceased west of the river.

In all these activities the air forces had played a conspicuous part. Particularly in the Saar offensive the tactical air units effected noteworthy destruction upon German rail and road traffic. On Feb. 22 one single operation had involved nearly 9.000 aircraft from bases in England, France, the Netherlands. Belgium and Germany which attacked targets over an area of 250,000 sq.mi. extending from Emden to Berlin, Dresden, Vienna and Mulhouse. Their widespread blows struck minor communications facilities such as railroad signal points and grade crossings, canal locks and junctions. Against such attack the Germans could make no defense.

8. Crossing of the Rhine; the Ruhr Pocket.—Maintaining his main effort on the north flank, Eisenhower now forced the Rhine. Under Montgomery the U.S. 9th army and British 2nd army began their crossing at 9 P.M. on March 23 near Wesel. Shortly after the ground assault the Allied 1st air-borne army dropped the 18th air-bone corps (U.S. 17th and British 6th air-borne divisions) north and northwest of Wesel. On the left flank the Canadian 1st army guarded the Scheldt estuary and then followed the other two armies across the river. The whole operation was preceded by air attacks which severed all communications with the Ruhr. Since the Germans still had a number of jet aircraft which effectively assisted their defense, the airfields upon which these aircraft were being concentrated were heavily bombed from the air. The crescendo of air attacks reached a climax at the moment of the assault of the Rhine: from March 21 to March 24 British and U.S. air forces based in the United Kingdom and the continent flew more than 42,000 sorties against Germany.

The major crossing met relatively light resistance; contact was made promptly with the air-borne troops. Meanwhile, the U.S. 1st army attacked in the Remagen area and, breaking out to the southeast on March 26, raced toward Frankfurt. Farther up the Rhine the 3rd army crossed at several points and, clearing Frankfurt, joined hands with the 1st army in a plunge toward Cassel. On March 26 the 7th army crossed the Rhine near Worms and three days later captured Mannheim. On April 1 the French 1st army crossed the Rhine at Phillipsburg.

Now occurred another brilliant operation which constituted one of the outstanding military successes of the campaign. Racing toward Munster, the armoured elements of the 9th army swung round the north flank of the Ruhr and near Paderborn made contact with 1st army elements which had swept round the south flank of that area, thus trapping within the industrial heart of Germany the whole of the German army group C and two corps of the army group H. On March 30 the 15th army under Gerow had moved into the line along the Rhine opposite the Ruhr. Leaving strong forces to contain and reduce the defenders in the Ruhr, the 9th and 1st armies swept eastward and. with this huge operation still continuing at their backs, maintained their momentum toward the Mulde and Elbe valleys. On April 18 the Ruhr pocket was finally liquidated; German prisoners totalled 325,000, including 30 generals.

9. The German Collapse.—As the Russians were now at the gates of Berlin. Eisenhower decided to throw the weight of his advance toward Leipzig and thus cut the remainder of Germany in half. Jena. Chemnitz and Leipzig fell, and on April 18 the Allied armies set foot in Czechoslovakia. On April 25 patrols of the 273rd regiment, 69th division, jth corps, of the U.S. 1st army met Russian patrols in the vicinity of Torgau on the Elbe, thus effecting the junction of the eastern and western Allies.

Meanwhile, Montgomery's forces were sweeping the north German plains. The British 2nd army crossed the Weser and reached the Elbe on April 19, Bremen was captured on April 26 and Hamburg one week later. Pushing northward through the Netherlands, the Canadian 1st army cleared the area east of the Zuider Zee by April 21. Arnhem fell on April 1j, and the Germans withdrew into Fortress Holland beyond the Grebbe and New Water defense lines which had been built by the Dutch before the war. Had they been pursued there they would have opened the dikes. Eisenhower therefore reached an agreement with Arthur Seyss-Inquart, the nazi commissioner for the Netherlands. on April 30, whereby the Allied forces were to stand on the Grebbe line and the Germans were to cease flooding the country and to allow the introduction of food to the Dutch by land, sea and air. No further progress was made in the western Netherlands until the German troops surrendered simultaneously with those in northern Germany.

Covering the right flank of the 12th army group, the 7th army in early April pushed through Schweinfurt to Nuremberg, where stiff fighting delayed its fall until April 20. Karlsruhe fell to the French 1st army on April 4, Kehl on the 15th; and the Germans along the upper Rhine retired to the Black forest.

Evidence had reached S.H.A.E.F. that the German government intended to leave Berlin and to seek refuge in the "national redoubt" in the Berchtesgaden area. Into this mountainous region Eisenhower directed the 6th army group. On April 30 the 7th army captured Munich. Berchtesgaden and Salzburg fell on May 4. By this swift advance the possibility of resistance within the redoubt was dissipated. On the same day. elements of the 103rd division. 6th corps, which had pushed through Innsbruck and the Brenner pass to Vipiteno in Italy, met the 88th division of the U.S. 5th army.

Simultaneously, the French 1st army broke through resistance in the Black forest and pushed along the southern,boundary of Germany to Lake Constance, making contact with the 7th army at the western end of the redoubt. Farther east the western Allies had extended their contacts with the soviet forces.

Meanwhile. back in France. the French forces with powerful air assistance had on April 14 launched an attack against the Germans resisting at the mouth of the Gironde. which was cleared with the reduction of the island of Oltron on May 1. St. Nazaire and Lorient held out until the final surrender of the German army.

Hitler having disappeared, the German forces surrendered piecemeal. On May 5 Adm. Hans von Friedeburg arrived at Reims to represent Adm. Karl Donitz, who had taken over the direction of the German state. Gen. Alfred Jodl arrived the following day. Friedeburg and Jodl attempted to play for time in negotiating the surrender, presuinably to allow the remaining German forces to surrender to the western Allies rather than to the Russians; but under the threat that Eisenhower would seal his front within 48 hr., Donitz authorized the acceptance of Eisenhower's demands for unconditional surrender. At 2:41 A.M. on May 7 the act of surrender was signed by Jodl. to become effective at midnight May 8–9. This act mas ratified at Berlin on the night of May 9.

Casualties in these operations for the reconquest of Europe were heavy, the Germans losing in the region of 80,000 dead, 265,000 wounded and probably a considerable proportion of the

500,000 reported missing before the German surrender. Allied casualties were also heavy, amounting to approximately 187,000 dead, 546,000 wounded and 110,000 missing.

10. Summary. — Among the purely military reasons for Germany's defeat, the following are perhaps the most noteworthy: (1) faulty appreciation of the Allied intentions, which arose partly from Allied air superiority and partly from a fostering of the German error by the Allies before the landing in Normandy; (2) the destruction of German war industries and communications by Allied air forces; (3) the initial German failure to provide defenses in depth in Normandy, with the result that, once the Atlantic wall had been breached such reserves as mere available had to be used piecemeal; (4) the German stubbornness in fighting for every mile of ground, at tremendous expense of men and materials, which they could ill afford; (5) superior generalship, inexhaustible supplies and meticulous planning on the part of the Allies; (6) the two-front war, which Hitler himself had originally condemned but subsequently brought upon himself.

(T. N.; A. W. LE.)

III. THE CHINESE-JAPANESE WAR (1937–45)

A. PRIOR TO PEARL HARBOR

The overt act which made the Chinese-Japanese war inevitable was the Mukden incident of Sept. 18. 1931, when Japanese garrisons in the vicinity of that important northeast city forcibly took over control from the Chinese authorities. But this incident was only a manifestation of a long-planned Japanese policy for continental Asia which became evident after the Chinese-Japanese War of 1894–95. This war resulted in Japan's occupation of Korea and gave the island empire a foothold on the mainland.

1. Background of War.—After the Russo-Japanese War of 1904–05, Japan officially proclaimed the annexation of Korea. At the same time it began to exploit China's three northeastern provinces, obviously with a view to converting them into a base for the establishment of its continental empire. In the wake of World War I, Japan extended its control from the northeast to north China. At this time it acquired a mandate over the German islands in the Pacific which it began to fortify. Thus, with the simultaneous execution of Japan's twin programs of northward and southward expansion, what were later publicized as the New Order in East Asia and Sphere of Co-Prosperity in Greater East Asia gradually assumed physical shape. Because of abundant coal and iron deposits and the agricultural products in the northeast which Japan needed, together with its available manpower, in order to fight for world hegemony, the northeast became the first victim of Japan's ambition for territorial conquest. But no sooner had it considered its exploitation of the northeast complete, than it began to proclaim that north China was its "lifeline."

The Japanese adopted a policy of divide et *impera* in interfering with political and military affairs in China, Throughout the years of internal strife after the inauguration of the republic, Japanese intrigue or instigation in one form or another was always present. The Northern Punitive expedition, led by the Chinese Kuomintang, came to a successful end in 1928, and two years later national unification, though in crude outlines. became a reality in China. A unified China, however, was anything but agreeable and tolerable to Japan. The foreign policies of European and American nations were none too harmonious following the world economic depression of 1929 Capitalizing on this situation, Japan took a Sold step forward and invaded the northeast on Sept. 18, 1931.

After taking Mukden, Japan adopted an attitude of caution and "pulse feeling." Not being prepared for the invasion, China, on the one hand, offered what resistance it could muster to the onslaughts in Heilungkiang (northernmost province) and other places. On the other hand, it tenaciously maintained its adherence to the League covenant. the Nine Power treaty and the Anti-War pact and appealed to the League of Nations and the world at large.

In a proclamation to the world on Nov. 14, 1931, China pledged full support of the "sanctity of treaties" and urged the friendly nations signatory to the various pacts to "fulfill their obligations undertaken thereunder in order that peace in the Far East and the world may not be endangered by Japan and that international justice and humanity may not be bludgeoned into submission by brute force." For China was thoroughly aware of Japan's designs. Consistently it warned the world that the northeast issue and the Sino-Japanese conflict constituted a vital, integral part of the over-all problem of world peace.

China demanded the application of articles xv and xvi of the covenant of the League of Nations, which would mean imposing economic sanctions against Japan, but without success. As the second choice, article x of the covenant was invoked. The result was the organization of the Lytton Inquiry commission of the League of Nations.

On the eve of the arrival in China of the commission, Japan moved again. It occupied still more cities and towns in the northeast. It started hostilities in and around Shanghai (Jan. 1932) in an attempt to menace the Chinese national capital. Determined resistance by the Chinese brought Japan to the bitter realization of the futility of intimidation. So it signed an agreement with China for cessation of hostilities in and around Shanghai.

Frustrated in the south, Japan turned its attention to the north. In March of the same year, it established puppet Manchoukuo at Changchun, northeast railroad centre, with Henry Pu Yi, last emperor of the deposed Ching (Manchu) dynasty. on the throne. In addition, under Japanese instigation and coercion, a puppet Mongolian autonomous government appeared in Inner Mongolia.

Meanwhile, the general attitude of the League of Nations was one of appeasement and timidity. It was slow to act. Worse still, the proposal of Henry L. Stimson, then U.S. secretary of state, which called for an appeal to the Kine Power treaty and the adoption of joint action by the member states, brought no response from the powers in Europe. The impotency of international treaties and the League structure made Japan all the more audacious.

Thus, the existing peace structure, the League of Nations, was flouted by Japan. Then the inevitable took place. Other aggressive, ambitious nations were encouraged to follow suit. Benito Mussolini invaded Ethiopia. Adolf Hitler marched into the Rhineland, annexed Austria and dismembered Czechoslovakia.

China, although nor. adequately equipped to wage a major war, was nevertheless impelled to hasten its preparation for such an eventuality. In so doing it had to trade space for time. For instance, in the hostilities of 1933, despite the desperate resistance of its soldiers, China had to yield the provincial seat of Jehol, Chengteh and the Great Wall region to the invading Japanese.

In this interval, Japan feverishly pushed forward its program of "specialization of North China," while China applied itself assiduously to consolidating its national unification. With national defense as their objective, the Chinese renovated the army, developed an air force, improved ordnance by maximum possible standardization of arms, unified the national currency through the adoption of a *fapi* (legal tender) policy and within two and a half years rushed to completion the Canton-Hankow railway, beating a schedule which called for four years.

2. The **Loukouchiao** Incident. — At this moment, Koki Hirota, Japan's foreign minister, adopted toward China a three point program for "readjustment" of Sino-Japanese relations. Under point one. "abandon the policy of playing one foreign country against another," Japan demanded that China recognize the existence of Manchoukuo and its relation to Japan as protégé.

Point two, "iointly devise effective measures for preventing the spread of communism," was a demand for the privilege of stationing troops in certain northern provinces, apparently aimed at the U.S.S.R. It was tantamount to a Sino-Japanese military alliance in the cloak of "joint defense against Communism," which would have pressed China into the aggressor camp as a satellite. Hirota's third point, calling for "economic co-operation," aimed at expelling from China the economic Interests of Great Britain. the United States and other countries and giving Japan a monopolistic position in their stead.

In order to maintain a national independent existence while upholding international justice and the interests of all friendly nations in China, the Chinese government flatly refused to consider these three points. This taxed further the "endurance" of the Japanese samurai. Encouraged by the ever-deteriorating situation in Europe and the mounting influence of noninterventionism in the United States, Japan took another determined step forward and precipitated the Loukouchiao (Marco Polo bridge) incident.

On July 7, 1937, a party of Japanese troops held a large-scale manoeuvre at Loukouchiao, on the outskirts of Peiping, and, declaring that a soldier was missing, attacked the county seat of Wanping (at the southern end of Loukouchiao). The Chinese garrison resisted. The full-scale war which resulted was inevitable in view of the fact that Peiping, besides having been the Chinese capital for about 700 years, was the centre of Chinese culture and civilization and a vital strategic base in north China.

In a statement made at Lushan, Kiangsi province, on July 17, to the nation's leaders in all walks of life, who had been invited to the famed summer resort for consultation on important problems confronting the nation, Generalissimo Chiang Kai-shek proclaimed the "arrival of the stage where it is impossible to avoid the inevitable." The generalissimo specifically defined the mar as "a war between right and wrong, between good and evil, between right and might, between justice and brute force, between the treaty abider and the treaty violator." He further asserted: "Once war has begun there will be absolutely no premature cessation or compromise. For we should realize that terms for such an alternative will be nothing but terms for a total surrender and destruction of the nation." Again, in his message of Oct. 10, 1937, to the people of China, Generalissimo Chiang called their attention to the fact that the war was one of "seeking life from the jaws of death" and that it "can by no means be concluded within a short time."

Thus, with a determination steeled by indignation and the fight for survival, China went into the war. This determination sustained it through the more than eight years of hard and bitter fighting.

3. Strategy. — That China had to fight a long-term war was decided on the outset. This determined its strategy of attrition. In view of the lack of time necessary for building up coastal and river defenses, the shortage of both heavy industries and heavy armament, the deficiency of the air force, a loosely knit transportation system founded on inadequate means of communication and the slowness and difficulties in obtaining foreign aid, the Chinese supreme command took the vital decision that the Chinese should not fight decisive battles in the coastal and river regions but should fight city by city and town by town, thereby luring the Japanese into deep inland penetrations. This strategy, not only wearing down but also spreading thin the Japanese strength, was known as magnetic warfare.

Quite the reverse was the Japanese strategy. Encouraged by the easy success of their earlier adventures and whetted by sheer arrogance, the Japanese militarists were confident that the China campaign would not last more than three months. Following the conquest of China, they calculated that they could make use not only of their victorious forces but also of the newly subjugated manpower and material resources in their coming struggle for world hegemony. The Japanese, therefore, adopted a strategy of "a quick, decisive war" during the initial stage of the conflict. This strategy gave way to that of "a quick peace, a quick end" when Japan found China as undaunted and stubborn as ever despite the loss of Nanking, its national capital, and Wuhan, its heart. Japan, therefore, tried to employ all means and devices to entice China into a negotiated peace. This attempt, however, failed. And in view of the rapidly changing world situation, the Japanese strategy for the third stage of hostilities changed again into that of "a war to sustain war." This strategy was accompanied by the much-vaunted mopping-up warfare. Comparable to task force operations, this latter strategy called for grouping of a sizable force to launch surprise attacks on vital strategic points, its main tasks being the dislodging of field forces. the nullifying of counteroffensive preparations and the plundering of materials. Such strategy was resorted to only when there was a shortage of military strength for distribution and when the best defense was offense.

To meet the strategic changes of Japan, Chinese strategy also varied in formula from stage to stage, but its fundamental principle remained unchanged. Without grasping this fact, there can be no true understanding of the evolution of the various battles during the Chinese-Japanese War.

During the first days of the war, when the Japanese employed the strategy of a quick, decisive war, China avoided, wherever possible, large-scale, decisive battles. This was because Chinese military preparations in north China were yet incomplete, and Japanese heavy armament could easily be brought into full play on the vast plateaus there. Furthermore, the Japanese Kwantung army with its base in the already occupied northeast would have no diffieulty in furnishing reinforcements. When the Japanese drove westward into Shansi province, however, the Chinese were not hesitant to hit back and, in an east-west flanking assault in September in the vicinity of Pinghsingkwan (one of the Great Wall passes in northeastern Shansi) pounded the invaders severely. In Oct. 1937 three Japanese divisions, including two crack Kwantung army divisions, were dislodged from their stronghold, Sinkow, on the north-south Tatung-Puchow railway, after suffering numerous casualties. When the Japanese fought back with large reinforcements, the Chinese withdrew to their bases in the Taihangshan and Chungtiaoshan ranges and clung like barnacles to the south Shansi triangle, which placed them in control of the four rail lines, the Peiping-Hankow, the Lunghai, the Chengting-Taiyuan and the Tatung-Puchow. These lines were used as bases for harassing and counterattacking the Japanese from behind. Another portion of the Chinese forces, following the loss of the northern section of the Tientsin-Pukow railway, retreated into the mountains south of Shantung and controlled the basins of the Yangtze and Huai rivers in anticipation of future fighting.

China also offered stout resistance to the Japanese invasion of Shanghai on Aug. 13, 1937. In this unfortified region, the Chinese defenders stood their ground for three months in defiance of the combined onslaught of the Japanese land, navy and air forces. Time and again reinforcements arrived from Japan, totalling approximately 200,000 men. The Chinese retreated only after having exacted a large toll from the Japanese. China, too, paid very heavily in men. The battle, nevertheless, had a tremendous bolstering effect on the morale of both the fighting services and the civilians throughout the country.

4. Fall **of** Nanking.——With Shanghai and adjoining Woosung in their pocket, the Japanese rumbled westward by land and by river and, with their mechanized units, swooped down on Nanking, allowing the Chinese front line troops little breathing spell to regroup themselves. They took Nanking on Dec. 13, 1937, and plunged into the biggest slaughter ever known in human history. Even civilians were roped together and mowed down by Japanese machine-gun fire for sport. Shocking crimes were committed against women. Hardly any female, nith the exception of some of those concealed within mission compounds, escaped violation. Even the very aged and the very young received no mercy from the invaders. What was worse, a great many were ruthlessly butchered after they had been raped. This wrote, in every sense of the term, the blackest page in the modern annals of mankind.

China appealed to the League of Nations on Aug. 30, while hostilities were going on in and around Shanghai. On Oct. 30 the member nations signatory to the Nine Power treaty met in Brussels, Belg., but came to no agreement. The British ambassador, Sir Hughe Knatchbull-Hugessen, while travelling on the Nanking-Shanghai highway on Sept. 7, was machine-gunned by Japanese planes near Wusih (industrial town on the Nanking-Shanghai railway).

A similar incident occurred on Dec. 12, when the U.S.S. "Panay," Yangtze river gunboat, was bombed and sunk by Japanese planes near Wuhu (rice town in southern Anhwei). These incidents well reflected Japan's defiance of the United States and Great Britain.

On the eve of the fall of Nanking, the Japanese sent peace overtures through the German ambassador, Oscar P. Trautmann, but these were rejected flatly by the Chinese government.

To show its determination to fight the war to the end, even over a long period, China at this juncture announced the removal of the government to Chungking, 1,200 mi. up the Yangtze from Nanking. On the night before he evacuated Nanking, Generalissimo Chiang Kai-shek in a press statement asserted that in entering Nanking the Japanese were inviting ultimate defeat. By that he ruled out completely the possibility of peace negotiations.

China, naturally, suffered a grievous blow in the loss of its national capital. Most of its troops, notwithstanding, succeeded in redeploying themselves in western Chekiang and southern Anhwei. These areas were held, till the end of the war, as bases of guerrilla warfare and counteroffensives against the Japanese rear. By virtue of its strategic location, Wuhan (the triple cities of Hankow, Wuchang and Hanyang) became the new headquarters of the Chinese supreme command.

5. Victory at Taierhchwang; Defeat at **Wuhan.**—In April 1938 Chinese forces in Shantung and Hopei, taking advantage of the opportunity of moving into the hilly region of southern Shantung, scored a major victory near Taierhchwang, on the Tientsin-Pukow line. Two Japanese ace divisions crumbled in the battle. The significance of this victory was that it restored the morale of the entire Chinese rank and file, which had been impaired by the fall of Nanking.

A Japanese drive was launched against Hsuchow (important rail junction in northern Kiangsu) in May in an attempt to destroy the bulk of the Chinese strength in that sector but the invaders fell short of their objective. The fact was that the Chinese main force, after having given the Japanese considerable mauling, had long since retired to predesignated hill bases in southern Honan and northern Hupeh.

Hsuchow won, the Japanese made for the Wuhan cities, still bent on the realization of their fond hope of a quick, decisive war.

According to the original plans of the Chinese supreme command, the Chinese were to build up their counteroffensive strength west of the Peiping-Hankow and Canton-Hankow railways and to bide their time for fighting a decisive battle against the Japanese. Chinese resistance, however, was to continue east of the two railroads by capitalizing on the topographical advantages of the region, thus making the invasion as expensive as it could be for the Japanese and also trading space for time. Since Wuhan was the heart of China and a vital point on the Canton-Hankow railway and, moreover, since hills and marshlands were abundant on both sides of the Yangtze around Wuhan, it was decided to direct telling blows against the invading columns at the outer perimeter of the triple cities.

The Japanese offensive started in June 1938, with the navy blasting its way up the Yangtze to penetrate the Chinese river defenses. In a pincers movement, the invaders pushed one column from south of the Yangtze to attack the northern section of the Kiukiang-Nanchang railway with the object of covering the left flank as well as poising for a westward thrust. North of the Yangtze, the Japanese made a two-pronged advance. One prong wheeled westward along the river and another column fringed the northern foot of the Tapiehshan range on the Honan-Hupeh border in an attempt to seize Sinyang, on the Peiping-Hankow railway, and thus make a detour to the north of Hankow. The battle for the Wuhan cities began.

The Japanese lunge at Teian, on the northern Kiukiang-Nanchang line, was a costly failure, while on the north side of the Yangtze the invaders also received setbacks in a number of sectors. All in all, as many as 12 Japanese divisions were called in, with repeated regroupings and replenishments. On Oct. 25, 1938, after a campaign lasting four and a half months, the Japanese won control of the Wuhan cities.

Meanwhile, in south China, Canton, seat of Kwangtung province, also fell on Oct. 21 when the Japanese attacked the southern section of the Canton-Hankow line. This marked Japan's seizure of China's last seaport.

With the conclusion of the battle of Wuhan, the Chinese-Japanese War entered a new stage, in which terrain gradually became strategically favourable to China. The Chinese main strength retired to previously-built positions west of the Peiping-Hankow and Canton-Hankow lines. The supreme command moved to Chungking. Further westward penetration by the Japanese was prevented by hazards and dangers in the Yangtze gorges. The fertile plain of Chengtu, provincial seat of Szechwan, afforded a granary in the interior; and the Yunnan-Indo-China railway and the Burma road brought to China, though in dribbles, supplies from other countries, thereby sustaining the Chinese resistance.

Large Chinese forces, however, remained deployed in areas east of the Peiping-Hankow and Canton-Hankow railways, retaining strategic regions. To protect the left and the right flanks of Szechwan, the Chinese also massed considerable strength in the Siang river valley, north of the Yangtze, in Shensi west of the Yellow river (Hwang-Ho) as well as in the basin of Tungting lake (China's rice bowl) and mountainous western Hunan. In fact, vast territory behind the Japanese lines remained under Chinese control. South of the Yangtze, the Chinese held southern Anhwei, eastern Chekiang and areas in Fukien, Kiangsi and Kwangtung; on the lower reaches of the Yellow river, they retained hilly southern Shantung, most of the Huai river valley and certain areas north of the Yellow river; in north China, they preserved the southern Shantung triangle despite several unsuccessful Japanese penetrations. On top of all this, the Chinese held off the Japanese for six years in the Taihangshan range (eastern Shansi) and more than four years in the Chungtiaoshan range (southwestern Shansi).

All of the guerrilla operations to harass the Japanese rear were initiated by Chinese national troops which operated behind the Japanese lines or in adjacent areas. This Chinese strategy of advance through infiltration into the Japanese rear yielded excellent results. Its execution narrowed the Japanese occupation of any locality down to the extent of a point or line rather than a large piece of territory. Thus, even after the loss of a hsien, or county, the original magistrate could continue his official duties in the surrounding villages inasmuch as the Japanese occupied only the county seat. Likewise, the governor of a province would still be able to carry on his administration within his province even though his capital had been lost.

In the costly capture of Wuhan, Japan began to realize the difficulties of military subjugation. Therefore, the war cabinet under Prince Fumimaro Konoye changed to the program of a quick peace, a quick end. To that end, every artful stratagem was exploited; and, in order to slacken the Chinese army's will to fight, propaganda was dosed out that Japan was willing to cease fighting first. All these overtures of peace were spurned by the Chinese generalissimo.

Realizing that it could no longer hope for a negotiated peace, Japan, in the winter of 1938, entered into liaison with the Chinese arch defeatist, Wang Chinp-wei. Wang deserted from Chungking to the Japanese side, and March 1940 saw the inauguration of his puppet regime in Nanking and the conclusion of a Japan-Wang secret treaty. In these events the Japanese designs for establishment of a New Order in Greater East Asia were fully exposed.

Japan, on the one hand, tried to work for the disintegration of the central government in Chungking. On the other, beginning in May 1939, the Japanese carried out unremitting and indiscriminate bombing of Chungking and other cities in the interior.

China at this time was under most trying circumstances, both internally and externally. Its official invocation of articles xvi and xvii of the League covenant in Sept. 1938 had failed to bring any tangible result from the League except denunciation of the Japanese use of poison gas and adoption of a report urging the member states to abstain from any action that would weaken China. The League council meetings the following year, in January, May and September, again failed to achieve the collective application of article xvi of the covenant, aside from the passing of a resolution requesting the member states to "hold consultations to consider individually measures to aid China." As it was, China's only consolation was the branding of Japan as an aggressor.

What tormented China most at this juncture was the growing paucity of war supplies. Although it was capable of producing acceptable light arms and ammunition, there was an acute shortage of raw materials. Conversely, Japan, through its open sea lanes, shipped in all the U.S. scrap iron and metals and all the U.S. and Netherlands Indies gasoline it could possibly get.

Having attained its objective of blockading the south China coast through the occupation of Canton, Japan plunged headlong into the planned realization of its "Greater East Asia co-prosperity sphere" design. It occupied Hainan Island and the Spratley Islands, respectively, in February and March 1939. Upon the invasion of Hainan Island, Generalissimo Chiang Kai-shek sounded a warning to the world that it was "the 'Mukden Incident' of the Pacific," but it drew no attention from the nations concerned.

6. Situation After Outbreak of European War.—The outbreak of war in Europe in Sept. 1939 removed the big nations still farther from the far eastern arena. They strengthened their so-called appeasement policy and continued to give up pawns to Japan.

China, on the other hand, wavered not a whit in its determination to carry on resistance. In an address of the Chinese generalissimo before the People's Political council on Sept. 10 of the same year, he asserted: ". . . The Sino-Japanese conflict is not merely a world issue but one of the utmost importance. The present turmoil in the world is due mainly to Japan's wanton invasion of Chinese territory and violation of international pacts, thereby jeopardizing world peace. We of China are fighting to perpetuate our national independence and existence, and also to check the rise of international gangsterism, of which Japan is the ringleader, as well as to uphold justice and peace under the sun. In short, the Sino-Japanese war was the starting point of a general conflict, and is the real center of the present world-wide struggle." In that same year, on Oct. 29, the generalissimo declared at a military conference at Hengshan (southwest of Changsha, seat of Hunan province) that "we must fight on till the world war is ended and righteousness and justice fully vindicated, and only then shall we have attained our final victory."

In the continued execution of the appeasement policy of the big powers, Great Britain, on June 19. 1940, signed the Tientsin agreement with Japan and on July 18 declared closure of China's only remaining international outlet, the Burma road, for a period of three months. On the day following the signing of the Anglo-Japanese Tientsin agreement, France, too, concluded a Franco-Japanese agreement, which closed the Yunnan-Indo-China route of transit. On Sept. 22 an agreement mas concluded between Japan and Indo-China, permitting Japanese troops to enter Indo-China in three columns and to use the airfields in southern Indo-China as bases for bombing southwest China. On Sept. 29, in full appreciation of nazi Germany's military supremacy, Japan officially signed a tripartite pact with Germany and Italy.

Following a directive to stop the licensing of aviation gasoline shipments to Japan in August. the United States on Oct. 16, 1940, placed an embargo on the export of scrap iron and steel to the island empire. Two days later, on Oct. 18, the Burma road was reopened, after three months of closure. Not until July 1941, however, did the Netherlands Indies begin to stop shipping oil to Japan.

In this period, Japan was becoming increasingly aware of the futility of its plan for a quick peace, a quick end, and of the tremendous development of a global struggle. With the view, therefore, of conserving its military strength and, simultaneously, of exploiting the material and manpower resources in occupied China through the various puppet regimes, Japan reoriented its China program and decided upon a war to sustain war plan. This new program, as announced, was also one for long-term warfare, long-term reconstruction. In the northeast, fresh impetus was given to the development of the coal and iron industries. In the other occupied areas the Japanese established so-called national policy companies to issue paper currency and readjust taxation in order to absorb resources and materials.

Meanwhile, Japan's military blockade and pressure against Chungking continued. In the month following the outbreak of the European war (Oct. 1939), the Japanese staged a big drive on the Hunan capital, Changsha. But they were thrown back with heavy losses as the result of fierce Chinese resistance and encircling operations at the perimeter of the city. In November a fresh Japanese push started in south China, resulting in the occupation of Nanning, Kwangsi capital, and other localities in southern Kwangsi. However, in the ensuing encounters at Kunlunkwan, strategic mountain pass (northeast of Nanning), which culminated in the Chinese recapture of the pass and the Japanese retreat to the city of Nanning, the Japanese lost very heavily. (The Chinese regained Nanning in the following October and, three years later, in Oct. 1944, lost it to the Japanese again.) In May 1940, in order to remove the Chinese threat to the Wuhan cities. the Japanese started separate drives in southern Honan and northern Hupeh. Taking advantage of their mountainous positions in Tungpehshan and Tahungshan on the Honan-Hupeh border, the Chinese, in a flanking movement, sent the Japanese back.

But at that time the war situation took a critical turn. In June China lost Ichang, trading town in western Hupeh and gateway to the Yangtze gorges, thus giving the Japanese a greater threat against Chungking. Thereupon, in August, the Japanese subjected Chungking to successive, terrific air bombardments but again failed to break China as anticipated. Rather, the Chinese went on building industries in the interior in preparation for a protracted struggle.

7. Japan's Pre-Pearl Harbor Offensives.—In 1941, desirous of playing its part in the global theatre, Japan made repeated attempts to crush the Chinese field forces and eliminate the Chinese menace to their rear. In January they staged a fresh drive in southern Honan, throwing in huge forces. Chinese operations taking advantage of the mountainous terrain of Tungpehshan and Tahungshan again compelled the Japanese to retreat from Nanyang to the Sinyang sector on the Peiping-Hankow railway. A violent battle was fought in northern Kiangsi in March when the Japanese attempted to seize Shangkao, southwest of Nanchang (provincial seat), with the aim of clearing up the hilly northwestern part of the province, a mounting threat to the flank of the Japanese in case of a swoop on Changsha. The Japanese not only failed in this attempt but suffered greatly as the result of a Chines.: task force attack. In May the Japanese carried out another operation on the worst appendix behind their lines, the Chungtiaoshan range, against which they had during the preceding 5 years launched more than 15 unsuccessful attacks. This last appendectomy proved a success, but part of the Chinese defensive force broke through and infiltrated into the Japanese rear.

However, the Chinese remained hostilely entrenched in the Taihangshan range, an additional thorn in the flesh of the Japanese. Consequently, in Oct. 1941, when the Japanese in the Yellow river valley crossed over the flooded areas to attack Chengchow, key city in central Honan and rail junction of the Peiping-Hankow and Lunghai lines, they were intercepted and forced to retreat. This was partly because of frontal Chinese resistance and partly because of the harassing of the Chinese in the Taihangshan range, another testimony to the success of the Chinese strategy of advance through infiltration into the Japanese rear. In the same year, in September, the Japanese made another drive on Changsha but took another defeat at the beginning of October.

On April 13, 1941, Japan and the Soviet Union signed a neutrality pact. They mutually recognized Manchoukuo and Outer Mongolia. Two days later, Pres. Franklin D. Roosevelt declared that the United States had begun listing materials for China under the Lend-Lease act such as had been extended to Great Britain and Greece. He said: "China likewise expresses the magnificent will of millions of people to resist the dismemberment of their nation. China, through Generalissimo Chiang Kai-shek, asks our help. America has said that China shall have our help."

B. AFTER PEARL HARBOR

1. One World War.—The bold Japanese attack on Pearl Harbor in Dec. 1941 changed not merely the war situation of the world but also, in a much greater degree, the war situation in the far east. It marked the integration of the far eastern front and all other fronts into the global theatre.

In conformity with its consistent stand fcr international pledges and commitments, China on the day following the sneak Japanese attack declared war against the three major axis nations, Japan, Germany and Italy, Until this date China had not formally declared war on Japan lest the latter's belligerent status permit interception and seizure of China-bound military supplies on the high seas. There was no ground for such apprehensions now. Although the outbreak of war in the Pacific had a most stimulating effect on China, it entertained no overoptimism as to the conduct of the war during the initial stage. Rather, it was anticipating another interval of great tribulation.

Inadequate preparation in the beginning of the Pacific war caused a series of Allied reverses and setbacks—the successive fall of Guam, the Philippines, Hong Kong, Singapore and Rangoon. Not only was the Burma road closed, but the hostilities spread to China's back door, Yunnan province.

Its own difficulties and hazards notwithstanding, China assembled three of its crack armies, the 5th, the 6th and the 66th, which it had reserved for a general counteroffensive, and force-marched them to the Burma border to assist the Allied forces. Repeated negotiations with the Allied authorities gained the Chinese expeditionary force entrance into Burma and had it placed under the U.S. general, Joseph W. Stilwell. By that time the Japanese had already penetrated into Burma from Indo-China and Siam.

The Chinese on March 25, 1942, launched a vigorous offensive against the Japanese converging on Toungoo, important rail city in lower Burma. But because of the lack of time for developing an Allied air force capable of supporting ground troops and the disunity of Allied command coupled with army supply difficulties, the general battle order deteriorated into fighting by isolated units. The disparity between the Allied and the Japanese forces widened even more because of the latter's superior air might and easy sea supply. After a bitter defense of more than ten days the Chinese expeditionary force retreated because of lack of reinforcements.

Undaunted, the Chinese carried on the campaign on the Burma border. In the middle of April, at great risk, they rushed to the rescue of a besieged Allied force at Yenangyaung on the Irrawaddy river. After two days and nights of terrific fighting the Chinese breached Japanese defenses and reached the Allied troops, including several high-ranking commanding officers.

Western Yunnan was invaded when Lashio, Burmese terminal of the Yunnan-Burma highway (April 29), and Wanting, highway town on the Yunnan border, fell to the Japanese. Enormous losses were suffered by the Chinese expeditionary force, including the loss of Divisional Commander Tai An-lai of the 200th division. When the Burmese campaign was pronounced definitely lost, a part of the Chinese troops withdrew to Chinese soil, and another, led by Lieutenant Genera? Stilwell, retreated to Eedo on the eastern Indian border. This latter Chinese force, upon regrouping and training in India, later played a vital role in the Allied counteroffensive in Burma.

Generalissimo Chiang Kai-shek accepted supreme command of the China theatre of war on Jan. 3, 1942, and the Pacific war command was established in Washington, D.C., on March 30. Thenceforth, a more co-ordinated strategy was made possible between China and its allies.

Nevertheless, China's chief problem remained. It was the complete paralysis of its overland conimunication with the outer world and the inadequacy of its air transport. The most effective aid it received then was from the American Volunteer group (later known as the "Flying Tigers") formed in Kunming (Yunnan capital) by the U.S. Major General Claire L. Chennault in Aug. 1941. Scores of air victories were won by these airmen over the Kunming region, thereby reducing Japanese air raids on other interior cities. On July 4, 1942, the duties of the American Volunteer group were taken over by the 23rd fighter squadron of the United States army air force. In March 1943 the 14th air force of the United Stares army was officiaily inaugurated, and, by the latter half of that year, China had gradually gained control of its air domain.

2, New Japanese Objectives.—After the Pearl Harbor outrage the Japanese continued and intensified their war to sustain war program on the China front whereby Chinese resources and manpower were exploited to sustain Japanese military operations on other fronts. At this stage the Japanese war blueprint had a threefold objective: (1) to intensify its military blockade and blows against China; (2) to destroy the Chinese air bases in order to curb U.S. air activity in China; and (3) to make maximum exertions to put a corridor through the continent in view of the growing shortage of seaworthy vessels and the mounting U.S. air menace. The Chinese formulated a new operational plan aimed at smashing these Japanese objectives and thus achieving their twin objectives of protracted warfare and attrition. In the meantime, they tried to build up their combat strength, paving the way for a co-ordinated action with the anticipated Allied general counteroffensive.

Toward the close of 1941, Japan, intent upon accomplishing its first military objective as outlined above, pitted a large army against Changsha for a third time. Against this fresh drive the Chinese prepared a much better timetable than on the previous two occasions. The Chinese garrison in the city of Changsha stubbornly resisted the invasion, thus neutralizing large Japanese forces, while its own position remained firm and unshaken. Other Chinese units, deployed on the exterior lines, closed in on the Japanese in a counterencircling movement and gave heavy blows to group after group of Japanese reinforcements. On Jan. 15, 1942, came the wholesale debacle of the invading army after having suffered heavy casualties.

With a view to consolidating their hold on north China, the Japanese launched so-called mopping-up operations against the Chinese-held Taihangshan range in the summer of 1943. This was the third drive the Japanese had made against that region. Outnumbered and with their supply line severed, the Chinese gave up their mountain base in early August.

Simultaneously in western Hupeh, the Japanese, in heavy strength, lunged forward from the south side of the Yangtze, along the northwestern corner of the province, reducing the important pass of Yuyangkwan (southwest of Ichang). The Japanese push was aimed at a westward thrust against Enshih, war capital of Hupeh, thereby threatening Chungking, and also at a southward thrust against Changteh on the west bank of Tungting lake. The Chinese struck back, taking advantage of their mountainous positions, delivered a serious blow to the invaders and compelled them to retreat on May 31.

On Nov. 2, 1943, the Japanese massed a strength of more than 100,000 men and hurled them against Changteh in a full-scale attempt to seize the rice bowl of Tungting lake and to threaten the left wing of Changsha. Changteh changed hands several times but was finally retaken by the Chinese after five days. The battle ended late in December in favour of the Chinese. Japanese losses were high and, testifying to the severity of the fighting, the Chinese lost three division commanders. Effective Chinese air support was the most important factor for this victory; it was the first time throughout the China war, which had entered its 6th year, that as many as 280 interior-based bombers had been thrown into a single battle.

The Japanese northern Burma and western Yunnan campaigns were also integral parts of their general operations during this period.

In order to attain its second post-Pearl Harbor military objective'on the China front, the Japanese carried out widespread sorties and sweeps against the Chinese air bases, particularly those built for the U.S. air force. At a time when there was a critical shortage of machinery and instruments in China because of the Japanese blockade, construction of these air bases in many cases involved use of hundreds of thousands of labourers, and oftentimes several months were spent for the completion of a single base.

These bases presented a positive menace to the Japanese, all the more so since the Lieut. Col. James H. Doolittle raid on Tokyo, Yokohama and Osaka on April 18, 1942. The battle of the Chekisng-Kiangsi border in the summer of 1942, though in itself a mopping-up operation, was primarily designed to neutralize the largest seaboard airfield at Chuhsien in eastern Chekiang. Likewise, the Japanese objective in the drives on Suichuen and Kanchow in southern Kiangsi in Jan. 1944 was the destruction of the airfields in those localities. In addition, they sought to achieve full possession of the Canton-Hankow railway. The 35 days of fighting that ensued took a heavy Japanese toll.

In October of the same year, the Japanese attacked and took the twin Kwangsi cities of Kweilin and Liuchow, also because they were important strongholds of the Chinese and U.S. air forces. In May 1945 the Japanese threw their last stakes into an all-out assault on the Chihkiang airfield in western Hunan but underwent a disastrous defeat at the hands of newly trained Chinese ground forces supported by air operations.

As a necessary move toward the attaining of its third military objective in post-Pearl Harbor China operations Japan tried to gain full control of first the Peiping-Hankow line and then the Canton-Hankow line, thereby forming a corridor from the south to the north of China to be linked with the main military transportation artery of Indo-China and Burma. This need became all the more pressing to the Japanese in view of the extensive U.S. bombing operations in the Pacific theatre. Thereupon, the Japanese, at the end of April 1944, took Chengchow, Honan, strategic city on the northern section of the Peiping-Hankow railway, and, in May, fought into Loyang with the object of consolidating their defenses west of the railway. By June 17, 1944, they had won complete control of the entire line.

Moving toward its next objective, full possession of the Canton-Hankow railway, Japan brought up ten divisions early in May and threw them into what was its fourth drive on Changsha. The Hunan capital fell on June 19 as the result of a flanking movement by large Japanese forces from the east and west wings. Pushing south along the Canton-Hankow line, the invaders converged on Wengyang, important rail centre in southern Hunan, with good airfields. The Chinese garrison of rhe city, the 10th army, was ordered to make a determined stand at all costs in order to upset the Japanese military timetable for occupation of the entire length of a transcontinental line of communication. This lone Chinese force checkmated the Japanese advance for 48 days and fought virtually to the last man. The battle for Hengyang, though finally lost on Aug. 8, went down in hisrory as one of the most heroic defense actions in the Chinese-Japanese War.

Though the Japanese succeeded in occupying the whole Canton-Hankow line, the lack of time for repairs prevented through traffic even by the conclusion of the war. The four Changsha battles, the Hengyang defense and several major encounters on the Peiping-Hankow line, therefore, were closely related to the global war.

3. Shansi Front. — A summary of the Shansi front is essential before the general war situation in China on the eve of the all-out counteroffensive is described.

Ever since the Japanese invasion of Shansi and seizure of the Tatung-Puchow railway in 1938, practically the whole of western and northern-Shansi, with the exception of a handful of hsien (counties), had been under Japanese control. In reality, the contending forces kept a vigilant watch on each other across the Yellow river.

That the Japanese never pushed across the Yellow river for westward thrusts was the result of two causes. In the first place, such attempts would have made heavy claims on men and caused an overextension of their supply line. The other cause was purely political in character. The Chinese Communist party possessed armed troops, which at the outbreak of war hardly exceeded 10.000 men. When the hostilities began, the Communist party had announced its acceptance of the Three People's principles of Sun Yat-sen, its support of the national government and its obedience to the command of Generalissimo Chiang Kai-shek in the nation's united resistance to Japanese aggression.

The Chinese Communists participated in the battle of Pinghsingkwan in northeastern Shansi; but, after the Wuhan battle, they went counter to their promises. Insiead of obeying the supreme command, they tried to develop their own strength to be used in a future struggle for political power and to carry out their Communist revolution. For that purpose they made frequent attacks on national troops in order to seize weapons from them. Being fully preoccupied with the resistance campaign against a powerful foe, the Chinese government was unable to prevent such attacks. The Communist activities, therefore, sorely grieved the government. It was precisely with the purpose of exploiting and intensifying this internal strife in China that the Japanese had abstained from crossing the Yellow river and attacking Shansi province.

4. Increased **Air** Transport. — Besides devising effective measures to thwart the three major Japanese military moves in the post-Pearl Harbor period, China held to the strategy of protracted warfare pending aid fiom the Allies and, at the same time, reorganized and renovated its army in order to co-ordinate it with the future Allied counteroffensive. But everything hinged upon the reopening of international communication lines and the inflow of Allied arms and war materials.

From July 1942 on, U.S. supplies began trickling by air into Kunming, Chinese terminal of the China-India shuttle, via the Himalayan "hump." Not until the formation of the United States 14th air force in the following year, however, was there air cover or protection and a subsequent increase in air cargo tonnage. Hardships and hazards undergone by these "hump" fliers wrote a brilliant record of bravery and seif-denial. Most of the cargo flown in was aviation gasoline and equipment, which were sorely needed by the Chinese. There was no way of bringing in heavy arms, and only limited quantities of other arms were flown over the Himalayas. For these reasons, China pooled its resources with its allies to hack out the Stilwell road from Ledo on the eastern frontier of India to Yunnan and laid an oil pipe line through the entire length of the highway. It also fought a bitter battle to reopen the old Burma road and even had to fight for control of certain sections of the Stilwell road.

By then the United States had a fairly large and powerful air fleet based in China, and the huge airfields under construction in various places in Szechwan came into use one after the other. By 1944 China-based U.S. superfortresses were shuttling back and forth between China's interior and the Japanese empire on bombing missions. Contributory to the success of these raids was the intimate collaboration between the Sino-American Co-operation organization and the United States navy, which supplied military intelligence and reports on weather conditions along the China coast.

5. Japan's Last Adventure. — The Chinese army that was regrouped and trained by U.S. instructors for the general counteroffensive was composed of two portions. One portion comprised, in addition to the India-based Chinese troops as its nucleus, airborne men and officers selected for their good qualities from among various units within China. The second pcrtion consisted of a selected number of interior-based units transferred to Kunming and vicinity to be re-equipped and given intensive training by U.S. army personnel. Both were intended for performing China's role in a co-ordinated Allied counteroffensive against Japanese-held Burma.

Just as these picked troops were in training in Yunnan and the Chinese were still nursing their wounds sustained in the battle of Changteh, the Japanese, in the winter of 1944, drove with a powerful force into Kweichow from northwestern Kuangsi, heading toward Tushan, railroad and highway junction. The sudden and swift Japanese advance threatened the rear of Kweiyang (provincial seat of Kweichow) and China's war capital, Chungking. The Chinese fought back, making use of the favourable topography, and, by the beginning of December, forced the Japanese to retreat. Thus, the last Japanese adventurous move in China failed.

At that time Generalissimo Chiang Kai-shek sent out a "Join the Army!" call to the students of universities and secondary schools throughout China. It instantaneously brought to the colours nine divisions of students. This marked another forward step which China took to pit its strength against the Japanese in co-ordination with future Allied landings and counteroffensive operations against Japan.

China's 6 India-based divisions and about 10 Yunnan-based divisions (there were 36 divisions at the time of the Japanese surrender), in co-ordination with Allied forces, opened up well-timed assaults and counteroffensives separately in north Burma and western Yunnan.

On the north Burma front, they captured Maingkwan on March 5, 1944, and Kamaing shortly afterward. On June 26 they took Mogaung, important Japanese base in northern Burma, virtually putting out of existence the Japanese 18th division. Meanwhile, a Chinese task force, in collaboration with U.S. units, made a daring penetration against Myitkyina, important rail town in northern Burma, and in one swoop captured the city's airfield. The city itself fell on Aug. 3, thereby removing for the Allied air transport command the danger of Japanese air interception and the hazards of "hump" flying.

On the western Yunnan front, on May 10, 1944, the Chinese effected a forced crossing of the swift Salween river and battled their way, inch by inch, through the most difficult mountainous terrain and under adverse weather conditioris. By Sept. 7, Sungshan, Japanese stronghold in western Yunnan, was recaptured, thus reopening the important Huitung bridge spanning the Salween. On Sept. 14, another Japanese stronghold, Lungling, fell. With these achievements, the Chinese were now able to start the construction of the northern section of the Stilwell road.

In Jan. 1945 Wanting, the last Japanese base on the old Burma road, was recovered. By the end of that month the historic juncture of Chinese forces striking from the north Burma and Salween fronts took place at Maymyo in eastern Burma. which marked another significant Allied success and rendered possible the repairing of the old Burma road. These troops from the two fronts, fighting in well-nigh unnegotiable territory and inclement weather, demonstrated a tenacious combat spirit and achieved an excellent battle tally that formed an important chapter in the war history of the Allies.

Attesting further to the combat strength of these newly trained Chinese troops on their own soil, which had already been well-demonstrated in the Salwe-n offensive and the battle for Chihkiang (allied air base in western Hunan), were the Chinese counterattacks against Kweilin and Liuchow (Kwangsi cities) at the end of April 1945. The Chinese advanced in two separate columns.

One prong restored Nanning, border town near Indo-China, toward the close of May and by the middle of June was converging on the Liu river. Another prong made for Ishan, rail town northwest of Liuchow on the Kweichow-Kwangsi railway, which changed hands time and again. Well-co-ordinated assaults by both columns caused the Japanese to evacuate Liuchow at the end of June and Kweilin at the end of the following month. By then the weakening of the Japanese fighting strength became even more obvious.

6. Surrender. — Following the capitulation of nazi Germany in May 1945, sea battles moved ever closer to the Japanese homeland while intensified air assaults were made upon important Japanese cities. In China, increasingly high-degree co-ordination of Sino-U.S. combat strength for the continental counteroffensive was being attained. Japan itself realized that it had lost the contest.

China, the United States and Great Britain, on July 26, jointly announced the Potsdam declaration. On Aug. 6 the first atomic bomb was dropped on Hiroshima, and, three days later, the second atomic bomb fell on Nagasaki. On Aug. 9 the soviet government declared war on Japan.

On the afternoon of Aug. 10 Japan's surrender offer, accepting the Potsdam terms, was forwarded to the Allies through the governmerits of Switzerland and Sweden. After four days, the Japanese government officially proclaimed Japan's unconditional surrender on Aug. 14.

On Sept. 2 the representatives of China's supreme command participated in the formal signing of the instrument of Japanese surrender aboard the U.S.S. "Missouri" in Tokyo bay. In Nanking, on Sept. 9, Gen. Yasutsugu Okamura, commander in chief of the Japanese expeditionary army in China, officially signed the surrender instrument for the China theatre in the presence of Gen. Ho Ying-chin, commander in chief oi the Chinese army and personal representative of Generalissimo Chiang Kai-shek, supreme commander of the China theatre. Thus, the Chinese-Japanese War of 8 years and 2 months or, rather, the continuous Chinese-Japanese hostilities of 14 years after the Mukden incident, were brought to a victorious conclusion.

The area in which China was to accept the Japanese surrender comprised China and Indo-China north of latitude 16° N., but excluded the Japanese Kwantung army in the northeast, which was to surrender to the Soviet Union. The surrendering Japanese troops, which represented the entire remaining Japanese strength during the closing stage of the war, totalled about 1,300,000 (including about 30,000 in northern Indo-China but excluding those in the northeast). These were the troops which had been pinned down in China during the final phase of the war and which otherwise could have been used in other war theatres. This was the net result achieved through China's magnetic warfare strategy.

Throughout the war of more than 8 years, 22 large-scale battles, 1,117 major encounters and 38,931 minor engagements took place. China's total casualties amounted to 3,211,419 officers and men, including 1,319,958 killed, 1,761,335 wounded and 130,116 missing. Altogether, 14,050,521 able-bodied men were conscripted. Civilian casualties were far heavier; they included victims of shellfire, air raids and slaughter; those who were killed while constructing roads and airfields or transporting military and food supplies to the front; and war refugees who fell exhausted by the wayside.

Losses of public and private property, including that either destroyed or wasted, were incalculable.

Aside from strategical mistakes, Japan's failure may be traced to four other causes: (1) the militarists' underrating of the opponent's strength; (2) the absence of far-sighted statesmen at the helm of the state and the frequent conflicts inside of the militarist groups which controlled the government, as evidenced by the repeated cabinet changes in wartime Japan; (3) Japan's faith in the supremacy and dominance of military force over everything else; (4) a nationalism which centred on loyalty to the emperor and developed a feudalistic national character. Added to these was the blending of technological research with the worship of military force, which rendered it difficult for the Japanese to live peacefully with other racial groups in the modern society of nations.

The Japanese claimed that they knew China and were well-grounded in China, having an understanding of the individual habits and traits of Chinese political and social figures. As a matter of fact, they saw only the individual trees, not the whole forest. China's military might at that time was far weaker in comparison with Japan's, but Japan did not know: (1) that China's vast territory was a force; (2) that China's teeming population was a force; and (3) that China's national characteristic of tenacious resistance against any foreign rule, a legacy of China's long, continuous history and culture, when blended with national consciousness developed by the Three People's principles of Sun Yat-sen, was also a vital force. That any aggressive act in China would constitute a threat to world peace and therefore a grave world problem baffled Japan's understanding and appreciation even more.

It seemed a miracle to many that China, despite its inferior military might, was able to resist the Japanese aggression for more than eight years. Of course, the final victory was won by China in co-ordination with its allies. Nevertheless, during the first four and a half years of war China fought singlehanded against powerful Japan. Especially during the two years and more following the war in Europe, it struggled with a prospect darkened almost completely with gloom and dismay. But it never weakened or cringed from the Japanese. The integration of the China front with the other sectors of the world after the outbreak of war in the Pacific, the initial reverses of the Allies and the subsequent "Europe first" strategy — these forged China ahead, with greater hope but in more intense tribulation, until the winning of the ultimate triumph. (C. P.-LI.)

IV. THE WAR IN THE PACIFIC

A. THE PERIOD OF JAPANESE CONQUESTS

1. The Japanese Plan of Conquest.—The Japanese entered World War II with relatively limited objectives in mind and. contrary to the classic principles of warfare, had no plan to press home their attacks by meeting and defeating the main bodies of the Allied forces opposing them. Japan's offensive plans thus called simply for the occupation of an area they designated the Greater East Asia Co-Prosperity sphere, part of which they had seized before Dec. 1941. The region included Korea, Manchuria, China, French Indochina, Malaya. Burma, the Philippines and the Netherlands East Indies, as well as the Japanese empire as it existed before the Manchurian incident. To protect the Greater East Asia Co-Prosperity sphere against attack from the east, the Japanese were prepared to develop a defensive perimeter extending from the Kuriles on the north, southward through the Mariana Islands and Wake, the Marshall Islands and the Gilbert Islands to Rabaul, on New Britain of the Bismarck archipelago. The Japanese expected that the quick occupation and development of this vast region, coupled with a crippling attack upon the U.S. Pacific fleet, would lead ultimately to a negotiated peace which would leave Japan in possession of most of the Greater East Asia Co-Prosperity sphere.

The time the Japanese began their expansion into British, Dutch and United States possessions was chosen by reason of weather considerations, because further diplomatic negotiations seemed futile and because growing Allied air, land and sea power in the Pacific boded ill for the success of the initial offensive moves. The final Japanese decision to attack was made during November, and the first assaults took place on Dec. 7, 1941 (Dec. 8 west of the Hawaiian Islands).

2. Pearl Harbor.—Beginning an almost unbroken series of successes. the Japanese mounted a surprise air attack against the U.S. Pacific fleet at Pearl Harbor, Hawaii. The attack was executed by about 360 planes from 6 Japanese carriers which, with 2 battleships, 2 heavy cruisers, 11 destroyers and miscellaneous other ships, comprised the Pearl Harbor striking force, under Vice-Adm. Chuichi Nagumo. U.S. Pacific fleet units at Pearl Harbor comprised 70 combat vessels and 24 auxiliaries, most of them moored for the week end. There were also about 300 U.S. army, navy and marine corps planes present. Of eight U.S. battleships in the harbour, five nere sunk. one severely damaged and the other two hit. Two destroyers were also sunk and 9 other ships sunk or severely damaged, while 140 aircraft were destroyed and approximately another 80 damaged. About 2,330 military personnel were killed and 1,145 wounded, and about 100 civilians were killed or wounded.

The Japanese made no effort to land at Hawaii, nor had they any plans to do so. They succeeded in knocking out the battleship force, but as a result of a blunder in planning caused no damage to shore installations, power plants or oil storage facilities. The Pacific fleet's three aircraft carriers, not at Pearl Harbor on Dec. 7, escaped damage. The attack was a limited tactical success. and it prompted the immediate entry of a vengeful United States into the war.

3. The Philippines.—While not as important economically to the Greater East Asia Co-Prosperity sphere as were the Netherlands East Indies and Malaya, the Philippines threatened Japanese lines of communication to the Indies and Malaya Accordingly, on Dec. 8, Philippine time, the Japanese launched an air attack on Clark and Iba airfields, north of Manila. Formosa-based Japanese bombers caught most of the U.S. army air force's strength in the far east on the ground, destroying more than half its fighter and bomber planes. Other raids, two days later, resulted in the loss of more U.S. fighters and in the destruction of Cavite Naval yard, south of Manila.

Adm Thomas C. Hart (U.S.N.), commander in chief U.S. Asiatic fleet, had sent part of his force south in November. With little air protection available, the position of remaining surface vessels in the Philippines was untenable. and Hart sent the rest of his larger ships south to Java or Australia early in December. The U.S. bombers (there were only 14 left after the first Japanese attacks) were little better off and moved to Australia in mid-December. Only the ground forces, a few fighter planes, about 30 submarines and a few small vessels were left behind to hold the Philippines.

The Japanese began landing forces on Luzon on Dec. 10 and the main assault—the bulk of one division—came at Lingayen gulf on Dec. 22. Other landings were made on Luzon during the same month and from all directions the Japanese forces began converging toward Manila. Gen. Douglas MacArthur, the commander of all U.S. army forces in the Philippines, had prepared plans to make a final stand on Bataan peninsula and Corregidor Island in order to deny the use of Manila bay to the Japanese. As the Japanese advanced, he moved his Luzon forces, both U.S. and Filipino troops, into Bataan with a series of brilliant withdrawal actions. He declared Manila an open city on Dec. 26 to spare it from Japanese bombing. But the Japanese, possibly aware that the U.S. troops were still moving supplies out of the city and using some of its communications facilities, bombed Manila the next day. The last U.S. troops did not leave until the 31st, and two days later the Japanese marched in, unopposed.

The first Japanese attacks against the Bataan defenders were stalled by casualties from both battle and disease, but the Japanese could be reinforced while the Americans could not. The outcome on Bataan was inevitable and to save General MacArthur for important tasks elsewhere, Pres. Franklin D. Roosevelt, on Feb. 22, 1942, ordered him to leave the islands. The general finally left Bataan on March 11 and reached Australia on the 17th. Gen. Jonathan M. Wainwright (U.S.A.) became commander of all U.S. forces left in the Philippines.

The Bataan defenders, lacking sufficient ammunition, food and medicines, were gradually worn down and could not hold back a final Japanese offensive in the spring. Bataan fell on April 9. The Japanese intensified aerial and artillery bombardment of Corregidor and during the night of May 5–6 established a foothold on the island. On the 6th General Wainwright surrendered. The southern Philippines, where the Japanese had already occupied some ports and airfields, capitulated on May 9, 1942.

It is impossible to determine with any degree of accuracy U.S. and Filipino casualties during these operations. Probably no more than 5,000 men were actually killed in action, and figures for wounded, missing or captured are even less dependable. Japanese casualties are also unknown. Suffice it to say that both sides lost far more men from sickness and disease than from battle.

4. Malaya **and** the Netherlands East Indies.—Even before war began the Japanese were in an excellent position to move toward the Indies and Malaya. They had occupied Hainan Island and were using port facilities and airfields in French Indochina. Moreover, they had gained some measure of political control in Thailand and found it easy to occupy Bangkok. at the head of the Malay peninsula, on Dec. 9, 1941. The drive toward the Indies started with an air assault on Dec. 8 which destroyed British air power at Hong Kong. To safeguard their line of communications through the South China sea the Japanese began a ground attack against Hong Kong from the Kwantung peninsula, pushing back the 12,600 British and 1,900 Canadian defenders. By Dec. 24 the Japanese had gained a foothold on the island and the next day the garrison surrendered. Further protection for the Japanese flanks and rear during their push south was obtained on Dec. 20 when they occupied Davao, Mindanao, in the southern Philippines, establishing there an air and staging base.

The first landings at Malaya took place on Dec. 8 when a Japanese force, staged at Hainan Island. landed about halfway down the peninsula. More troops landed on the 9th and 14th while the defenders (two Indian divisions and an Australian division which lacked one brigade) organized hurriedly. Air cover for the garrison was inadequate and naval support, lacking air protection, was of no avail. In an attempt to cut the Japanese overwater communications to the landing forces, the British battleship "Prince of Wales" and the battle cruiser "Repulse" sallied from Singapore, only to be sunk on Dec. 10 by Japanese land-based aircraft. With their line of communications thus secured, the Japanese drove on down the Malay peninsula in a series of frontal attacks and flanking manoeuvres. By the end of December they had occupied all but the southern tip and Singapore.

President Roosevelt and Prime Minister Winston Churchill, conferring in Washington, D.C., decided on Dec. 31 to establish in southeast Asia and the southwestern Pacific a unified command known as ABDACOM, after its Australian, British, Dutch and American components. Command was assigned to Gen. Sir Archibald P. Wavell, whose area of responsibility included Burma, Malaya, the Netherlands East Indies and the Philippines (although for all practical purposes General MacArthur's command remained independent). The mission was to hold the Malay barrier — Malaya, Sumatra, Java and the approaches to Australia— as a defensive line-north of which the Japanese were to be halted. General Wavell assumed his command on Jan. 15, 1942. His chief deputy was Lt. Gen. George H. Brett (U.S.A.) ; his air commander Air Chief Marshal Sir Richard E. C. Peirse (R.A.F.) ; his naval commander Admiral Hart; and his ground force commander Lt. Gen. Hein ter Poorten (N.E.I.A.).

Before ABDACOM began operations, the Japanese had already started moving toward the oil-rich Indies. Sarawak was occupied on Dec. 17,1941 ; Brunei bay was secured on Jan. 6, 1942; Tarakan on Jan. 11; Jesselton the same day; and landings were made in the Celebes on the 11th also. Balikpapan fell on the 24th, and Kendari, in the southern Celebes, the same day. Ambon fell on Feb. 4 after a heroic four-day defense by Dutch troops and an Australian infantry battalion. So far, these actions had cost the Japanese only five transports or cargo ships. Despite opposition from an Allied naval striking force under Rear Adm. Karel W. F. M. Doorman (R.N.N.), the Japanese sent. convoys through Makassar strait to seize Makassar town on Feb. 8 and Bandjermasin, on the southwest coast of Borneo, on the 16th.

Japanese progress on the west flank of ABDACOM was equally steady. On Feb. 8 the Japanese landed on Singapore Island and a week later the garrison had to surrender. About 64,000 men— 17,000 British, 15,000 Australians and 32,000 Indian troops— were lost, 20,000 more than the British had lost at Dunkirk. On Feb. 13 the Japanese landed paratroopers at Palembang, Sumatra, following with amphibious assaults on the 16th. Admiral Doorman's striking force, although it had sallied forth many times to give battle. had been ineffectual in the face of Japanese air power, while such limited Allied air power as was available dwindled steadily in the face of the overwhelming Japanese air superiority. After an abortive attempt to stem the invasion of Sumatra by naval action there was a change in ABDACOM naval command and Admiral Hart, at Dutch insistence, was replaced by Vice-Adm. C. E. L. Helfrich (R.N.N.).

Swinging their offense back east the Japanese, on Feb. 19, 1942, launched a surprise air raid on Darwin, Austr., destroying valuable supplies and about 20 aircraft, sinking 11 ships, demolishing the airfield and killing almost 250 military and civilian personnel. The next day Japanese forces landed on Timor and by the 24th, pushing the small Australian and Dutch detachments back into the hills, had secured control of the island. Bali was invaded on the 18th. Just after the latter event Admiral Doorman again led his striking force against Japanese fleet units, but succeeded in inflicting damage only to one Japanese destroyer while one Dutch destroyer was sunk and two Dutch cruisers and a U.S. destroyer received considerable damage. Nothing stood in the way of an invasion of Java, the only important island still in Allied hands.

General Wavell had decided that the defense of Java was no longer feasible. Most of his fighter planes had been knocked out of the sky; the modern bombers had left for India or Australia; the naval forces were pitifully inadequate. On Feb. 25 he left for India and ABDACOM ceased to exist, all command functions passing to Dutch officers. A last effort to send fighter planes to Java ended with disaster on Feb. 27 when Japanese planes sank the U.S. tender "Langley" (once a carrier) and its deckload of aircraft. Ancther ship accompanying the "Langley" reached Java, but its cargo of crated planes was destroyed to keep it from falling into Japanese hands. The final blow to hopes of defending Java was struck during the naval battle of the Java sea on Feb. 27. Admiral Doorman's force, with incomplete planning and lacking adequate communications, struck at the Japanese invasion fleet. In the course of seven hours' manoeuvring, two Allied cruisers and three destroyers were sunk at a cost to the Japanese of only one destroyer damaged. The effort probably postponed the invasion of Java one day, but during the night of Feb. 28 the Japanese began landings at three points. Seeking to escape the final débacle, four Allied cruisers and four destroyers were sunk during the period Feb. 28–March 2, at a cost to the Japanese of only one transport and one mine layer sunk. Only four U.S. destroyers managed to make good their escape.

Java was finished. Admiral Helfrich and remaining senior British and U.S. officers left on March 2. On Java, Japanese ground forces had little difficulty once they attained momentum and on March 9 General Ter Poorten was forced to capitulate. About 20,000 Allied troops were surrendered, including 11,300 Dutch, 5.600 British, 2,800 Australians and 800 Americans. Only in the hills of Timor was any important Allied force left intact; that group was finally evacuated more than a year later.

5. Operations to the East. — While principally concerned during the early stages of the war with the quick seizure of the rich natural resources in Malaya and the Indies, the Japanese had not neglected their eastern flank. On the opening day of the war in the Pacific they had bombed lonely Wake atoll and on Dec. 11, 1941, attempted a landing which was beaten off by the U.S. marine corps garrison. A new invasion force reached Wake on Dec. 23 and started putting ashore about 2,000 men from a special naval landing force—a type of naval ground unit often erroneously known as imperial Japanese marines. The Wake garrison could not halt this force and surrender came quickly. The invasion cost the Japanese about 820 men killed and 335 wounded while the defenders lost 50 marines and 70 civilians killed. The rest of the Wake personnel, about 475 marines and U.S. navy men and nearly 1,150 civilian engineers, were captured by the Japanese.

Guam, a U.S.-held island in the otherwise Japanese Marianas, was also attacked from the air on Dec. 8, 1941. Invasion came on Dec. 10 when 5,000–6,000 Japanese troops landed at four different points. Since resistance was futile, the island's garrison — 365 marines and a militia of 300 Chamorro natives — soon surrendered. Further to secure their flanks. the Japanese also occupied Makin and Tarawa in the Gilberts during early December and, as at Wake and Guam, established air bases. The next move was toward strategically located Rabaul, New Britain, where invasion began during the predawn hours of Jan. 23, 1942. The Australian garrison of about 1,400 men was soon overwhelmed by about 5,000 Japanese who poured ashore under the cover of heavy naval guns. About 400 Australians ultimately escaped from New Britain but the small detachment at Kavieng, New Ireland, was captured when Japanese naval troops landed there late in January.

With the seizure of Rabaul and Kavieng, the fall of the Philippines and the Indies, and the loss of other points in the Pacific, the Japanese had realized their initial plans, bringing to a close one phase of the Pacific war. On the east, there was little to oppose them. The region in which Rabaul and Kavieng lay was included in the Anzac area, formally established by the U.S.-British combined chiefs of staff on Jan. 29, 1942. Anzac area comprised the waters around eastern Australia, New Zealand, New Caledonia, the New Hebrides, Fiji, the Solomons, the Bismarck Archipelago and eastern New Guinea. It was not a combined air-sea-ground command such as ABDACOM, and its commander, Vice-Adm. Herbert F. Leary (U.S.N.), was charged simply with the defense of the approaches to Australia and New Zealand. Anzac force, his operational command, initially comprised five Australian and U.S. cruisers and four destroyers from the same countries. A few U.S. and Australian aircraft were also placed under his command from time to time, and upon occasion carrier task forces of the U.S. Pacific fleet operated within Anzac area. But these latter operations appertain to another phase of the Pacific war, a phase which both sides were to begin sooner than expected.

B. THE ALLIES STRIKE BACK

1. New Japanese Plans. — Despite their success in quickly bringing under control most of the Greater East Asia Co-Prosperity

sphere, the Japanese found no signs of a negotiated peace. Instead, the Allies indicated they were prepared to strike back. Small carrier task forces of the U.S. Pacific fleet hit the Marshalls on Feb. 1, 1942, Wake on Feb. 23 and Marcus Island on March 1, while Anzac land-based bombers caused some damage at Rabaul on Feb. 23. These pinpricks did not accomplish much materially, but they gave Allied morale a boost and the Japanese something to worry about. Worse still, from the Japanese point of view, the Allies had begun estabiishing bases in Australia for future counter-offensives and were developing a well-protected line of communications across the southern Pacific to Australia and New Zealand.

Accordingly, the Japanese decided to expand their perimeter and cut the line of communications to Australia. First, they would occupy New Caledonia, the Fijis and Samoa, and they began preparations for these actions by pushing down the Solomons from Rabaul. To protect their flanks, the Japanese would seize eastern New Guinea and western New Britain, establishing an air base at Port Moresby in southeastern New Guinea. They also decided to take Midway Island and to establish air bases in the U.S. Aleutians. They hoped that the Allies would wear themselves cut in attacks against the new. outer perimeter, affording Japan better chances for a negotiated peace.

The new expansion began with the occupation of Gasmata, western New Britain, on Feb. 10. On March 8 the Japanese began occupying the Lae and Salamaua areas in eastern New Guinea and five days later made their first landings in the Solomons, at Buka. They started occupying the Admiralty Islands about April 8. thus ensuring complete control over the Bismarck archipelago. and on April 7 they began landings at Bougainville, in the Solomons. Serious opposition to these moves came only at the Lae-Salamaua area where, on March 10, U.S. carrier-based planes sank four Japanese ships and damaged three others. At all the new areas they seized, the Japanese began developing air bases from which to support the seizure of Port Moresby, southeastern New Guinea. After Port Moresby was to come the occupation of Midway and the Aleutians.

To gain control of the Indian ocean, isolating Australia from the west as well as the east, the Japanese seized the Andaman Islands on March 23, 1942. From April 2 through April 9 carrier-based aircraft and submarines succeeded in sinking 1 British carrier, 2 heavy cruisers, 1 destroyer and 28 merchantmen in the Indian ocean and Bay of Bengal. Great damage was also caused to shore installations at Ceylon. The British eastern fleet was crippled and Japan's western flank seemed secure.

2. Allied Reorganization and Plans.—While the Japanese had been expanding their perimeter, the U.S.-British combined chiefs of staff, faced with the dissolution of ABDXCOM and recognizing the anomalies in the Anzac establishment, decided to establish new command structures in the Pacific. The entire area was placed under the strategic direction of the U.S. joint chiefs of staff, who divided the Pacific into two major theatres. General MacArthur was appointed supreme rornmander, Southwest Pacific area. which included the Netherlands East Indies (less Sumatra), the Philippines, Australia, the Bismarck archipelago and the Solomon Islands. Adm. Chester W. Nimitz (U.S N.), who had recently become the commander of the U.S. Pacific fleet, was appointed commander in chief. Pacific ocean areas, which included most of the rest of the Pacific not in General MacArthur's area.

Admiral Nimitz' area was subdivided into three parts: the North Pacific area (the region north of 42° N Lat.) ; the Central Pacific area (including the Hawaiians, the Marianas, the Marshalls, the northern Gilberts, the Carolines and Palaus, the Ryukyus, Formosa and Japan) ; and the South Pacific area (New Zealand, New Caledonia, the southern Gilberts, the Ellice Islands, the New Hebrides, Fiji, Samoa and others). Admiral Nimitz retained direct command of the North and Central Pacific areas but appointed Vice-Adm. Robert L. Ghormley (U.S.N.) to the operational command in the South Pacific area.

The missions assigned to Admiral Nimitz and General MacArthur by the U.S. joint chiefs of staff were practically identical: to hold the line of communications between the United States and Australia; to contain the Japanese within the Pacific; to support the defense of North America; and to prepare for major amphibious counteroffensives, the first of which would take place in the South and Southwest Pacific areas.

General MacArthur formally assumed his command on April 18, 1942, the same day that 16 U.S. army B–25 bombers, under Lt. Col. James H. Doolittle, delivered another pinprick at the Japanese by raiding Tokyo from the U.S. carrier "Hornet." The raid caused little destruction but provided Allied morale with another boost, caused considerable loss of face within the Japanese government, pinned down Japanese fighter planes on home fields and accelerated Japanese plans for extending their conquests.

Anzac force and area ceased to exist on April 22 and Vice-Adm. Herbert F. Leary became the first commander of the Allied naval forces S.W.P.A. under General MacArthur. Gen. Sir Thomas Blamey (A.I.F.) was appointed commander, Allied land forces S.W.P.A. while Lt. Gen. George H. Brett (U.S A) was the first commander of Allied air forces S.W.P.A. Admiral Nimitz began acting in his capacity as commander in chief, Pacific ocean areas on May 7 and Admiral Ghormley, who reached New Caledonia on May 17, assumed his duties as commander, South Pacific area on June 19. By that time much of importance had transpired in the Pacific's various theatres.

3. Battles of the Coral Sea, Midway and the Aleutians.—By the end of April 1942 the Japanese were ready to turn the Coral sea (between Australia and New Caledonia) into a Japanese lake by the establishment of air bases at Port Moresby in southeastern New Guinea and Tulagi in the southern Solomons. But Allied intelligence learned that the Japanese were to attempt an amphibious invasion at Port Moresby and alerted available sea and air power. The Japanese operations aimed at the seizure of Port Moresby began on May 3 with landings at Tulagi. Carrier-based planes from a task force commanded by Rear Adm. Frank J. Fletcher (U.S.N.) struck the Tulagi landing group, sinking one destroyer, three mine sweepers and four landing barges. The main Japanese invasion force left Rabaul for Port Moresby on May 4, the bulk of the Japanese naval cover, including carriers, taking a circuitous route to the east, inviting a clash with Admiral Fletcher's forces.

On May 5 and 6, 1942, opposing carrier groups looked for each other and on the morning of the 7th Japanese carrier-based planes sank a U.S. destroyer and an oiler. Admiral Fletcher's planes sank one Japanese light carrier and one cruiser. The next day Japanese aircraft sank the U.S. carrier "Lexington" and damaged the carrier "Yorktown," while U.S. planes so damaged a large Japanese carrier that it had to retire from the action. So many Japanese planes were lost that the Port Moresby invasion force, lacking adequate air cover and harassed by Allied land-based bombers, turned back to Rabaul. While the four-day engagement. designated the battle of the Coral sea, was a tactical victory for the Japanese, it was a strategic victory for the Aliies, whose naval forces, employing only aircraft and never closing within gunshot range of Japanese vessels, had saved Port Moresby.

As an anticlimax to the battle of the Coral sea, four Japanese midget submarines sneaked into the harbour of Sydney, Austr., during the night of May 31–June 1. The submarines were sunk before substantial damage was done. The action may have been intended to divert Allied attention from an impending attempt to seize Midway Island, off Hawaii, but again the Allied forces were prepared.

Seeking a naval showdown, the Japanese sent out with the Midway and Aleutians invasion forces the bulk of their fleet—4 heavy carriers, 3 light carriers, 2 seaplane carriers, 11 battleships, 15 cruisers, 44 destroyers, 15 submarines and miscellaneous small craft. The U.S. Pacific fleet mustered 3 heavy carriers, 8 cruisers, 18 destroyers and 19 submarines The Japanese had no land-based air support, but from Midway and Hawaii the U.S. Pacific fleet could count on the aid of about 115 navy, marine corps or army land-based planes.

Operations off Midway started on June 3 when U.S. army and navy bombers struck ineffectually at Japanese vessels about 500 mi. southeast of Midway Island. Early the next morning Japanese planes caused considerable damage at Midway and Japanese ships again escaped damage from Allied land-based planes. But at midmorning U.S. carrier-based aircraft began attacks which resulted in the sinking of three heavy Japanese carriers, one heavy cruiser, and damaging another carrier which was later sunk. During the afternoon the fourth Japanese carrier was knocked out and the U.S. carrier "Yorktown" disabled. On the 6th the "Yorktown" was struck by a torpedo and on the 7th it sank; a U.S. destroyer was sunk on the 6th. During June 3–4. while the battle of Midway was going on, another Japanese carrier force caused considerable damage at Dutch Harbor, in the Aleutians, and on the 7th, Japanese invasion forces occupied Attu and Kiska. No invasion of Midway was attempted, for the Japanese commander, appalled at the loss of the four carriers in that area, ordered a general retirement on the night of June 4–5.

If any one action can be called the turning point of the war in the Pacific, it is probably the battle of Midway. There the Japanese lost their first-line carrier strength and most of their best-trained naval pilots, bringing some semblance of naval parity back to the Pacific. For the Allies it was a great strategic victory. The Japanese were prompted to cancel their plans for the invasion of New Caledonia, Fiji and Samoa. and they lost all but the last vestiges of their earlier strategic initiative.

4. **Guadalcanal.**—Having decided to take positive steps to secure the lines of communication between the United States and Australia, the U.S. joint chiefs of staff on July 2, 1942, issued a directive to the commanders in the Pacific to begin limited offensive operations for the recapture of the New Britain-New Ireland-Solomons-eastern New Guinea area. The offensive had three stages: first, the seizure of Tulagi, the Santa Cruz Islands and adjacent positions in the South Pacific area; second, the occupation of the central and northern Solomons and the northeast coast of New Guinea as far as the Lae-Salamaua area; third, the seizure of Rabaul and other areas in the Bismarck archipelago. The first phase was to be controlled by Admiral Ghormley; the boundary between the South and Southwest Pacific areas was therefore moved westward to place the southern Solomons within the South Pacific area. The latter two stages mere to be conducted under General MacArthur's strategic direction.

On July 6 the Japanese landed troops on Guadalcanal and began constructing an air base there. The Allied high command, perturbed that this action might presage further advances toward the southeast, speeded preparations to move into the southern Solomons in order to strike before the Japanese were firmly entrenched, and to secure a base from which to stage later advances toward Rabaul. The U.S. 1st marine division poured ashore on Guadalcanal, Tulagi and adjacent islands on Aug. 7, 1942, against negligible opposition. By nightfall the next day the Japanese airfield at Lunga Point, Guadalcanal, and Tulagi's excellent harbour had been secured. So far, the task had been easy, but the Japanese were determined to hold the island and began sending reinforcements south from Rabaul and dispatching naval units to give battle to Allied vessels, bombard Allied positions ashore, sink Allied transports and protect the reinforcement ships.

During the battle of Savo Island, Aug. 8–9, Japanese surface forces sank four Allied cruisers and one destroyer while suffering damage to two cruisers, one of which was sunk on the 10th by a U.S. navy submarine. In the battle of the eastern Solomons, Aug. 23–25. Allied land- and carrier-based aircraft sank one Japanese light carrier, one destroyer and one submarine, damaging one cruiser and a seaplane carrier. Allied naval losses were one destroyer sunk and one heavy carrier severely damaged. Another U S. carrier was damaged severely on Aug 31 and on Sept. 15 Japanese submarines sank the U.S. carrier "Wasp" and damaged a battleship.

During these actions the Japanese had landed more than 6,000 fresh troops on Guadalcanal to reinforce what remained of the original 7.500-man garrison. On Aug. 20–21 the marine beachhead was ineffectually attacked, and another ground attack occurred during Sept. 12–14. On Sept. 18 another marine regimental combat team (RCT) arrived to reinforce the 1st marine division, just in time to help turn back more ground attacks. By mid-October the Japanese had assembled about 22.000 troops on the island in preparation for an all-out assault against the 23,000-odd defenders, who now comprised the 1st marine division, an RCT of the 2nd marine division and an RCT of the U.S. army's Americal division. In late October, during the naval battles of Cape Esperance and of the Santa Cruz Islands, further Japanese attempts to reinforce and bombard the island resulted in the loss of two Japanese cruisers and two destroyers sunk, and three carriers and two destroyers damaged. The Allies lost one carrier and two destroyers sunk and six other ships damaged. The Japanese ground attack, occurring during the period Oct. 20–29, failed.

After Oct. 1942 the Allies built up air and ground strength at Guadalcanal until by mid-November there were present two U.S. marine corps divisions (less one infantry regiment), two RCT's of the U.S. Americal division and most of a separate U.S. army infantry regiment. The Japanese organized another large-scale attempt to reinforce the island but during the naval battle of Guadalcanal, Nov. 13–15, lost 2 battleships, 3 destroyers, 1 cruiser, 2 submarines and 11 cargo vessels or transports. Of the nearly 12,500 Japanese troops who attempted to land, only about 4,000 managed to get ashore and they were without supplies or ammunition. Allied naval losses were two cruisers and seven destroyers sunk, and one battleship and one cruiser severely damaged. On Nov. 30 eight Japanese destroyers tried to land more troops, but failed after one destroyer had been sunk and another severely damaged. This action, the battle of Tassafaronga, cost Allied naval elements one cruiser sunk and three damaged.

U.S. army and marine corps troops gradually expanded their hold during Nov. and Dec. 1942 as fresh reinforcements were brought in and the 1st marine division was relieved. By Jan. 5 the Allied garrison included the U.S. 2nd marine division, the Americal division, the 2jth infantry division and the separate 147th infantry regiment, in all, about 44,000 men to oppose the 22,500 Japanese then on the island. By this time major command changes had also taken place within the Allied establishment. On Oct. 18 Adm. William F. Halsey, Jr. (U.S.N.) had become commander, South Pacific area. On Jan. 2, 1943, ground operations on Guadalcanal passed from the control of Maj. Gen. Alexander A. Vandergrift (U.S.M.C.), commanding the 1st marine division, to Maj. Gen. Alexander M. Patch (U.S.A.), commanding general, U.S. 14th corps. Steady pressure by the 14th corps pushed the Japanese northward, and early in January the Japanese decided to evacuate their remaining troops. In daring destroyer runs during the first week of Feb. 1943, about 12,000 Japanese escaped, effectively ending the operation. The Japanese had lost more than 24,000 men during the campaign, while Allied combat losses were about 1,600 men killed and 4,250 wounded, figures which do not reflect the higher number of casualties from diseases. Allied naval losses were 2 heavy carriers, 6 heavy cruisers, 2 light cruisers and 14 destroyers. The Japanese lost 2 battleships, 1 light carrier, 3 heavy cruisers, 1 light cruiser, 11 destroyers and 6 submarines. The final action in the Guadalcanal campaign began on Feb. 21, 1943, when the U.S. 43rd infantry division began occupying the Russell Islands against no opposition. There, as at Guadalcanal, air and naval bases were developed from which to support subsequent advances toward Rabaul.

5. The Papuan Campaign.—While operations at Guadalcanal were underway, another major ground action was taking place in eastern New Guinea. In accordance with the directive of July 2, 1942, General MacArthur's Southwest Pacific area headquarters had laid careful plans to secure eastern New Guinea and establish bases from which operations against the Lae-Salamaua area and New Britain could be mounted. But before these plans could be realized the Japanese moved into the north coast of Papua to begin an attempt to take Port Moresby by overland action. On July 21 the Japanese began putting troops ashore near Gona, from which an overland march via the Kokoda trail started about Aug. 22 by two Japanese RCT's. The Kokoda trail was defended by the 21st Australian infantry brigade, the bulk of the 30th Australian infantry brigade and a battalion of a third brigade, but by Sept. 17 the advance Japanese elements had reached a ridgeline only 32 mi. from Port Moresby. There they stopped, primarily because of supply difficulties, and the next day began withdrawing in order to regroup pending the outcome of operations at Guadalcanal.

Pursued by the 16th and 25th Australian infantry brigades, the Japanese fell back to Buna and Gona, where by Nov. 18 they had assembled about 7,500 men. By that time two regiments of the U.S. 32nd infantry division were near the front and on the 19th one of these regiments, together with the two Australian brigades, began attacks against the firmly entrenched Japanese. In the course of the next two months the Japanese moved in about 3,000 fresh troops by small craft while the Allies committed the 7th Australian division (the 16th, 18th and 25th brigades), the 21st and 30th Australian infantry brigades, the 2/7th Australian cavalry regiment, the Papuan infantry battalion, the U.S. 32nd infantry division and the 163rd infantry regiment of the U S. 41st infantry division. Until mid-Jan. 1943 operations were under the control of Lt. Gen. Edmond F. Herring (A.I F.) and then under Lt. Gen. Robert L. Eichelberger (U.S.A), commanding general of the U.S. 1st corps.

Gona fell on Dec. 9, 1942, to the 21st Australian infantry brigade; Buna village to the U.S. 127th infantry regiment on Dec 14; Buna government station to the same unit on Jan. 2, 1943; Sananända to the 18th Australian infantry brigade on Jan. 18; and the last resistance was over on Jan 22.

Other incidents of the Papuan campaign included a Japanese attempt to outflank Port Moresby to the east by seizing Milne bay. On Aug. 26 the Japanese began putting 1,900 men ashore. The defenders, comprising the 7th and 18th Australian infantry brigades and U.S. army engineers, held and on Sept 4 the Japanese evacuated 1,300 of their troops, the rest being killed. Goodenough Island. off southeastern New Guinea, was taken by Australian troops on Oct. 22–26 against scattered opposition from Japanese stranded there during supply runs to New Guinea The entire series of operations had cost the Japanese nearly 12,000 men killed and 350 captured. while about 4.000 escaped to the Lae-Salamaua area or Kew Britain. Allied combat losses were approximately 3,300 killed and 5,500 wounded. The operations had been undertaken principally by ground and air units, the Allied naval forces S.W.P.A. contributing only small craft. The Allied air forces S W.P A., now under the command of Lt. Gen. George C. Kenney (U.S.A.), had given a good account of itself interdicting Japanese supply lines and flying Allied supplies and reinforcements to the front.

6. Reduction of **Rabaul.**—The Allied victories at Guadalcanal and in Papua made it clear that the Japanese were forced completely on the strategic defensive in the Pacific, completing the trend which had begun with the Japanese naval defeat at Midway. With Guadalcanal and Papua out of the way, Allied forces in the South and Southwest Pacific areas prepared for the other phases of the operations directed by the joint chiefs of staff on July 2, 1942. The pace of these operations could not be as fast as hoped, since the Allied policy of defeating Germany first left relatively limited means for the Pacific. Therefore, a new schedule of operations, involving some new targets, was worked out by the joint chiefs of staff and high ranking commanders from the Pacific theatres during the Pacific Military conference held at Washington, D.C.. in March 1943.

The first major action in the Southwest Pacific after that in Papua occurred when the Japanese decided to send about 7.000 reinforcements to New Guinea from Rabaul. But during the battle of the Bismarck sea, March 2–5, 1943, U.S. 5th air force and royal Australian air force planes sank 4 destroyers and 8 transports of the 16-ship convoy which had set sail from Rabaul. U.S. navy PT boats mopped up survivors, of whom less than 1,000 reached the Lae-Salamaua area, their original destination. This was the last large-scale Japanese attempt to reinforce New Guinea from the Rabaul area. Thereafter, a few troops mere brought in by submarine or barge under cover of darkness, but the Japanese main supply line was pushed to the west, along the northern New Guinea coast.

In the next Southwest Pacific action, the U.S. 112th cavalry and the U S. 158th infantry (both separate regiments not part of any division) took Woodlark and Kiriwina Islands during the period June 22–30. Allied planes based on these islands were aithin closer range of Rabaul and could cover vast areas of the Coral and Solomon seas. Meanwhile, from Buna, Australian and C.S. units had worked up the coast of New Guinea toward Lae and Salamaua, while other Australian troops pushed toward the same areas from an inland air base at Wau. During the night of June 29–30, elements of the U.S 162nd infantry, 41st infantry division, landed at Nassau bay to secure a supply base for further advances toward Lae and Salamaua.

During the same night the advance was resumed in the South Pacific area as major elements of the U.S. 43rd infantry division began landing at New Georgia and Rendova in the central Solomons. The Japanese reacted strongly with air and naval forces to this step toward Rabaul and, as they had at Guadalcanal, began moving reinforcements south from New Britain. During the period July 5–16 these Japanese manoeuvres resulted in the battles of Kula gulf and Kolombangara, which cost the Allied forces one cruiser and two destroyers sunk and three cruisers severely damaged. The Japanese, at the cost of one cruiser and two destroyers sunk, had managed to land considerable reinforcements. Maj. Gen. Oscar W. Griswold (U.S.A.), now commanding the 14th corps in the area, therefore found it necessary to call for many additional ground force units before the New Georgia group and neighbouring islands could be secured. The operations, including the occupation of Vella Lavella, which began on Aug. 15, employed the entire 43rd infantry division, the 25th and 37th infantry divisions (both less one RCT), an infantry brigade of the 3rd New Zealand division and two U.S. marine corps raider battalions. Further naval actions also took place. At the battle of Vella gulf, Aug. 6–7, the Japanese lost three destroyers. and two more were sunk later by Allied aircraft. Evacuating Vella Lavella. the Japanese lost another destroyer during the battle of Vella Lavella, Oct. 6–7, an engagement which cost Allied naval units one destroyer sunk and two more severely damaged. U.S. losses on the ground in the New Georgia group were approximately 1.150 men killed and 4,100 wounded, while the Japanese lost about 10,000 men.

Meanwhile, operations in the Southwest Pacific area had gone on apace. In preparation for new ground offensives, the C.S. 5th air force struck Japanese fields at Wewak on Aug. 17–18. 1943, destroying more than 200 planes. On Sept. 4 the 9th Australian division began amphibious landings near Lae and on the next day the U.S. 503rd parachute infantry, a separate regiment, dropped at Nadzab, in the Markham river valley above Lae. On Sept. 6 the 7th Australian division began arriving at Nadzab by troop-carrier planes and started driving overland toward Lae and up the Markham river. Lae fell on Sept. 16, while Salamaua had been seized on the 12th after a series of operations involving the U.S. 162nd infantry and two brigades of the 5th Australian division. On Sept. 22 a brigade of the 9th Australian division landed near Finschhafen. which fell on Oct. 2. The 7th Australian division continued clearing the Markham and Ramu river valleys while the 9th Australian division pushed against Japanese trying to escape westward from the Huon peninsula.

Keeping the Japanese off balance, the Allied offensive shifted back to the South Pacific area in Oct. and Nov. 1943. Elements of the 3rd New Zealand division secured the Treasury Islands, just south of Bougainville, during the period Oct. 27–Nov. 6, while on Oct. 28 the U.S. 2nd marine parachute battalion made an amphibious landing on Choiseul Island to make the Japanese believe that the Shortland Islands and Choiseul were major Allied targets. But the principal target was Bougainville where, on Nov. 1, the U.S. 3rd marine division moved ashore at Empress Augusta bay, on the west coast. A beachhead was secured against negligible opposition, and airfields from which future advances could be supported were quickly constructed.

There was the usual Japanese aerial and naval reaction; and at the battle of Empress Augusta bay. Nov. 2, the Japanese lost one light cruiser and one destroyer, while the Allies lost one destroyer severely damaged. From Nov. 5 through Nov. 8 Allied land- and carrier-based aircraft hammered at Japanese shipping and airfields at Rabaul. sinking one destroyer, damaging other combat vessels and causing considerable destruction to shore installations The U.S. 37th infantry division began reaching Bougainville on Nov. 8

and by Jan. 9, 1944, all of that division as well as the U.S. America1 division mere on the island. Counterattacks in Dec. 1943 were beaten back and new reinforcement efforts cost the Japanese at least two more destroyers sunk by the time the 3rd marine division was relieved in mid-Jan. 1944. A final attack took place during March 1944 but was beaten off by the 14th corps' divisions with a loss of more than 6,000 Japanese killed. This was the last significant Japanese effort, and the remnants of the garrison remained in starving condition on the island to the end of the war, by which time Australian troops had replaced the U.S. forces.

In Dec. 1943 General MacArthur's Southwest Pacific area forces had instituted operations to open Vitiaz and Dampier straits, between New Britain and New Guinea, and thus make the straits safe for Allied shipping. On Dec. 15 the U.S. 112th cavalry RCT landed at Arawe on the southwest coast of New Britain, diverting Japanese attention from the main effort—a landing by the 1st marine division on the north coast at Cape Gloucester on Dec. 26. On Dec. 30 the marines captured Cape Gloucester airstrip and by Jan. 16, 1944, had secured a defensive perimeter. Talesea, almost halfway to Rabaul, was taken by the 1st marine division in March 1944, and shortly thereafter the 40th infantry division began relieving both the marines and the 112th cavalry RCT. Little further offensive effort was made on the island and late in the year the 40th infantry division was relieved by Australian troops. Rabaul was never taken, and the strong Japanese garrison there was left to die on the vine, beyond hope of succor. Control of Vitiaz and Dampier straits had been assured by the capture of the western part of the island.

In New Guinea, the 126th RCT of the U.S. 32nd infantry division had landed at Saidor on the northwest coast of the Huon peninsula on Jan. 2, 1944, and Allied planes were soon operating from an airstrip there. The 9th Australian division took Sio, on the northeast coast, on Jan. 16, while the 5th Australian division completed mopping up in the western section of the peninsula and the upper reaches of the Markham and Ramu river valleys. Elements of the 32nd infantry division landed at Mindiri, west of Saidor. on March j, and during the next month the 8th and 15th Australian infantry brigades (jth and 11th Australian divisions, respectively) moved up the coast to take Bogadjim, Madang and Alexishafen. The Japanese 18th army, in full flight. retreated westward toward Hansa bay and Wewak; the former was captured by elements of the 5th Australian division on June 15.

The isolation of the Rabaul area had been completed during Feb. and March 1944. Elements of the 3rd New Zealand division took the Green Islands, southwest of New Ireland. on Feb. 15, to secure an air base site from which the noose around Rabaul could be tightened. On Feb. 29, in a daring reconnaissance in force, a squadron of the dismounted U.S. 1st cavalry division landed at Los Negros, in the Admiralties. A beachhead was secured and the rest of the division began arriving on March 2. By March 9 Los Negros had been secured and the cavalrymen had moved on to Manus. The occupation of the Admiralties supplied the Allies with a base athwart Japanese lines of communication to Rabaul and also provided an invaluable air, naval and staging base for subsequent advances to the west.

The last step in the campaign against Rabaul was the unopposed occupation of Emirau Island by the U.S. 4th marine regiment on March 20. There another airfield was built to complete the ring of Allied bases around Rabaul and Kavieng. The campaign was strategically completed without the necessity of capturing the two strong Japanese bases. More than 100,000 Japanese were left behind, as the war moved westward and northward.

7. Recapture **of** the Aleutians.——While the joint chiefs of staff never had any serious intention of using the Aleutians as an avenue of invasion toward Japan, they did wish to clear the islands as early as possible to prevent further Japanese attacks on Alaskan bases; to secure the north flank of Allied forces in the Pacific; and to create in the minds of the Japanese. high command the ides that an offensive might come from that direction, thus forcing the Japanese to pin down troops in the home islands. Allied air and naval units bombarded Japanese bases in the Aleutians during early hug. 1942, and on Aug. 30 occupied Adak in order to establish an air base closer to Kiska and Attu. Air attacks from Adak began in Sept. 1942, and on Jan. 11, 1943, Amchitka, 70 mi. W. of Kiska, was occupied to establish another airfield. The Japanese were unable to support their Aleutians garrison through the air and naval blockade which was set up and made no attempts to do so after an effort in March ended in disaster.

By-passing Kiska, the U.S. 7th infantry division landed at three points on Attu on May 11, 1943. Under the most adverse weather conditions, the division slowly fought its way over the island toward an end which was speeded by a Japanese suicide attack. By May 31 most of the Japanese garrison of about 2,300 men had been annihilated, at the cost of approximately joo Americans killed. The Japanese, realizing their position on Kiska was now untenable, evacuated the latter island, and when an invasion force of U.S. and Canadian infantry arrived there on Aug. 15 they found Kiska unoccupied. Any danger from the north was over. and the Aleutians could be used by the Allies to mount bombing attacks against Japan's northern Kuriles, contributing to the cause of deception in the Pacific and helping to tie down Japanese forces.

C. ACROSS THE PACIFIC

1. Allied **Offensive Plans.**—With the completion of the campaign against Rabaul, the war in the Pacific entered a new strategic phase for which the Allies had long been planning. Prewar plans having been rendered obsolete by early Japanese successes, the U.S. joint chiefs of staff developed new ones, which were ready by April 1943. The new plans were based on two premises: first, that an invasion of Japan proper might be necessary before the war could be successfully ended; second, that the main offensive against Japan would be launched across the Pacific rather than from the Aleutians, China or southeastern Asia. Before an invasion of Japan became possible, it would be necessary to undertake extensive aerial bombardment of that country and to cut Japan's lines of communications to the Netherlands East Indies and Malaya. In early 1943 it appeared to the joint chiefs of staff that the necessary aerial bombardment could best be undertaken by land-based planes operating from southeastern China. The construction of airfields and the supply of air units in China in turn demanded the seizure of a port on the south China coast. while to reach the south China coast and cut Japan's supply lines to the south, it would be necessary to gain control of the South China sea. This would be accomplished by the occupation of the Luzon-Formosa-south China coast triangle, which would be reached by driving across the Pacific from bases already in Allied hands or which would be in Allied hands by the time the offensive could gain momentum in 1944.

This plan was approved in principle by the U.S.-British combined chiefs of staff at the Trident conference, held at Washington during May 1943 and was further developed before and during the Quadrant conference at Quebec, Que., in August of the same year. In detail. it provided that after completion of the tasks set forth in the directive of July 2, 1942 (see above), General MacArthur's forces would push up the north coast of New Guinea into the southern Philippine Islands, which would be invaded late in 1944. Simultaneously, Admiral Nimitz' Central Pacific forces mould drive across the Pacific via the Gilberts, Marshall~, Marianas, Carolines and the Palaus toward Formosa. Emphasis was to be given the Central Pacific route since that one promised more speed. threatened Japan's vulnerable eastern flank, permitted best use of the U.S. Pacific fleet for a naval showdown and provided for occupation of bases in the Marianas from which the U.S. army air force's huge B-29 bombers could hit Japan. Advances both through the Southwest and Central Pacific areas would be mutually supporting.

While there were changes in detail in this plan, it remained basically the same until Japanese offensives in eastern China made it obvious to the joint chiefs of staff that seizure of a foothold on the south China coast would probably entail an extended land campaign for which the Allies could not muster sufficient strength. Formosa also began to appear an unnecessary and costly operation. Thus, as the plan was ultimately developed. the seizure of an early foothold in the southern Philippines, coupled with a rapid advance to Luzon in the northern Philippines, became of prime importance. After Southwest Pacific area forces were firmly established on Luzon, from which Japan's supply lines to the south could be cut by concerted air and naval action, including extensive employment of submarines, further advances toward Japan could be undertaken. The China coast and Formosa operations were abandoned and the seizure of bases in the Ryukyu Islands was substituted.

2. The **Gilberts** and **Marshalls.**—While the joint chiefs of staff envisaged that the offensive across the Pacific would not gather momentum until mid-1944, they decided during the summer of 1943 that a limited offensive could be opened in the Central Pacific, both to accelerate the pace of the war and to draw Japanese forces away from the Southwest and South Pacific areas. Accordingly, on Nov. 20, 1943, Admiral Nimitz sent his forces into the Gilbert Islands. The 165th RCT of the U.S. 27th infantry division took Makin Island, losing about 70 men killed and 150 wounded. Simultaneously the 2nd marine division, against stronger resistance from well-fortified positions, pushed ashore on Tarawa. The atoll was secured four days later, but the operation cost the marines about 990 men killed and 2,300 wounded. The Japanese had lost perhaps 8,500 men in the Gilberts.

From airfields which were soon established in the Gilberts, U.S. army and navy land-based planes continually struck at Japanese bases in the Marshalls. Preceded by heavy carrier attacks, the U S. 7th infantry division and the 4th marine division landed on Kwajalein atoll in the Marshall Islands Jan. 31, 1944. The same day a battalion of the 7th infantry division's 106th RCT and the reconnaissance company of the U.S. marine 5th amphibious corps took Majuro. By the end of the first week in February most resistance at Rwajalein had been overcome. Admiral Nimitz had planned to move further in the Marshalls in mid-April, but Japanese resistance and reactions at Kwajalein and Majuro had been so weak that he moved his forces on to Eniwetok on Feb. 17. There the 106th infantry (less the 2nd battalion) of the 7th infantry division and the 22nd marine regiment landed, securing the atoll by Feb. 22. American casualties in the Marshalls operations numbered about 640 men killed and 1,885 wounded, while the Japanese lost approximately 9,000 men.

To support the Marshalls operations, the U.S Pacific fleet had launched a heavy carrier strike against the strong Japanese fleet base at Truk in the central Carolines on Feb. 16–17. The bulk of the Japanese fleet had already fled westward and Truk's defenses proved much weaker than had been supposed. Admiral Nimitz therefore cancelled plans to occupy the atoll and left it to be neutralized by land-based aircraft from the Marshalls.

3. Up the New Guinea Coast.—While these operations were underway in the Central Pacific, General MacArthur and Admiral Halsey had been completing the final phases of the campaign against Rabaul, and the Southwest Pacific commander was ready to institute his offensive up the New Guinea coast toward the Philippines. Ground operations during this offensive were directed by Lt. Gen. Walter Rrueger, commanding general of the U.S. 6th army, whose headquarters during the drive acted as a special task force under General MacArthur and was designated "Alamo" force. Vice-Adm. Thomas C. Kinkaid (U.S.N.) commanded the Allied naval forces S.W.P.A. and the U.S. 7th fleet during these operations, while amphibious phases of the advances were carried out under the direction of Rear Adm. Daniel E. Barbey (U.S.N.), the commander of the 7th amphibious force, 7th fleet. The Allied air forces S W.P.A. remained under General Kenney's command.

The Admiralty Islands having been seized a month ahead of schedule, General MacArthur could accelerate his advance toward the Philippines. He had planned to move first to Hansa bay, but with airfields operational in the Admiralties the Hansa bay operation nas deemed unnecessary and was cancelled in favour of a daring jump to the Hollandia area of Dutch New Guinea, bypassing Japanese strongholds at Wewak and Hansa bay.

Landings were made at two points in the Hollandia area on April 22. 1944 with the U.S. 24th infantry division moving ashore at Tanahmerah bay and the 41st infantry division (less one RCT) pushing inland at Humboldt bay, 25 mi. to the east. The landing was supported by carrier-based planes of the U.S. 5th fleet, which had also struck Japanese air installations at Wakde and Sarmi to the northwest. Land-based planes of the Allied air forces S.W.P.A. had softened up the Hollandia area, destroying more than 300 aircraft of the Japanese 4th air army there in the weeks preceding April 22. Opposition at Hollandia mas negligible and by April 26 the two divisions had secured inland Japanese airfields. Ultimately, a major air and staging base was developed in the Hollandia area and most of the higher headquarters in the Southwest Pacific area established their command posts there during the summer of 1944.

Meanwhile, the 163rd RCT of the 41st infantry division had gone ashore at Aitape, in British New Guinea about 12j mi. southeast of Hollandia. There, by April 24, Australian engineers had completed an airstrip from which the Allied air forces could have supported ground operations at Hollandia after the US. 5th fleet's carriers left the latter area. Although such support was not necessary, the Allied perimeter at Aitape provided flank protection for the more important Hollandia area bases.

During late April and May, the U.S. 32nd infantry division moved up to Aitape, relieving the 163rd RCT for another operation. The Japanese 18th army, based on Wewak. mounted an attack against the Aitape perimeter during July and August, employing more than 20,000 troops in the forward area. But the 32nd infantry division, reinforced by the 112th cavalry RCT and the 124th RCT of the 31st infantry division, all co-ordinated by headquarters, U.S. 11th corps, broke the impetus of the Japanese attacks and began pushing the Japanese 18th army back toward Wewak. The U.S. 43rd infantry division, elements of which had participated in the heavy actions during July and early August, relieved the rest of the 11th corps later during the latter month.

While the Hollandia area had been seized cheaply — about 130 men killed and 1,050 wounded as compared with the 4.475 Japanese killed and 655 captured — the Aitape action was much more costly. There, about 450 U.S. troops uere killed and 2,j50 wounded, while 8,82j Japanese were killed and 125 captured. In Nov. 1944 the 6th Australian division relieved the last U.S. army units in the Aitape area and instituted a drive down the coast toward Wewak, which fell on May 10, 1945. By the end of the war the campaign against the Japanese 18th army had cost the Australians about 450 men killed and 1,160 wounded, as opposed to approximately 7,200 Japanese killed and 270 captured.

The advance of Southuest Pacific area forces continued, and on May 17, 1944, the 163rd RCT of the 41st infantry division landed at Arara, on the Dutch New Guinea mainland about 125 mi. N.W. of Hollandia. The next day a reinforced battalion of the 163rd infantry moved across a narrow channel to Wakde Island, site of a Japanese airfield. There, in two days mas fought a bitter action which was the only one undertaken in the Southwest Pacific to bear close resemblance to the island warfare in the Gilberts and Marshalls. About 760 Japanese were killed and the 163rd RCT had approximately 40 men killed and 110 wounded.

The 163rd RCT was replaced on the mainland by the separate 158th RCT, which moved westuard from Arara to secure the shores of Maffin bay, needed for a forward staging area. The latter region was not taken until the U.S. 6th infantry division, in a series of bloody assaults, seized a dominating hill. Later. the 31st infantry division (less one RCT) and the 123rd RCT of the 33rd infantry division saw action in the area. The Maffin bay area was secured by late June. but before final defense lines had been established, about 415 U.S. army troops had lost their lives in the Wakde-Arara-Maffin bay region and another 1,500 had been wounded. Almost 4,000 Japanese were killed and 75 were taken prisoner.

On May 27, 1944, the 41st infantry division (less the 163rd RCT) landed near Bosnek on Biak Island which, lying about 200 mi. N.W. of Wakde, dominated the entrance to Geelvink bay. An initial offensive west along the coast toward Japanese airfields was thrown back by about 10.000 defending Japanese and it was not until late June that the airfield area was finally secured By that time the 163rd RCT had reached the island, and headquarters, U.S. 1st corps, had arrived to take control of operations, bringing with it the 34th RCT of the U.S. 24th infantry division. As they had previously in the Solomons and eastern New Guinea, the Japanese attempted to reinforce Biak, and succeeded in landing about 1,100 fresh troops during early June, losing for their pains 2 destroyers sunk, 5 destroyers and 1 cruiser damaged, and at least 50 aircraft shot down. By the time Biak was declared secure in early August, the Japanese had lost about 6,125 men killed and 450 captured, mhile U.S. army and navy forces involved had lost about 470 men killed and 2,400 wounded.

4. The **Marianas.**—While the reinforcements the Japanese put ashore at Biak could not effect the ultimate outcome of operations on the island, they were sufficient, combined with the fanatic defense of the original garrison, to prevent the Southwest Pacific area's land-based aircraft from using Biak fields to support the Central Pacific area's invasion of the Mariana Islands on June 1j, 1944. It appears, indeed, that the Japanese gave up further attempts to reinforce Biak only when they learned of Admiral Nimitz' move to the Marianas, and they hurriedly assembled the bulk of their fleet to give battle to the U.S. Pacific fleet off the Marianas. On the other hand, Japanese preoccupation with Biak had diverted much land-based air strength from islands in the central Pacific to western New Guinea, where many of the pilots had been shot down or fell prey to malaria, thus making the Allied invasion of the Marianas easier.

On June 15 the U.S. 2nd and 4th marine divisions moved ashore on Saipan Island in the Marianas against stubborn opposition from almost 30,000 Japanese. Occupation of the island went slower than anticipated, and by June 20 the army's 27th infantry division had been sent ashore to reinforce the marine corps units. Gradually compressed into smaller and smaller pockets, the Japanese themselves ended most organized resistance with a suicidal counterattack on July 7. After the U.S. forces had thrown back this counterattack, only mopping up remained. On July g the island was declared secure.

The Japanese combined fleet had meanwhile steamed northward from anchorages in the Philippines and the Netherlands East Indies determined to greet the Allied invasion of the Marianas with a naval showdown battle. On June 19 Japanese carriers launched air attacks against U.S. 5th fleet vessels supporting the landing operations at Saipan. These attacks cost the Japanese more than 400 aircraft, while the 5th fleet's carriers lost only 26. With the bulk of its carrier planes lost, the Japanese fleet began withdrawing, pursued by U.S. 5th fleet aircraft. By June 21, when the pursuit ended, the Japanese had lost 3 carriers and 2 tankers sunk; 4 carriers, 1 battleship, 1 cruiser and 1 tanker severely damaged; and, finally, almost 450 planes. The U.S. 5th fleet lost only 20 aircraft in combat and damage to ships was negligible. For some time the Japanese combined fleet would not be a factor with which the Allies would have to reckon.

After Saipan, Admiral Nimitz' Central Pacific area forces proceeded with the occupation of the rest of the major islands in the Marianas. The invasion of Guam began on July 21, follotving extensive naval bombardment, but before the island was secured on Aug. 10 the U.S. 3rd marine division, the 1st marine provisional brigade and the U.S. army's 77th infantry division had all been committed to the action. Tinian was taken, beginning July 24, by the 2nd and 4th marine divisions, which met relatively light opposition. The entire Marianas campaign cost U.S. forces about 4,750 men killed and 18,100 wounded, while the Japanese lost approximately 46,000 men killed and captured.

While the fighting had been going on, U.S. army and navy engineers had started work on an extensive system of airfields for the army's huge B-29s and other planes. On Nov. 24 the first B-29 raid from the Marianas was sent against Japan. From the strategic point of view, the capture of the Marianas was even more important, The Japanese defensive perimeter had been breached at a vulnerable point and the Allies were assured control over vast reaches of the Pacific ocean. To realists in the Japanese high command, the loss of the Marianas spelled the ultimate loss of the war.

5. **Allied** Reorganfzations in the Pacific.—In mid-1944 many changes in organization were made in the Pacific theatres. First, with completion of the reduction of Rabaul, the South Pacific area was closed out as an active theatre and Admiral Halsey left to take command of the C.S. 3rd fleet for future advances. Army units in the South Pacific were transferred to General MacArthur's direct control in June, and the U.S. 13th air force moved bodily over to the Southwest Pacific area to form, with the U.S. 5th air force, the far eastern air force, which was commanded by General Kenney in addition to his position as commander, Allied air forces S.W.P.A. The royal Australian air force and Dutch air units remained under General Kenney's control as part of the Allied air forces, while the royal New Zealand air force, together with certain U.S. marine corps and U.S. navy land-based air units, continued to operate along the Solomons axis.

Administratively, the U.S. army units in the South Pacific area passed to the control of Lt. Gen. Robert C. Richardson (U.S.A.), previously commander of U.S. army units in the Central Pacific area under Admiral Nimitz. General Richardson now became commanding general, U.S. army forces Pacific ocean areas, in which capacity he remained subordinate to Admiral Nimitz' operational control. U.S. army air forces in the Pacific ocean areas (except the B-29s) were placed under Lt. Gen. Millard F. Harmon (U.S.A.), who was also subordinate to Admiral Nimitz. The B-29s in the Pacific, forming a part of the C.S. 20th air force, were controlled by the U.S. joint chiefs of staff, acting through Gen. Henry H. Arnold, commanding general of the U.S. army air forces.

In the Southwest Pacific area, in addition to the creation of the far eastern air force, there were few changes. General MacArthur, the supreme commander in the area, also commanded all U.S. army troops in the Southwest Pacific in his capacity as commanding general, U.S. army forces in the far east. The U.S. 6th army continued to operate as "Alamo" force until September, when it dropped the pseudonym. Australian ground units operated under General Blamey, commander of the Allied land forces S.W.P.A., while Air Vice-bfarshal William D. Bostock (R.A.A.F.) commanded Australian air units assigned to the Allied air forces. Late in the summer Lt. Gen. Robert L. Eichelberger (U.S.A.), previously commander of the U.S. 1st corps, became commander of the newly formed U.S. 8th army. The naval command in the Southwest Pacific remained as it had been.

6. Westward Toward the **Philippines.**—After Biak, the advance in the Southwest Pacific area was resumed when, on July 2, 1944, the 158th RCT landed at reef-studded Noemfoor Island, 90 mi. S.W. of Biak. Two battalions of the U.S. 503rd parachute infantry jumped during the ensuing two days to reinforce the 158th RCT, and the other battalion arrived by ship later in the month. There was little strong organized resistance and Noemfoor's airfields were soon in Allied hands, deepening the air penetration of which the Allied air forces S.W.P.A. were capable. The operation cost U.S. forces involved about 70 men killed and 350 wounded, while the Japanese lost almost 2,000 killed and 250 captured.

The next step was the occupation of the Sansapor-Mar area at the northmest tip of New Guinea's Vogelkop peninsula on July 30 and 31 by elements of the U.S. 6th infantry division. Airfields from which Allied planes could strike the southern Philippines and the northern Netherlands East Indies were soon operational. There had been negligible opposition by the time the area was secured, and only 15 men had been killed and 45 wounded. The Japanese lost about 700 killed and 100 captured.

On Sept. 1j the U.S. 11th corps, comprising the 31st infantry division and the 126th RCT of the 32nd infantry division, started ashore at Morotai Island, between the Vogelkop peninsula and Mindanao, southernmost large island of the Philippines By-passing Japanese strength at Halmahera, south of Morotai, the 11th corps quickly secured a defensive perimeter behind which airfields were rapidly constructed in order to provide air support for further advances. Except for some fairly severe air raids, the Japanese attempred little reaction to this penetration of their last defenses before the Philippines, and the Morotai operation cost the U.S. forces only 45 men killed and about 95 wounded. The Japanese lost about 325 men killed or captured.

With the occupation of Morotai, the long drive up the New

Guinea coast was strategically completed. The only subsequent operation of offensive significance in the area occurred Nov 15–20, when the U.S. 8th army, directing its first operation, sent elements of the 31st infantry division off to capture the Asia and Mapia Island groups, north of the Vogelkop. There, the U.S. forces, losing 20 men killed and 45 wounded and killing 170 Japanese, established radar stations and navigational guides. The forces of the Southwest Pacific area were ready to move on to the Philippines.

Simultaneously with the Morotai landings in the Southwest Pacific, Admiral Nimitz' forces had moved into the Palau Islands in the western Carolines. On Sept. 15 the U.S. 1st marine division pushed ashore against heavy opposition on Peleliu, while two days later the 81st infantry division (less one RCT) landed on Angaur Island, immediately to the south. The most important area of Angaur, where airfields were to be constructed, was secured by Sept. 20, but it was not until Oct. 23 that the 81st division's 322nd RCT had overcome the last stubborn, organized resistance in rugged terrain at the island's northwest corner.

On Peleliu, although the 1st marine division had secured the southern part of the island with its important Japanese airfield by Sept. 17, the Japanese continued fanatic resistance from rough, dominating ground in the centre of the island, and also held the northern tip. where reinforcements from more northerly islands in the Palau group could be landed. Fighting was so fierce and casualties so high that the 1st marine division had to be reinforced by the 81st division's 321st RCT from Angaur. The 321st RCT swung into action on Sept. 22, soon isolating the central Japanese pocket and helping the marines secure the northern tip and offshore islets.

The 1st marine division, having lost almost 6,500 men from combat and many more from disease and fatigue, had to be relieved in the latter part of October and the 81st infantry division completed the job. The 321st RCT bore much of the burden of the final offensive, but the 323rd RCT, fresh from the unopposed occupation of Ulithi atoll (Sept. 23), had taken over when, on Nov. 25, organized resistance ceased.

Operations in the Palaus cost the U.S. army, marine corps and navy forces involved approximately 2,850 men killed and 9,000 wounded, while the Japanese lost about 13,600 men killed and 400 captured, including about 650 men sent from the northern Palaus to reinforce the original 11,000-man garrison on Peleliu. The occupation of Peleliu and Angaur had proved to be one of the bloodiest battles in the war, but with the southern Palaus and Ulithi in Allied hands the western Pacific was safe for Allied air and naval forces. The rest of the Palaus could be neutralized by air action alone. The road to the Philippines was open from both the south and the east.

D. THE LAST CAMPAIGNS

1. Revised Allied Plans.—At the time of the Morotai and Palau landings, General MacArthur was intending to invade the Philippines at Sarangani bay, Mindanao. on Nov. 15, 1944, to establish air and naval bases from which to support a larger invasion at Leyte Island on Dec. 20. Admiral Nimitz' plans called for an invasion of Yap, in the Carolines east of the Palaus, on Oct. 5. But the U.S. 3rd fleet. striking the Philippines on Sept. 9–10 in strategic support of the Palaus and Morotai landings, discovered unexpected Japanese weakness on Mindanao. Cancelling further strikes against that island. Admiral Halsey sent his 3rd fleet planes against the central Philippines on Sept. 12 and 13, again finding hostile reaction meagre. Admiral Halsey suggested to Admiral Nimitz, General MacArthur and the joint chiefs of staff that the Palaus, Yap and Mindanao operations might well be cancelled in favour of a direct move to Leyte. Admiral Nimitz did not believe it safe to by-pass the Palaus, but he was willing to forget about Yap and he offered General MacArthur the use of the U.S. 24th corps (the 7th, 77th and 96th infantry divisions) already staged for Yap, for an early invasion of Leyte. In the name of General MacArthur, who was keeping radio silence aboard a ship off Morotai, Lt. Gen. Richard K. Sutherland (U.S.A.), General MacArthur's chief of staff, accepted this proposal and so informed the joint chiefs of staff. The joint chiefs. then meeting with the British chiefs of staff at the Octagon conference in Quebec, quickly approved the proposed changes, and the Yap and Mindanao operations were cancelled for a direct move to Leyte, now rescheduled by General MacArthur for Oct. 20.

2. Leyte.—In preparation for the Leyte invasion, Admiral Halsey's 3rd fleet struck the Philippines again during the period Sept. 21–24, and provided additional strategic support by hitting the Philippines, Formosa and the Ryukyus from Oct. 10 through Oct. 21. The Allied air forces S.W P A. sent available land-based planes against the southern and central Philippines also, while escort carriers of the Allied naval forces S.W.P.A. provided direct air support for the landings of the U.S. 6th army.

First landings in the Leyte area were made on Oct. 17 and 18 by the U.S. 6th Ranger infantry battalion, which seized offshore islands in Leyte gulf. On Oct. 20 the 10th corps (1st cavalry and 24 infantry divisions) and the 24th corps (7th and 96th infantry divisions) poured ashore on the east coast of Leyte. where strong opposition was met at only one of the four division beaches. Within three days a fair-sized beachhead had been secured and work had started on airfields.

Japanese plans for the defense of the Philippines had originally called for the main effort to be made at Luzon, but possibly as the result of exaggerated claims of damage to the U.S. 3rd fleet off Formosa, the Japanese high command made an eleventh-hour change and decided to make an all-out effort to defeat the Allied forces at Leyte. First, they reinforced their land-based aircraft in the Philippines to attack Allied shipping in Leyte gulf and to support a three-pronged fleet offensive aimed at the destruction of the U.S. 3rd and 7th fleets and the severance of the Allied lines of communication to Leyte. For this purpose, the bulk of the Japanese combined fleet, under Adm. Soemu Toyoda, was divided into three sections and sent toward Leyte. One group of battleships, cruisers and destroyers advanced on Leyte gulf from the south, through Surigao strait. and was soundly trounced by U.S. 7th fleet surface vessels during the predawn hours of Oct. 25. In the centre, moving into Leyte gulf via San Bernardino strait, came a force of the most modern Japanese battleships, cruisers and destroyers. This force created considerable damage among 7th fleet escort carriers, destroyers and other ships before it retired on the same day, apparently frightened lest Admiral Halsey's 3rd fleet launch strong carrier aircraft attacks.

The 3rd fleet had moved north, off the east coast of Luzon, to intercept the third Japanese force, which was built around carriers. Launching strong carrier-based air attacks, the 3rd fleet turned back this Japanese force on Oct. 25 also. The next day Allied planes from the 3rd and 7th fleets, as well as available land-based aircraft of the Allied air forces S.W.P.A , pursued Japanese stragglers as the remnants of the three Japanese forces fled toward safer waters. The battle for Leyte gulf cost the Japanese combined fleet three battleships. one large carrier. three light carriers. six heavy cruisers, four light cruisers and nine destroyers. Almost all the rest of the Japanese ships engaged received considerable damage. Allied losses were one light carrier, two escort carriers, two destroyers and one destroyer escort sunk, while some additional ships received some damage. The core of the Japanese navy had been demolished, and was no longer a significant factor in the Pacific war.

Despite their huge naval losses, the Japanese were determined to hold Leyte and after the naval battle started sending strong reinforcements to the island, while continuing aerial attacks against Allied shipping in Leyte gulf. During October too few Japanese reinforcements arrived to have much effect upon operations, and the U.S. 10th corps drove rapidly up Leyte valley to the north coast, while the 24th corps pushed inland and sent one division overland to the southwest coast. Continued bad weather and strong Japanese reinforcements—the equivalent of two and a half divisions by late November—slowed the 6th army's advances during November and early December, while the Japanese defended the Ormoc valley and the mountainous interior. General MacArthur therefore found it necessary to reinforce the 6th army, and during November the U.S. 11th airborne division, the 32nd infantry division and the separate 112th cavalry RCT reached the island. Both the 10th and 24th corps maintained heavy pressure on all fronts to keep the Japanese off balance and to prevent them irom organizing strong, co-ordinated counter-attacks.

Japanese reinforcements continued to arrive at Ormoc, on the northwest coast, despite staggering losses of ships and troops to Allied air and naval elements. The Japanese even tried some abortive airborne assaults which accomnlished little. To speed the inevitable end and to prevent further reinforcements from reaching the island, General MacArthur sent the 77th infantry division (which reached Leyte late in November) on a shore-to-shore movement from the east coast to Ormoc, near which town the division landed on Dec. 7. Ormoc fell on Dec. 10 and the 77th infantry division pushed up the Ormoc valley to establish contact with the 10th corps units fighting their way southward. This contact marked the end of the strongest organized resistance on Leyte and General MacArthur declared the island secure on Dec. 25

The 6th army, preparing for future operations, turned over the arduous task of mopping up to the U.S. 8th army. The 24th corps (the 7th, 77th and 96th infantry divisions) was relieved by the U.S. Americal division. The Americal division, Filipino troops, the 10th corps, the 38th infantry division and elements of the 81st infantry division, continued operations against the 20,000 Japanese left on Leyte at the end of Dec. 1944, and mopping up continued well into 1945, until almost 75,000 Japanese had been killed or captured on Leyte by the 6th and 8th armies.

3. The Luzon Campaign. — Even before Leyte had been declared secure, the U.S. 6th army had started moving toward Luzon, and on Dec. 15, 1944, the 19th RCT of the 24th infantry division and the separate 503rd parachute RCT made amphibious landings at the southwest corner of Mindoro Island. There was negligible opposition, and airstrips were rapidly constructed. The move to Luzon by Southwest Pacific area forces again had the strategic support of the U.S. 3rd fleet, which struck the island on Dec. 14–16, 1944, and again on Jan. 3–9, 1945. On the latter date the 6th army started invading Luzon at Lingayen gulf, putting ashore the U.S. 1st corps (6th and 43rd infantry divisions) and the 14th corps (37th and 40th infantry divisions). The generally unopposed landings were supported by escort carriers of the U.S. 7th fleet and by land-based planes of the U.S. 5th and 13th air forces. The 3rd fleet moved into the South China sea to strike the Indo-China coast, Formosa, Hong Kong, Canton, Hainan and the Ryukyus during the period Jan. 12–22, 1945.

Realizing that the diversion of forces to Leyte and the inability of the Japanese high command to send reinforcements to Luzon gave him little hope of defeating the 6th army, Gen. Tomoyuki Yamashita, commanding the Japanese 14th area army, decided upon static defense aimed at pinning down Allied troops on Luzon for as long as possible. He established three principal defensive sectors: one in the mountains west of Clark field in the Central Plains; a second in mountainous terrain east of Manila; and the third and strongest in the mountains of northwestern Luzon, centring initially around Baguio. Manila was also strongly defended, although General Yamashita at one time apparently had some thought of abandoning the city.

First Allied contact with strong Japanese forces came at the outskirts of the Baguio sector as the U.S. 1st corps, securing the 6th army's left flank so that the 14th corps could drive south through the Central Plains unmolested, drove north and east from Lingayen gulf. The 14th corps met negligible resistance until it reached the Clark field area. There the 40th infantry division was dropped off and the rest of the corps, now including the 1st cavalry division, continued toward Manila.

While the drive south gained momentum, the U.S. 11th corps (comprising the 38th infantry division and the 34th RCT of the 24th infantry division) landed on Jan. 29. 1945, at the west coast north of Bataan peninsula to secure Subic bay and cut access routes to the peninsula, thus preventing the Japanese from using Bataan as General MacArthur had employed it in 1942. By Feb. 5 the 11th and 14th corps had established contact inland at Dinalupihan. On Jan. 31 the U.S. 11th airborne division (less the 511th parachute RCT but reinforced by two infantry battalions of the 24th infantry division) made an amphibious landing at Nasugbu, south of Manila bay. On Feb. 3 the 511th parachute RCT jumped on Tagatay ridge, inland, soon linking up with the amphibious units from Nasugbu. The division then pushed northward toward Manila. The landings of the 11th corps and the 11th airborne division had been made under the operational control of the 8th army, control passing to the 6th army early in February.

On Feb. 3 the 1st cavalry division reached Manila and the 37th infantry division arrived there the next day. The 11th airborne division reached the southern outskirts on Feb. 6. Manila was bitterly defended by the Japanese with steady house-to-house warfare, and it was not until March 3 that the 14th corps could announce that organized resistance was over. With Manila under siege, further steps had been taken to open Manila bay for Allied shipping. On Feb. 15 the 151st RCT of the 38th infantry division secured the southern tip of Bataan and the next day the 503rd parachute infantry dropped on Corregidor Island, supported by an amphibious assault on the part of an infantry battalion of the 34th RCT, 24th infantry division. Within two weeks the island was secured, with Japanese dead numbering 4,500. The east and west coasts of Bataan peninsula were cleared by elements of the 6th infantry division, while other 11th corps troops secured smaller islands in Manila bay during March and April. The 11th airborne division cleared the bay's south shore.

The 6th army's strength was rapidly built up, and divisions wete moved from one sector to another as the need arose or when troops needed a rest by assignment to a quieter front. At the Clark field defegse sector, for instance, the 40th, 43rd and 38th infantry divisions all fought before organized Japanese resistance had ceased in April and the Central Plains could be declared secure. With the Central Plains, Manila and Manila bay secured, the Luzon campaign turned into a sort of grandiose mopping-up operation against firmly entrenched and fanatically resisting Japanese. Southern Luzon and the Bicol peninsula were cleared by the 11th airborne division, the separate 158th RCT (which made an amphibious landing at Legaspi on April 1), and a brigade of the 1st cavalry division. Organized resistance in those areas was over by the end of May, but in the mountainous defensive sector east of Manila organized resistance continued almost to mid-June. In the latter area. the 1st cavalry division and the 6th, 38th and 43rd infantry divisions, as well as many Filipino guerrilla organizations, were committed to action at one time or another.

The defensive sector in the mountains of northwestern Luzon held out the longest. There, at various times, the 158th RCT, the 6th, 25th, 32nd, 33rd, 37th and 43rd infantry divisions, and Filipino units were all employed in drives north and northeast from Lingayen gulf before Baguio iell on April 26. During March, April and May the 1st corps continued to drive northeastward toward the Cagayan valley, the southern entrances to which were secured in mid-May. Operations to occupy the entire valley continued through June, and included a drop by elements of the 11th airborne division on June 21. The valley was declared secure a week later, leaving as the only strong, organized resistance on Luzon the Kiangan pocket, located in mountain fastnesses north of Baguio.

On July 1 headquarters, 14th corps, assumed control of operations against the Kiangan pocket and headquarters, 1st corps, began preparing for other advances. On July 4 General MacArthur declared Luzon secure, and the U.S. 8th army took over the task of final mopping up. just as it had at Leyte. The iast drive into the Kiangan area was undertaken by the 6th and 32nd infantry divisions and former Filipino guerrilla units now reorganized as regular elements of the Philippine army. By the end of the war the Japanese 14th area army mas still maintaining some organized resistance in northern Luzon, and only the final surrender ended the fighting there.

4. The Southern Philippines and Borneo. — The campaign for the reoccupation of the southern Philippines was conducted by

the U.S. 8th army, and the operations went on simultaneously with those on Luzon. The first major step was the seizure of Palawan Island by the 186th RCT of the 41st infantry division, beginning Feb. 28, 1945. At Palawan airfields were quickly constructed to assure complete Allied control over the South China sea. Panay Island was invaded by the 40th infantry division on March 18 and the island was secured against negligible opposition, Filipino guerrillas under the leadership of Col. Marcario Peralta (P.A.) having previously bottled up the small Japanese garrison at three or four isolated posts. The 40th infantry division moved to northwestern Negros Island on March 29 and was reinforced there by the 503rd parachute RCT on April 8. There was bitter fighting in the hills of northern Negros and it was not until mid-May that organized resistance was broken. The Americal division landed on Cebu Island on March 26. Again there was some stiff resistance and the last organized opposition was not over until May 2. The Americal division also cleared southeastern Negros and Bohol Island.

By the end of May almost all the rest of the many small islands in the central Philippines had been secured, many of them by or with the aid of Filipino guerrillas.

Mindanao, second largest island in the Philippines, had been General MacArthur's first target before the change in plans made in Sept. 1944, but as events turned out, Mindanao was the last island secured. The first landings were made by the 41st infantry division (less the 186th RCT) on March 10, 1945, at Zamboanga, southwestern Mindanao. Airfields were quickly constructed from which to support operations against the Netherlands East Indies, and the 41st infantry division secured the Sulu archipelago, between Borneo and Mindanao, in a series of shore-to-shore manoeuvres beginning on April 2. On April 17 the U.S. 10th corps, comprising the 24th and 31st infantry divisions, started landings in central Mindanao to begin the seizure of the interior of the island. The 108th RCT of the 40th infantry division reinforced the 10th corps on May 9, and elements of the 41st infantry division were also employed in the central and eastern sections of the island. A strong guerrilla organization, under Col. Wendell Fertig (U.S.A.), proved of considerable help to the 10th corps, but some isolated pockets of Japanese resistance were still holding out at the end of the war.

The reoccupation of Borneo began on May 1, 1945, when the 26th Australian brigade group of the 9th Australian division landed at Tarakan Island, northeastern Borneo, to establish bases from which future operations could be supported. The rest of the 9th Australian division landed at Brunei bay, on the northwest coast, on June 10, rapidly securing the area against scattered resistance. The 7th Australian division went ashore at Balikpapan on the east-central coast July 1, meeting resistance which delayed the seizure of the oil-rich area until the middle of the month. A Dutch infantry company and U.S. army amphibious engineers had participated in these operations, which had been supported also by available elements of the Allied air forces and Allied naval forces S.W.P.A. Borneo's oil was denied to the Japanese, and bases were secured from which further operations in the Netherlands East Indies could have been mounted, had they proved necessary before the end of the war.

5. Iwo **Jima.**—To provide a base from which fighter planes could protect B–29s on their raids against Japan; to step up air operations against Japan; to secure fields for B–29 emergency landings; to maintain pressure against Japan from all directions; and. finally, to extend Allied control over new areas of the Pacific, the Allies decided to seize Iwo Jima, in the Bonin Islands about 750 mi. S. of Tokyo. Following prolonged aerial and naval bombardment, the U.S. marines' jth amphibious corps began landing at Iwo on Feb. 19. 1945. The initial assault was made by the 4th and 5th marine divisions and the 3rd marine division (less one RCT) was put ashore later in the month. With little manoeuvre room available, the 5th amphibious corps faced a fanatically resisting Japanese garrison which organized strong counterattacks from well-fortified positions. But the island was declared secure on March 14, and only mopping up of a few stubbornly resisting pockets remained to be accomplished.

The Iwo Jima operation was primarily a marine corps action. U.S. army port companies, amphibious truck companies and anti-aircraft battalions also participated in the assault phase. The island garrison force had as its principal ground element the army's separate 147th infantry regiment, which completed the mopping up, and the air garrison stationed on the island comprised principally units of the army's 7th air force. The Iwo Jima operation resulted in the killing or capturing of about 22,000 Japanese, while U.S. forces engaged suffered more than 21,000 casualties, including almost 4,500 men killed. Despite this heavy cost, Iwo Jima proved an invaluable air base, and the first fields there became operational in early April.

6. **The Ryukyus; Okinawa.**—The seizure of positions in the Ryukyus was to have been the last step in the Pacific war prior to actual invasion of the Japanese home islands. From bases there, preassault aerial bombardment of Japan could be intensified; the invasion forces could be provided with direct land-based air support; and the islands could be used as staging and supply bases.

Okinawa. largest island in the Ryukyus, lies only 350 mi. S. of Kyushu Island, where the initial invasion of the Japanese home islands was to have taken place.

Ground operations in the Ryukyus mere under the direct command of Lt. Gen. Simon Bolivar Buckner (U.S.A.), commanding general of the U.S. 10th army, which fought under Admiral Nimitz' operational control. The 10th army comprised the U.S. 24th corps (the 7th, 27th, 77th and 96th infantry divisions) and the marines' 3rd amphibious corps (the 1st, 2nd and 6th marine divisions). Of the 2nd marine division, only one RCT was actively engaged in the Ryukyus fighting.

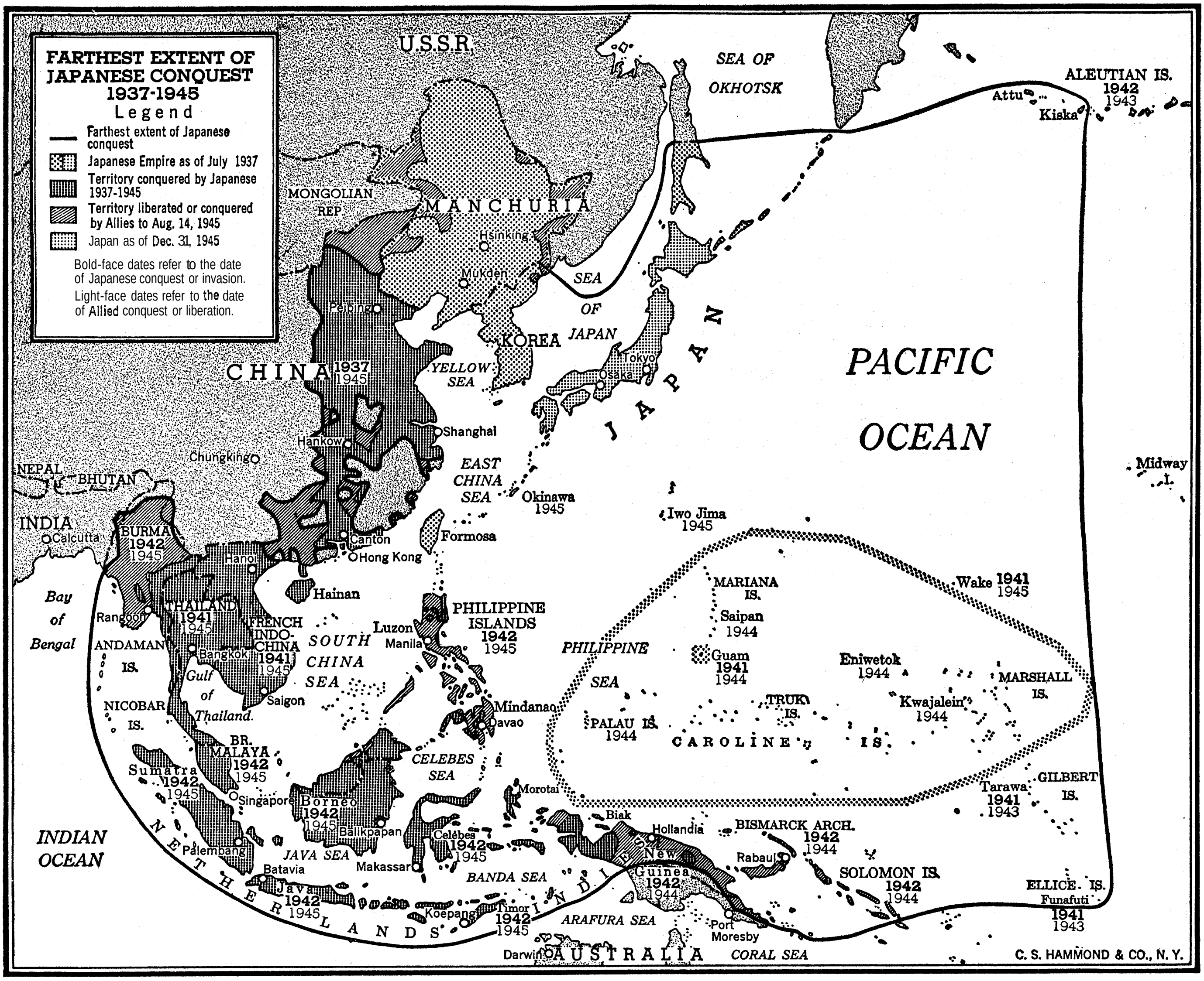
Following extensive aerial and naval bombardment by the U.S. 5th fleet, landings in the Ryukyus began on March 26, 1945, when the 77th infantry division began securing the Kerama Islands, 1j mi. W. of Okinawa. On March 31 army artillery was put ashore on Keise Island, only 11 mi. from Okinawa. A seaplane base and fleet anchorages were quickly established in the Keramas, and about 350 suicide boats, with which the Japanese had expected to destroy the Allied invasion convoys off Okinana. were destroyed. Artillery was soon bombarding Okinawa from Keise Island.

The main landings in the Ryukyus were made by the 7th and 96th infantry divisions and the 1st and 6th marine divisions at Okinawa on April 1. There was little opposition at the beaches, the Japanese having decided to maintain a static defense inland. The 3rd amphibious corps' two divisions secured northern Okinawa by April 18, while the 24th corps instituted a drive against the main Japanese defenses, located in the southern part of the island. While attacks on the south continued, the 77th infantry division, during the period April 16–21, secured tiny Ie Shima, off northwestern Okinawa. There, airfields were constructed from which to support ground operations on Okinawa and to undertake early air attacks against Japan.

In southern Okinawa vicious fighting continued against well-entrenched Japanese who launched local counterattacks and fought stubbornly for every square inch of ground. The 27th infantry division was committed to action on April 18, and the 77th infantry division had to be brought over from Ie Shima later in the month. By mid-May the two marine divisions were moved to the south and the 3rd amphibious corps was reinforced by an RCT of the 2nd marine division.

Organized resistance was not over until June 21, mopping up not completed until June 30 and the campaign not declared over until July 2.

The Ryukyus operations cost the 10th army about 7,600 men killed, 31,800 wounded and 26,200 nonbattle casualties. Total U.S. casualties during the campaign, including those of naval and air units, were about 12,500 men killed and 36,650 wounded. Approximately 110,000 Japanese were killed and 7,400 more were taken prisoner. The Japanese had reacted strongly with aerial attacks executed by planes based in Japan, Employing a multitude of suicide planes and small, one-man rocket missiles, the Japanese sank 36 Allied ships and damaged 368 more. In addition,



about 763 U.S. aircraft were destroyed. The Allied air units, both carrier- and land-based, destroyed about 7,800 Japanese aircraft in the Ryukyus or Japan and sank 16 Japanese ships. General Buckner lost his life and was replaced first by Maj. Gen. Roy S. Geiger (U.S.M.C.), commander of the 3rd amphibious corps, and then by Gen. Joseph W. Stilwell (U.S.A.), previously commander of U.S. army forces in China, Burma and India. However costly the operation, the seizure of the Ryukyus provided the Allies with an invaluable base.

The Japanese knew that invasion of the home islands could not be far off.

7. Victory in the Pacific.—While the campaigns in the Philippines and the Ryukyus were underuay. Allied commanders had been busy preparing plans for the assault on Japan. First, there was a sweeping reorganization of forces in the Pacific. On April 3, 1945, the U.S. joint chiefs of staff appointed General MacArthur commander of all U.S. army forces in the Pacific and Admiral Nimitz the commander of U.S. navy units. For the invasion of Japan, General MacArthur would also have retained operational control of marine corps and allied ground force units, and his position as supreme commander, Southwest Pacific area. Admiral Nimitz would likewise have had operational control over the naval units of Allied nations during the invasion. The U.S. 10th army on Okinawa passed to General MacArthur's control on July 31, and the headquarters of the U.S. 1st army, redeployed from Europe, set up an advance command post in the Philippines about the same time. The U.S. 20th and 8th air forces (units of the latter were being redeployed from Europe) were combined to form a bomber command designated the U.S. strategic air forces, under Gen. Carl Spaatz (U.S.A.), whose operations remained subordinate to the directives of the U.S. joint chiefs of staff. The U.S. 7th air force, based in the central Pacific, passed to the control of General Kenney's far eastern air force, while the U.S. Pacific fleet was reinforced by a British carrier task force.

Throughout July, Allied carrier- and land-based planes hammered at the Japanese home islands, and the area from northern Hokkaido to Tokyo was subjected to severe naval bombardments. The invasion schedule contemplated an assault at southern Kyushu in Nov. 1945 and a major effort in the Tokyo plain area of Honshu in March 1546. But what would obviously have been a most costly assault on Japan never had to be undertaken.

U.S.-British-Canadian research and development had succeeded in making possible the atomic bomb, the first experimental explosion of which was undertaken in the United States during July 1945. At that time the U.S., British and Russian chiefs of staff and heads of states were meeting at Potsdam, Ger., discussing both European problems and the prosecution of the war against Japan. The Allies decided to use the atomic bomb against Japan in an effort to shorten the war and save lives. Accordingly, on July 27 (Tokyo time) the Allies issued an ultimatum inviting Japan's immediate and unconditional surrender. This ultimatum was rejected.

On Aug. 6 a U.S. army air force B–29 bomber dropped a single atomic bomb on Hiroshima, Japan, creating unbelievable destruction and killing thousands of Japanese civilians. On Aug. g the

U.S.S.R. declared war on Japan and immediately began invading Manchuria and northern Korea. The cream of Japanese army forces in these areas had been drained away for operations in the Pacific or for the defense of the homeland, and the Russian troops found that resistance melted rapidly away. Still there was no satisfactory indication from the Japanese government that surrender was acceptable, and on Aug. 9 an even more powerful atomic bomb was dropped on Nagasaki.

The next day, Aug. 10, the Japanese declared their acceptance of the Potsdam ultimatum with the reservation that the emperor be retained as head of the state. The Allies, in turn, accepted this condition with the proviso that the emperor would remain subject to the directives of the supreme commander for the Allied powers, to which position General MacArthur was appointed. The Japanese accepted these final terms on Aug. 14. Five days later a Japanese delegation arrived in Manila to confer with General MacArthur's staff for the procedure concerning cessation of hostilities through the Pacific and Asia, the peaceful occupation of Japan by the Allied powers and the signing of formal surrender papers. Surrender ceremonies were conducted aboard the U.S. battleship "Missouri" in Tokyo bay during the morning of Sept. 2. The war in the Pacific was over.

The occupation of Japan was soon complete and Japan's scattered forces were rapidly rounded up and sent home. The nation had surrendered while still possessing a strong army capable of determined defense of the home islands. Japanese air strength had been considerably reduced in the summer of 1945, but there were still about 3,000 operational planes of various types available in the homeland. The navy, however, had practically ceased to exist, and Japan's industries had suffered such damage that the nation's ability to prolong the war was severely impaired. Finally, Allied air, surface and submarine operations had cut the home islands from all sources of raw materials. The effective and close blockade the Allies established around the home islands would ultimately have made it impossible for the Japanese to supply their military and civilian components with even the bare essentials of life. An early surrender was inevitable, probably even without the impetus supplied by the atomic bombs. It was better for both the Allies and the Japanese that the end came when it did. (R. R. SH.)

V. THE WAR AT SEA

A. PRIOR TO U.S. ENTPY INTO WAR

For many decades it had been a keystone of Britain's policy to maintain a fleet equal to any combination of two opponents likely to be brought against it. This policy rested on the belief that Britain could exist only by the importation of a large proportion of its food and could maintain the unity of its world-wide commonwealth of nations only by the mobile power of a dominant navy. The Washington naval treaty (1922) accepted equality with the United States while limiting the navies of France, Italy and Japan in proportion to their needs. The German navy already, by the Versailles treaty, had been reduced to impotence. The treaty of London (1936) imposed further limitations on cruisers and destroyers; but Italy, under fascist influence and expansionist ideas, declined to be bound, being already engaged in developing a fleet which might in favourable conditions give it mastery of the Mediterranean. The growing nationalism of Germany and the feeling that that country could be made peaceful only by allowing it a navy sufficient to satisfy national self-respect, resulted in the Anglo-German agreement of 1935 and declaration of 1937. These gave Germany the right to build up to 35% of Britain's strength in all categories and to 100% in submarines. Germany had started to rebuild its fleet and had produced the pocket battleships "Deutschland." "Admiral Graf Spee" and "Admiral Scheer," nominally 10,000-ton cruisers but in fact powerful commerce raiders of considerably larger tonnage. It now settled down to construct a modern fleet. "Gneisenau" and "Scharnhorst," 26.000-ton battleships, were completed in 1938 and 1939, respectively; the "Tirpitz" and "Bismarck," capital ships more powerful than any afloat or contemplated elsewhere, were laid down. Submarines were built in great numbers.

Britain became conscious of the inevitability of war as early as 1936 when a rearmament program was begun, but the recovery of the navy was slow. As forecast in 1938 the naval strength of the countries likely to be involved in the coming struggle would in 1940 be as given in Table II.

***TABLE 11.—Anticipated 1940 Naval Strength of Belligerents,** 1938*

	Battleships	Aircraft carriers	8-in. cruisers	Light cruisers	Destroyers	Submarines
British empire .	17	7–11	15	63	188	69
Germany . .	7		5		22	119–129
France , . .	10		7	10	66	94
Italy . . .	6	...	7	12	99	120–130
				28		

The British battleships were old, and the new program of battleship construction, introduced by Lord Chatfield when first sea lord, could not reach completion till 1941–42.

1. Two Great Strategic Aims.—British strategy had a threefold object: to ensure the safe arrival of supplies of all kinds to the home country, to prevent the landing of any enemy military expedition on its coasts and to provide force whereby a British expedition could be landed and maintained on enemy territory. Long experience had taught Britain that these essentials were best met by seeking out and destroying any enemy force which showed itself at sea.

German strategy aimed at cutting off Britain's supplies, primarily by submarines, secondly by surface raiders and thirdly by aircraft. Britain could thus be reduced to impotence, after which an actual invasion, well supported by air, could destroy its power forever. This plan involved disregard of the limitations on the use of submarines agreed on at Washington and demanded not only a large fleet of U-boats but an invincible army and overwhelming air power, all of which Germany had attained by 1939 when it invited war with Britain and France by its invasion of Poland.

The events which followed all took their place in the struggle between these two great strategic aims. Either one might be successful; both could not.

Britain declared war on Germany on Sept. 3, 1939; but before that date Germany had already stationed its fleet for the attack on British merchantmen. The "Admiral Graf Spee" was at sea in the South Atlantic with a number of improvised commerce raiders. U-boats were on the trade routes, and supply ships were in position. Britain had a battle fleet based on Scapa flow to contain the German fleet, another at Malta to contain the Italian fleet, which, in view of the axis treaties, could not be ignored. A number of cruiser squadrons were formed for trade protection and the hunting of raiders. Britain's greatest weakness lay in the absence of escort craft for merchant-ship convoys. Nevertheless, it was British policy to establish convoys as soon as possible for all except fast merchant ships.

On the opening day of the war the "Athenia," a British passenger liner outward-bound carrying 1,480 passengers and crew, was torpedoed off Ireland; and in the first fortnight Britain lost 27 merchant ships totalling 131,000 tons. By Sept. 7, however, the first outward-bound convoy had been assembled and sailed, and by the end of the first fortnight the convoy system was in regular operation and being extended daily. Convoys were escorted by destroyers and trawlers from British waters to longitude 20°–30° W., and thereafter by cruisers, battleships or armed merchant cruisers as defense against raiders. Many U-boats were attacked and a few were sunk, but as the war developed it became evident that the U-boats could and would operate right across the North Atlantic and that anti-submarine escort must accompany convoys for the whole journey. To meet this threat, the range of action of a number of destroyers was increased by the sacrifice of a boiler to permit added oil stowage, and a simple type of escort vessel known as the corvette was designed and laid down in large numbers in British building yards. A separate organization, coastal convoy, was created for the protection of coastal traffic resulting from the assemblage and dispersal of the great ocean convoys which took place off the west coast of Scotland.

On Sept. 6 Britain suspended its obligations under the London naval treaty. On Sept. 17 the great aircraft carrier "Courageous" was torpedoed by a U-boat and sunk in the North Atlantic. On Oct. 14 a German U-boat under the command of Capt.-Lieut. Gunther Prien made a daring entry into Scapa flow through a narrow channel between two islands and there found and torpedoed the battleship "Royal Oak." This proof that Scapa flow was not impregnable came as a shock to the British. Urgent measures were then taken to strengthen the base.

Germany meanwhile had developed new types of mines, and on Nov. 19 came the first announcement of sinkings by magnetic mines. Fifteen ships, largely neutrals, were lost in four days by the indiscriminate use of this secret 'weapon, laid sometimes by aircraft and sometimes by ships. The British secured a mine, discovered its secret and in a very short time developed an antidote and equipped their rapidly swelling fleet of mine sweepers with the means to explode it and so clear a safe channel.

The surface raiders mere also active; a German battle cruiser sank the AMC (armed merchant cruiser) "Rawalpindi" off Ireland on Nov. 26, and about the same time the "Admiral Graf Spee" sank the Polish liner "Pilsudski." the British "Doric Star" and a number of other ships. Despite these setbacks Winston Churchill was able to report on Dec. 6 that the convoy system was in full operation and only one ship per 750 sailings had been sunk. In addition, the British expeditionary force had been safely conveyed to France.

2. Battle of the River Plate: the **"Altmark."**—On Dec. 13, 1939, a British cruiser squadron under Comm. (later Admiral Sir) Henry Harwood, consisting of "Ajax," "Exeter" and "Achilles," fought the pocket battleship "Admiral Graf Spee" in the South Atlar tic. The "Ajax" and "Achilles" had 6-in. armament, the "Exeter" 8-in., while the "Graf Spee's" armament of six 11-in. and eight 5.9-in. exceeded in broadside weight that of all three British cruisers. The action opened soon after dawn; the British divided their force, the "Exeter" taking one side and the two 6-in. cruisers the other so as to force the "Graf" to split its fire. The "Exeter" received the brunt of the fire and was heavily hit and eventually forced out of action while the three British, together, so pummelled the German that it turned away and made for the neutral port of Montevideo with the British in pursuit. On Dec. 17 the "Admiral Graf Spee" left harbour and to the surprise of the British. waiting outside, scuttled itself in mid-channel. Its crew was interned and its commander, Capt. Hans Langsdorff, committed suicide. The action was remarkable for the tactical handling of the cruisers which enabled them to defeat the-much more heavily armed "Graf Spee."

The problem of transporting large contingents of troops from overseas was now urgent and was met throughout the war by the use of large iast liners specially fitted up for troop transport. The first Canadian consignment arrived in Britain on Dec. 17, 1939, and the method proved extremely successful, the liners' speed rendering U-boat attacks very difficult.

In Jan. 1940 the British requisitioned all British shipping capable of overseas trade, and in February the Germans announced that all British ships nould be sunk without warning

On Feb. 16 an incident occurred which, though relatively unimportant. created considerable stir. The armed merchantman "Altmark." returning to Germany after its campaign in the South Atlantic with 300 British prisoners of war, was known to be working its way down the Norwegian coast to Germany, inside territorial waters. It put into Josing fiord, and thereupon the British destroyer "Cossack", Commander (later Admiral Sir) Philip Vian, entered the fiord, ranged alongside and rescued the prisoners.

3. Operations off Norway and Denmark. — On April 9 Germany invaded Norway and Denmark. It claimed that it was forced to this action because the British had laid mines in Norwegian naters. In fact, however, the mines were laid only on the morning of April 8, when some of the Germsn invading force had already left for Norway. The Germans occupied Oslo. Trondheim and Narvik as well as a number of other ports On April 9 the battle cruiser "Scharnhorst" was engaged and severely damaged in an action with H.M.S. "Renown" but escaped under the cover of smoke screens laid by the cruiser "Hipper." On April 10 a British destroyer force led by Capt. H. Warburton-Lee in the "Hardy" entered Narvik fiord to attack German naval forces. In the ensuing battle, one German destroyer was sunk, three were set on fire and a number of supply ships sunk or burned. The British lost the "Hardy" and "Hunter" and Captain Warburton-Lee was killed. On the same day German troopships were sunk by submarines in the Skagerrak and the cruiser "Koenigsberg" was sunk by the fleet air arm at Bergen.

On April 13 the battleship "Warspite" and a strong force of destroyers made a second attack on Narvik under Vice-Adm. William Whitworth and succeeded in sinking seven German destroyers and capturing the fiord. On the same day the cruiser "Blucher" was sunk in Oslo fiord. The "Karlsruhe" was sunk by the British submarine "Truant" while the British lost the aircraft carrier "Glorious" by U-boat, and the cruisers "Curlew" and "Effingham." Two days later a British, French and Polish force was landed in Norway, and the British occupied the Faroe Islands. The German invasion had been successful, though at a heavy cost, including 26 transports. It remained to establish their position, and in the ensuing struggle on land, assisted by greatly superior air support, they forced the Allies to evacuate between June 1 and 4.

The Norwegian adventure gave Germany a long Atlantic coast line and many harbours. It greatly facilitated the submarine campaign and improved the flow to Germany of the important Swedish iron ore. These advantages were bought at the cost of a serious dispersion of force in all three arms, as well as the moral stigma of having invaded two peaceful countries without the slightest justification. an action which shocked the neutral world.

4. Germany on the Atlantic. — By May 14, 1940, the Netherlands, overrun by German troops, capitulated; four days later Brussels was taken and German forces had broken through in France. The royal navy was doing all in its power to evacuate Dutch and Belgian merchantmen to British ports and succeeded in saving considerable tonnage. On May 28 Belgium surrendered. The British army, split off by the German advance from its French allies, was compelled to retreat to the coast. Dunkirk was chosen as the place of evacuation.

The British mobilized every available small vessel to assist their destroyers in this evacuation. The operation started on June 1 and lasted four days, during which 345,585 men were brought back, mostly from open beaches; but their equipment was lost.

On June 10 Italy declared war on Britain and France; four days later Paris surrendered and on June 15 the British completed their army's evacuation from Brest and St. Nazaire. On June 24 an armistice was concluded between Germany and France. Britain then stood alone, its army without equipment, and only its navy and its air force (greatly reduced by losses in France) between it and invasion. The occupation of the Netherlands, Belgium and France, as well as Denmark and Norway, now gave Germany a vast Atlantic coast line. Its U-boats need no longer run the gauntlet of the Dover straits or the Fair Island channel, and it promptly developed U-boat bases at Brest, St. Nazaire, Lorient and Bordeaux. Its aircraft based near the coast in the Netherlands, Belgium and France could operate over the North sea, English channel and Bay of Biscay, while its iast coastal craft, based on Dutch and Belgian ports, were well placed to attack British coastal convoys moving in and out of the port of London. The British prepared to meet invasion. They kept a close watch on channel ports where invasion barges were collecting and harried them by bombing.

5. Immobilization of French **Navy.**—Now that Italy was in the war the French navy presented a serious problem; for if Germany obtained possession of it, the combined Italian and German-French navies would be superior in every arm to the royal navy. The French armistice provided that the French fleet was to be assembled in French and Italian ports and demilitarized except for units which the Italian or German governments desired for the protection of French colonial interests. This obvious loophole and the distrust in German promises prompted the British to take decisive action. On July 3 all French warships in British ports were boarded and placed under British control. Ships in North African ports were offered alternative conditions designed solely to keep them out of German hands. An important contingent, including the battle cruiser "Dunkerque," lay at Oran; Adm. Marcel-Bruno Gensoul, in command, refused to accept any conditions and prepared his ships for sea and for action. A British force under Adm. Sir James Somerville, after a delay of $8\frac{1}{2}$ hr., opened fire; a battle ensued in which the majority of the French force was destroyed. The battleship "Richelieu" lay at Dakar, and there again the French admiral refused the alternatives offered. On July 8 a launch manned

by British personnel entered Dakar, placed depth charges against the "Richelieu's" hull and seriously damaged it. Naval aircraft completed the damage which kept the ship immobilized for two and one-half years.

On July 9 a British fleet was at sea to the east of Malta, covering an important convoy, when a mixed Italian force of two battleships, cruisers and destroyers was encountered. The British force gave chase, but the Italians turned away, covering their retreat with smoke screens. One Italian battleship was hit and a cruiser torpedoed by aircraft. The British pursued to within sight of land and although heavily attacked by aircraft suffered no loss. Ten days later the cruiser "Sydney," under Capt. (later Rear Adm.) J. A. Collins, accompanied by destroyers, encountered two Italian cruisers and sank the "Bartolomeo Colleoni."

6. Operations during Battle of Britain. — In Aug. 1940, the threatened invasion of Britain appeared imminent. The Germans had reorganized their armies for the task, and embarkation was being practised. On Aug. 8 the campaign opened with mass air raids, and the battle of Britain began. In this, British fighter aircraft created havoc in the German bombing forces, which were eventually so weakened that the German high command was forced to abandon its plans for invasion, a fact which became apparent to the British as the autumn wore on. In November Germany concentrated its air attacks on British ports. Southampton was the first to suffer. Portsmouth, Plymouth, Portland and Bristol all experienced severe raids and were gravely damaged. The London docks were frequently attacked and immense fires caused. None of these ports, however, was entirely immobilized; and work continued.

The battle of the Atlantic also continued. In June 1940 the liner "Lancastria," carrying troops, was bombed and sunk, as was the AMC "Andania." In July the "Arandora Star" was sunk, in August the AMC "Transylvania," and in September the "City of Benares" carrying *évacuée* children, all by U-boat. In October the "Empress of Britain" was sunk by bombing. Against these successes the British could claim the capture of the German liner "Weser" in the Pacific.

The British were desperately short of escort vessels, and on Sept. 3 an agreement with the U.S.A. was announced leasing a number of bases to the latter in exchange for 50 overage U.S. destroyers, transferred to the royal navy. These vessels, after a good deal of modernization, helped greatly to fill the void.

7. Mediterranean Operations. — In the Mediterranean the British continued to command the sea, operating by extensive sweeps in search of the Italian fleet. On Oct. 12 the cruiser "Ajax," under Capt. (later Vice-Adm.) E. D. B. McCarthy, encountered three large Italian destroyers south of Sicily and sank two of them. In a subsequent action against a cruiser and four destroyers it crippled one, the remainder escaping in darkness. Next day the cruiser "York" found the crippled destroyer and sank it after allowing time for its crew to abandon ship. British submarines maintained continuous pressure against Italian supply ships plying to the African coast and sank three in October.

These results did not satisfy the British naval commander in chief, Admiral of the Fleet Sir Andrew (later Viscount) Cunningham. The Italian battle fleet of two new and four reconstructed battleships constituted an ever-present threat to his supremacy. A carefully prepared attack by carrier-borne torpedo aircraft was delivered against the great Italian base at Taranto on the night of Nov. 11. All the six battleships lay in the outer harbour; three were hit and left in a sinking condition. Only the shallowness of the water prevented their final loss. In the inner harbour two cruisers were badly damaged and two fleet auxiliaries sunk. The British lost only two aircraft. This shattering blow established British naval supremacy in the Mediterranean, but shore-based aircraft operating from Sicily, Sardinia, the African coast and the Dodecanese still interfered with free movement of British transports. The majority of these, including troop transports and ammunition ships, now made the long journey around the cape in order to maintain and reinforce the British armies operating against Ethiopia, Eritrea and Libya.

In the North Atlantic the struggle continued to be severe. On Nov. 5 the AMC "Jervis Bay," under Capt. E. S. F. Fegen, was escorting a convoy of 38 ships when the pocket battleship "Admiral Scheer" was sighted closing to attack. Captain Fegen at once ordered his convoy to scatter and make smoke, while he steamed rapidly toward the raider and opened fire. It was evident from the first that the odds were hopeless; nevertheless, he engaged the "Scheer" for nearly an hour and held the Germans' fire. When at last the "Jervis Bay," crippled and in flames, sank beneath the waves, the merchantmen had had time to scatter so that of the whole 38 only four were sunk.

In the Mediterranean the British now scored a series of successes. The offensive launched from Egypt on Dec. 9, 1940, led to a rapid advance culminating in the capture of Benghazi. This advance was strongly supported by the royal navy whose main base was now, by agreement with the Egyptians, at Alexandria. But at this point, because of the pressure on Greece from German and Italian forces, the British decided to send reinforcements there. There followed a number of contacts between naval forces in which the Italians invariably retired behind smoke screens. Powerful forces of Italian and German aircraft, however, attacked with determination; and on Jan. 14, 1941, while protecting a convoy en route for Greece, the aircraft carrier "Illustrious" was damaged and the cruiser "Southampton" set on fire so seriously that the British sank it. On Feb. 9 Adm. Sir James Somerville led a heavy bombardment on the naval base at Genoa which caused great destruction.

8. Battle of Cape Matapan.—On March 19, 1941, aircraft reported Italian cruisers southeast of Sicily steaming to the southeastward. The British commander in chief dispatched a force of four cruisers, a carrier and some destroyers under Vice-Adm. (later Adm. Sir) Henry Pridham-Whippell to make contact and followed with three battleships screened by destroyers. The light forces sighted an Italian battleship and two cruisers, and while attacking the battleship by torpedo, aircraft led the cruisers toward the British battle fleet. The Italian battleship received several hits in the course of the day's fighting but escaped, badly damaged, to its base.

A second Italian force of two battleships and several cruisers was now sighted some distance to the northward, and a chase ensued until the 8-in. cruiser "Pola," which had been attacked by torpedo aircraft, was sighted, stopped and heavily damaged, and the British battle fleet closed on it. Night had already fallen when three more large cruisers crossed the British battle fleet's bows, possibly in support of the "Pola." The battleships opened fire and the cruisers were quickly destroyed. The result of this action was that the three 8-in. cruisers "Pola," "Zara" and "Fiume," one or two smaller cruisers and two destroyers were sunk. The remaining Italian forces escaped northwestward. The British lost two aircraft but had no other casualties; they picked up more than 900 Italian officers and men next morning. The action was notable in having been brought on by the delay imposed on the Italians by torpedo aircraft. The Italians had 3 battleships, 11 cruisers and 14 destroyers at sea against the British 3 battleships, 1 aircraft carrier, 4 cruisers and a number of destroyers. Greek destroyers co-operated effectively with the British.

On April 1, 1941, Asmara, the capital of Eritrea, surrendered; and an Italian flotilla in the Red sea was engaged and sunk.

The necessity for reinforcing Greece seriously weakened the British forces in Africa. The Germans were coming to the rescue of their Italian allies and pouring panzer troops and ammunition into Tripoli. This supply line had Malta on its flank, and although the island had suffered severe bombing and was no longer used by the battle fleet, it remained the base of destroyers and submarines. These harried the Italian convoys. On the night of April 15–16 a force of four British destroyers led by the "Jervis" sighted a convoy of five large ships escorted by four destroyers. In the first few minutes of the British attack the leading Italian destroyer was overwhelmed and sunk, then every ship of the convoy was set on fire and a battle ensued between the remaining destroyers. The British lost the "Mohawk" by torpedo. All the Italian destroyers were sunk or set on fire, while the entire convoy which consisted of ammunition ships, motor transport and German troops was destroyed. Despite naval victories the British position in the Mediterranean now suffered a decline. On April 3, 1941, the British evacuated Benghazi; and a retreat to the Egyptian frontier followed. Tobruk held out and was supplied from the sea.

9. Operations off Greece and Yugoslavia.—On April 6, 1941, the Germans invaded Greece and Yugoslavia, the Yugoslav army withdrawing. Salonika fell to the Germans on April 9, and Monastir was reached the next day. The British forces in Greece now fell back fighting, and on April 23 the Greek government was evacuated to Crete. Two days later the Germans occupied Lemnos Island and shortly afterward the whole of the Dodecanese group. The British were forced to evacuate their army in Greece, and about 43,000 escaped to Egypt and to Crete, 3,000 being left. The Germans then brought overwhelming air superiority to bear on Crete and made parachute and glider landings. Their air- and sea-borne troops suffered heavy losses but gained a foothold, and the British found it necessary to evacuate Crete also. This proved a costly operation. In the course of May and June the British lost by aerial attack three cruisers and eight destroyers, proving beyond all doubt that naval operations within the reach of shore-based aircraft could not be carried out without air support. By June 1, however, the evacuation of Crete was complete.

In the summer months of 1941 the air attacks on Malta were intense, but the fortress held out and the British fought their convoys through and took a heavy toll of Italian supply ships to Africa. In the course of these operations the battleship "Nelson" was torpedoed on Sept. 27, but not fatally. The aircraft carrier "Ark Royal" was torpedoed and sunk on Nov. 14. The "Barham" was torpedoed and sunk on Nov. 25.

On the reverse side, Capt. (later Rear Adm. Sir) William G. Agnew in the cruiser "Aurora," patrolling on the night of Nov. 9 in the central Mediterranean with a force of two cruisers and two destroyers, encountered two convoys of ten supply ships escorted by destroyers and covered by two 8-in. cruisers. In the resulting action all the supply ships were destroyed and three destroyers sunk, a fourth being subsequently sunk by a British submarine. The British suffered no casualties. An armed merchant cruiser and several supply ships were sunk two days later. British submarines had many successes.

Supported by the fleet, the British attacked in Libya on Nov. 18 and gained much ground. Severe fighting followed but by Dec. 1 the German and Italian tank forces had pressed the British back once more to the Egyptian frontiers and beyond, and Tobruk was again invested.

Turning to the Atlantic, the British had planned a raid on the Lofoten Islands where, under German occupation, quantities of fish oil and other products were made and sent to Germany. On March 4 the raiding squadron fell upon the islands, captured the garrison, sank ten merchant ships and some armed trawlers, revictualled the Norwegian inhabitants, destroyed the fish-oil plant and withdrew with their prisoners. The operation was sudden, swift and precise. There were a few German but no British casualties.

10. The "Hood" and "Bismarck."—In the middle of May 1941 the battleship "Bismarck," which for some time had been sheltering at Bergen, set out in company with the heavy cruiser "Prinz Eugen" on a commerce-raiding expedition, and the task of finding and bringing it to action fell to the commander in chief of the home fleet, Vice-Adm. Sir John (later Admiral of the Fleet Lord) Tovey. He sent the cruisers "Norfolk", and "Suffolk" to the Denmark straits, while three groups containing capital ships took up intercepting positions. On the evening of May 24, the "Suffolk," commanded by Capt. R. M. Ellis, sighted the "Bismarck" and a cruiser and started to shadow, and as a result the battlecruiser "Hood" and the new battleship "Prince of Wales" made contact and engaged next morning. The engagement was fortunate for the Germans, for while both the "Bismarck" and "Prince of Wales" received only slight damage the "Hood" was hit in a magazine and blew up. The "Bismarck" turned southwestward and broke off action; but it was shadowed, and the "Prince of Wales" again engaged toward evening. The Germans turned to the west and then to the south in an endeavour to shake off pursuit. But on May 25 the "Victorious" launched a torpedo aircraft attack which scored a hit at 12:15 A.M. At 3 A.M. in misty weather, contact was lost, the "Bismarck" being then about 350 mi. S.S.E. of the southern point of Greenland. Admiral Tovey's squadron, led by the "King George V," was closing in from the north, while another group under Admiral Somerville was converging from the south. It was not until 10:30 A.M. on May 26 that the quarry was again located by aircraft. The "Bismarck" was now alone and steering east, about 550 mi. W. of Land's End. In the course of the day the "Ark Royal" sent off two striking forces, the second of which succeeded in making two torpedo hits. Cruisers were then in touch, and during the night successful torpedo attacks were led by Captain Vian in the "Cossack," after which the "Bismarck" was reduced to eight knots though its gun armament was still intact. At 9 A.M. on May 27, the "King George V" and "Rodney" engaged and silenced it; finally the "Dorsetshire" sank it with torpedoes. About 100 officers and men were rescued. This lesson made the German grand commander in chief, Adm. Erich Raeder, very chary of sending out commerce raiders.

11. Naval Help for Russia.—On June 22, 1941, the war entered a new phase when Germany invaded Russia. Russia was desperately short of munitions and means had to be found to supply it. Stretched to the limits though it already was, Britain organized a system of convoys to Archangel, the first convoy sailing in August. These convoys continued throughout the war. The Germans based on Norway were well placed to interfere by aircraft, surface ships and submarines. Each successive convoy was attacked, but the great majority of ships got through.

On Aug. 15 President Roosevelt met Winston Churchill in Argentia bay, Newfoundland, and drew up the Atlantic charter. That these two leaders, so vital to their countries' welfare, could risk an Atlantic voyage was a measure of the mastery of the submarine menace which had been attained. But while fast and well-escorted ships could travel with relative safety, the slower convoys, still inadequately protected, were far from safe. In the first 11 months of the war, Britaig lost 1,500,000 tons of shipping, out of a total of 21,000,000. Losses averaging 500,000 tons a month were sustained in the early part of 1941, when Germany had developed its Atlantic bases and its production of U-boats had become gigantic. Adm. Karl Donitz, directing the U-boat war, constantly introduced new tactics, while, step by step, the British countered them. April 1940 had seen the first corvette at sea; by 1941 they were afloat in large numbers, and many U-boats had been sunk. In the latter months of that year losses diminished markedly to 180,000 tons per month and it seemed that, for the time being at least, the British had the upper hand in the unending struggle.

Mine sweeping had developed to vast dimensions, the sweepers now being equipped to destroy magnetic and acoustic mines as well as the older contact mines.

In British waters hundreds of motor gunboats had been built and were at sea guarding the coastal convoys and fighting the E-boats which operated from Dutch and Belgian harbours. The struggle to protect shipping was at a peak. The percentage of losses on a voyage was never great, but cumulatively they were serious.

British eyes were turning to the east, where Japan was becoming increasingly menacing. On Aug. 24, 1941, Churchill warned Japan that opposition to the passage of supplies to Russia must stop. Such reinforcements as could be spared were sent to Hong Kong and Singapore. (C. V. U.)

B. WAR AT SEA AFTER PEARL HARBOR

(For complete figures on naval losses in the Pacific, see section IV, *The* War in *the* Pacific.)

In Dec. 1941 the United States was confronted with war at sea in both the Atlantic and Pacific oceans. The geographical position of the nation necessarily required control of the seas before U.S. troops could fight offensively upon land.

In the Atlantic, United States strategy involved maintaining lines of communication to Great Britain and to future bases of operations against the continent of Europe, in opposition to the vigorous efforts of the German submarine and air forces to secure and maintain control of that ocean. In the Pacific, not only the initial success of the Japanese attack upon Hawaii but the lack of any well-developed bases in Australia and in the South Pacific islands, combined with the immense distances, placed Allied naval forces immediately upon the defensive. However, before the end of 1942 the offensive had been seized in both oceans.

1. Defensive Phase in the Pacific.—After the Pearl Harbor attack, which resulted in the permanent loss of two battleships of the United States Pacific fleet and the incapacitation of six others for varying periods of time, the Japanese withdrew from the Central Pacific and, except for the capture of Guam and Wake Island, devoted their attentions to the Philippine Islands, the Malay region and the Netherlands Indies. The Allied naval forces in that part of the world were hopelessly outnumbered, but though incapable of permanently checking the Japanese advance, they undertook with great gallantry to delay it as long as possible. The British battleship "Prince of Wales" and battle cruiser "Repulse"—sent to Singapore as a token force, without adequate escorts or air support—were sunk on Dec. 10, 1941, by Japanese torpedo-carrying planes before they had an opportunity to give any account of themselves. With no hope of predictable reinforcement from the United States Pacific fleet, the small U.S. Asiatic fleet (commanded by Adm. Thomas C. Hart, consisting of 3 cruisers, 13 overage destroyers, 29 submarines, 2 squadrons of patrol planes and a few gunboats and auxiliaries, operating in conjunction with equally slender British and Dutch forces) was all that was available to stem the Japanese tide. At the outbreak of war Admiral Hart's forces in the Philippines were already skilfully deployed in anticipation of a possible attack, which soon came. On Dec. 10 the navy yard at Cavite was practically wiped out by Japanese bombing, and the Asiatic fleet (save for units which remained to assist in support of the army's positions on Bataan and Corregidor) moved south to the Netherlands Indies. On Jan. 3, 1942, Gen. Sir Archibald P. Wavell of the British army assumed supreme command of the Australian, British, Dutch and U.S. forces in the theatre, and Admiral Hart became commander of the Allied naval forces.

During the next few months, the Japanese advanced rapidly in many directions by overcoming the inferior Allied air opposition at a given point of attack and then sending heavily screened amphibious forces to make landings. As soon as they were in control of a new area, they would repair the airfields and move on to still another. With totally inadequate air support, the Allied naval forces could only attempt to delay the Japanese advance by breaking up landing operations wherever possible. In the battle of Makassar strait, early in the morning of Jan. 24, 1942, and in Madura strait on Feb. 4, naval attempts were made to disrupt Japanese invasion forces. Though one drive might be impeded by one of these gallant delaying actions, others would go forward almost simultaneously, and by mid-February the Japanese were in a position to advance on Java. At this point, in accordance with previously made international agreements, the command of the Allied defensive was assumed by Netherlands officers, and Admiral Hart relinquished operational command of the Allied naval forces to Vice-Adm. C. E. L. Helfrich of the royal Netherlands navy. Attempts to halt the Japanese invasion of Java were made in Bandung strait on the night of Feb. 19-20 and in the battle of the Java sea on Feb. 27. Allied losses were heavy, and on Feb. 28 the Japanese landed on the north coast of Java. As no suitable base for naval surface forces remained, the Allied naval command was dissolved, and the surviving U.S. naval vessels proceeded to Australia.

In the course of March 1942 Java was occupied, and the Japanese continued their plan of conquest in directions as widely separated as Burma and New Guinea. A British fleet including old battleships and aircraft carriers under command of Adm. Sir James Somerville had been assembled in the Indian ocean to prevent the westward spread of the Japanese offensive. This force suffered the loss of the cruisers "Dorsetshire" and "Cornwall" in the Japanese attack on Colombo, Ceylon, on March 28, and of the aircraft carrier "Hermes" and other smaller vessels in a Japanese raid on Trincomalee, Ceylon, on April 9. The possibility that the Japanese would follow up this successful offensive in the Indian ocean by threats farther west emphasized the strategic importance of Madagascar, which was in Vichy-French possession. Consequently, to forestall any Japanese aspirations in that direction, a British force, under command of Rear Adm. E. Syfret, successfully occupied the main base at Diego Suarez at the northern end of Madagascar on May 5–7. However, the April raid on Trincomalee proved to he the last blow struck by the Japanese in the Indian ocean; and it was to the eastward in the Pacific, where the United States navy was gathering its strength, that the war at sea was to be decided.

No United States aircraft carriers had been at Pearl Harbor during the Dec. 7 attack, and so Adm. Chester W. Nimitz, who had become commander in chief, United States Pacific fleet, late in Dec. 1941, was able to use these ships in the first offensive strikes of the Pacific war, while the situation was still going from bad to worse in the far east. A force consisting of the carriers "Enterprise" and "Yorktown," cruisers and destroyers, under the command of Vice-Adm. William F. Halsey, Jr., struck various points in the Marshall and Gilbert Islands beginning Feb 1, 1942, with such success that several similar raids were conducted during the following weeks on Wake Island, Marcus Island and the New Guinea ports of Salamaua and Lae, where Japanese troops were landing in early March. On April 18 United States army bombers, which took off from the carrier "Hornet," struck Tokyo.

By the middle of April 1942 the Japanese had extended their conquests into New Guinea, New Britain and the Solomon Islands and had attained a position from which they could threaten the whole of Melanesia as well as the continent of Australia; they were moving their forces in anticipation of an offensive to the southeast that would threaten the lines of sea communication between the west coast of the United States and Australia and New Zealand. To protect these lines of communication, advance bases were being developed in the Fijis and New Caledonia to serve as fuel and troop staging stations, and consequently any Japanese movements in that direction were anxiously watched.

2. Battle of the Coral Sea.—Thus, when the Japanese began to occupy Florida Island in the Solomons on May 3, 1942, Rear Adm. Frank Jack Fletcher, who was cruising in the Coral sea with a force consisting of the carrier "Yorktown," cruisers and destroyers, undertook to binder them. Planes from "Yorktown" on May 4 sank and damaged various Japanese vessels at Tulagi, and on the following day Fietcher's force joined other United States and Australian units, including the carrier "Lexington."! The concentration of Japanese forces in the Bismarck archipelago-New Guinea area indicated that an amphibious operation, possibly against Port Moresby, New Guinea, was in prospect. Consequently, Rear Admiral Fletcher placed part of his force within striking distance of the probable course of the invasion fleet and moved his remaining ships northward in search of the Japanese covering forces. On the morning of May 7 aircraft from the "Lexington" and "Yorktown" located and sank the Japanese carrier "Shoho." The carrier "Shokaku" was attacked and damaged to such an extent that it could not be used, as planned, in the forthcoming operation against Midway. In a counterattack by Japanese carrier planes, both the "Lexington" and "Yorktown" were damaged, and it later became necessary to abandon the "Lexington" and have it sunk by one of the United States destroyers. The battle of the Coral sea, from which the Japanese forces withdrew with heavy losses, was the first major check that Japan had received in an otherwise successful campaign of aggression. It was, moreover, the first major naval engagement in history between aircraft of opposing fleets, with no contact between the surface vessels of the fleets.

Thus ended the period in which the United States navy was entirely upon the defensive in the Pacific, save for the operations of its submarines, which from the very beginning brought the war to regions that the Japanese thought they controlled. Although entirely unpublicized, for reasons of operational security, the activities of these submarines reduced the Japanese supply of fuel from the East Indies and decimated their shipping. Postwar interrogations of Adm. Osami Nagano and Adm. Soemu Toyoda, successively chiefs of the Japanese naval general staff, indicated that during the first half of the war U.S. submarines caused the greatest difficulty, just as naval aviation did in later years.

3. Battle of Midway.— During the lull which followed the battle of the Coral sea, it was correctly assumed that the Japanese were preparing for a large-scale operation somewhere, and the best evidence seemed to indicate that they would strike in the central or northern Pacific or both. In consequence the carriers and supporting vessels that had been operating in the South Pacific were recalled, and the ships available--carriers "Enterprise," "Hornet" and "Yorktown," 8 cruisers, 14 destroyers and about 20 submarines—were organized into task forces commanded by Rear Adm. Raymond A. Spruance and Rear Admiral Fletcher. A marine corps air group based on Midway Island and army bombers from Hawaii were made ready for active operations.

Scouting and patrol lines, which had been established to the westward of Midway, sighted a large Japanese attack force on the morning of June 3 which was bombed later in the day by a squadron of army B-17s. On the following day Japanese aircraft bombed Midway, while army, navy and marine corps planes from Midway attacked the Japanese fleet. Planes from the "Hornet," "Enterprise" and "Yorktown" attacked a force of four Japanese carriers with telling results? though planes from a Japanese carrier inflicted damage on the "Yorktown." Throughout June 5 and 6, army and navy aircraft, which had now won control of the air, pursued and attacked the fleeing Japanese. Although the damaged "Yorktown" and the destroyer "Hammann," which was aiding her, were fatally torpedoed by a submarine on June 6, the score was heavily against the Japanese, for United States carrier planes sank the carriers "Akagi," "Hiryu" and "Kaga" and the heavy cruiser "Mikuma," while the carrier "Soryu," which was damaged by carrier planes, was later sunk by the submarine "Nautilus." These losses, plus damage to other ships, were the first serious setback to the Japanese fleet since the outbreak of the war.

4. Solomon Islands Campaign.— The landing of the U.S. 1st marine division, reinforced, on Guadalcanal and Tulagi Islands in the Solomons on Aug. 7, 1942, marked the first Allied offensive move in force in the Pacific war. In this so-called offensive-defensive phase of the war, United States forces had seized the initiative, though progress was slow since they were still obliged to use a large part of their efforts to defend recent gains. Just before the battle of the Coral sea in early May the Japanese were occupying Tulagi Island in the Solomons, and in July they began the construction of an airfield on Guadalcanal. irom which land-based planes could have endangered Allied control of the New Hebrides and New Caledonia. This penetration toward Allied lines of communication to Australia and New Zealand represented a peril that had to be stopped at all costs, and prompt steps were taken to eject the Japanese from that area.

This operation, under the command of Vice-Adm. R. L. Ghormley, involved moving the marines, under Maj. Gen. A. A. Vandergrift, from New Zealand, with naval surface and air support. The landings on Aug. 7 took the Japanese by surprise, and good progress was made in the early stages. Later the Japanese reacted strongly, and for many months there followed intense ground fighting, with frequent actions at sea between the fleets that were endeavouring to reinforce and support the opposing land forces. An initial reverse occurred in the battle of Savo Island in the early hours of Aug. 9, when Japanese cruisers and destroyers attacked Allied naval forces protecting the landings, and sank the cruisers "Quincy," "Vincennes," "Astoria" and "Canberra." After this action the U.S. positions were under frequent attack from air and sea, but the marines held their ground, and in a battle beginning on Aug. 20 were successful in repelling counterattacking Japanese troops. In anticipation of a further Japanese reinforcement, Vice-Admiral Ghormley concentrated southeast of Guadalcanal two task forces, which included the carriers "Saratoga" and "Enterprise," the battleship "North Carolina," cruisers and destroyers. On Aug. 24 contact was made with a powerful Japanese force, and the battle of the eastern Solomons ensued, during which planes from the "Saratoga" sank the Japanese carrier "Ryujo." Marine and army land-based planes joined in, and the Japanese, after the loss of carrier support, broke off the action, although not before inflicting damage on the "Enterprise."

During the next six weeks, no major action took place in the Solomons, although Japanese planes and submarines, which were harassing U.S. supply lines, were responsible for the loss of the carrier "Wasp" and several destroyers. The Japanese also succeeded in reinforcing their positions on Guadalcanal by almost nightly runs of the so-called "Tokyo express," naval runs of supplies and reinforcements. On the night of Oct. 11–12 United States cruisers and destroyers, in a surprise attack, engaged a sizable force in the battle of Cape Esperance, near Guadalcanal, but the Japanese showed no signs of discontinuing their efforts to launch a full-scale attack. A fortnight later, on Oct. 26, while Japanese troops were actively attacking the marine positions on Guadalcanal, the carriers "Hornet" and "Enterprise" exchanged blows with carriers operating with a powerful naval force moving to support land operations on Guadalcanal. In this action, known as the battle of Santa Cruz Island, although damage was done to Japanese carriers, the United States carrier "Hornet" was lost.

The climax of sea fighting in the Solomons came in the battle of Guadalcanal, Nov. 13–15, 1942, when the Japanese, having concentrated an invasion force at Rabaul, were met by United States naval forces (covering reinforcements for troops on Guadalcanal) and defeated in a series oi violent engagements which caused heavy losses on both sides. On Nov. 11 and 12, two contingents of reinforcements and supplies were landed at Guadalcanal. When strong Japanese forces were located approaching Guadalcanal from the northwest, a force of cruisers and destroyers under the command of Rear Adm. D. J. Callaghan (who was, with Rear Adm. h'orman Scott, killed in the ensuing action) was assigned to fight a delaying action to cover the withdrawal of the transports and cargo vessels. Shortly after midnight on the morning of Nov. 13 the opposing forces met in a surface engagement of great violence. During the 24 min. that it lasted, gunfire was exchanged at close range, and though the Japanese battleship "Hiyei" was lost in consequence of this action, so were the United States cruisers "Atlanta" and "Juneau," as well as several destroyers.

On the morning of Nov. 14 Japanese cruisers and destroyers shelled Henderson field on Guadalcanal, and an invasion force, preceded by an escort of battleships, cruisers and destroyers, mas discovered to the north of the island. This was subjected to air attack throughout the day, and on the evening of Nov. 14 the battleships "Washington" and "South Dakota" and the carrier "Enterprise" reached the scene of the action. Shortly after midnight, contact was made north of Savo Island. and in another fierce night action, which resulted in the loss of the Japanese battleship "Kirishima" and three United States destroyers, the Japanese were turned back. Although United States losses were heavy, the battle of Guadalcanal was decisive in that U.S. positions in the southern Solomons were never again seriously threatened. After this action, United States forces on Guadalcanal retained the offensive, gradually driving the Japanese westward.

On Nov. 30, a Japanese effort at reinforcement was broken up by the battle of Tassafaronga (Lunga point), although at the cost of the loss of the cruiser "Northampton." Through December and January the Japanese ground forces found themselves in an increasingly unfavourable position as U.S. troops were reinforced. and the 1st marine division was gradually replaced by fresh army forces. However, in anticipation of another Japanese effort to retake the island. Admiral Halsey (who had replaced Vice-Admiral Ghormley as commander, South Pacific force, on Oct. 18) maintained considerably augmented naval forces in adjacent waters. On Jan. 29, 1943, the heavy cruiser "Chicago," escorting a convoy from New Caledonia to Guadalcanal, was torpedoed and sunk; but no further major action developed in the southern Solomons since on the night of Feb. 7–8, 1943, exactly six months after the initial U.S. landings, the Japanese withdrew their remaining forces irom Guadalcanal. So ended the first Allied offensive campaign of the Pacific war.

5. Defensive War in the Atlantic.—When the year 1942 opened, the Allied navies were fighting a defensive war in the Atlantic, as they were in the Pacific. The Germans, who had been unable in their years oi rearmament to build up a powerful and balanced fleet, had concentrated upon submarine construction and counted upon this underseas iorce to cut the sea routes to Great Britain. The German U-boat campaign followed the submarine strategy of World War I, which had been so nearly successiul in isolating the British Isles. As the basic Allied strategy of the war called for the defeat first of Germany and then of Japan, it was essential that the control of Atlantic sea lanes be maintained to ensure the safe passage to Great Britain of U.S. troops and supplies. The shipment oi supplies to Russia could be accomplished only through the northern ports of Murmansk or Archangel and required naval protection against German forces based in Norway, while the royal navy had heavy commitments to maintain the vital supply line to the Mediterranean.

Germany was able to operate a large number of submarines in the Atlantic, and sustained attacks on German shipyards by the British bomber command did not appear materially to have reduced production. In the minter and spring of 1942 submarine attacks were extended westward to the Atlantic coast of the United States and continually reduced the available total of Allied tonnage throughout the rest of the year. At that point increased Allied forces, improved anti-submarine measures and the growing production of U.S. and British shipyards turned the tables, and from 1943 onward new construction of merchant ships far outweighed the tonnage sunk by German submarines.

The battle of the Atlantic was a war of wits and of scientific devices, in which new measures and countermeasures were constantly evolved by the opposing navies, but upon its success depended the outcome of the military operations that eventually led to the defeat of Germany. Its pattern throughout the entire war may most clearly be seen in Table III included in Adm. Ernest J. King's third report to the secretary of the navy.

TABLE 111.—Naval *Military* Statistics, *1939–45*

Year	German sub-marines sunk	Allied shipping sunk	New Construction			Net gains or losses
			U.S.	British	Total	
	(Number)		(In thousands of tons)			
1939 (4 mo.)	9	810	101	231	332	−478
1940	22	4,407	439	780	1,219	−3,188
1941	35	4,398	1,169	815	1,984	−2,414
1942	85	8,245	5,339	1,843	7,182	−1,063
1943	237	3,611	12,384	2,201	14,585	+10,974
1944	241	1,422	11,639	1,710	13,349	+11,927
1945 (4 mo.)	153	458	3,551	283	3,834	+3,376
Totals	782	23,351	34,622	7,863	42,485	+19,134

Although the major German naval effort was devoted to submarine warfare, German shore-based aircraft were a menace to shipping, and a small number of powerful surface ships had to be taken into account. On Feb. 12, 1942, the German battleships "Scharnhorst" and "Gneisenau" and the cruiser "Prinz Eugen" made a successful dash from Brest, France, through the English channel to German waters, despite gallant attacks by British destroyers and Swordfish aircrait. The new battleship "Tirpitz," based in Norway, with cruisers, destroyers, submarines and aircrait, constituted a continuing menace to Allied north Russian convoys, which ran a gauntlet on every voyage requiring a strong covering force. The protection of these convoys was the main task oi the British home fleet, which mas irom time to time augmented by U.S. heavy ships. Particularly vicious attacks were made upon these north Russian convoys in July and Sept. 1942, and during the last quarter of 1942 they were discontinued because of the requirements of shipping and escorts elsewhere. When they were resumed in December the Germans were on the alert, and on Dec. 31, 1942, a convoy was attacked by the German pocket hattleship "Lutzow," the cruiser "Hipper" and six destroyers. In a series of short, sharp engagements, these iorces were held off ior iour hours by six British destroyers commanded by Capt. Robert Sherbrooke, and eventually were driven out oi the area by two 6-in.-gun cruisers of Rear Adm. Sir R. Burnett's covering iorce.

In Sept. 1943, royal navy volunteers manning midget submarines entered Aalten fiord, Norway, and torpedoed the "Tirpitz," putting it out of action for six months; on April 3, 1944, when repairs were advancing, fighters and bombers oi the naval air arm operating from carriers attacked the battleship again and mauled it severely, thus neutralizing one of the potential threats to the north Russian convoys. The "Tirpitz" was attacked three times in July and Aug. 1944 by carrier planes and finally sunk on Nov. 12, 1944, by royal air force bombers.

The most dramatic action of the royal navy in arctic waters occurred on Dec. 26, 1943, when the German battleship "Scharnhorst" attempted to molest a convoy. Adm. Sir Bruce Fraser was at sea with the battleship "Duke of York" and other ships, providing distant cover for a convoy escorted by iour cruisers under Rear Admiral Burnett. The "Scharnhorst" was sighted when the convoy was to the southeast of Bear Island, and was shadowed by the British cruisers, while the "Duke of York" moved up from the southwest at high speed to intercept. The British hattleship obtained a hit at long range, and the "Scharnhorst" was prevented from escaping by destroyers which delivered a torpedo attack that reduced its speed enough to allow the "Duke of York" to close the range and renew the battle. In a short time the German battleship had been set on fire and almost stopped, and it was then sunk, 60 mi. northeast of North Cape, by a torpedo fired by the cruiser "Jamaica."

Throughout 1942, while the German navy was impeding the progress of north Russian convoys in Norwegian waters, the Italian navy constituted a potential threat to supplies and reinforcements in the Mediterranean. The fluctuations of the land fighting in the North African campaign emphasized the vital importance of a naval base in the central Mediterranean and the necessity of maintaining Malta at all costs. A Malta convoy got through in Jan. 1942, but the February convoy was driven back. On March 22, 1942, Vice-Adm. Sir Philip Vian, with inferior forces, outwitted and repelled a larger Italian naval force. The convoy that he was covering, though subsequently attacked by German aircraft, got through to Malta. In the spring Spitfires were flown in to the island from carriers that penetrated the Mediterranean, the United States carrier "Wasp" taking part in these operations with the royal navy. In June an attempt was made to relieve Malta simultaneously from the east and from Gibraltar, and in August a heavily escorted convoy was sent from England. Although these attempts involved heavy fighting and losses and were only partially successful, some ships got through, and by September the situation at Malta had improved. The Italian navy at no time made adequate use of its extensive resources, and until its surrender in the autumn of 1943 remained in the character of a potential threat rather than a true adversary of the numerically inferior British Mediterranean naval forces.

During the defensive period of 1942, two operations of very limited scope against the continent of Europe were attempted. On March 27–28 an attack was made upon the French port oi St. Nazaire to put the graving docks there out of action; the British destroyer "Campbeltown," loaded with high explosives, rammed the lock gates and scuttled itself. On Aug. 19 a commando raid upon Dieppe was carried out, with very heavy casualties. Though continuous fighter cover was maintained by the royal air force, this raid indicated the necessity of being able to support landings of troops by naval gunfire.

6. Amphibious Assaults upon North Africa and Europe.—World War II was characterized by a series of successful amphibious operations of unparalleled magnitude, which were made necessary by the geographical extension of axis aggression on both sides of the world. In the Pacific, the Japanese could be reached only by crossing thousands of miles of ocean. In Europe, the rapid successes of German arms in 1940 had driven the Allies irom the continent and had penetrated Africa. There also, Allied ground troops could come to grips with the axis only aiter transportation over water and landings on hostile shores. Amphibious landings required the most complicated planning and co-ordination between the various branches of the armed forces of the United States and Great Britain.

(a) North Africa.—The combined chiefs of staff decided in July 1942 to effect landings in force in French North Africa in the autumn oi that year, and to postpone the assault upon the continent of Europe until a later date. Lieut. Gen. Dwight D. Eisenhower was appointed commander in chiei of the Allied force, with Adm. Sir Andrew Browne Cunningham as his principal naval subordinate. Three points were to be attacked: Oran and Algiers by U.S. army troops supported by British naval forces, and Casablanca by U.S. troops under Maj. Gen. George S. Patton, Jr., supported by naval forces commanded by Rear Adm. H. Kent Hewitt, who commanded United States naval units in all subsequent amphibious operations in the Mediterranean. The Oran and Algiers iorces proceeded from the British Isles, but the Casablanca force came entirely from United States ports and crossed the Atlantic without untoward incident. Landings were made early in the morning of Nov. 8, and though there was resistance ashore and a naval action off Casablanca with French ships, good progress had been made before an armistice was negotiated with the French forces on Nov. 11. By this operation, the largest overseas expedition ever dispatched to that time, the axis was denied the use of northwest Africa, and ports and bases had been secured which were essential for the control of the Mediterranean and subsequent entry into Europe.

(b) Sicily and Italy.—Within six months after the North African landings, German forces had been driven from Tunisia, and Allied strength was augmented to a point that made it possible to plan for a movement across the Mediterranean into axis territory. During May and June naval forces were assembled at Algerian and Tunisian ports for the invasion oi Sicily. The specially designed landing craft, which allowed the landing of troops and tanks directly upon assault beaches, had just begun to emerge from U.S. and British shipyards and were used for the first time in large numbers in the Sicilian operation. The larger types of these craft mere capable alike of crossing the ocean under their own power and beaching themselves in shallow water for the discharge of their loads by means of ramps. The development of these highly specialized vessels contributed immeasurably to the amphibious successes of the war.

Landings took place on July 10, the United States forces having objectives at Scoglitti, Gela and Licata, on the south coast of Sicily, while

British iorces attacked beaches on the southeastern coast. Naval gunfire was extensively used before the landings; and for several weeks afterward, as troops were pushing across the island toward Messina, cruisers and destroyers assisted them by bombarding axis positions.

Messina was occupied on Aug. 17; with Sicily under control, immediate invasion of the Italian mainland was planned. British forces began crossing the Straits of Messina, and to assist them in their advance up the Italian peninsula, amphibious landings were made in the Bay of Salerno on Sept. 9. In spite of counterattacks, some of which naval fire succeeded in breaking up, the port of Salerno was captured on Sept. 10, and on Oct. 1 Allied troops entered Naples.

After the Italian surrender, the greater part of Italy's fleet sailed to Malta to surrender, arriving on Sept. 11. Thus ended the astonishing and ignominious career of a powerful navy, which gave no useful account of itself in the day of battle. The Mediterranean was free once more of axis surface vessels, though not of German aircraft.

There were no further amphibious operations against the Italian peninsula on the scale of the Sicilian and Salerno landings, although on Jan. 22, 1944, a joint force landed at Anzio, south of Rome, and established a beachhead behind the German lines. Resistance and counterattacks were so severe that it required great effort to support the troops.

(c) The Normandy *Landings.*—In Jan. 1944, General Eisenhower arrived in Britain from the Mediterranean and assumed the duties of supreme commander, Allied expeditionary force. His principal naval subordinate in the planning for the cross-channel invasion of France was Adm. Sir Bertram Ramsay, designated as Allied naval commander in chief. The site chosen for the attack was the Baie de la Seine in Normandy, near the ports of England and within easy range of fighter-plane bases; but, since there was no adequate harbour for a quick build-up aiter the initial assault, it was necessary to devise artificial harbours which could be quickly constructed once the beachhead was secured. This involved a naval problem of great magnitude. Added to the large numbers of ships and craft needed to move the troops and their supplies were those necessary to tow the hollow concrete caissons that had been secretly built in England for sinking at designated points to establish breakwaters. The scale of the operation was indicated by the fact that 5,000 ships and about 200,000 officers and men of the Allied navies and merchant fleets were involved. After the first landing about 2,000 merchant ships (totalling 4,000,000 tons) were continually employed in supplying the armies.

The beaches on the western half of the Baie de la Seine were assigned to United States troops, landed from U.S. vessels, while the eastern half of the area was taken by British and Canadian troops, transported chiefly in British vessels. Loading of troops began on June 1, 1944, and by June 3 all had been loaded and briefed. D-day had been initially set for June 5, but because of unfavourable weather was postponed 24 hr. This great armada, setting sail from various ports in the British Isles upon an intricately timed and involved schedule, was preceded by great ncmbers of mine sweepers, clearing the channels, and by about 80 fire support vessels—battleships, cruisers and destroyers—which brought 800 guns, ranging in calibre from 4-in. to 16-in., to batter shore defenses and cover the landing of the troops. On June 6 the initial landings took place, substantially according to schedule, closely followed by the build-up convoys of transports and cargo ships. On June 7 all the elements of the artificial harbours, or Mulberries as they were called in code, had been towed from England, and the work of installation began.

For many days aiter the landings, while the Allied troops were still within range of ships' guns, the battleships, cruisers and destroyers furnished highly useful fire support, and on June 25 Cherbourg was bombarded to assist the army forces that were advancing on the port from the land side. Cherbourg fell on June 27, and naval salvage forces began clearing the port, as they subsequently did at Le Havre when that city surrendered on Sept. 12. The build-up following the invasion proceeded so rapidly that 100 days after the initial landings more than 2,000,000 men, nearly 500,000 vehicles and 4,000,000 tons of stores had been landed in France; and the Allied armies were far advanced in their drive across France to Germany.

(d) Southern France.—Landings on the south coast of France were also involved in the plan for the penetration of the continent, and consequently the fire support ships and landing craft of the Normandy invasion were deployed to the Mediterranean as soon as they could be spared from the English channel operations. On Aug. 15 United States and French troops were put ashore on beaches near St. Tropez, Fréjus and St. Raphael, on the southern coast of France in the area between Toulvn and Nice. These operations, of which the naval commander was Vice-Admiral Hewitt, were successful in establishing a firm beachhead. With strong air support, the army pressed rapidly inland up the Rhône valley and eventually effected a junction with troops from the Normandy beachhead. By the end of August Toulon and Marseille had surrendered, and by the end of September the last beaches were closed and the amphibious phase of the campaign had ended, leaving the United States navy free to concentrate on the Pacific.

7. Offensive-Defensive in the Pacific.—Although the landings in the Solomon Islands in Aug. 1942 had wrested the initiative from Japan, progress in the Pacifir was necessarily slow for more than a year thereafter. When the Japanese evacuated Guadalcanal on Feb. 8, 1943, it remained to eject them from the northern Solomons, and then (as it seemed at that time) from an almost endless chain of island positions. The Japanese had held some of the latter since World War I and had fortified them in defiance of mandate agreements.

Throughout the spring of 1943 naval forces bombarded Japanese positions in the central Solomons, while the Japanese still continued air attacks upon Guadalcanal. On June 30 amphibious landings were made on Woodlark and Trobriand Islands (between the Solomons and New Guinea), at Nassau bay on New Guinea and at Rendova harbour and Viru harbour in the central Solomons. On July 2 and 3 landings were made on New Georgia and at Vangunu Island near by. This movement to the northward soon brought contact between United States naval iorces and the "Tokyo expresses" that were making nightly runs to supply and reinforce Japanese positions in the central Solomons. The battle of Kula gulf on July 6 and the battle of Kolombangara (also called second battle of Kula gulf) on July 12–13 discouraged interierence with U.S. operations on New Georgia and prevented the Japanese from using Kula guli as a route for supply runs. The former action, however, resulted in the loss of the cruiser "Helena," and the latter in the loss of the destroyer "Gwin" and damage to other ships.

The capture of Munda airfield on Aug. 5, six weeks after the invasion of New Georgia, marked the climax of the central Solomons campaign, which ended with the Japanese evacuation of Kolombangara and Vella Lavella Islands on Oct. 6.

8. The Pacific Offensive.—In the autumn of 1943, United States strength in the Pacific had reached a point where it was possible for the army and navy to attack at points of their own choosing. Allied strategy called for an advance upon the core of the Japanese positions from two different directions, which, reduced to the simplest terms, consisted of a movement northward from Australia by forces under the command of General MacArthur, and a thrust westward across the central Pacific from the Hawaiian Islands by forces under the command of Admiral Nimitz. During the next year these two great advances from different points in the Pacific rapidly converged, finally closing in a gigantic pincer movement upon the Philippines in Oct. 1944. From that point on, there was but a single route to Tokyo.

Both routes involved a constant succession of amphibious landings, though in the move northwarc! from Australia the large land masses of New Guinea entailed a greater amount of ground fighting than in the Central Pacific, where the distances were greater and the island groups of diminutive size. The Central Pacific campaign consequently offered more points of naval interest, for it was there that the technique of the fast carrier striking forces was evolved.

In Oct. 1942 United States carrier strength was at its lowest point; four of the seven U.S. aircraft carriers in commission at the outbreak of war had been lost in the Pacific. New and more powerful types were, however, under construction in large quantities, and by the late summer of 1943 a sufficient number had joined the fleet to make large-scale offensive operations possible. Since the battle of Midway in June 1942 there had been no naval operations of importance in the Central Pacific. At the time of Midway, the Japanese, in a thrust into the North Pacific. had occupied Kiska and Attu in the Aleutians; but Attu had been recaptured by United States forces in May 1943 and Kiska was reoccupied in Aug. 1943 aiter its evacuation by the Japanese. The North Pacific was therefore no longer a threat, but in the Central Pacific the Japanese were thoroughly established in the Marshall, Gilbert, Caroline, Palau and Mariana Islands. The great distances between groups of islands required the development of a special technique for attack. The new carriers, accompanied by fast battleships and cruisers, were formed into mobile striking forces that were able to travel far afield and deliver a powerful attack from the air, or by naval gunfire, upon Japanese ships and bases.

(a) *Gilbert* and Marshall *Islands.*—In Aug., Sept. and Oct. 1943 the first large-scale carrier-based air strikes were made against Marcus Island, Tarawa in the Gilbert group, Apamama and Wake Island. Following in rapid succession, they were designed to soften Japanese installations and to confuse the Japanese as to U.S. intentions. During October and November major units of the Pacific fleet were placed under the command of Vice-Adm. Raymond A. Spruance, who was designated commander, Central Pacific force (later commander, 5th fleet); and plans were made for an amphibious assault upon the Gilbert Islands. This group of coral islands, lying athwart the equator, which had been seized by the Japanese from the British in Dec. 1941, was of great strategic importance since it lay to the north and west of Allied bases in the South Pacific and to the south and east of Japanese bases in the Caroline and Marshall Islands. During the second week in November, the Central Pacific force headed west from the Hawaiian Islands and on Nov. 20, 1943, attack groups were off Tarawa and Makin Islands in the Gilberts. After heavy shore bombardment, army units were put ashore on Makin and marines on Tarawa. The fighting on Tarawa was particularly severe and casualties were heavy, but after four days the island was captured. The capture of Makin was announced on Nov. 22.

On Jan. 29, 1944, Admiral Spruance's forces began the most intensive offensive operations yet conducted against the Marshall Islands. Carrier planes simultaneously struck Kwajalein, Roi, Taroa and Wotje, while cruisers bombarded Taroa and Wotje, and shore-based aircraft bombed all four islands as well as Mille and Jaluit. The attacks were resumed the next day, with battleship bombardment of Kwajalein and Roi in addition. On Jan. 31 an unopposed landing was made on Majuro, and on Feb. 2 landings were made on Roi, Namur and

Kwajalein. Resistance on Roi and Namur was quickly overcome; although it was stiffer on Kwajalein, that entire atoll was secured by Feb. 8.

It was now possible for Admiral Spruance's forces to venture further with impunity. His fast carriers, battleships, cruisers and destroyers on Feb. 17–18 carried out an attack upon the Japanese base at Truk, far to the westward in the heart of the Caroline Islands. Similar strikes against the western Carolines were made at the end of March, when carrier-based planes attacked shipping in the Palau group on March 30 and 31, while others attacked Yap and Ulithi. In April these forces were in New Guinea waters, in support of General MacArthur's assault upon Hollandia. For an understanding of the significance of this operation, it is necessary to leave the Central Pacific temporarily, and turn back to the beginning of accelerated operations in the South and Southwest Pacific.

(b) New Guinea.—While forces of the South Pacific area were attacking the central Solomons in the summer of 1943, General MacArthur's troops in the Southwest Pacific were launching powerful attacks in New Guinea to the westward. Landings had taken place at Nassau bay on June 30. Early in September amphibious forces moved against the Huon gulf area. On Sept. 11 Salamaua was captured, and Lae fell five days afterward. Finschhafen was captured on Oct. 2.

With the conclusion of the central Solomons campaign, South Pacific forces continued the northward advance through the Solomons in order to protect the eastern flank of the Allied troops in New Guinea and to aid in the ultimate isolation of the Japanese stronghold in the Rabaul-Kavieng area. At the end of October, United States marines landed at Empress Augusta bay, on the west coast of Bougainville, and so established a position in the northern Solomons. The intention there was not so much to eject the Japanese from Bougainville as to gain a perimeter in which air facilities could be established for attacking the port oi Rabaul, which had until that time been in a key position to control the area to the south. On Nov. 5, and again in the following week, carrier forces of the Pacific fleet attacked Rabaul, and during the last ten days of December it was struck by land-based planes operating from bases in the Solomons. Carrier strikes were made against Kavieng, another important base on the northern tip of New Ireland, on Dec. 25 and 28, 1943, and Jan. 1, 1944.

Amphibious landings were made on the western end of Kew Britain Island at Arawe on Dec. 15 and at Cape Gloucester on Dec. 26, while on Jan. 2 an unopposed landing was made at Saidor on the New Guinea coast. On Feb. 13, 1944, the final occupation of the Huon peninsula in northeast New Guinea was completed by United States and Australian troops. Thus, from the Solomons (to the eastward) and from New Guinea (to the westward) Allied pincers were closing upon Rabaul. Although not directly assaulted and captured, its usefulness was neutralized, and it no longer represented a major threat to Allied progress along the northern coast of New Guinea. Landings were made on Green Island, 120 mi. from Rabaul, on Feb. 15, on the Admiralty Islands on Feb. 29 and on Emirau (in the St. Matthias group north of New Britain) on March 20. The capture of the Admiralty Islands, which established Allied forces in a position to interfere with Japanese supply lines to the Bismarck archipelago from the north, isolated large numbers of troops in that region.

This same leapfrog strategy was pursued with telling effect by General MacArthur in a series of amphibious landings which carried his troops westward along the northern coast of New Guinea. In accordance with it, the next major bypassing move was directed at the coastal area in the vicinity of Aitape and Hollandia, about 200 mi. beyond Wewak, where the Japanese had concentrated a considerable force. The assault on Hollandia involved three separate attacks; one at Tanahmerah bay and a second at Humboldt bay (30 mi. to the eastward) secured the Hollandia airstrips, while a third at Aitape (go mi. to the eastward) won another airfield. On April 21 the Pacific fleet carriers that were supporting the operation attacked the area, which had previously been bombed for some days by land-based aircraft. The actual landings, which took place on April 22, were virtually unopposed. By this operation approximately 50,000 Japanese troops were cut off, and airfields indispensable for future progress were obtained.

Returning north from the support of the Hollandia landings, the fast carrier task force attacked Truk again on April 29 and 30, carrier planes dropping 740 tons of bombs on land installations. Similarly, cruisers and destroyers of the force bombarded Satawan Island on April 30, while battleships and destroyers bombarded Ponape on May 1. The task force then returned to the central Pacific, in anticipation of impending operations against the Mariana Islands, for which preparations had begun as soon as bases in the Marshall Islands were secured.

(c) The Marianas; Battle of the Philippine Sea.—The Mariana Islands provided the Japanese with a series of highly useful airfields and bases that afforded protected lines of air and sea communication to distant possessions. Allied occupation of the group would not only hamper Japanese communications, but provide United States forces with bases from which aircraft could bomb Tokyo; also, the sea areas farther to the west could be controlled. The operation for the capture of the Marianas, which involved more than 600 ships, 2,000 aircraft and 300,000 navy, marine and army personnel, was under the command of Admiral Spruance, who had already conducted the Gilberts and Marshalls operations. Japanese air bases on Marcus Island and Wake Island to the northward, which might have threatened the operation, were attacked by carrier planes, cruisers and destroyers during the third week in May 1944. Marcus was struck on May 19 and 20 and Wake on May 23. From the beginning of June, land-based aircraft from the Admiralty Islands and Hollandia kept neighbouring bases at Truk, Palau and Yap under attack, while the fast carrier task force began attacks on the Marianas on June 11. As the island of Saipan had been in Japanese hands since World War I, it was formidably fortified; and an intensive attack was necessary before landings could take place. Surface ships began bombardment on June 13, and early on the morning of June 15 marine and army troops were put ashore. The Japanese resisted vigorously; and, though initial beachheads were established, progress inland was slow.

At this point it became apparent that the Japanese fleet was en route to the Marianas, apparently bent upon provoking a full-scale action. This presented a problem in objectives, for although Admiral Spruance's ships and planes were entirely ready and able to meet the Japanese at sea, his basic mission was to capture the Marianas, and therefore the forces attacking Saipan had to be protected from interierence at all costs. In consequence, he operated aggressively to the westward of the Marianas, but did not move so far away from the islands that he could not protect the amphibious forces from any possible attack. While some of the fast battleships and carriers were operating to the westward in anticipation of the arrival of the Japanese fleet, other carriers went north and struck Iwo Jima and Chichi Jima, thus eliminating temporarily the threat of air attack from the Bonin and Volcano Islands. Upon completion of this attack, the carriers rejoined Admiral Spruance's other ships west of Saipan.

On June 19, 1944, the battle of the Philippine sea began in the form of a large-scale attack by Japanese carrier aircraft on Admiral Spruance's fleet. Four hundred Japanese planes were shot down, with only very moderate United States air losses and minor damage to surface vessels, while the Japanese carriers, "Taiho" and "Shokaku" were sunk by United States submarines. Because of these substantial carrier-plane losses, further Japanese attacks upon Saipan seemed unlikely; and Admiral Spruance's forces therefore headed to the westward in the hope of intercepting and destroying the Japanese fleet in a decisive engagement. Search planes did not locate the Japanese surface ships until afternoon, and it was nearly sunset by the time carrier strikes were launched. These attacks had to be made at extreme range; nevertheless, they sank the carrier "Hiyo," damaged the carrier "Junyo," sank two fleet tankers and damaged one. Nightfall cut short the attack. Although only a small number of United States planes were lost to Japanese anti-aircraft fire, 73 were lost while returning to their carriers when they ran out of fuel and crash landed in the darkness, although a high percentage of the personnel of planes that landed in the water near their carriers was rescued.. The Japanese fleet continued its retirement during the night of June 20, and on June 21 was out of range. Though it had not been destroyed, its effort to reinforce the Marianas had been very thoroughly broken up, and its corps of carrier-plane pilots had been practically eliminated. Japanese naval aviation never entirely recovered from this severe blow. The occupation of the Marianas, in consequence of the battle of the Philippine sea, then proceeded without further threat of naval interference, although the land fighting on Saipan was bitter and protracted, All organized resistance finally ceased on the island on July 9.

Landings on the neighbouring island of Guam (which had been captured by the Japanese in Dec. 1941) had been scheduled for June but had been postponed because of the unexpectedly intense resistance on Saipan and the threat of the battle of the Philippine sea. Because of the postponement, a long period of preliminary bombardment and air attacks was possible, beginning on June 16. From July 8 until July 21, when U.S. troops landed, battleships, cruisers and destroyers shelled the island daily, while planes from fast and escort carriers, as well as from the newly won fields on Saipan, bombed defense installations. Japanese resistance, although stubborn, was less intense than on Saipan, and on Aug. 10 all organized resistance ended. Guam was rapidly developed as a naval and air base for further offensive operations.

Amphibious operations in the Mariana Islands were completed by the capture of Tinian, an island located across the narrow channel to the south of Saipan. There also were heavy advance air and surface attacks before the actual landings, which began on July 24. Resistance was less severe there than in the other islands, and in a fortnight the assault and occupation phase was completed.

(d) The *Carolines*.—The next major objective in the Central Pacific was the western Caroline Islands, the capture of which would complete the isolation of Truk and other Japanese positions in the central and eastern Carolines. This operation was commanded by Adm. William F. Halsey (commander, 3rd fleet) who, having completed the mission in the South Pacific that had begun in Oct. 1942, thereafter alternated with Admiral Spruance in command of the great striking forces of the Pacific fleet. As new ships were constantly joining the fleet, the forces available for the western Carolines operation were even greater than those used in the Marianas; nearly 800 vessels were employed.

Prior to the landings, which were scheduled for Sept. 15, air and surface strikes were made in many directions to divert and eliminate Japanese forces that might have interfered. Attacks were made by the fast carrier task iorce on the Bonin and Volcano Islands, to the northward, between Aug. 31 and Sept. 2, and on Yap on Sept. 7 and 8. As the plan for a landing on Peleliu Island in the Palau group of the western Carolines by Admiral Halsey's forces was co-ordinated with a simultaneous landing on Morotai Island (between New Guinea and the Philippine Islands) by General MacArthur's forces, who had advanced the length of New Guinea, the fast carrier task force made strikes on Mindanao Island in the southern Philippines on Sept. 9 and 10 to prevent opposition from that direction. Because of the slight resistance encountered at Mindanao, further carrier strikes were made against the Visayas, in the central Philippines, from Sept. 12 to 14, which achieved tactical surprise and inflicted considerable damage on Japanese installations, ships and planes.

Preceded by three days of surface bombardment, air bombing, mine sweeping and clearing of beach obstacles, landings took place on Peleliu Island on Sept. 15, and on Angaur Island, six miles south of Peleliu, on Sept. 17. No landings were made on Babelthuap, the largest of the Palau group, since the bases obtained on Peleliu and Angaur made possible the domination of the group and neutralized Japanese ground forces on the other islands. Progress ashore on Peleliu was slow, and it was the middle of October before the assault phase of the operation was completed, but the island of Angaur was overrun by Sept. 20. An unopposed landing was made on Ulithi on Sept. 23, and steps were immediately taken to develop an anchorage for large surface forces.

Simultaneously with the landings on Peleliu, General MacArthur's forces landed on Morotai Island, in a move calculated to isolate Japanese forces on Halmahera Island, which were in a position to impede any movement into the southern Philippines. This operation was the result of a succession of amphibious landings that had been made along the north coast of New Guinea after the capture of Hollandia five months before. The landings, designed to prevent Japanese air and troop movements in New Guinea and to secure the southern flank of the offensive operations to the northward in the central Pacific, were in general not heavily opposed. Consequently, they involved the support of no ships larger than heavy cruisers, unlike the Hollandia operation in April, which had been supported by battleships and carriers of the Pacific fleet. The Wakde Island area, 70 mi. west of Hollandia, was occupied on May 17–19, and on May 27 an amphibious assault was made on Biak Island to secure a forward base for the operation oi heavy bombers. On July 2 a landing was made on Noemfoor Island, southwest of Biak, and on July 30 an amphibious force landed in the Cape Sansapor area on the Vogelkop peninsula in western New Guinea. Thus, during the spring and summer, General MacArthur's forces had reached the western extremity of New Guinea, neutralizing that great island as a base for Japanese operations and obtaining airfields that facilitated the attack on the southern approaches to the Philippines.

(e) Leyte—After supporting the western Carolines landings, the fast carrier task force resumed the attack upon the Philippine Islands, making the first carrier strike of the war on Manila and Luzon Island on Sept 21 and 22. On Sept 24, carrier planes hit the central Philippines and photographed the area around Leyte and Samar, where landings were to take place in October. It had originally been planned to attack the Philippines at a somewhat later date, but Admiral Halsey's air strikes had revealed an unexpected weakness of Japanese defense in the islands; and, accordingly, the joint chiefs of staff, acting with the greatest rapidity, undertook to capitalize upon this situation. Plans were quickly revised, and preparations were made for the invasion of Leyte Island in the central Philippines on Oct. 20.

The Leyte operation marked the joining of the two advances upon Japan from different directions. It was under the command of General MacArthur, to whom Admiral Nimitz made available strong forces of the Pacific fleet. Admiral Halsey's 3rd fleet covered and supported the landings by air strikes over the northern and central Philippines and Formosa and provided protection against an attack upon the landings by the Japanese fleet. Preparatory carrier strikes occupied the period from Oct. 9 to 20. The Ryukyu Islands (including Okinawa) were attacked on Oct. 9 and 10, northern Luzon on Oct. 11. Formosa and the Pescadores on Oct. 12 and 13. On Oct. 13 and 14 a part of the fast carrier task force was attacked by Japanese planes and two cruisers were damaged. To prevent further attacks while these damaged ships retired, U.S carrier aircraft attacked airfields in Formosa and the northern Philippines repeatedly during Oct 14 and 15. On Oct. 18 and 19 further strikes were made against objectives in the central and northern Philippines, and during and after the actual landings on Leyte some of the fast carriers furnished direct support while others conducted searches for Japanese fleet units.

On Oct. 20. after heavy bombardment and air bombing, forces of the central Philippine attack force, commanded by Vice-Adm. Thomas C. Kinkaid (commander, 7th fleet, and General MacArthur's principal naval subordinate), went ashore on the east coast of Leyte Island. The initial landings mere entirely successful, but they were soon challenged by the Japanese navy in a full-scale operation, designed to drive U.S. forces from the Philippines.

(f) Battle of Leyte Gulf.—There followed the battle of Leyte gulf, the greatest naval engagement of the war, which resulted in the complete and thorough defeat of the Japanese. This battle, which consisted of a series f surface and air-engagements taking place between Oct. 23 and 26, culminated in three actions, designated as the battle of Surigao strait, the battle off Samar and the battle off Cape Engaño.

The Japanese attack came from three directions. One force (the southern) approached Leyte from the south through Surigao strait; another force (the central) came through San Bernardino strait, while a third (the northern) approached from the direction of Japan. As the battle of the Philippine sea had resulted not only in the sinking of three Japanese carriers, but in the virtual destruction of the air groups of three carrier divisions, the fleet had been reorganized for surface action. The Japanese plan for driving U.S. forces from the Philippines was consequently dependent upon surface ships' provoking a decisive naval engagement. The only Japanese carriers involved were in the northern force, which was intended chiefly for a decoy since the only air support counted upon by the Japanese was from land-based planes

Early in the morning of Oct. 23 the Japanese central force was discovered off Palawan by two United States submarines, "Darter" and "Dace." The "Darter" sank the heavy cruiser "Atago" and damaged the heavy cruiser "Takao," but in manoeuvring went aground and was itself lost. The "Dace" sank the heavy cruiser "Maya." On the following day 3rd fleet carrier planes located and attacked the central iorce in the Sibuyan sea and the southern force in the Sulu sea. In the course of the Sibuyan sea action heavy damage was inflicted, and the Japanese battleship "Musashi," equipped with 18-in. guns and one of the two largest battleships in the world, was sunk. Nevertheless, the central force pushed doggedly onward toward San Bernardino strait and Leyte. The Japanese southern force entered Surigao strait in the early hours of Oct. 25 and was annihilated there in a surface engagement with destroyers and battleships of the 7th fleet. The battleships "Yamashiro" and "Fuso" and three destroyers were sunk almost immediately in this battle of Surigao strait, which was one of the few actions of the war in which aircrait did not participate.

The central iorce, having passed through San Bernardino strait, moved southward off the coast of Samar and shortly after daybreak attacked a group of lightly armed escort carriers of the U.S. 7th fleet. This battle off Samar was finally broken off by the retirement of the greatly superior Japanese force.

During the night of Oct. 24–25, Admiral Halsey's carrier task force had been moving northward to meet the Japanese northern force. In the resulting battle off Cape Engaño the Japanese carriers "Zuikaku," "Zuiho," "Chitose" and "Chiyoda" were sunk; but upon receiving word of the battle off Samar, Admiral Halsey sent a detachment of carriers and battleships to assist the 7th fleet escort carriers. These ships were unable to intercept the retiring Japanese central iorce before it had reentered San Bernardino strait, but on the afternoon of Oct. 25 and during Oct. 26 carrier planes attacked the fleeing Japanese and inflicted further damage. At the end of the battle of Leyte gulf, three Japanese forces had either been destroyed or had retired out of range. While 6 U.S. vessels (the light carrier "Princeton," 2 escort carriers, 2 destroyers and 1 destroyer escort) had been sunk, the Japanese had lost in the course of the battle 3 battleships, 4 carriers, 10 cruisers and 9 destroyers—a total of 26 combatant ships. The battle of Leyte gulf represented the end of the Japanese navy as *a* powerful element in the Pacific war.

During the remainder of 1944 no major naval actions developed, but the fast carriers were constantly employed in support of the Leyte campaign; and, because of delays in establishing airfields on shore during unfavourable weather, naval aircraft gave direct support to the troops on Leyte for a considerably longer period than had been anticipated. Manila and other targets on Luzon were attacked repeatedly. In furtherance of the Leyte operation, an amphibious landing was made at Ormoc bay, on the west coast of the island, on Dec. 7, while on Dec. 15 a further landing was made on Mindoro Island, nearly 300 mi. to the northwest.

(g) The Philippines.—The attacks upon Manila in December had caused the Japanese to expect landings in that area, but the next large amphibious operation entirely bypassed Manila and was directed against Lingayen gulf, in the northern part of Luzon Island. In preparation, the 3rd fleet attacked Formosa and the southern Ryukyu Islands on Jan. 3 and 4, 1945; and on Jan. 9, while troops were going ashore on beaches in the Lingayen gulf area, Formosa was again attacked by carrier planes. A thrust by the fast carrier task force into the South China sea then followed, during mhich the coast of Indochina between Saigon and Camranh bay was attacked on Jan, 12, Formosa on Jan. 15 and Hong Kong and Canton on Jan. 16. The coinplete inability of the Japanese to resist the movements of the United States navy on the very shores of the continent of Asia was indicated by the fact that Admiral Halsey's forces traversed 3,800 mi. in the South China sea during this series of attacks without receiving damage to any ship.

Although U.S. forces were securely established in the Philippines, large land areas and innumerable islands remained to be cleared; and until the end of the war land fighting, accompanied by amphibious landings, was going on in various parts of the group. Landings to accelerate the capture of Manila were made in the vicinity of Subic bay on Jan. 29 and 30 and at Nasugbu, south oi Manila bay, on Jan. 31. On Feb. 13 cruisers and destroyers bombarded the entrances to Manila bay; on Feb. 15 troops landed on the Bataan peninsula and on Feb. 16 on Corregidor Island—the scenes of bitter United States reverses three years earlier. Subsequent operations were undertaken to gain control of the straits leading into the waters of the central Philippines and to seize coastal cities and strongly held Japanese positions in various central and southern islands. Landings were made at Zamboanga on Mindanao Island on March 10, at Iloilo on Panay Island on March 18 and at Cebu Island on March 26. On April 17 a landing at Malabang in southern Mindanao resulted in the seizure of the important Davao gulf area. In May similar operations were extended to the westward into Borneo to recover Japanese conquests in the Netherlands Indies and cut off Japanese oil supplies. The first Borneo landings were against the island of Tarakan on May 1; the second large operation was against the Brunei bay area on the north coast on June 10, and on July 1 an amphibious force attacked Balikpapan on Makassar strait.

(h) Attacks on the Home Islands.—While the Philippine Islands were still being fought over, the war was simultaneously being carried not only to the inner deienses of the Japanese empire but to the home islands themselves. The occupation of the Mariana Islands in the summer of 1944 had furnished bases from which U.S. long-range bombers could attack Japan, but to increase the effectiveness with which these planes could operate, fighter support was desirable. The island of Iwo Jima in the Volcano Islands, only 750 mi. from Tokyo, offered an ideal site for a fighter base to support the Mariana-based B-29s, as well as for the operation of medium bombers. An amphibious assault upon Iwo Jima was therefore undertaken in Feb. 1945, although it was known that the island was heavily fortified and would be vigorously deiended. The operations for the capture of Iwo Jima were under the command of Admiral Spruance, who had relieved Admiral Halsey in command of the fast carrier task iorce of the Pacific fleet after the latter's successful sweep through the South China sea. Although the island was only 2 mi. wide and 5 mi. long, such severe fighting was anticipated that a landing iorce of 60,000 United States marines, put ashore by a naval iorce of more than 800 ships, was provided ior its capture. Iwo Jima had been intermittently attacked since June 1944 by surface ships and carrier planes, and irom December onward the attacks had been intensified. Landings were scheduled ior Feb. 19; as a preliminary move the carrier aircraft of Admiral Spruance's 5th fleet struck Tokyo on Feb. 16, one year to the day after the first attack on Truk. This'attack was renewed on Feb. 25. Meanwhile, surface ships and planes were attacking the deienses of Iwo Jima. As soon as the marines were ashore, severe fighting developed which continued for several weeks; but on March 16 all organized resistance ceased. The airfields which mere immediately developed on the island greatly facilitated the air attack upon the Japanese home islands.

To bring Japan even more closely under attack, a very large amphibiohs operation was directed against Okinawa, in the Ryukyu Islands, in the spring of 1945. The capture of the Mariana and Philippine Islands had brought U.S. iorces within 1,300 mi. of the Japanese homeland. The capture of Iwo Jima placed them about 750 mi. from Tokyo, while Okinawa offered sites for airfields within 350 mi. of Kyushu, the southernmost oi the main islands of Japan. The difficulty of this assault was considerable, for Okinawa was heavily defended, and its proximity to Japan meant that any attack upon it could readily be resisted by the main strength of the Japanese air iorce.

After preliminary strikes by the iast carriers, and intensive nayal bombardment, landings were effected on the southwest coast of Okinawa on April 1. Though there was relatively light resistance on the beaches, and the northern two-thirds of the island was occupied in a matter of three weeks, Japanese resistance in the southern portion of Okinawa, where strong deiensive positions had been established, was extremely bitter and protracted. It was not until June 23 that the entire island was captured. During this long period, many naval vessels were required for the support of the troops ashore. More than 1,200 had been employed in the initial landings, and a considerable number were required for many weeks thereafter. These ships were subjected to heavy air attack by Japanese suicide planes and received considerable damage. There was relatively little danger irom Japanese naval vessels in consequence of the defeat inflicted the previous October in the battle of Leyte gulf, and through April, May and June the fast carrier task force constantly operated in support of the Okinawa assault, frequently launching attacks upon Kyushu. On April 7, in a last attempt to make some use of surviving surface vessels, the great Japanese battleship "Yamato" (sister ship of "Musashi," which had been sunk in the battle of Leyte gulf) sortied, but was promptly sunk off Kyushu.

With the approaching conclusion of the war in Europe, major units of the royal navy had been dispatched to the Pacific and organized as a British Pacific fleet, under the command of Adm. Sir Bruce Fraser. These ships were placed under the operational control of the commander in chiei, United States fleet, and in the spring of 1945 a British carrier task force was assigned to Admiral Spruance's 5th fleet to assist in the air support of the Okinawa operation. This iorce attacked Sakishima Gunto, southwest of Okinawa, from March 26 to April 20 and again from May 4 to 25 to neutralize air installations there.

After the conclusion of the Okinawa operation, Admiral Halsey's 3rd fleet, the greatest assembly of sea power in the history of naval warfare, moved northward toward Japan to conduct a preinvasion campaign aimed at the destruction of the remaining units of the Japanese navy and of industrial sites. Strikes were made against airfields and iactories in the vicinity of Tokyo on July 10, and against northern Honshu and southern Hokkaido on July 14–15. On July 17, in company with units of the British Pacific fleet, 3rd fleet ships conducted the first U.S.-British bombardment of the Japanese home islands. Carrier planes attacked the Yokosuka naval base in Tokyo bay on July 18; the Inland sea area on July 24, 25 and 28; northern Honshu on Aug. 9 and 10 and Tokyo on July 30 and Aug. 13 and 15. These 3rd fleet operations were in preparation for Operation "Olympic," a vast amphibious landing projected against southern Kyushu, which was to be followed later in 1945 by Operation "Coronet." an amphibious assault into the Tokyo plain area. These last great efforts were not required, ior on Aug 14 Japan accepted the terms of the Potsdam proclamation, which involved the absolute surrender of all military iorces. The cease-fire order was given on Aug 1;.

Amphibious iorces were organized ior the occupation which began on Aug. 28. On Sept. 2, on board the battleship "Missouri" in Tokyo bay, the formal surrender was signed. (W. M. W.)

VI. CONCLUSION

The costs of war could not be measured alone in such mathematical terms as battle casualties, dollar expenditures and similar data. Such figures were but partial and inadequate yardsticks. The data regarding casualties among civilians were only partially available. They were known to be very great, often exceeding the military losses. The loss of life because of the privations, cruel treatment and mass murders which were a feature of the axis concentration camps had to be included in any comprehensive record of costs in terms of human lives. A more difficult problem was to appraise the losses occasioned by the displacement and dislocation of populations. Recognition had to he given to the long-term effects of devoting the major portion of the world's over-all capabilities for a period of years to the objective of destruction.

Costs, computed in terms of dollars, of raising and supporting armed forces, lost their significance as the conflicts of war extended from high in the air to the depths of the oceans and over most of the earth's surface. The destruction of homes, industries and means oi livelihood of millions of people probably represented a greater monetary cost factor than the support of armed iorces. The destruction common to World War II could not be measured in terms of the replacement cost alone.

The figures in the succeeding paragraphs must be considered in light of the foregoing factors.

Fifty-seven nations, Allied and axis, were belligerents in World War II. In the final compilation of figures as to casualties and expenditures of resources, the data ior each nation should be viewed in the light of that nation's total manpower and national wealth. The major portion of the cost was borne by the United States, the British commonwealth, the Union of Soviet Socialist Republics, China and France and by the three major axis powers, Germany, Italy and Japan. The battle dead gave a partial picture of that cost.

The cost of victory for the United States in battle dead was more than 292,100 lives, or about 1 in every 450 of the 1940 population. Separate service casualty figures for persons killed in action, died of wounds or died as prisoners of war are: army (including the air force which was the army air corps during World War 11), 234,874; navy, 36,950; marine corps, 19,733; coast guard, 574.

The cost to the British commonwealth in military personnel killed and missing during the period Sept. 3, 1939, to V-J day mas 544,596. This represented 0.09% of the population of the British commonwealth. These casualties came irom all parts of the empire, but the majority were suffered by people of the home islands. The figures for those killed and missing were approximately 397,762 from the United Kingdom itself, or 1 in every 150 of the population; 39,319 irom Canada, 29,395 from Australia, 12,262 irom New Zealand, 8,681 irom South Africa, 36,092 from India and 21,085 irom the rest of the empire.

The Union of Soviet Socialist Republics reported its losses as approximately 7,500,000 military personnel killed and missing, or one in every 22 of its 1940 population.

In France, the number of servicemen killed was 210,671 (one in every zoo of its 1940 population) including 22,219 members of the forces of the interior; 36,877 prisoners oi war who died in captivity. The total number of civilians killed in war operations was 107,874, including 6,450 foreigners killed on French soil.

Germany lost 2,850,000 military personnel killed and missing, or one in every 25 of its 1940 population.

Italy had about 300,000 military casualties, or one in every 1jo of its 1940 population. It was estimated that losses in the campaign against the Allies, June 10, 1940, to Sept. 8, 1943, totalled 294,297, including 57,422 dead, 112,405 wounded and maimed and 124,470 missing. In the campaign against the Germans, Sept. 8, 1943, to May 2, 1945, losses totalled 13,151, including 3,482 dead, 6,848 wounded and 2,821 missing.

During the course of the war, China suffered the second largest number of casualties of any of the Allied nations. Its battle losses numbered 2,200,000 or 1 in every 200 of its 1940 population, excluding Manchuria. These figures covered the period during which time China was formally at war with Japan and did not include the six years of undeclared hostilities beginning in 1931.

Japan had lost 1,506,000 military personnel killed and missing since 1937, or 1 in every 46 of the 1940 population of its home islands.

The total number of military personnel of the major Allied powers killed and missing during World War II was about 10,650,000. The total number of military personnel of the major axis powers killed and missing during the war was approximately 4,650,000. The total cost to the principal belligerents, both Allied and axis, in military personnel killed and missing in battle exceeded 15,000,000.

The very considerable costs to the smaller countries, particularly

Poland and the nations in southeastern Europe, added hundreds of thousands more to the total.

As a result oi nazi slave labour drafts and the battles fought over so much of the European continent, approximately 10,000,000 civilians were displaced outside their own country on V-E day. More than 8,000,000 of these displaced persons had been returned to their homes by early 1946. The International Refugee organization subsequently repatriated 72,800 persons, resettled 1,050,000 in immigration countries and established 300,000 in countries of refuge. At the termination of the I.R.O. in Jan. 1952, approximately 100,000 refugees of World War 11 still required assistance and new refugees from Central and Western Europe continually increased this residue.

In the far east, by the end oi March, 1950 approximately 1,000,000 Chinese, Formosans, Koreans and other Pacific ocean area inhabitants had been repatriated from Japan, while 6,500,000 Japanese nationals had been returned home. At that date, however, 60,000 Japanese remained unaccounted for in Manchuria and 300,000 in the Soviet-controlled areas of Siberia, Karafuto and the Kuriles.

World War II, both in the operations and in the weapons developed, demonstrated that, with the exception of the wealthy powers, a nation could no longer depend on its armed forces alone ior security against external aggression. The Netherlands, Norway and even Poland fell in a matter of a few days. Modern methods of war required large populations, large national areas and great industrial capacity not only to support these methods, but to sustain the impact when attacked. Hence, the majority of the nations in the world had to depend primarily on international action for their security. Even if all other elements were available to them, they would not possess the wealth to support the costly modern weapons and forces.

Turning to the political results of World War II, the world was left with two great political forces: soviet communism and western democracy in its various forms. Germany had been eliminated as a great pomer. France, recognized as a major power in the 1930s, one of the victorious allies of 1918, was weaker than before the war. Italy, a cobelligerent at the end of the war, was definitely a minor pomer. Thus the four great powers on the European continent in 1939 had bern reduced to one—soviet Russia.

The destruction oi Germany and the impact of the war on other European countries left a weak western Europe overshadoxved by the military pomer of the U.S.S.R. The Soviet Union emerged as one of the two greatest world powers, although with temporary weaknesses to overcome resulting from its enormous expenditures and losses during the war. All Europe suffered from the economic ills of dislocation and scarcity and from the artificial barrier separating eastern and western Europe as established by the occupation forces.

Great Britain had been weakened, not only directly by the cost of the mar but also relatively by the shifts in the power potential of other nations and the impact of the war on the controls through which it had long made its influence felt throughout the world.

World War II gave a great impetus to the awakening of backward and colonial peoples, and the generation of a feeling of nationalism and some cohesion in such peoples. This was true in the iar east and in the middle east and even in Airica.

It was U.S. industrial and military power which provided the additional strength necessary to stem the high tide of initial axis successes and finally to bring the war to a victorious conclusion. The direct military cost to the U.S. for the mobilization of more than 12,000,000 men and the supply of war materiel to its allies was approximately $350,000,000,000 between 1939 and 1946. It required three to five years for the United States to bring the various components of its pomer actually to bear against the axis. It was U.S. industry which was called upon to equip and support not only U.S. iorces, but considerable portions of allied forces, and earned the title of "the arsenal of dcmocracy." But all this required time, since the total mobilization of a nation's iorce is dependent on mobilization of its industry.

An important economic result of World War II was the tremendous expenditure of resources, either through destruction or through absorption in the manufacture of implements oi war.

During the struggle there mas developed to a high degree of efficiency a form oi psychological warfare, or the war of nerves. Extensive use was made oi propaganda in all its forms, both during the mar and aiter cessation oi hostilities. This mar of words had an unhappy aftereffect seriously complicating and retarding the negotiations concerning the terms ior peace settlements. (*G.* C. ML.; X.)

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WORLD WAR II CONFERENCES, ALLIED. The Allied war of 1939–45 was. in a sense. fought by conference. When it broke out in Sept. 1939, Great Britain and France revived the Supreme War council of World War I. The British prime minister and the French premier, as members of the council, met 16 times before the French collapse in 1940. Though the United States was not an active belligerent until Dec. 1941, Anglo-C.S. conferences began much earlier. Secret talks between British and U.S. military and naval staffs were held in Washington, D.C.. Jan. 29–March 29, 1941, resulting in an agreed report (ABC-1), which stipulated. among other things, that if the United States found itself at war with both Germany and Japan, it would give first priority to the defeat of Germany. Pres. Franklin D. Roosevelt then met Prime Minister Winston S. Churchill at sea off Argentia, Nfd., Aug. 9–12, 1941.

Further staff conversations were held. The president and prime minister were able to exchange views about a possible Japanese attack on British or Dutch possessions in Asia and to perfect arrangements for U.S. assistance in protecting supply vessels against German submarines. At the end of the conference, they issued a declaration, subsequently known as the Atlantic Charter, which stated the "common principles . . . on which they base their hopes for a better future for the world." The charter called, in effect, for self-determination of nations, freer trade, freedom of the seas, disarmament of aggressor nations. common action to secure higher living standards for the world and "After the final destruction of the Nazi tyranny . . . a peace which will afford to all nations the means of dwelling in safety within their own boundaries, . . ."

This article is divided into the following sections:

I. Arcadia and After
1. Arcadia
2. The Hyde Park and Washington Meetings (June 19–25, 1942)

I. ARCADIA AND AFTER

On the day after the Japanese attack at Pearl Harbor, Churchill proposed a fresh meeting with the president, and from Dec. 22, 1941, to Jan. 14, 1942, he, Roosevelt and their chief civil and military advisers conferred at Washington. The leading item on their agenda was combined strategy and, to the relief of the British, the first act of the conference was a re-endorsement of ABC-I, the "Europe-first" accord reached earlier.

1. Arcadia.—It remained to determine how British and U.S. forces should be used. British planners envisioned the Allied position as a ring around the European Axis. It was their concept that this ring should be closed and tightened by operations on the Russian front, in Africa and perhaps in the Scandinavian region, while the enemy was worn down by air attack, blockade and the constant drain of fighting on the periphery of the European stronghold. Eventually, either in emergency or as a coup de *grâce*, forces were to be put ashore in France.

Although U.S. planners already entertained some doubts about this concept, they mere not yet prepared to challenge it. As a result, the conference (code-named Arcadia) produced highly tentative agreement upon build-up in the United Kingdom of an attack force ready to land in France if it became necessary or expedient to do so (Operation "Sledgehammer") and upon combined operations to secure all of north Africa for the Allies.

The British had already drafted a plan (Operation "Gymnast") for landing forces in northwest Africa behind the German desert army. In conjunction with this attack, U.S. forces were to land at Casablanca, the combined operation to be known as "Super-Gymnast." But the execution of all these arrangements depended on factors still uncertain, such as the developing situations on the Russian front and in Africa and the availability of troop and cargo shipping.

Since events modified most of these military arrangements, a more lasting result of the Arcadia conference was the creation of machinery for future conduct of the war. It was agreed that the United States joint chiefs of staff and the British chiefs of staff committee should join together as a combined chiefs of staff. The result was that virtually all major military decisions were made by a staff representing both nations. The organization was one of the most extraordinary creations in the history of warfare.

On the political side, the Arcadia conference brought forth the declaration of the United Nations. A carefully drawn document, it embodied the general war aims of the Allies and committed all signatories to making no separate peace or armistice. After a reaffirmation of the Atlantic Charter, it declared the purpose of the Allies "to defend life, liberty, independence, and religious freedom, and to preserve human rights and justice." Ultimately, this declaration received the adherence of all states allied against the Axis powers.

Though Arcadia indicated the solidarity of the great Allies, its practical decisions were reached in such an atmosphere of uncertainty that other meetings were necessary very soon after its adjournment. As the United States chiefs of staff examined the worsening position on the eastern front, in the Pacific, in Africa and in the Atlantic, they became convinced that the closing-ring strategy evolved by the British was inadequate and perhaps perilous.

Super-Gymnast, proving impossible of execution in the spring of 1942, was temporarily abandoned. In its place the U.S. military chiefs hoped to put a massive build-up in the United Kingdom ("Bolero") and a landing in force on the European continent at the earliest possible date ("Roundup"). In mid-April 1942 Harry Hopkins and Gen. George C. Marshall traveled to England to urge acceptance of this concept by the British government. Though they obtained agreement in principle, it was not long before Churchill and the British chiefs of staff displayed belief that early execution of Roundup would be impractical if not impossible and that U.S. troops ought to be fighting Germans somewhere else during 1942.

2. The Hyde Park and Washington Meetings (June 19–25, 1942).—A new conference was necessary. The prime minister had already proposed to the president reviving Super-Gymnast, and Roosevelt had indicated that, while hoping for Roundup, he was as eager as Churchill to see a fighting front opened speedily. In meetings at Hyde Park, N.Y., and in Washington, the prime minister urged a north African operation with all his expertness, eloquence and charm. In the same period he had his first conversations with the president about the research then in progress on nuclear weapons. But the main issue. Super-Gymnast v. Roundup, remained unsettled when Churchill returned to London.

Not until July 18–25, when Hopkins, Marshall and Adm. Ernest J. King conferred with Churchill in England, was a provisional decision at last reached. The U.S. representatives sought with all their powers to obtain acceptance of the Roundup concept, but the British remained firm, and the president had instructed his delegates to yield, if necessary. Recent British reverses in Africa had emphasized the peril if Germany achieved control of Suez and established a link with Japan. The U.S. therefore agreed that north African landings (renamed Operation "Torch") should proceed in the autumn.

II. CASABLANCA

When the success of Torch appeared certain, a new conference became imperative. The president had hoped for a meeting of British, U.S. and Russian leaders, but Soviet Premier Joseph Stalin proved unable to leave his headquarters. It was only Roosevelt, Churchill and their staffs, therefore, who joined at the Anfa hotel near Casablanca, Mor., Jan. 12–23, 1943, for the conference code-named Symbol.

Debate on military questions was trying, often tense and sometimes acrimonious. It was an indication of the growing unity in the Anglo-U.S. alliance that issues were fought out rather than disguised. The major question, however, was one that, in any case, demanded a clear-cut answer: where were Anglo-U.S. troops to operate after triumph in Africa? General Marshall and other U.S. military leaders wished to concentrate on build-up for a landing in France; they opposed any further operations in the Mediterranean. Churchill and the British chiefs of staff favoured strengthening units in Africa and employing them for an attack on Sicily or Sardinia and perhaps later for an invasion of Italy. They reasoned that a landing in France could not come before 1944, unless Germany suddenly weakened, and that while forces for that operation were accumulating in the United Kingdom. offensives should be continued in the Mediterranean. Some officers on U S. staffs concurred, and the president was sympathetic. As a result, the military conferees eventually accepted the British point of view. The combined chiefs of staff reported in favour of an invasion of Sicily, and the president and prime minister set the time for it as the favourable July moon.

The conferees also discussed future operations in the Pacific. The initiative had passed into Allied hands, and two major lines of attack were agreed upon. Gen. Douglas MacArthur in the South Pacific was to move toward Rabaul in northern New Britain, which Gnited States planners regarded as the key to the Japanese position. Another operation ("Anakim"), to recover Burma, was to be carried out by forces available on the Asian mainland. In co-ordinated attack, British forces were to advance from India while U.S. forces conducted an amphibious attack toward Rangoon. Though the directive to MacArthur was subsequently modified and Anakim never carried out, the combined chiefs also reached a tacit decision of great importance for the Pacific war.

From Casablanca forward they accepted the principle that the Mediterranean and Pacific theatres should have roughly equal priority. Whatever was diverted from the build-up in England was divided 50–50.

Though the work of the conference was primarily military, the president and prime minister also found time to resume discussions of nuclear bomb research, to consider the competing claims of French leaders in exile and, most important of all, to proclaim a demand for "unconditional surrender" by Germany, Italy and Japan.

This announcement was made by Roosevelt at a final press conference. As an alternative to a statement of specific terms, as a reassurance to Russia and as a comfort to those in the United States who had criticized earlier arrangements with the Vichy government of France, a demand for "unconditional surrender" had been under consideration for some time. The president had discussed it with the joint chiefs of staff at a meeting on Jan. 7, 1943, and the prime minister had taken up with the war cabinet the possibility of naming only Germany and Japan so as to encourage overtures from Italy for a negotiated peace. Roosevelt's utterance nevertheless surprised Churchill, but he immediately endorsed it. Afterward, he and Roosevelt both restated the demand several times, always declaring that they had no intention of enslaving the German people but that they needed a free hand in dealing with the Axis leaders.

Both the announcement and the policy came in for severe criticism after the mar, when it was contended that opposition groups in Germany might have overthrown Hitler and negotiated an earlier peace if they had not been discouraged by fear of Allied vindictiveness. Churchill's reply was that any statement of the terms then acceptable to Allied leaders and their peoples. such as the dismemberment of Germany, its complete demilitarization and reparations in kind and in forced labour, would have been more discouraging still.

III. TRIDENT

Though the range of Casablanca decisions had evidenced the meshing of British and U.S. staff work, the result had been to expose issues rather than clearly to resolve them. In the spring of 1943, the British became fearful that the U.S. might retract its approval of the Sicily landing or, at any rate, refuse to approve further operations in the Mediterranean after Sicily had been secured. The British also became alarmed at what seemed a steady drain of force toward the central and south Pacific theatres of operations.

The joint chiefs of staff, at the same time, had suddenly been brought to realize how short was the supply of shipping. MacArthur estimated, for example, that he would need more than seven fresh divisions and at least 30 new air groups to attempt the operations toward Rabaul that had been authorized at Casablanca; studies in Washington showed that available shipping could bring him, at most, two divisions and a few additional aircraft; the South Pacific program had, as a result, to be made much more modest in scale. Such recalculations in Washington, added to apprehensions in London and to the approach of the target date for Sicily, necessitated a new conference. The president, the prime minister and the combined chiefs of staff agreed upon a new meeting (code-named Trident) to be held in Washington, May 12–25, 1943.

The most pressing question before the conferees was where to go after Sicily. Both Churchill and the British chiefs of staff were insistent that Italy should be the next point of attack. It was evident that no landing in France was likely before the spring of 1944, and the British chiefs of staff argued that an Italian campaign, by holding down large enemy forces, would make that invasion easier. Churchill stressed the psychological effects of forcing Italy's surrender. Though Roosevelt saw merit in these arguments, he and his chiefs of staff were fearful that the diversion of shipping required to support an Italian campaign might make it impossible to carry out any effective operations in the Pacific and even prevent the landing in France in 1944. They would not accept the British proposition until the situation, especially with regard to shipping, was more clear. It was decided, therefore, that the combined chiefs of staff should make their decision later. May 1, 1944, was, at the same time, set as the date for the landing in France, and the size of the landing force mas fixed at 29 divisions. According to U.S. planners, this figure ensured first priority in shipping for the build-up in the Cnited Kingdom.

Much time of the conference also went into discussion of Pacific strategy. The British had concluded that it would be wrong to carry out the attack on Burma that had been agreed upon at Casablanca. Although the United States chiefs of staff had also come to view the earlier scheme as unrealistic, they urged a more limited campaign, intended, in the end, to open a free supply route to China. In view of the curtailments in Pacific operations seemingly necessitated by the shortage of shipping. the U.S. chiefs of staff were all the more eager to reinforce China and to establish secure air bases there. In the upshot, the combined chiefs, the prime minister and the president agreed to a limited campaign in Burma, conducted with forces already in the theatre. The scale of this operation was to be so small that recapture of Rangoon was not expected before the end of 1944. But the decision itself may have had unforeseen consequences. for a by-product of it was a gradual change in U.S. activity in China. Theretofore, the main effort had been to equip and train the army of Generalissimo Chiang Kai-shek; thereafter, the emphasis went to building up U.S. bomber forces in China.

It has been argued that if the former program had been continued, Chiang might have been better able to cope with Chinese Communist forces in the conflict of 1946–49.

IV. QUADRANT

Though barely three months elapsed before the next Anglo-U.S. conference, the question of an Italian invasion had already been resolved before Churchill, Roosevelt and their staffs gathered at Quebec for the Quadrant meeting (Aug. 11–24, 1943). The Sicilian campaign, launched in early July, had proved overwhelmingly successful. In the meantime, the shipping shortage had been appreciably relieved, partly by the reopening of the Mediterranean, partly by successful intensification of antisubmarine measures. Then, in late July, came the fall of Italy's Fascist premier, Benito Mussolini. These events brought a relaxation of U.S. fears and, before the beginning of August, a decision by the combined chiefs of staff in favour of an ambitious campaign in Italy. At Quadrant, all that remained was to discuss the supplementary action that should be taken in response to secret peace overtures from Italy.

A hot debate on strategy nevertheless occupied many of the sessions at Quebec. The issue was whether the cross-channel attack, renamed Operation "Overlord," should be given "over-riding priority," as the U.S. chiefs of staff proposed. The U.S. position was that the invasion should take place on schedule even if the enemy had, in the meanwhile, concentrated forces to oppose it. The British were willing to undertake it only if German fighter-plane strength had been reduced and if the enemy had no more than 12 divisions on hand and 15 on call in the west; they held a vigorous Italian campaign to be essential in order to draw off German strength.

Though debate on these propositions involved no immediate military questions, representatives of the opposed points of view dug in their heels and grappled. Neither, however, won, and the military protocol of the conference read:

> As between operation OVERLORD and operations in the Mediterranean, where there is a shortage of resources, available resources will be distributed with the main object of insuring the success of OVERLORD. Operations in the Mediterranean Theater will be carried out with the forces allotted at TRIDENT except as these may be varied by decision of the Combined Chiefs of Staff.

This agreement merely meant that the issue would be debated again.

The conferees did agree that Overlord itself should be carried out with an assault force one-fourth larger than originally scheduled. With little discussion or consideration, they also decided that it should be supported by a landing in southern France, made by troops from the Mediterranean command. This decision was to provoke much controversy later.

Though the president and prime minister took some part in the debates on strategic issues, they also concerned themselves aith questions of command and with postwar topics. To evidence his undiminished interest in the far east, the prime minister proposed creation of a new southeast Asia theatre under British command. He also volunteered to cancel the earlier arrangement that a British officer should lead the cross-channel attack. Since the preponderance of forces would be U.S., he declared that a U.S. officer should be in command, and Roosevelt gratefully acquiesced.

In the interludes between conversations on such military subjects, the prime minister and president supervised discussions between the British foreign secretary, Anthony Eden. and the U.S. secretary of state, Cordell Hull, on a wide range of political topics, notably the principles to guide an organization that would succeed the League of Nations.

V. THE MOSCOW FOREIGN MINISTERS CONFERENCE

Though the U S S R had been at war with Germany since 1941, Russian, British and U.S leaders had had little opportunity for consultation Eden visited Moscow in Dec. 1941. The Soviet foreign minister. Vyacheslav Molotov, traveled to London in May 1942, mainly to conclude negotiations for a 20-year Anglo-Russian alliance, and then to Washington for a meeting with President Roosevelt In Aug. 1942 Churchill went to Moscow for three days in order to explain to Stalin why he and Roosevelt had reached the disappointing decision to postpone opening a second front and nhy only meagre supplies were reaching Russia over the perilous northern route. It proved difficult, however, to arrange a conference *à trois*, and problems requiring mutual consultation became increasingly urgent It was finally arranged, therefore, for the foreign ministers of the three Allies to confer in hloscow, Oct. 18–30, 1943.

The conferees found themselves in agreement that Austria should. in effect, be restored to its pre-1938 status. On the treatment to be accorded Germany, they did not disagree, but they found no common formulas. As a result, it was decided to create a European advisory commission. which would sit in London and continue deliberations on this difficult problem. Finally, the conferees endorsed a four-power declaration which Hull had submitted to Eden at Quebec and which the Chinese had subsequently accepted, calling for an international organization and for postwar collaboration among the great Allies—a document faintly reminiscent of the Quadruple Alliance of 1814.

VI. CAIRO AND TEHERAN

1. Cairo.—In the late autumn of 1943, conferences among the principal Allied leaders finally took place. Churchill and Roosevelt met Chiang Kai-shek at Cairo. Nov. 23–27, for the Sextant conference. They then traveled to Teheran, the capital of Iran, for Eureka, a separate conference with Stalin. Afterward they spent five more days in Cairo (Dec. 2–7) for Anglo-C.S. staff talks.

During the first Cairo talks, the far east dominated the conversation. Churchill had hoped that most of the meeting could be devoted to further consideration of Overlord v. the Mediterranean, so that the English-speaking Allies would be more of one mind when they met the Russians, but Roosevelt willed otherwise. Churchill did have an opportunity to argue against further weakening of the Italian front, stressing recent indications of intensified German resistance. He was also able to urge the need of supporting partisan movements in the Balkans which he said were holding donn as many German divisions as the Anglo-U.S. forces already in combat. And he presented his own substitute for the U.S. formula of "over-riding priority" for Overlord: a division of resources allocating six-tenths of all available for the invasion build-up, three-tenths for Italy and the remaining one-tenth for the eastern Mediterranean. But the issues which he raised were not threshed out.

Instead, debate centred on plans proposed by Chiang and Roosevelt for new undertakings in Burma: an Anglo-U.S.-Chinese force to move from the north in concert with a British amphibious attack on the Andaman Islands (Operation "Buccaneer"). The C.S and Chinese insisted upon these operations, even if they required a diversion of strength from Overlord. Churchill resolutely opposed the diversion of landing craft required by Buccaneer. The issue remained unresolved nhen the president and prime minister departed for Teheran.

While in Cairo. they had, moreover, reached one important political agreement. They drew up a declaration of Allied aims in the far east. Japan was to lose all Pacific islands which it had acquired after 1914 and was to be "expelled from all other territories which she has taken by violence and greed." Manchuria. Formosa and the Pescadores were to be restored to China, and Korea was, "in due course," to become free and independent. Though these terms appear to have been devised by the president and prime minister without much consultation of political advisers, the Cairo declaration, published Dec. 1. 1943, was one of the most explicit and far-reaching statements of Allied aims issued during World War II.

2. Teheran.—At Teheran the disputes between the U.S. and the British were temporarily shelved. There was little discussion of the far eastern war. in which Russia was not yet engaged. Stalin did listen to a long summary by Roosevelt of Allied operations in the Pacific, and he renewed the promise, which he had first made during the Moscow foreign ministers meeting, of eventual action against Japan. In discussing the peace settlement, he acknowledged desire for a year-round port on the Pacific, and Roosevelt suggested internationalizing Dairen. Manchuria, for the purpose. Stalin indicated, too, that Russia might want south Sakhalin Island and the Kuril Islands from Japan Otherwise, however, the three-power negotiations concentrated on the war against Germany and postwar settlements outside of Asia.

There was much conversation about a second front. Stalin desired categorical assurances that the invasion of France would take place in 1944. The U.S. undertook to satisfy him. The British sought to do so as well, without yielding the reservations which they still hoped their allies would accept, and Stalin declared that the Red army would stage an offensive timed to coincide with Overlord, so that Germany could not transfer strength from east to west. On the plan for a co-ordinate landing in southern France (Operation "Anvil"). which Roosevelt described, the Soviet premier not only stated his approval, but he suggested that it might be scheduled two months ahead of Overlord. so as to disrupt enemy defenses. He was more reserved in endorsing a project, advanced by Roosevelt and enthusiastically supported by Churchill, for small-scale operations at the head of the Adriatic. It was his view, as it was that of Hopkins and the U.S. military staffs, that no such actions should be taken if they reduced the force available for Overlord or the southern France landing.

Though military questions still dominated, the Teheran conference saw more discussion of political issues than had occurred in any previous meeting between Allied governmental heads. The Soviet leader restated the territorial objectives that had been disclosed during the Anglo-Soviet alliance negotiations: the eastern frontiers provided in the Nazi-Soviet pact of 1939 and in the Russo-Finnish peace treaty of 1940. Stalin added that Russia would also wish the Baltic coast of East Prussia. Although the settlement for Germany nas discussed at length, all three Allied leaders appeared as uncertain as their foreign ministers had been. Nor were their views any more precise on the topic of a postwar international organization. On Iran, which Allied forces were partly occupying, they were able to agree on a declaration (published Dec. 1, 1943), guaranteeing the postwar independence and territorial integrity of that state and promising postwar economic assistance.

The only question upon which the conferees found themselves in sharp disagreement was the tortured issue of Poland. While the Soviet premier made no secret of Russia's desire for portions of eastern Poland, he indicated possible approval of compensatory Polish annexations in eastern Germany, perhaps to the line of the Oder river. The president and prime minister were not averse to such an arrangement, although they had some reservations about

Russian acquisition of purely Polish districts and Polish acquisition of purely German districts. The real difference of opinion arose, not over Poland's frontiers, but over its government, for Stalin expressed distaste for the Polish exile regime resident in London, and he left Roosevelt and Churchill with the accurate impression that the Polish question might cause difficulty later on. Even so, the meetings seemed to justify Stalin's farewell statement: "Now it is assured that our peoples will act together jointly and in friendship both at the present time and after the end of the war."

3. Second Cairo Meeting. — The subsequent conference between Churchill and Roosevelt at Cairo saw resumption of the Anglo-U.S. debate on strategy. As the president summarized the compromises agreed upon: "(a) Nothing should be done to hinder OVERLORD. (b) Nothing should be done to hinder ANVIL. (c) By hook or by crook we should scrape up sufficient landing craft to operate in the eastern Mediterranean if Turkey came into the war." Reluctantly, the U.S. agreed to abandon Buccaneer and therefore the whole Burma campaign envisioned by Chiang. A much smaller campaign mas to be undertaken, with China to be compensated by increased airlift of supplies over the Himalayas.

Toward the end of this second Cairo meeting. Roosevelt informed Churchill that he had at last reached a decision on the command for Overlord. Gen. Dwight D. Eisenhower was to have the job. Coupled with the decisions of the Washington, Quebec, Cairo and Teheran conferences, the actual naming of an invasion force commander indicated that the central Anglo-U.S. debate was ended and that Overlord would proceed as scheduled.

VII. SPECIAL CONFERENCES ON POSTWAR SUBJECTS

While the heads of the Allied governments brooded over methods of bringing the war to an end, their technical experts laboured over problems of the postwar world.

1. UNRRA.—After complex negotiations that began in London in 1940, an agreement was finally worked out for a United Nations Relief and Rehabilitation administration (*q.v.;* UNRRA). The document was signed at the White House in Nov. 1943, and the council of the new agency assembled immediately at Atlantic City, N.J., with the United States represented by Dean G. Acheson and Francis B. Sayre. Subsequently, former New York Gov. Herbert H. Lehman became UNRRA's first director general.

2. FAO.—A conference of Allied and neutral delegates at Hot Springs, Va., May 18–June 3, 1943, had meanwhile produced an interim commission that was, by the summer of 1944, to have devised the United Nations Food and Agriculture organization (*q.v.;* FAO).

3. International Monetary Fund and the International Bank. — From still another series of conferences, beginning in Washington in Sept. 1943, and culminating at Bretton Woods, N.H., in July 1944, had come charters for the International Monetary fund (*q.v.*) and the International Bank for Reconstruction and Development (*q.v.*).

4. ILO and **ICAO.—An** international labour conference was held in Philadelphia in 1944, resulting in the "Philadelphia Declaration" looking toward a larger role for the International Labour organization (*q.v.*) after the war. Later in the same year a conference in Chicago established the International Civil Aviation organization. (See AVIATION, CIVIL.)

5. **UN.**—The formation of an international organization to supersede the League of Nations was also undertaken by technical experts of the Allied nations. In the United States, numerous state department and interdepartmental committees studied the intricate problems of organization, membership, voting procedure and sanctions, upon which the heads of governments had found their views clouded and imprecise. At Dumbarton Oaks, Washington, D.C., Aug. 21–Oct. 7, 1944, U.S., British, Russian and Chinese experts finally gathered to draw up a charter for the United Nations (UN) organization (*q.v.*). As a result of careful preparation and cautious procedure, the experts were able to reach agreement on all but two issues.

One was whether a permanent member of the Security council should be able to employ the veto in a case in which it was a party. The other was whether the 16 Soviet republics should enjoy individual membership. These two issues had to be resolved by Roosevelt, Churchill and Stalin in their conference at Yalta (*q.v.*). At the San Francisco conference, April 25–June 26, 1945, the charter produced at Dumbarton Oaks and Yalta proved, with relatively few changes, to be acceptable to all the United Nations.

VIII. THE SECOND QUEBEC CONFERENCE

After the Cairo and Teheran conferences, the president and prime minister did not meet again until they came together at Quebec in Sept. 1944, for Octagon. By that time, Overlord had been launched, and the Allied invaders had met unbroken successes. Despite British efforts to cancel the operation, Anvil (renamed Dragoon) had also been brought off, apparently to the benefit of the major undertaking farther north. In the meanwhile, Rome had been captured, and Allied troops in Italy had made steady though slow progress northward. Successes in the Pacific had brought Allied forces within striking distance of the Philippine Islands rind of bases near the Japanese homeland. Coupled with steady Russian advances in eastern Europe, these events seemed to make eventual triumph certain.

Military questions still occupied most of the conference agenda. Eisenhower's forces were in position either to concentrate for a drive into Germany across one point on the Rhine or to advance more slowly in co-ordinated offensives along the coast and south of the Ruhr. The conferees discussed these alternatives and finally approved Eisenhower's own compromise, which was to stage a major attack in the north and a subsidiary attack in the south. They talked still more about the far eastern war, where they did not expect victory until one or two years after Germany had been defeated. The combined chiefs discussed Burma, where unexpected successes by the Allies had made it possible to plan a land and amphibious assault on Rangoon. It remained uncertain whether Chiang, beset by internal problems, would undertake any useful action in that theatre, and. during the conference, Roosevelt sent off a dispatch, strongly urging Chiang to place his armies under U.S. command. It has been argued that both of these acts were fraught with political consequence, for Anglo-U.S. forces, advancing on two fronts, failed to reach Berlin ahead of the Russians and Chiang, by rejecting Roosevelt's urging, missed an opportunity to make the United States responsible for Nationalist China's future. But these eventualities did not enter into deliberations at Quebec.

Some other military issues, however, were considered with an eye to their political implications. It was agreed that a few landing craft might be left with the Allied middle east command for a landing on the Istrian peninsula, so that Anglo-U.S. troops could occupy Vienna and perhaps Hungary before Russian forces arrived. For much the same reason, it was also agreed that British units should be landed by parachute in Greece. And the British insisted successfully on being assigned air and naval tasks in the U.S. plan for defeating Japan, because, as Churchill explained, he did not want it said that the U.S. had helped Britain against Germany while Britain had failed to help against Japan.

Two largely nonmilitary questions were also dealt with at the conference. It was agreed that lend-lease aid to Britain should continue after the defeat of Germany, ostensibly because of the Japanese war but actually to help in rebuilding the British economy. And the president and prime minister approved accords on the treatment of defeated Germany. One, drawn up by the European advisory commission, provided for British, U.S. and Russian occupation zones, the Russian to reach 200 mi. W. of Berlin, the British to include northwestern Germany and the U.S. the area south of the Saar and the Lower Palatinate. A second stipulated a "programme for eliminating the war-making industries in the Ruhr and in the Saar . . . looking forward to converting Germany into a country primarily agricultural and pastoral in its character."

Known as the Morgenthau plan, this document had emerged from conferences between U.S. Secretary of the Treasury Henry Morgenthau. Jr., Secretary of War Henry L. Stimson and Hull. Signed with some reluctance by Churchill, it was subsequently revoked and replaced by a more moderate program for the treatment of Germany.

The second Quebec conference was the last at which military issues dominated. In Oct. 1944, when Churchill again went to Moscow, it was primarily to discuss postwar problems. The Soviet premier did outline his plans for eventual massive intervention in the Japanese war, and he and Churchill discussed the co-ordination of British and Russian operations in the Balkans. But their main business was the still unsettled issue of Poland's frontiers and future government, and their most important transaction was a provisional agreement on division of influence in southeastern Europe: Russia's interest to be considered paramount in Rumania and Bulgaria, Britain's to be paramount in Greece and the two to divide influence in Yugoslavia and Hungary.

When Churchill and Roosevelt met again at Malta early in 1945, just prior to their conference with Stalin at Yalta, they dealt summarily with military problems. It was agreed that three divisions from Italy should reinforce the Allied armies in northern Europe, thus making possible a sustained drive across the Rhine but precluding any ambitious campaign in southeastern Europe. It was also agreed that in Asia, U.S. forces should aid China while British troops undertook the reconquest of Malaya and Singapore. This latter decision, by implication, assigned Britain chief responsibility for the future of southeast Asia, but it was treated as a military problem. When the president and prime minister then met with Stalin, political issues occupied all but a fraction of their time. At the Yalta conference (*q.v.*) of Feb. 1945 the three leaders dealt with postwar problems in both Europe and Asia.

IX. POTSDAM

The last conference of World War II, appropriately code-named Terminal, was held at Potsdam, outside Berlin, July 17–hug. 2, 1945. Roosevelt had died in April, and his seat was occupied by the new president, Harry S. Truman. Though Churchill attended the initial sessions, a British general election resulted in overthrow of the Conservative party, and his place was taken by Clement Attlee as the new prime minister. Of the wartime leaders, Stalin was the only one to sign the Potsdam protocols.

The war with Germany had ended in May, but the war in Asia went on. There was some discussion, therefore. of the operations to be conducted against Japan. The combined chiefs of staff debated the U.S. plan for invading Honshu and attendant preliminary operations. Since Russia had promised to enter the war shortly, there were also meetings between the combined chiefs and the Russian chiefs of staff. Most important among the military exchanges, however, was a brief after-dinner conversation in which Truman disclosed to Stalin that the United States had successfully tested an atomic bomb and was shortly to employ it against Japan.

Most of the questions before the three government heads concerned either the procedure or the substance of the peace settlement. At U.S. instance, it was agreed to create a council of foreign ministers, in which the United States, Britain, Russia, France and ultimately China would have seats. It was hoped that this high-level committee could draft peace treaties for Germany and other defeated Axis states, and many of the questions that proved too intricate or too difficult for the Potsdam conferees were left for debate within this council.

Stalin. Truman and Attlee were able to reach provisional agreement among themselves on some comparatively minor issues. Without acrimonious debate it was agreed that Russia should have one-third of the German navy and the German merchant marine. The reparations problem was partly solved by a compromise which gave Russia the right to exact its quota from its zone of occupation and from Bulgaria, Finland, Hungary, Rumania and eastern Austria. Russia was also to receive a percentage from the western occupation zones, but the total figures for all were to be determined at a later date. Finally, agreement was reached on the trial of Axis war criminals. A United Nations commission to investigate war crimes had been in existence since the autumn of 1943, and a conference of jurists. held in London concurrently with the Potsdam sessions, created an international military tribunal to conduct the trials. The only difference among the Potsdam conferees mas whether a list of those to be tried should be published, and accord was reached on printing the list a month later.

On a number of other questions, disagreements could not be reconciled, but the issues were deferred. Stalin's desire for a treaty with Turkey which would return to Russia the districts of Kars and Ardahan was displeasing to the British and U.S. So was the Soviet indication of a wish to serve as UN trustee for one or more of the former Italian colonies in north Africa. But both matters were left for debate in the council of foreign ministers. Russian proposals for united action to unseat Gen. Francisco Franco in Spain and for four-power discussions of the situation in Syria and Lebanon were tabled. The president and the prime minister feared precipitating a new war in the Iberian peninsula, and the British insisted that affairs in the Levant concerned only Britain and France.

On some issues, profound disagreement among the great Allies was impossible to disguise. One of these was the situation in the Balkan areas occupied by Russian forces, for both the U S. and the British felt obliged to protest the treatment being accorded their representatives and observers in those states and to complain of Russia's lone-handed management of affairs there. Another was the extension of Poland's western boundaries, which the British and U.S. conferees at Potsdam found as a *fait accompli*. The line of the Oder, which had been approved at Teheran, had been taken by the Poles, but so had the land lying between the Oder and the western Neisse. Truman, Churchill and Attlee all protested against Poland's having been given a large occupation zone without their sanction. Stalin simply replied that there were no Germans remaining in the area, and Poles had moved in. The matter occupied much hot debate, but, in the end, the conferees could do nothing but approve Polish administration of the zone, pending a peace treaty for Germany.

The protocols of the conference suggested continued harmony among the great Allies. The memoirs of Churchill, Truman and others who attended indicate that there was great hope for continued collaboration. The president did write to his mother and sister, " 'You never saw such pig-headed people as are the Russians. I hope I never have to hold another conference with them — but, of course, I will.' " (Harry S. Truman, *Memoirs*, New York: © Time Inc. 1955.) But he toasted the hope of a future meeting in Washington, to which Stalin responded, "God willing." That conference never took place.

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WORM, a term used popularly to denote almost any kind of elongated, apparently limbless creature, from a lizard, such as the blindworm, to the grub of an insect or an earthworm. In old usage it sometimes denoted a mythical dragon. The Latin term for worms, *Vermes*, was employed as a taxonomic unit to include practically all invertebrates by Linnaeus in his system of classification of animals. Although later zoologists, such as Lamarck and Cuvier, working in the early 19th century, realized the unsatisfactory nature of Linnaeus' Vermes and restricted it somewhat, the term Vermes continued to be applied off and on during much of the 19th century to a heterogeneous assemblage of vermiform invertebrates. Although still having some vogue in Europe, the concept of a phylum Vermes has been abandoned by most modern zoologists as an impossibility because the animals termed worms belong to many different groups and have widely varied anatomical construction and life histories.

Worms in the zoological sense include the following main groups: flatworms (see PLATYHELMINTHES), elongated flattened animals of solid construction and soft consistency, divided into the Turbellaria (*q.v.*), including planarians, the flukes (see TREMATODES) and the tapemorms (*q.v.*) or Cestoda; the roundworms or Nematoda (*q.v.*), slender elongated worms of cylindrical form with tapering ends and clothed in a smooth tough cuticle; the nemertine worms (see NEMERTINA), marine worms common along ocean shores. often of very great length and notable for a long protrusile proboscis: the spiny-headed worms (see ACANTHOCEPHALA), intestinal parasites with an eversible spiny head; the gordian worms (see NEMATOMORPHA), very long slender worms found in wet places and popularly called horsehair worms from a myth that they originate from horsehairs dropped in water; and the segmented worms (see ANNELIDA), worms with elongated jointed bodies including the earthworms (*q.v.*), leeches (*q.v.*) and a variety of marine and fresh-water types. Other minor groups of less typical worm shape but allied to the above groups are the Rotifera, Gastrotricha, Kinorhyncha, Echiurida, Priapulida, Sipunculida and Phoronida (*qq.v.*).

Many of the groups of worms are wholly or partly parasitic during all or part of their life cycles and have therefore secured a large measure of attention from zoologists and physicians. In the groups of the flukes. tapemorms and roundworms are included many important parasites of man, some of which, as for instance the hookworm! a roundworm and the oriental blood fluke (*Schistostoma*). constitute health problems of vast proportions. It is characteristic of parasitic worms that they have complicated life cycles involving a succession of larval stages in hosts different from those that harbour the adult worm. The working out of these life cycles and identification of larval stages have required the earnest labours of a succession of zoologists and still constitute an active branch of zoological research. See also Index references under "Worm" in the Index volume. (L. H. H.)

WORM, a screw which touches tangentially and which rotates a toothed wheel (the worm wheel). *See* GEARS.

WORMS, a city of Germany, in the *Land* of Rhineland-Palatinate. It is on the left bank of the Rhine, 20 mi. N.W. of Heidelberg and 9 mi. by rail N.W. of Mannheim. Pop. (1950) 52,239.

History. — Worms was known in Roman times as Borbetomagus, which in the Merovingian age became Wormatia. The town had before Caesar's time become the capital of a German tribe, the Vangiones. Drusus is said to have erected a fort there in 14 B.C. In 413 the emperor Jovinus permitted the Burgundians under their king Guntar or Guntiar to settle on the left bank of the Rhine between the Lauter and the Nahe. There they founded a kingdom with Worms as its capital. Adopting Arianism they came into conflict with the Romans, and under their king Gundahar or Gundicar (the Gunther of the Nibelungenlied) rose in 435 against the Roman governor Aetius, who called in the Huns against them. The destruction of Worms and the Burgundian kingdom by the Huns in 436 was the subject of heroic legends afterwards incorporated in the Nibelungenlied (*q.v.*) and the *Rosengarten* (an epic probably of the late 13th century). Worms was rebuilt by the Merovingians, and became an episcopal see, first mentioned in 614, although a bishop of the Vangiones had attended a council at Cologne as early as 347. There was a royal palace from the 8th century, and in it the Frankish kings, including Charlemagne, occasionally resided.

Under the German kings the power of the bishops of Worms gradually increased. Otto I granted extensive lands to the bishop, and in 979 Bishop Hildbold acquired comital rights in his city. Burchard I (bishop, 1000–25) destroyed the castle of the Franconian house at Worms, built the cathedral and laid the foundations of the subsequent territorial poner of the see. There were frequent struggles between the bishops and the citizens, who espoused the cause of the emperors against the church, and were renarded by privileges which fostered trade. The city retained its freedom until 1801, in spite of the bishops, who ruled a small territory south of the city, on both sides of the Rhine, and resided at Ladenburg near Mannheim till 1622.

The city of Worms was frequently visited by the imperial court. The concordat of Worms closed the investiture controversy in 1122. The "perpetual peace" (*ewiger* Landfriede) was proclaimed by the emperor Maximilian I at the diet of 1495, and Luther appeared before the famous diet of 1521 to defend his doctrines in the presence of Charles V. Four years later, Worms formally embraced Protestantism, and religious conferences were held there in 1540 and 1557. It suffered severely during the Thirty Years' War. The French under Mélac burned the city almost entirely in 1689, and it; only fully recovered from this blow in recent years. Thus the population, which in its prosperous days is said to have exceeded 50,000, had sunk in 1815 to 6,250. By the treaty of Worms in 1743 an offensive alliance was formed between Great Britain, Austria and Sardinia. The city was annexed to France at the peace of Lunéville in 1801, together with the bishop's territories on the left bank of the Rhine. The remaining episcopal dominions were secularized in 1803 and given to Hesse-Darmstadt, which acquired the whole by the Vienna congress in 1815.

Antiquities. — Some parts of the ancient walls and towers still remain. The cathedral of SS. Peter and Paul ranks beside those of Spires and Mainz among the noblest Romanesque churches of the Rhine. This basilica, built of red sandstone, with a choir at each end, has an imposing exterior. Only the ground plan and the lower part of the western towers belong to the original building consecrated in 1110; the remainder was mostly finished by 1181, but the west choir and the vaulting were built in the 13th century, the elaborate south portal was added in the 14th century, and the central dome has been rebuilt. The baptistery contains five stone reliefs of the late 15th century. The church of Our Lady (Liebfrauenkirche) is a Gothic edifice outside the town, finished in 1467. The principal Protestant place of worship is Trinity church. built in 1726. Second in interest to the cathedral is the church of St. Paul. also in the Romanesque style. dating from 1102–16. with a choir of the early 13th century, cloisters and monastic buildings. This church has been converted into a museum. The late Romanesque church of St. Andrews is not used.

The old synagogue, an unassuming building erected in the 11th century and restored in the 13th. is completely modernized. The Jewish community of Worms claims to be the most ancient in Germany and to have existed continuously since the very early Christian era, though the earliest authentic mention of it occurs in 588. The old Bischofshof, in which the most famous Diet of Worms (1521) was held, has been replaced. The Luginsland is an old watch-toner of the 13th century. The Lutherplatz contains a group of statuary commemorating the Protestant reformers and their forerunners. Extensive burial grounds, ranging in date from neolithic to Merovingian times, were discovered near the city.

Worms is the centre of a vine-growing country. The manufactures include patent leather, machinery, cloth, chemicals, paints, cork, furniture, slates, etc. Worms possesses a good river harbour and carries on a considerable trade by water.

See also Index references under "Worms" in the Index volume.

WORMSEED, the name given to various plants whose seeds are used as vermifuges. Among the best known is the Levant wormseed (Artemisza *santonica*), from whose dried Bower heads is extracted the drug santonin, very efficacious in expelling roundworms. The American wormseed (*Chenopodium ambrosioides* var. *anthelminticum*), also called Mexican tea, yields wormseed oil. an officinal vermifuge. See ARTEMISIA; CHENOPODIUM

WORMWOOD, the popular name for any aromatic herb of the genus *Artemisia,* a member of the family Compositae. The best knonn is A. *absinthium,* one of the ingredients of absinthe. It grows from one to three feet high and is silkily hairy; the leaves are small and much cut, and the flowers are small yellow hemispherical heads among the leaves at the end of the branches. It is a native of Europe, grows in waste places in the British Isles, is widely naturalized in eastern North America and is cultivated for use in domestic medicine. *A. pontica* is Roman wormwood; *A. stelleriana,* a dusty miller, is sometimes called beach wormwood, etc. *See* MUGWORT.

WORSAAE, JENS JACOB ASMUSSEN (1821–1885), Danish archaeologist who founded the science of prehistoric archaeology, mas born in Vejle, Den., on March 14, 1821. He was interested in excavation from his school days, and when very young he argued with senior researchers who went to old written sources for the explanation of archaeological finds instead of looking at the finds themselves. In 1843 the publication of his *Danmarks Oldtid,* Eng. trans., *Primaeval Antiquities of England and Denmark* (1849), aroused great interest. After several years' research abroad, Worsaae was in 1847 appointed inspector of Danish prehistoric and historic monuments and in 1855 became in addition a lecturer at the University of Copenhagen. In 1865 he succeeded C. J. Thomsen as director of the Museum of Northern Antiquities, later the National museum, in Copenhagen. Among Worsaae's greatest discoveries (1850) were Denmark's Early Stone Age kitchen middens, which consisted chiefly of accumulations of shells. In controversy with the zoologist Japetus Steenstrup he maintained that these were older 'than the large, stone Neolithic tombs. Worsaae's many publications show his broad views and deep knowledge of European archaeology. He died at Copenhagen on Aug. 15, 1885. (T. MN.)

WORSHIP (*i.e.,* "worth-ship"), honour, dignity, reverence, respect. In religion the word is used in a special sense of the service, reverence and honour paid, by means of devotional words or acts, to God, to the gods or to hallowed persons and hallowed objects. The Roman Catholic Church distinguishes three kinds of worship: (1) latria, the worship due to God alone; (2) hyperdulia, the worship or adoration due to the Virgin Mary as the Mother of God; and (3) dulia, that due to the saints.

WORSLEY, an urban district in the Farnworth parliamentary division of Lancashire, Eng., 7 mi. W. of Manchester. Area 11.3 sq.mi. Pop. (1951) 27,365. The district is divided into a residential area in the south, where there are many parks and open spaces, and an industrial area in the north. The arterial road from Manchester to Liverpool passes through Worsley and there are two main railway stations and a freight yard. Two Roman roads passed through the district which remained agricultural until the coal mines were developed in the 18th century by the 3rd duke of Bridgewater, who also built the Bridgewater canal which ran underground. Worsley has many beautiful old houses among which are Wardley hall, originally built in about 1290 but rebuilt in 1550–51, now the residence of the bishop of Salford; Worsley Old hall, an Elizabethan mansion now the regional office of the National Coal board; Kempnough hall, a half-timbered house dating from the 14th century; the originally moated Elizabethan Peel hall, now a tuberculosis sanatorium; and Kenyon Peel hall, also a fine Elizabethan house.

The district's chief industries are coal mining, cotton spinning and weaving, clothing manufacture and engineering works producing sheet metal, stainless steel, etc.

WORSTED MANUFACTURE. Straightness of fibre is the essential feature of worsted yarn (for distinctions between woolen and worsted yarns, *see* WOOLLEN MANUFACTURE). The manufacture of worsted yarn in the United States rests basically on two systems, the English and the French; the latter is more expensive and produces a softer, finer and less hairy yarn. Ordinarily the wool is first scoured, dried and prepared by dusting, shaking and teasing (*see* WOOL).

It is then ready to be carded. Exceptionally long wools such as mohair are fed into sheeter gill boxes for straightening and disentanglement — a process of five or six operations which takes the place of carding; these long wools are not generally prepared in the United States.

Carding. — Worsted carding straightens, parallelizes, cleans and blends the fibres, so as to make a sliver of uniform quality, thickness and weight. This uniformity is necessary for a yarn of strength and fineness; hence great care is exercised. Long fibres must be whole, short ones must not curl up even though they are later combed out. Extraneous substances must be removed since they interfere with the operations. Worsted carding, unlike woolen carding, is done on one long card.

Modern cards are divided into three parts, feeding, carding and delivery, and consist primarily of sets of rollers moving in different directions at varied speeds. Automatic feeders have spiked lattices that pull loose wool from hoppers at a regular pace to be beater combed and form a uniform sliver; these are adjustable to form any sliver weight. The spikes deposit the wool on an apron from which it passes onto the card covering which opens and uniformly deposits the wool on an automatically weighing feed apron and from there it moves to the card proper. The latter has feed rolls, licker-ins (breast works), main cylinders, fancies and doffers. The feed rolls, inserted with saw-toothed wire or intersecting rings and pins, control the feeding of stock. Three feed rollers and a brush or wire stripper suffice for even fine wool. The licker-ins are the chief stock-opening machinery. Cylindrical in shape, from 20 to 30 in. in diameter, they are studded with garnet wire and angular flattened saw-teeth to keep burrs, etc., on top so that bladed beaters can remove them. For the removal of burrs the United States mills use a chemical treatment or burr breast works set close to high speed revolving burr knives; in England a burr crusher is also used. When the wool is freed of burrs and opened up it passes onto cylinders and strippers for carding.

From there it passes to the fancies and doffer dickeys, which latter, facing and running against the doffer, are small cylinders covered with flexible-tooth card clothing for raising any stock missed by the beater comb. The stock is delivered from the card by any one of four types of heads depending on the type of wool used: (1) can coiling; (2) railway balling; (3) centre balling; and (4) side drawing balling. The object of all these heads is to put the sliver in a convenient form. The centre balling head is generally used in the United States.

Backwashing. — Impurities not removed by scouring and those acquired in preparing or carding (such as oil, dust or dirt) are removed from the carded (or sheeter gilled mohair) wool by backwashing, which precedes combing. Many balls or cans of card slivers are fed to the backwashing machine at once. These machines have from one to four bowls for washing and have can or hot-air dryers. Coloured slivers get no more than four bowl washings — white slivers get three or less. The bowls contain olive or olein soap full of suds; at least one bowl contains warm rinsing water to which is added, on occasion, blueing or ammonia. The slivers are squeezed and then dried; in the United States a hot-air dryer is preferred. Because backwashing and drying tend to make the fibre brittle, wool oil is added at this point.

Gilling (preparing). — After backwashing, drying and oiling, the slivers pass into a giller to be combed out by steel pins and to be straightened by other pins. The sliver is delivered from the gill boxes faster than it enters; the ratio of delivery to speed of entering is termed the draft. The sliver enters between rollers and passes over strong steel pins (fallers) which move in the same direction as the sliver but at a faster rate, giving a combing and straightening action. The wool is then passed through delivery rollers to calender rollers (to prevent any bunching) and into a can (or from the delivery rollers to an apron for coiling). There are various types of mechanical drafts in gill boxes — front, back and total. The front (delivery) rollers move faster than the fallers and the fallers move faster than the back (entering) rollers. The ratio of surface speed of the front rollers to the fallers is the front draft; the ratio of the fallers to the back rollers is the back draft; and that of the back rollers to the front rollers is the total draft. These drafts, differing with different types of wool and gilling operations, are important. There is also a material draft which is the weight per unit of the sliver entering the back rollers compared with the sliver weight leaving the front rollers. The mechanical ratio is the product of the surface speed of all the increasing rollers divided by the product of the surface speeds of all the decreasing rollers. Usually, the rollers (back and front) are fluted spirally to grip but not break the fibres and keep them straight; obviously these flutes affect the draft. In the English system a simple measuring device is used in the gill box to keep the length of the slivers uniform. Usually, particularly in the English system, two more gillings may occur; these additional gillings vary from the first gilling only in the number of teeth per faller and the speed of the rollers. They are used for thickening the sliver and making it more uniform in a-eight and stock.

Combing. — The purpose of combing is to eliminate short fibres of a given length as well as to further straighten the fibres and eliminate impurities. There are four types of combs — the Noble, Lister. Holden (square motion) and French (rectilinear). The first two are used in the English system and the latter two in the French system.

The English System. — In the United States the Noble circular comb, imported from England, is most widely used. It is most productive and has a good length of fibre range. The Lister comb, while used somewhat, requires longer fibres and gives a smoother, straighter yarn. Preparation varies — the Noble comb has a ball winder attachment which makes a tight ball out of four slivers.. The Lister comb takes the wool in long slivers much as a gill box does. The Noble comb requires a good deal of moisture in the wool; this is left in from backwashing and by having the humidity high where the work is done. Rings of pins of varied number and sizes are used in Noble combing, the size and number depending on the wool used.

The French System. — The Heilman comb is used in the French system. It is good for long and short wools (and rayon staple fibre), is nearly as productive as the Noble comb, occupies much less room, uses 20% of the power and needs only half of the supervision — it is a straight comb. It is fed by groups of slivers (8) placed side by side. The wool, drawn off in tufts, is pressed into slivers and passes through feed rolls and a feeding gill onto nipper jaws that hold the sliver while it is combed by a circular comb which has 18 pin bars with needles of varying density. As the nippers open, another comb comes over the uncombed part of the sliver, and as the drawing-off rollers remove the wool it is completely combed. A brush removes the noil from the combs as the usable wool is being delivered in overlapping tufts onto an apron and then to a can. Burrs are removed by special blades.

Recombing. — This is done on special occasions, usually where dyed slivers are used because dyeing often causes the fibres to curl. Often it is used where blending of different coloured slivers is desired although such blending is reputedly best done in the gill boxes.

Drawing. — The theory of drawing in the English and French systems is to create a fine roving that can be spun into an even yarn. Drafting is used to thin out the sliver and doubling to make it uniform; care is exercised to maintain straightness and parallelism of the fibres. All systems use drafting rollers and a winding up of the reduced sliver.

In the United States the English, French and cone systems are generally used. The English system is used on long coarse lustre and crossbred wools; the French system on unoiled tops of short fine wools, of from 1½ in. to 4 in.; and the cone system is used on oiled tops.

Spinning. — Having obtained the roving by any one of the systems described, the next step is to spin the roving into yarn. There are four methods of spinning — flyer, cap, ring and mule. The English system uses ring, cap and flyer spinning. While most U.S. mills using the English system use cap spinning there is a definite trend toward ring spinning. Flyer spinning is used on mohairs and carpet wools. About 85% of the U.S. mills operating under the French system use mule spinning although ring spinning is increasing. In all systems there are three steps to spinning: (1) final drafting; (2) twisting the roving; and (3) packaging— these are continuous operations except in worsted mule spinning.

Flyer Spinning.——Invented by Richard Arkwright in 1769 and known in England as the "throstle," the flyer spinner gives its yarns smoothness and lustre. The flyer frame is similar to the English system drawing frame with front, back and carrier rollers to thin the roving. The flyers which impart the twist are at the top of spindles, revolving at 2,500 to 3,000 r.p.m. The yarn is automatically wound onto bobbins or tubes. Production is low, but the flyer is necessary for spinning mohair and does a good job. The yarn is laid on the bobbins in horizontal layers by use of friction drag — automatic doffing is common. The amount of twist depends on the speed of the flyer.

Cap Spinning. — Invented by Charles Danforth, an American. in 1828, cap spinning is the most common spinning method used in the United States for English system worsteds. The spindles are stationary and the methods of inserting twist and the bobbin winding differ from the flyer frames. The bobbin rotates at 6,000 to 9,000 r p m. by the lifting of a tube fitted with a whorl which is placed over the spindle; a twist is imparted to the yarn as the bobbin revolves and the spindle and cap do not. Weaknesses of this system are roughness and hairiness of yarn due to the great speed. Calculating the amount of twist is complicated; the number of twists varies according to type of wool, from 3 to 20 per inch, equalling the number of revolutions of the bobbin per inch of delivery.

Ring Spinning. — The use of ring spinning, formerly used for cotton has become widespread in the worsted field. The benefits of this type of spinning are quality yarns at low cost. The most prominent feature is the large size of the bobbin which holds many times that held by the ordinary one. Very few knots are found in the yarn and it is superior to cap-spun yarn. The yarn is fed through an eye, and onto a traveler which is dragged around a ring, lubricated to reduce friction, which in turn is fastened to a stationary ring rail. The yarn goes at right angles from the traveler to the bobbin. The bobbin motion inserts the twist and the traveler runs slower than the bobbin to ensure tension. Spindle speed is variated to compensate for loss of tension due to the filling up of the bobbin, hence the smaller the bobbin load the greater the spindle speed.

Mule Spinning. — Mule spinning, which was replaced in the United States by ring spinning, produces an exceptionally fine, soft yarn with short wools. The operations are performed intermittently rather than continuously, and the process is used only in the French system. Twist is put into the flat yarn by using cylinder-driven tapered spindles on a carriage which runs about five feet. When the carriage reaches the end of its run the yarn is completed and removed from the top of the spindles; the carriage then travels back and the yarn is again wound on the bobbin.

Doubling, etc.—It is often necessary to double or further thicken the yarns; this is done on the spinning frames. Similarly, fancy twists are often desired and these are imparted by numerous attachments on ring frames. Since yarns are available in many forms, spools, bobbins, etc., the buyer has a broad choice.

Weaving, Finishing. — The principles of weaving apply generally to worsted weaving (see WEAVING) except in a fen cases. Generally, the processes used in finishing worsteds are similar to those used in woolens except that the worsted is more nearly a completed fabric when it leaves the looms; hence though similar operations are required for finishing they are more lightly applied and the change from the unfinished to the finished worsted is not so noticeable. Worsteds may be crossed with other fabrics to form hybrids. See also WOOLLEN MANUFACTURE.

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WORTH, CHARLES FREDERICK (1825–1895), the famous English dressmaker, was born at Bourne, Lincolnshire, in 1825 and was sent to London as an apprentice to Swan & Edgar, drapers. In 1846, he went to Paris, without capital or friends, and after 12 years in a wholesale silk house he began business as a dressmaker in partnership with a Swede named Dobergh. Worth won the patronage of the empress Eugénie, and, through her. of fashionable Paris. After the Franco-German War, Worth continued the business with his two sons John and Gaston— both naturalized Frenchmen. For more than 30 years he set the taste and ordained the fashions of Paris.

WÖRTH, a village of Alsace region, Bas-Rhin *Département,* France, on the Sauer, 6 mi. N. of Hagenau. The village gives its name to the battle of Aug. 6. 1870, fought between the Germans under the crown prince of Prussia and the French under Marshal MacMahon. The battle is also called Reichshoffen and Fröschweiler. Pop. (1954) 1,146.

The events which led up to the engagement, and the general situation on the 6th are dealt with under FRANCO-GERMAN WAR.

WORTHING, a municipal and parliamentary borough, and seaside and residential resort in West Sussex, Eng., 11 mi. W. of Brighton by road. Pop. (1951) 69.431. Area, 12.5 sq.mi. It has a fine marine parade and a promenade pier. The mother parish of Worthing is Broadwater, the church of which, 1 mi. N. of Worthing, is a fine example of transitional Norman work. Richard Jefferies and W. H. Hudson are buried in the churchyard.

A Roman villa, evidence of a pottery works and a "mile-stone" have been discovered there. Sompting church (2 mi. N.E.) has a Saxon tower with a unique tower roof. The town was incorporated in 1890. An important industry is the raising of flowers and fruit, especially tomatoes, in greenhouses. The corporation owns about 1,000 ac. of downland.

The parishes of Durrington and Goring were added to the borough in 1929 and a portion of the parishes of Findon and Sompting in 1933.

WORTHINGTON-EVANS, SIR LAMING (1868–1931), British statesman, was born Aug. 23, 1868. In 1910 he was elected Conservative M.P. for Colchester, and in 1918 for the Colchester division of Essex, which he represented in succeeding parliaments.

In 1916 he entered the coalition government as parliamentary secretary to the ministry of munitions. He left the ministry of munitions in 1918 to become minister of blockade, and afterward filled the following offices under Lloyd George and Baldwin: minister of pensions, 1918–20; minister without portfolio, 1920–21; secretary for war, 1921–22; postmaster general, 1923–24; and again secretary for war, 1924–29. He wrote books on company law. He died Feb. 14, 1931.

WOTTON, SIR HENRY (1568–1639), English author and diplomatist, son of Thomas Wotton (1521–87) and grand-nephew of Nicholas Wotton, was born at Bocton hall in the parish of Bocton or Boughton Malherbe, Kent. He was educated at Winchester school and at New college and Queen's college, Oxford. At Oxford he was the friend of Albericus Gentilis and of John Donne. While at Queen's he wrote a play, *Tancredo,* which has not survived, but his chief interests appear to have been scientific.

About 1589 Wotton went abroad, probably in preparation for a diplomatic career, and his travels appear to have lasted for about six years. At Altdorf he met Edward, Lord Zouch, to whom he later addressed a series of letters (1590–93) which contain much political and other news. These (*Reliquiae Wottonianae,* pp. 585 *et seq.*, 1685) provide a record of the journey. He travelled by way of Vienna and Venice to Rome, and in 1593 spent some time at Geneva in the house of Isaac Casaubon. Wotton returned to England in 1594, and in 1595 was admitted to the Middle Temple. While abroad he had provided Robert Devereux, and earl of Essex, with information, and he now entered his service as one of his agents or secretaries to supply intelligence of affairs in Transylvania, Poland, Italy and Germany. Wotton was not actually involved in Essex's downfall, but he left England, and within 16 hours of his patron's apprehension he was safe in France, whence he travelled to Venice and Rome. In 1602 he was resident at Florence, and, a plot to murder James VI of Scotland having come to the ears of the grand duke of Tuscany, Wotton was entrusted with letters to warn him of the danger, and with Italian antidotes against poison. As "Ottavio Baldi" he travelled to Scotland by way of Norway. He remained three months at the Scottish court, retaining his Italian incognito. He then returned to Florence, but on receiving the news of James's accession hurried to England. James knighted him, and offered him the embassy at Madrid or Paris; but Wotton, knowing that both these offices involved ruinous expense, desired rather to represent James at Venice. He left London in 1604 accompanied by Sir Albertus Morton, his half-nephew. as secretary, and William Bedell, the author of an Irish translation of the Bible, as chaplain.

Wotton spent most of the next 20 years, with two breaks (1612–16 and 1619–21), at Venice. He helped the doge in his resistance to ecclesiastical aggression, and was associated with Paolo Sarpi, whose history of the Council of Trent was sent to King James as fast as it was written. In 1611 Caspar Schoppe, whom Wotton had offended. wrote a scurrilous book against James entitled *Ecclesiasticus,* in which he fastened on Wotton a saying which he had incautiously written in a friend's album years before. It was the famous definition of an ambassador as an "honest man sent to lie abroad for the good of his country." Wotton was at the time on leave in England, and made two formal defenses of himself, one a personal attack on his accuser addressed to Marcus Welser of Strasbourg, and the other privately to the king. He seems to have won back James's favour by obsequious support in parliament of his claim to impose arbitrary taxes on merchandise. In 1614 he was sent to The Hague and in 1616 he returned to Venice.

In 1620 he was sent on a special embassy to Ferdinand II at Vienna, to do what he could on behalf of James's daughter Elizabeth, queen of Bohemia. Wotton's devotion to this princess, expressed in his exquisite verses beginning "You meaner beauties of the night," was sincere and unchanging. At his departure the emperor presented him with a jewel of great value, which Wotton received with due respect, but before leaving the city he gave it to his hostess, because, he said, he would accept no gifts from the enemy of the Bohemian queen. After a third term of service in Venice he returned to London early in 1624 and in July he was installed as provost of Eton college. In 1627 he received a pension of £200, and in 1630 this was raised to £500 on the understanding that he should write a history of England. His most constant associates were Izaak Walton and John Hales. A bend in the Thames below the Playing fields, known as "Black Potts," was the spot where Wotton and Izaak Walton fished in company. He died at the beginning of Dec. 1639.

Of the 25 poems printed in *Reliquiae Wottonianae* 15 are Wotton's. Two obtained a place among the best-known poems in the language, the lines already mentioned "On his Mistris, the Queen of Bohemia," and "The Character of a Happy Life."

During his lifetime he published only *The Elements of Architecture* (1624), which is a paraphrase from Marcus Vitruvius Pollio, and a Latin prose address to the king on his return from Scotland (1633). In 1651 appeared the *Reliquiae Wottonzanae,* with Izaak Walton's *Life*. An admirable *Life and Letters,* representing much new material, by Logan Pearsall Smith, was published in 1907. *See* also A. W. Ward, *Sir Henry Wotton, a Biographical Sketch* (1898).

WOUND may be defined as a breach in the continuity of any body tissue. It is produced by intentional (as in surgical procedures) or accidental violence which is sufficient to overcome the tolerance of the tissue involved. This violence may be direct or indirect, and seldom is it confined to any single tissue structures. Wounds of bone such as fractures (breaks) are frequently caused by indirect violence and, unless of the most simple nature, cannot occur alone. For example, a person falling backward instinctively places his arm behind him and strikes on the palm; the hand is not injured but the force is transmitted along the bones of the forearm and the fracture occurs at the elbow. The wound is not confined to the bone, however, as the broken fragments will, by their displacement, injure muscles, blood vessels, joint capsules, ligaments and nerves. Wounds of direct violence are inflicted by knives, bullets, fire and the like. Minimal direct violence-may involve the skin alone as in a scratch (excoriation) or a friction burn (abrasion). Other forms of direct violence may wound deep structures without external evidence, as in the case of a blow with a sandbag fracturing the skull without opening the scalp; or a blow on the abdominal wall rupturing the spleen, liver, stomach or intestines, yet leaving no visible sign of its impact. These are also examples of closed wounds in which there is no open portal of entry for bacteria which commonly cause local (abscess) or general infection (blood poisoning). A bruise (contusion of the skin) is another wound of the same type; the blow does not open the skin covering proper, but ruptures the blood vessels in the deeper layers of the subcutaneous tissues. The typical black and blue appearance followed by fading green and yellow is due to the disintegration and gradual absorption of blood pigment thus freed.

Open wounds fall into many categories and their classification may be based on: (1) their appearance (incised, lacerated. punctured, avulsed, burned); (2) their depth and the related possibilities of involvement to important deeper structures (compound fractures, perforation of heart, lung, bladder, liver, bowel, brain, spinal cord) and (3) their potentialities as a future focus of infection or poisoning (barnyard dirt, snake bite, rabid-dog bite, retention of foreign material). Whatever the appearance of the wound, it can be of a minor or a deadly serious nature.

In the management of any open wound its possibilities must first be appreciated. Since such wounds are able to bleed, and since bleeding is frightening to most laymen, a doctor usually has the opportunity to evaluate it. Gradually, after about 1919, the strong so-called antiseptics were reluctantly excluded from wound treatment. Nature must, after all, heal the wound; treatment should be concerned only with restoration of the involved tissues and should preclude any interference with the natural' healing process. If any medication strong enough to kill bacteria is put into a wound, that substance is bound to also kill the delicate tissue cells that, from the moment of injury, are initiating the reparative process. Such treatment has been established to be a deterrent and not a stimulant to wound healing.

The open surface should be covered with sterile gauze or cotton and the surrounding skin shaved and washed with sterile water and plain white soap for a minimum period of ten minutes. Following this the wound should be similarly treated and all particles of foreign material scrubbed, picked or flushed from the surfaces and depths. It is then ready for closure. This procedure converts a contaminated open wound into a clean closed one, thus fulfilling the ideal of all wound treatment. The stage is then set for healing by so-called primary intention. Such favourable healing is further helped by application of a pressure dressing which, while not constricting, keeps the wound cavity collapsed and prevents accumulation of pockets of blood or serum which, by tension, could interfere with coaptation and repair. If nature's defenses cannot overcome the bacterial elements present in all wounds, infection will follow. If the infection remains local and an abscess forms, the wound will have to be opened for evacuation of pus, and then healing from the "bottom" (secondary intention) will follow. This is a slower and less satisfactory method, with defects and visible scars a likely result.

In the avulsed type of wound there is an avulsion or tearing away, with actual loss of substance. If circumstances permit, this loss may be replaced by a suitable skin graft as part of the initial treatment. Otherwise, transference of new skin is made after a suitable base of granulation tissue has developed in the defect. Similarly, wounds caused by thermal burns are closed by skin taken from uninvolved areas of the body.

The systemic effect of wounds should not be overlooked. Serious haemorrhage (*q.v.*) may be immediate or delayed. Shock may be primary or secondary. Infection may occur early if extremely virulent, or late by the classic signs of fever, malaise, rapid pulse and an increase in the white cells of the circulating blood. Penicillin, streptomycin or other appropriate antibiotics and the sulfa drugs have been of great value in lowering the incidence of wound infection. However, these agents are to be considered a supplement and not a substitute for competent surgical treatment. The antitoxins and specific sera are used as an adjunct to local care, to protect the patient from the general effects of the substances entering wounds, mentioned in category (3) above. (*See* INFLAMMATION.) (J. K. SK.)

WOUWERMAN, PHILIPS (1619–1668), Dutch painter of battle and hunting scenes, was born at Haarlem. where he was baptized on May 24. 1619. He learned the elements of his art from his father, Paul Joosten Wouwerman, a painter from Alkmaar. He then became a pupil of Frans Hals and probably of J. Wynants and of Pieter Verbeek. a painter of horses. He became a member of the guild of painters at Haarlem in 1642. and he died there on May 19, 1668.

Wouwerman is credited with more than 1.000 pictures, but probably many of these are the productions of his brothers Pieter (1623–82) and Jan (1629–66) and of his many other imitators His authentic works are distinguished by great spirit and are infinitely varied, though dealing recurrently with cavalry battle pieces, military encampments, cavalcades and hunting or hawking parties. He is equally excellent in his vivacious treatment of figures, in his skillful animal painting and in his admirable and appropriate landscape backgrounds. Horses were his favourite study, and a white horse is generally introduced. Three different styles have been observed as characteristic of the various periods of his art His earlier works are marked by the prevalence of a foxy-brown colouring and by a tendency to angularity in draftsmanship; the productions of his middle period have greater purity and brilliancy; and his last and greatest pictures possess more of force and breadth, and are full of a delicate silvery-gray tone. Pictures by Wouwerman may be seen in a number of public collections, including the Frick collection, New York city ("Cavalry Camp"), and the National gallery, London ("Interior of a Stable" and "On the Seashore").

WRAITH, a general term in popular parlance for the appearance of the spirit of a living person. (*See* PSYCHICAL RESEARCH.)

WRANGEL, FRIEDRICH HEINRICH ERNST, COUNT VON (1784–1877), Prussian general field marshal, was born at Stettin, on April 13, 1784. He entered the Prussian army in 1796 and distinguished himself in the campaigns against Napoleon. He was in command of the 13th division, with headquarters at Munster, in Westphalia, in 1834, when riots resulting from differences between the archbishop of Cologne and the crown occurred, and the determination and resolution with which he treated the clerical party prevented serious trouble. He was promoted lieutenant general, received many honours from the court, enjoyed the confidence of the Junker party, and commanded successively at Konigsberg and Stettin. In 1848 he commanded the 2nd corps of the German federal army in the Schleswig-Holstein campaign, was promoted general of cavalry and won several actions.

In the autumn he was summoned to Berlin to suppress the riots there. As governor of Berlin and commander in chief of the mark of Brandenburg (appointments which he held till his death) he proclaimed a state of siege, and ejected the Liberal president and members of the chamber. Thus on two occasions in the troubled history of Prussian revival Wrangel's uncompromising sternness achieved its object without bloodshed. In 1856 he was made a field marshal. At the age of 80 he commanded the Austro-Prussian army in the war with Denmark in 1864. The prestige of his name, and the good work of his subordinates, made the campaign a brilliant success. After the capture of Diippel he resigned the command, was created a count and received other honours. In 1866 "Papa" Wrangel assisted in the Bohemian campaign, but without a command because of his great age. He took a keen interest in the second reorganization of the cavalry arm, 1866–70, and in the war with France in 1870–71., He died at Berlin on Nov. 2, 1877.

See supplement to *Militar. Wochenblatt* (1877), and lives by Koppen and Maltitz (Berlin, 1884).

WRANGEL, KARL GUSTAV VON (1613–1676), Swedish soldier, was descended from a family of Estonian origin, branches of which settled in Sweden, Russia and Germany: His father, Hermann von Wrangel (1587–1643), was a Swedish field marshal in Gustavus Adolphus' wars. Karl Gustav was born near Uppsala on Dec. 23, 1613, and at the age of 20 distinguished himself as a cavalry captain in the war against the army of the league. Three years later he was colonel, and in 1638 major general, still serving in Germany. In 1644 he commanded a fleet at sea, which defeated the Danes at Fehmarn on Oct. 23. In 1646 he returned to Germany as a field marshal and succeeded Count Lennart Torstensson as commander in chief of the Swedish army in Germany, which post he held during the last three campaigns of the Thirty Years' War. Under Wrangel and Turenne the allied Swedish and French armies marched and fought in Bavaria and Wurttemberg. At the outbreak of a fresh Polish war in *1655* Wrangel commanded a fleet, but in *1656* he was serving on land again and commanding, along with the Great Elector of Brandenburg, in the three days' battle of Warsaw. In 1657 he invaded Jutland and in 1658 passed over the ice into the islands and took Kronborg. In 1657 he was appointed admiral and in *1664* general of the realm, and as such he was a member of the regency during the minority of Charles XI. But his last campaign was unfortunate. Commanding, ineffectively owing to his broken health, in the war against Brandenburg, he was recalled after his stepbrother Waldemar, Freiherr von Wrangel (1647–1676), had been defeated at Fehrbellin. He died at Riigen on July 5, *1676*.

WRANGEL, PETER NICHOLAIEVICH, BARON (1878–1928), Russian general, was born at St. Petersburg (Leningrad) on Aug. 15, 1878, of a noble family of Swedish descent. After experience in the ranks of the horse guards and as a mining engineer in Siberia, he served as an officer in a Cossack regiment, transferring after the Russo-Japanese War to the horse guards as a captain. During the World War he commanded successively a squadron, a regiment and a division of Cossacks. He was one of the first officers to join Kaledin against the Bolsheviks. After Kaledin's suicide Wrangel allied himself to Alexeyev and Denikin, distinguishing himself particularly by his defence of Tsaricsyn in the summer of 1919. On April *4*, *1920*, after Denikin's retreat, Wrangel was appointed commander-in-chief of the volunteer army. He was in Constantinople when the summons came. He arrived in the Crimea to find a force completely disorganized. In a very short space of time he had turned it into an effective force with which he held the Bolsheviks in check, and indeed made some advance. But after the signing of a peace treaty between Poland and the Bolsheviks the tide turned. On Nov. *1 j* Sebastopol was lost and the evacuation of the army carried out. Wrangel embarked with about 130,000 refugees, who were dispersed in the Balkans and other parts of Europe. He kept a staff for some time in Belgrade, from which centre he tried to organize the settlement of his soldiers. After a time he took a post as mining engineer in Brussels, where he died on April 25, *1928*.

WRANGEL ISLAND, in the Arctic sea, *85* m. N.E. of Cape Billings, eastern Siberia, extends between 176° W. and 179° E. in about 71° N. It is *80* m. long and *18–30* m. wide and has an area of about 2,000 sq.miles. The mountainous interior rises to *2,500* ft. in Berry Peak, but there is much low land on the south and north. Shoals and sandspits project to sea on the north and south-west. The west and east coasts are steep and lofty. The small Rodgers harbour is on the south-east. There are no true glaciers. Tundra covers many parts. Polar bears and foxes are numerous. Walrus and seals frequent the shores. In summer there are duck, geese, gulls and other birds. Driftwood is abundant. Mammoth tusks have been found. No minerals of value occur. Herald island lies *40* m. E. of Wrangel island. It is 5 m. long and 900 ft. high. The shores are mostly steep. There are no resources. Both islands are generally surrounded by pack-ice. Hunters do not visit them and there has never been a native population. Reports of land seen to the north by natives of eastern Siberia were investigated by F. von Wrangel in 1824, but he failed to reach the island. In *1849* Captain H. Kellett, R.N., discovered and landed on Herald island, from which he reported lands to the west, Plover and Kellett's Lands, thought to be parts of an Arctic continent. Commander J. Rodgers, U.S.N., landed on Herald island in 1855, and the American whaler T. Long sailed along the south of Wrangel island and gave it its name in *1867*. The first certain record of landing is by Capt. C. L. Hooper, U.S.N., in *1881*. The same year Captain R. M. Berry, U.S.N., explored the island and dispelled the idea of extensive land in that region. Russians first landed in 1911 when the "Taimir" and "Vaigach" erected a beacon. The survivors of V. Stefansson's "Karluk" lived on the island from March to Sept. 1914 (*see* ARCTIC REGIONS); in *1921* Stefansson sent another party of five under A. Crawford to establish a Canadian claim by occupation in view of the use of the island as a base in transpolar aerial trade routes. The party perished through accident with the exception of the Eskimo seamstress. In 1923 a party of Eskimos under an Alaskan trapper was established with the same end in view, but Russia, laying stress on a claim made in *1916*, removed the colony in Aug. 1924 and shortly afterwards brought 50 Chuckhee to form a settlement under Soviet officials. The Soviet flag was also hoisted on Herald island in 1926. The colony was visited by Russian aeroplanes in 1927. These claims were not officially disputed by Britain, Canada or the United States.

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(R. *N*. *R*. B.)

WRASSE, a name given to the fishes of the family Labridae. They are abundant in the tropical zone, less so in the temperate, and disappear altogether in the Arctic and Antarctic. Their body is compressed, like that of a carp, and covered with smooth scales; they possess one dorsal fin only, the anterior portion of which consists of numerous spines. Many wrasses are recognized by their thick lips, the inside of which is sometimes curiously folded. The dentition consists of strong conical teeth, of which some are larger than others. But the principal organs with which they crush shell-fish, and other hard substances are the solid and strongly-toothed pharyngeal bones, of which the lower are coalesced into a single flat triangular plate. All wrasses are surface fishes. Rocky parts of the coast overgrown with seaweed are their favourite haunts in the temperate, and coral-reefs in the tropical seas. Some 450 species of wrasses (including parrot-fish, *q.v.*) are known, chiefly from the tropics.

Of the British wrasses the ballan wrasse *(Labrus maculatus)* and the striped or red or cook wrasse (L. *mixtus)* are the most common. The goldsinny or corkwing *(Crenilabrus melops)* is much more frequent on the southern coasts of England and Ireland than farther north. It rarely exceeds 10 in. in length. The commonest temperate American species is the tautog.

WRECK, a term which in its widest sense means anything without an apparent owner that is afloat upon, sunk in, or cast ashore by the sea; in legal phraseology, it has a narrower meaning. Formerly an appreciable source of revenue to the Crown, afterwards a valuable addition to the income of a landowner on the sea-coast, wreck has almost within modern times ceased to be a perquisite of either, or to enrich the casual finder at the expense of its rightful owner.

History. — The general rule in the civilized maritime countries of Europe was that the right to wreck belonged to the sovereign, and formed part of the royal revenue. This was so under the Roman, French and feudal law; and in England the common law set out in the statute *De praerogativa regis (17* Edw. II., 1324) provided that the king has wreck of the sea, whales and sturgeons taken in the sea and elsewhere within the kingdom, except in certain places privileged by the king. This right, which it is said had for its object the prevention of the practice of destroying the property of the shipwrecked, was, however, gradually relaxed; and the owner of wreck was allowed to recover it if he made claim to it, and gave proof of his ownership within a certain time —fixed at a year or a year and a day alike by a decree of Antonine the Great, the feudal law, the general maritime law, the law of France and English law. Early in the 15th or at the close of the 14th century, it became usual for the Crown to grant to the lord-admiral by his patent of appointment, amongst other *proficua et commoditates* appertaining to his office, wreck of the sea; and when, early in the reign of Henry VIII., vice-admirals of the coast were created, the lord-admiral by patent under his own hand delegated to them his rights and duties in the several counties, including those in connection with wreck. He did not, however, part with the whole of his emoluments; his vice-admirals were required to render an account of the proceeds of wreck, and to hand over to him a part, usually one-half, of their gains. This system lasted until *1846* when an act (9 & 10 Vict. c. *99)* was passed forbidding the vice-admirals to intermeddle with wreck, and it required the receivers of droits of admiralty to receive all wreck from the finders and to detain it for 12 calendar months; at the end of that period it was to be sold and the proceeds carried to the credit of the consolidated fund. The ancient law by which the unfortunate owner was deprived of his property, if no living thing escaped from the wreck, had during the 16th and 17th centuries been gradually but tacitly relaxed; it required, however, a decision of Lord Mansfield and the king's bench in 1771 to settle the law definitely that, whether or no any living creature escaped, the property in a wreck remains in the owner. In Scotland it seems that the same law had been laid down in 172j, and there are indications that upon the continent of Europe there had before this date been a relaxation of the old law in the same direction. In the 17th century working salvors established the right to a lien upon property saved as a security for adequate remuneration of their exertions in saving it; and if the vice-admirals restored to its owners wreck that had come to their hands, they did so only upon payment of extravagant demands for salvage, storage, and often legal expenses. Stories of wilful wrecking of ships and of even more evil deeds are probably exaggerations, but modern research has authenticated sufficient abuses to show that further legislation was necessary to regulate the taking possession of wreck and ships in distress by "sea-coasters." Previously to the passing of the Act of 1846 the only substantial protection against plunder which owners of a wrecked ship could get was to apply to the admiralty judge for a commission enabling them or their agents to take possession of what came ashore, but to obtain such a commission took time and cost money, and before the commissioners arrived at the scene of the wreck a valuable cargo would have disappeared and been dispersed through the country. Plunder of wrecks was common, and the crowds that collected for the purpose set law at defiance. The vice-admirals, even if they had been able, did little to protect the ship wrecked. Many of the vice-admirals' accounts of the 17th and following centuries are extant. Most of them are for trifling sums, but occasionally the amounts are considerable. At the close of the 17th century the vice-admirals were required to make affidavits as to the amount of their gains; in 1709 20 of them swore that their office was worth less than £50 in the year.

The right of the warden of the Cinque Ports to wreck was derived from charters granted to the ports by Edward I. and his successors; many other seaports enjoyed a similar right under early charters. It would seem that these rights were of some value, for in 1829 the little towns of Dunwich and Southwold litigated at a cost of £1,000 the question whether a tub of whisky picked up at sea belonged to the admiralty jurisdiction of the one town or the other; and the town of Yarmouth is said to have spent no less than £7,000 upon a similar question. The Municipal Corporations Act of 1835 put an end to all dealings with wreck by local admiralty courts, except those of the Cinque Ports.

Grants of wreck to individuals are earlier than those to towns. Even before the Conquest it seems to have been not unusual for grantees from the Crown of lands adjoining the sea to get the franchise of wreck included in their grants. The lords of counties palatine had *wreccum maris* within their areas as part of their jura regalia, but yet inferior lords might prescribe for wreck belonging to their several manors within a county palatine.

From early times a distinction was made in English law between wreck cast ashore and wreck that is floating or sunken below low-water mark. Wreck proper, or common law wreck, *ejectum maris,* is what is cast by the sea upon the shore; for "nothing shall be said to be *wreccum maris,* but such goods as are cast or left upon the land" (Sir H. Constable's Case, 1599, 5 Rep. 106), and this belonged to the king jure coronae, and was dealt with by the common law. Floating and sunken wreck belonged to the Crown as *inter* regalia, but was granted to the lord-admiral *jure regis.* Even when the office of lord high admiral is in abeyance, and the duties are performed by commissioners, as now, these rights are distinguished from the other royal revenues as belonging to the Crown in its office of admiralty, or, as they are commonly known, droits (*q.v.*) of the Admiralty. From early times the lord-admiral tried to usurp, and there are several instances of his actually usurping jurisdiction over wreck proper; and in the reign of Richard II. special statutes (which were only declaratory of the common law) were passed for the purpose of confining his jurisdiction to its proper limits. Droits are flotsam, jetsam, lagan, derelict. In Lord Coke's words, flotsam is "when a ship sinks or otherwise perishes, and the goods float on the sea"; jetsam is "when goods are cast out of a ship to lighten her when in danger of sinking, and afterwards the ship perishes"; and ligan, or lagan, is "when heavy goods are, to lighten the ship, cast out and sunk in the sea tied to a buoy or cork, or something that will not sink, in order that they may be found again and recovered." Derelict is a ship or cargo, or part of it, abandoned by its master and crew sine *spe recuperandi* et sine animo *revertendi.* "None of these goods," adds Coke, "which are so called, are called wreck so long as they remain in or upon the sea; but if any of them by the sea be put upon the land then they shall be said to be wreck" (Sir H. *Constable's* Case, 1599, 5 Rep. 106; and 2 Inst. 167). Contrary to the opinion of Hale, Lord Stowell held that what is found anywhere derelict on the seas is acquired beneficially for the sovereign, if no owner shall appear. It seems that this was also Coke's view (2 Inst. 168).

The provisions of the Merchant Shipping Act, 1894, mentioned below, upon the subject of droits of admiralty are not clear. In practice the only droits of the admiralty that are commonly dealt with are anchors that have been slipped or parted from in heavy weather. In the Downs and other roadsteads these are "swept" for by creepers towed over the sea bottom, and in former days sweeping for anchors was a common industry. In the Downs large sums have been made after gales in this way. In the 17th century it became customary to obtain from the Crown grants of the right to fish for sunken wreck and treasure not only upon English coasts but all over the world.

The method of dealing with wreck outside territorial waters (which does not come within the scope of the act) is governed by the previous general law relating to droits of admiralty. The Board of Trade, and receiver-general, in its instructions to receivers, directs that wreck picked up at sea out of the limits of Great Britain, or brought to it by British ships, is to be taken possession of by the receiver and held by him on behalf of the owners, or, if the owners do not claim it, on behalf of the Crown. Derelict ships picked up at sea outside territorial limits and brought into British ports must be delivered to the receiver and kept by him until the owner can be found (but not longer than a year and a day). Wreck picked up out of territorial limits by a foreign ship need not be interfered with by the receiver, unless upon application by a party interested.

Although a ship on board which, or by means of which a man was killed, might be a deodand (*q.v.*), yet qua wreck she was not subject to forefeiture as deodand

Present British Law.—The Merchant Shipping Act, 1894, contains the whole of the existing statute law upon the subject of wreck within the territorial waters of Great Britain, and under the Sea Fisheries Act, 1883, it applies to fishing boats. For its purposes wreck includes jetsam, flotsam, lagan and derelict, found in or on the shores of the sea or any tidal water. The term does not extend to a barge adrift in the Thames, nor a raft of timber adrift; it must be the hull, cargo or appurtenances of a vessel.

The provisions of the Merchant Shipping Act dealing with wreck are of a detailed and administrative character and are concerned with the duties of the Board of Trade, receivers of wreck, finders of wreck and other matters. They will be found in part IX. of the act and are included in ss. 510–537.

The owner of a wrecked ship, sunk by his negligence in a navigable highway, so as to be an obstruction to navigation, if he retains the ownership of her, is liable in damages to the owner of any other ship which without negligence runs into her, unless he has taken steps to indicate her position, or the harbour authority at his request has undertaken to do so. He may, however (whether the sinking was due to his negligence or not), abandon the ship, and can thus free himself from any further liability in respect of her. If he abandons her to any other person—*e.g.*, an underwriter—who pays for her as for a total loss, that person does not become liable for her unless he takes possession or control in any way. Harbour authorities generally have under the Merchant Shipping Act, 1894, or by local statute, as they have by the general Harbours, Docks and Piers Clauses Act, 1847 (if incorporated in their own act), the power of removing the wreck in such a case, and recouping themselves for their expenses from its proceeds. The general act also gives a personal right of action against the owner for any balance of expense over the value of the wreck; but if the owner has abandoned it, and no one else has taken it, neither he nor anyone else is liable. A particular or local act (as *e.g.*, one of the State of Victoria) may, however, fasten this liability on the person who is owner at the time when the ship is wrecked, and then he cannot free himself of it. A harbour authority is not obliged to remove a wreck because it has power to do so, unless it takes dues from vessels using the harbour where the wreck lies, or in some way warrants that the harbour is safe for navigation, in which case it is under an obligation to do so. Further statutory provision is now made in this respect by the Merchant Shipping Act, which empowers harbour authorities to raise, remove or destroy (and meantime buoy or light), or to sell and reimburse themselves out of the proceeds of any vessel or part of a vessel, her tackle, cargo, equipment and stores, sunk, stranded or abandoned in any water under their control, or any approach thereto, which is an obstruction or danger to navigation or lifeboat service. They must first give due notice of such intention, and must allow the owner to have the wreck on his paying the fair market value. The act gives similar powers to lighthouse authorities, with a provision that any dispute between a harbour and lighthouse authority in this respect is to be determined finally by the Board of Trade.

By an Act of 1896 it is now the duty of the master of a British ship to report to Lloyd's agent, or to the secretary of Lloyd's, any floating derelict ship which he may fall in with at sea. By the Merchant Shipping Convention Act, 1914, a master must on finding a wreck communicate with the shore. But the operation of the act was suspended by order in council till Jan. 1, 1929. It will supersede previous acts when it comes into force. Under the Merchant Shipping Act it is a felony to take wreck found in territorial limits to a foreign port, and it is punishable by fine to interfere with a wreck. The receiver has power, by means of a search warrant from a justice, to search for wreck which he has reason to believe is concealed. By the law of Scotland plundering wreck is punishable at common law; and in England and Ireland it is a felony to plunder or steal any wreck or part thereof, to destroy any wreck or part thereof, to prevent or impede any person on board a wreck from saving himself, and to exhibit any false signal with the intent of endangering any ship, or to do anything tending to the immediate loss or destruction of a ship for which no other punishment is provided.

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(X.; E S R.)

WREN, SIR CHRISTOPHER (1632–1723), English architect and scientist. designer of St. Paul's cathedral and many other notable buildings of London, was born at East Knoyle, Wiltshire, on Oct. 20, 1632, the son of a clergyman. He attended Westminster school, London, until 1646. He showed an early interest in the sciences and continued his studies in this direction at Oxford where he took his M.A. degree in 1653, and in the same year was elected. a fellow of All Souls college. Four years later he was appointed professor of astronomy at Gresham college, London, a position that he exchanged in 1661 for the Savilian professorship of astronomy at Oxford. Among other scientific achievements Wren evolved a hypothesis concerning comets, studied Saturn and its rings, made a model of the moon and discovered a graphic method of computing eclipses. His interest in astronomy and the sciences never ceased, although architecture eventually became his main pursuit; Newton and Pascal thought highly of him and he was one of the founders of the Royal society, becoming its president, 1681–83. Wren was also a member of the Council of the Hudson's Bay company. and twice a member of parliament. He is said to have been a Freemason.

Wren's architectural career began with two commissions that came to him through his family connections and academic position: at Cambridge he designed the chapel of Pembroke college, 1663–65, for his uncle, Bishop Matthew Wren, and at Oxford he built the new "theatre," 1664–69, to serve for academic ceremonies, for Archbishop Sheldon. Both buildings are derived from Roman models.

When Wren undertook a journey to France in 1665—the year of the Great Plague in London—this, his only trip abroad. was made in pursuit of scientific interests and for architectural studies. Wren met Bernini in Paris. He observed the great building works of Louis XIV and his court in and around the capital and these impressions remained momentous for the rest of his career.

After his return to England, Wren prepared a scheme to remodel St. Paul's cathedral but soon afterward the Great Fire of London, 1666, made it necessary to consider an entirely new building, in addition to replanning the City and most of its parish churches. Wren presented a plan for the rebuilding of London a few days after the fire had been extinguished and although it was not implemented, he was made one of the six members of the commission for rebuilding. In his capacity as surveyor general, from 1669, he also dealt with matters of town planning and designed a unified monumental piazza around St. Paul's which again was never executed.

In 1670 work was begun on more than 50 City churches which had to be rebuilt after the fire. In their design, English traditions of church building and the demands of Anglican liturgy were of prime importance but Wren also tried to link up with the work of his great predecessor, Inigo Jones (*q.v*), and there are similarities with some churches in Calvinist Holland. Wren created a great variety of types, from buildings with a single nave to three-aisled and centrally planned structures. Among them St. Stephen (Walbrook) is the most successful solution: it integrates a dome and a longitudinal nave convincingly into a completely new and yet coherent design. Other City churches worth special mention are: St. Benet (Thames street), St. Lawrence (Jewry). St. Bride's (Fleet street), St. Magnus (London bridge), Christ Church (Newgate street) and St. Martin (Ludgate). Unfortunately the City churches suffered heavy damage during World War II. The church exteriors show a typically English predilection for simple cubic shapes combined with a delight in elaborate spires which are extremely varied in treatment. Compositions such as at St. Mary-le-Bow (Cheapside), St. James Garlickhithe (Garlick hill) and St. Vedast (Foster lane) represent a level of achievement in design that is equal to the best solutions of similar problems in continental Europe at that period.

The long and involved story of Wren's successive designs for St. Paul's cathedral can best be summed up in terms of continuous attempts on the part of the architect to reconcile medieval precedent, preferred by the clergy, with his own ideals that had been evolved in emulation of the great domed churches he had seen in Paris and their Italian prototypes. Several models illustrated different stages in this process; one of them is still preserved intact and represents the architect's favourite design. It is the Great Model which dates from 1673, the year Wren was knighted. Here a large domed space over a Greek cross plan with curves in the re-entrant angles is connected to a smaller vestibule, equally crowned by a cupola, at its west end. From this splendid combination of centralized and directional space a volumetric treatment ensues which is unusually rich in its modeled effects. The Great Model design was, however, rejected by the authorities and Wren had to work out another solution adhering more closely to the prototype of an English medieval cathedral and the formal vocabulary of Inigo Jones. This design was approved in 1675, but it was modified so substantially during the long years of construction that it changed practically beyond recognition. The choir of the new cathedral was consecrated in 1697 but the final shapes of the dome, lantern and western towers were not settled until a decade later and the work was not officially declared completed t i 1711. St. Paul's was the last great cathedral to be built in Europe before the era of 19th-century eclecticism; structurally and aesthetically its triple dome represents a remarkable achievement.

Wren's secular architecture can be roughly divided into buildings for academic purposes, buildings for the crown and domestic work. In a selection from his many executed buildings and designs the first group might be represented best by Trinity college library, Cambridge. 1676–84. Its reading room is one of the architect's finest interiors and the whole building has a quiet dignity that is typical of many Wren buildings and well exemplified in another instance at Chelsea hospital. 1682–91. At Hampton court. 1689–94, and Kensington palace, 1689–1702, Wren was able to realize large scale complexes, including splendid gardens and exquisite interior decoration. In these and in his last great secular work, Greenwich hospital (begun 1696, finished after his death), Wren as surveyor general was aided by the other officers of the office of works and during the later years of his activity their influence sometimes may be traced clearly. This may account for apparent discrepancies in his last style, such as the contrast between the truly baroque exuberance in some steeples and the severe classicism of Marlborough house, 1709–11.

Wren nominally retained his surveyorship until April 26. 1718, when he mas dismissed through court intrigues after having served for half a century under five sovereigns. He died on Feb. 25, 1723, and was buried in St Paul's where his well-known epitaph reads. *Si monumentum requiris, circumspice* ("If you seek a monument, look about you").

Wren's architecture never conceals the predominantly intellectual synthetic character of its process of origin: order and clarity result but also a certain monotony. Interiors are generally regular and simple to grasp. Plastic effects through modeling are rarely sought. Because of all this and because he favoured composition by addition rather than by subdivision, it is not always easy to recognize the baroque criteria in Wren's work. It is in his dome of St Paul's and the steeples of his City churches that Wren made a contribution of more than national importance and achieved European stature.

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WREN, the popular name for birds of the Passerine family Troglodytidae, of which the best known is *Troglodytes troglodytes,* the little brown bird with its vigorous song and its short tail cocked on high that braves the winter of the British Isles and even of the European continent. and figures largely in folklore. In St. Kilda isolation has brought about the evolution of a distinct subspecies. The better known forms in the Cnited States are the house wren. common in the eastern states but in bad odor for its egg-eating proclivities; the winter wren. remarkable for its resonant and brilliant song: the Carolina wren, also a fine singer; and the marsh wren, besides the cactus wrens and the cañon wrens of the western states.

Wrens have the bill slender and arched: their food consists of insects, larvae and spiders, but they will also take any small creatures. such as worms and snails, and occasionally eat seeds. The note is shrill. The nest is usually a domed structure of ferns, grass, moss and leaves, lined with hair or feathers, and from three to nine eggs are produced, in most of the species white. The headquarters of the wrens are in tropical America. but they reach Greenland in the north and the Falkland Islands in the south.

Some genera are confined to the hills of tropical Asia, but *Tuoglodytes,* the best known, ranges over North and South Xmerica, Asia and Europe.

The Troglodytidae by no means contain all the birds to which the name wren is applied. Several of the Sylviidae bear it, especially the little golden-crested wren (*see* GOLDCREST) and the group forming the genus *Phylloscopus* (*see* WARBLER), habitual summer visitants. The largest. P. *sibilatrix,* is called the wood wren. The willow wren, P. *trochilus,* is in many parts of Great Britain the commonest summer bird. and is the most generally dispersed. The third species, P. *collybita,* is the chiffchaff.

WRESTLING is one of the most primitive and universal of sports. It is a contest in which two persons strive to throw each other to the ground. Upon tbe walls of the temple-tombs of Beni Hasan, near the Nile, are sculptured many hundreds of scenes from wrestling matches, depicting practically all the holds and falls known at the present day, thus proving that wrestling was a highly developed sport at least 3,000 years before the Christian era. The description of the bout between Odysseus and Ajax in the 23rd book of the *Iliad,* and the evolutions of the classic Greek wrestlers, tally with the sculptures of Beni Hasan and Nineveh. The sport. in an organized and scientific form, may have been introduced into Greece from Egypt or Asia, though Greek tradition .ascribed its invention and original rules to the legendary hero Theseus. In Homer's celebrated description of the match between Ajax and Odysseus the two champions wore only a girdle, which was. however, not used in the classic Greek games. Neither Homer nor Eustathius, who also minutely depicted the battle between Ajax and Odysseus, mentions the use of oil, which, however, was invariably used at the Olympic games, where wrestling was introduced during the 18th Olympiad (about 704 B.C.). Wrestling contests for boys were added later. The Greek wrestlers, after the application of the oil! were rubbed with fine sand, to afford a better hold.

Wrestling was an important branch of athletics in ancient Greece. There were two principal varieties: upright wrestling and the pancratium (*pankration,* literally "all-strength"; cf. modern "all-in"). Upright wrestling was one of the five events of the pentathlon in the games at Olympia (*see* GAMES, CLASSICAL). The winner was the first to throw his opponent to the ground three times. the holds allowed being similar to those of the modern catch-as-catch-can style; tripping was allowed. but it is uncertain whether leg holds were forbidden or merely infrequently used. The pancratium was a much more savage type of wrestling, in which hitting, kicking, twisting of the limbs, strangling and struggling on the ground were all allowed, the only recognized fouls being biting and gouging; the contest lasted until one of the wrestlers acknowledged defeat. The pancratium was a feature of the Olympic meetings. but was not the style of wrestling admitted in the pentathlon. (For a full account, with illustrations. *see* E. N. Gardiner, *Athletics in the Ancient World* [Oxford, 1930].)

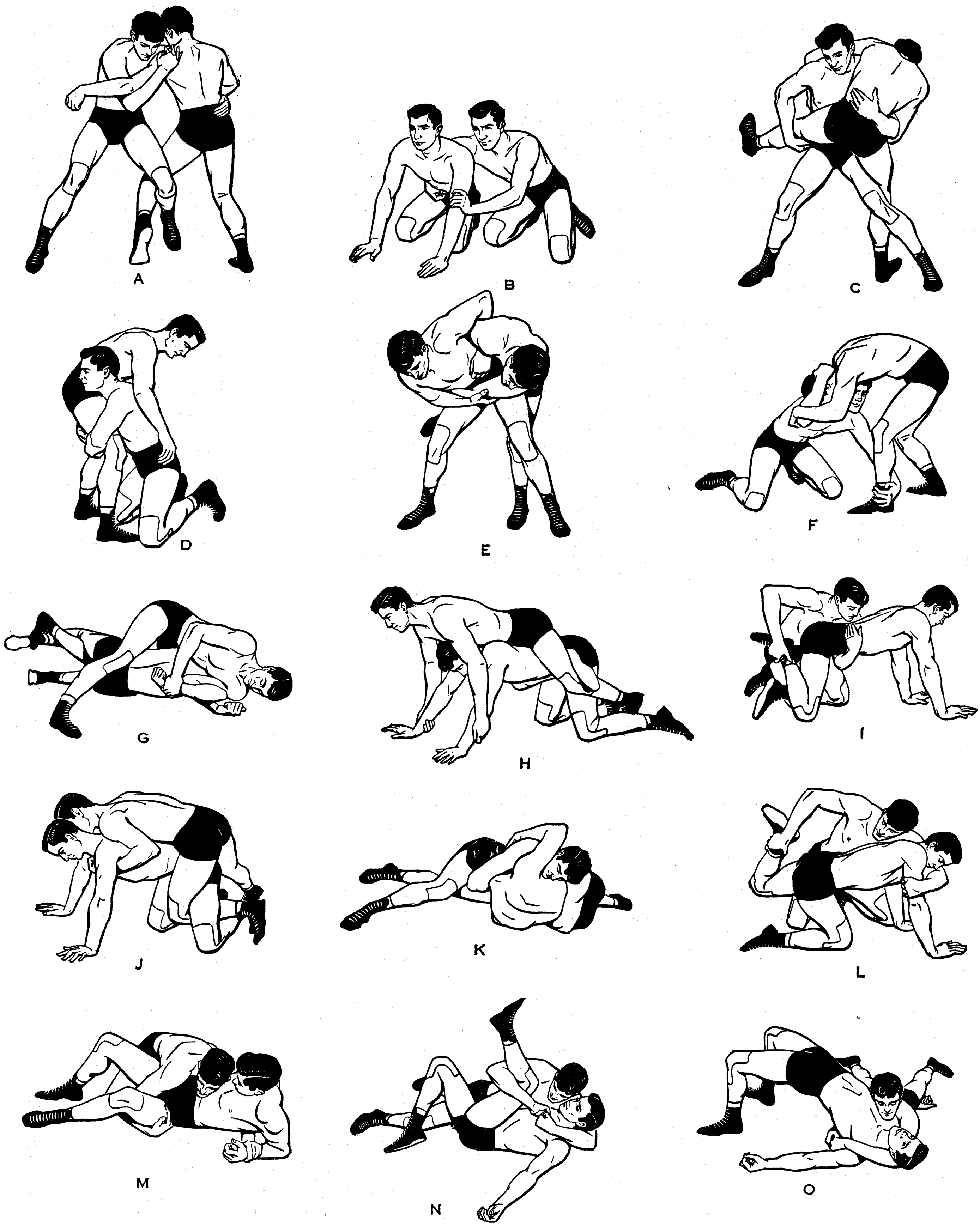
Other varieties of wrestling existed in the different Greek states. The most celebrated wrestler of ancient times was Milo of Croton (*c.* 520 B.c.). who scored 32 victories in the different national games, 6 of them at Olympia. Greek athletic sports were introduced into Rome in the last quarter of the 2nd century B.C.. but they never attained to the popularity they had enjoyed in Greece.

Wrestling is widely practised by Asian peoples, ranging in extent from Mongolia to the South Pacific islands. In general. the style, with minor exceptions. is of the catch-as-catch-can variety (*see* below) and a contest is terminated when a combatant is thrown to the ground or touches the ground with any part of his body other than the feet. In some countries it is permissible to touch the ground with one hand to avoid a complete overthrow.

Among the Mongolian peoples especially,. wrestling is a prominent feature of some religious festivals. There are no divisions into weight classes and the wrestlers are distinguished by enormous bulk and weight, poundages up to 300 being by no means uncommon, as with the *Sumo* contestants of Japan. Such ponderousness is common also among the Indian professional wrestlers. This excessive weight by no means produces slowness of movement, some attacks being made with surprising rapidity, the unexpected quickness ending a spell of near immobility.

Great reliance is placed upon the power of the arms and particularly of the hands. and among the Chinese—with whom wrestling events are frequently a feature of religious festivals—the abnormal strength of the hands and arms is obtained by the daily practice of closing the fingers tightly upon handfuls of wet sand, relaxing, and repeating the process again and again.

The popularity of wrestling has survived in many Asiatic countries, particularly in Japan, where the first match recorded took place in 23 B.c., the victor being Sukune, who has ever since been regarded as the tutelary deity of wrestlers. In the 8th century the emperor Shomu made wrestling one of the features of the annual harvest "festival of the Five Grains," the victor being appointed official referee and presented with a fan bearing the legend, "Prince of Lions." In 8j8 the throne of Japan was



Some of the holds used in wrestling

(A) Standing backheel. (B) Referee's position (collegiate only). (C) One-leg pickup and inside trip. (D) Leg drop. (E) Hip lock. (F) Cross-leg pull. (G) Cross-scissors ride with reverse arm lock. (H) Figure-four scissors. (I) Waist and ankle hold down. (J) Cross-scissors ride. (K) Half nelson and body chancery. (L) Near ankle and cross face. (M) Over-and-under. (N) Reverse nelson and cradle hold. (0) Double bar arm from side wrestled for by the two sons of the emperor Buntoku, and the victor. Koreshito, succeeded his father under the name of Seiwa. Imperial patronage of wrestling ceased in 1175, after the war which resulted in the establishment of the shogunate, but continued to be a part of the training of the samurai, or military caste. About 1600 professional wrestling again rose to importance, the best men being in the employ of the great daimios or feudal nobles. It was, nevertheless: still kept up by the samurai, and eventually developed into two separate systems. the national style called *Sumo*, and that peculiar and scientific combination of wrestling and self-defense known as jujitsu (see JU-JUTSU), the purpose of which is to disable an adversary. The national championships were re-established in 1624, when the celebrated Shiganosuke won the honour, arid have continued to the present day. The Japanese (*Sumo*) wrestlers place great reliance upon weight, some of the chainpions scaling 300 lh. or more; and as a result of highly specialized methods of physical training. they are generally of huge bulk and great strength. although surprisingly light on their feet. They form a guild which is divided into several ranks, the highest being composed of the *joshiyori*, or elders, in whose hands the superintendence of the wrestling schools and tournaments lies. The badges of the three highest ranks are damask aprons richly embroidered. The wrestling takes place within a ring 12 ft. in diameter, the wrestlers being naked but for a loincloth: and each contest is preceded by certain preliminaries of a quasi-religious significance. At the command of the referee the wrestlers crouch with their hands on the ground and watch for an opening. The contests are usually of brief duration. The method is very similar to that of the modern catch-as-catch-can style. except that touching the ground with any part of the person, the feet excepted, after the first hold has been taken, loses the bout. To step or be forced outside the actual wrestling circle is equivalent to losing a fall.

Indian wrestling resembles that of Japan in the great size of its champions and the number and subtlety of its attacks, called *penches*. It is of the "loose" order, the men facing each other nude. except for a loincloth, called *chaddi*, and maneuvering warily for a hold. Both shoulders placed on the ground simultaneously constitute a fall, which is seldom gained without much ground wrestling. It is highly scientific, though including many tricks that western rules exclude as "fouls."

In Switzerland and some of the Tirolese valleys a style of wrestling flourishes under the name of *schwingen* ("swinging"). The wrestlers n-ear *schwinghosen* or wrestling breeches, with stout belts. on which the holds are taken. Lifting and tripping are prevalent, and the first man down loses the bout. In Styria wrestlers stand firmly on both feet with right hands clasped. When the word is given, each tries to pull or push the other from his stance. the slightest movement of a foot constituting a defeat. In Russia belt wrestling, and in Iceland the glima are popular styles. Both require the wearing of a kind of harness about the loins and thighs. and otherwise are similar to schwingen. In the Balkan states the favourite style is catch-as-catch-can.

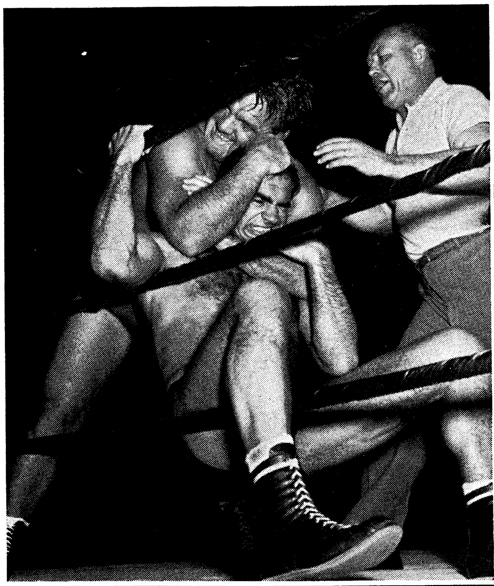
In Great Britain wrestling was cultivated at a very early age, both Saxons and Celts having always been addicted to it, with the men of Cornwall always holding a special eminence, and English literature is full of references to the sport. On St. James's and St. Bartholomew's days special matches took place throughout England, those in London being held in St. Giles's field! whence they were afterward transferred to Clerkenwell. The lord mayor and his sheriffs were often present on these occasions, but the frequent brawls among the spectators eventually brought these public matches into disrepute. English monarchs have not disdained to patronize the sport, and Henry VIII is known to have been a powerful wrestler.

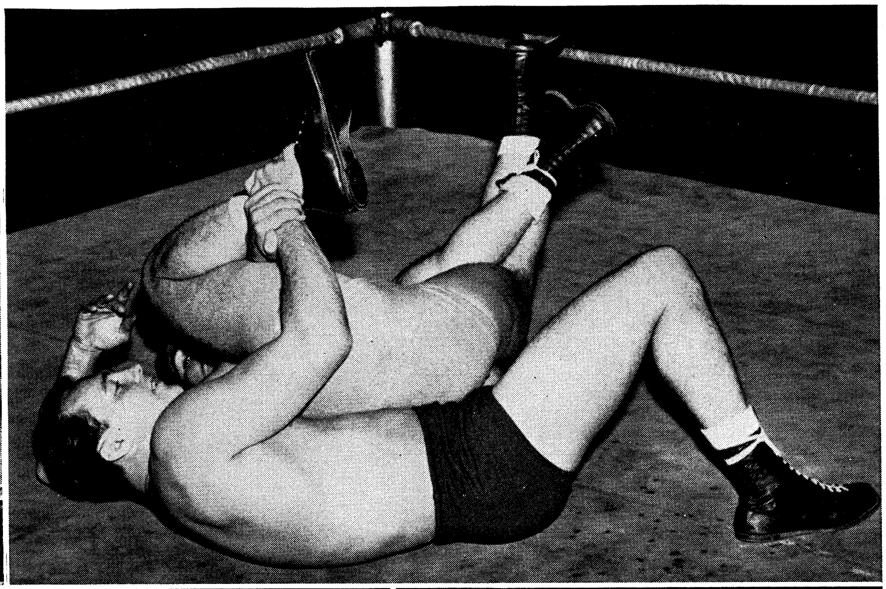
Cumberland Style.—This style prevails chiefly in the north of England (except south Lancashire) and in the south of Scotland. In this the wrestlers stand chest to chest, each grasping the other with locked hands around the body. each one's chin on the other's right shoulder. The right arm is below and the left above the adversary's. When the hold has been firmly taken the umpire gives the word and the bout proceeds until one man touches the ground with any part of his person except his feet, or he fails to retain his hold, in either of which cases he loses. If both fall together, the one who is underneath, or first touches the ground, loses. If both fall simultaneously side by side, it is a dogfall, and the bout begins anew. The different maneuvers used to throw the adversary are called chips, the most important being the backheel, in which a wrestler gets a heel behind his opponent's opposite heel, from the outside, and forces him over backward; the outside stroke. in which, after a sudden twist of his body to one side. the opponent is struck with the edge of the opposite foot on the outside of the ankle; the hank, or locking a leg and lifting the opponent with a sudden turn to the right. so that both fall together. but with the opponent underneath; the inside click, the locking ot an opposite leg applied after jerking the opponent forward, the pressure then being straight back; the outside click: a backheel applied by the defender as he is on the point of being lifted from the ground—it prevents this and often results in oversetting the opponent; the cross-buttock, executed by turning the left hip under the opponent's body, throwing the leg across both his and striking backward, while partially lifting and throwing him forward; the buttock, in which the hip is thrust still farther under the opponent. who by the action of the arms is thrown right over one's back; the hipe or hype. executed by lifting the opponent off his feet, and while carrying him to the right or left, placing the opposite knee under one of his legs and raising it as high as possible before throwing him sideways to the ground; the swinging hype. in which the opponent is lifted and swung nearly or quite round before the knee stroke is made; and the breast stroke. which is a sudden powerful twist, first to one side, then the other, followed by a throw. There is but a single foul—direct kicking.

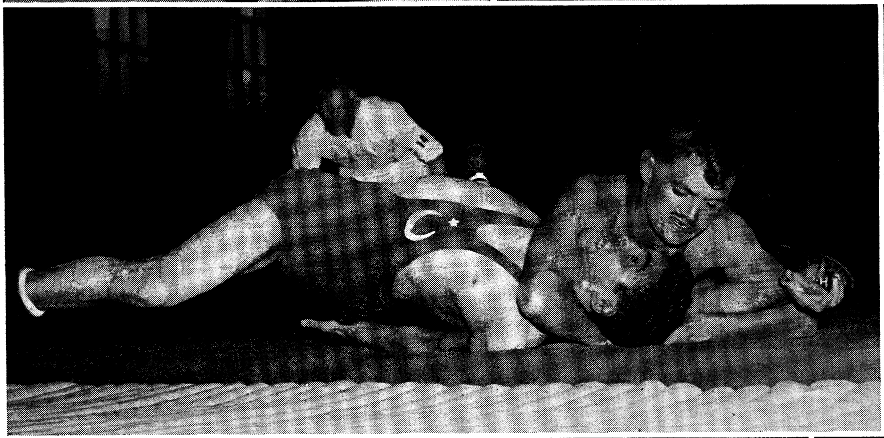
West Country Style.—In the Cornwall and Devon or west country style the wrestlers wear stout, loose canvas jackets. the hold being anywhere above the waist or by any part of the jacket. though any manipulation of the jacket collar to strangle an opponent is forbidden. A fall is gained when both hips and a shoulder or both shoulders and a hip (three points) touch the ground simultaneously. A throw that does not secure a fall is a hitch. Ground wrestling is forbidden. and a man, when he feels himself falling. will try to turn and land on his side or chest. Many of the chips used by Cumberland and Westmorland wrestlers are possible in this style, with slight differences of execution required by the different method of taking hold and under other names—forehip (cross-buttock); inside lock (hank), etc. More distinctive throws are the heave. and the flying mare: a chip of universal use in which the opponent's wrist is grasped mith the opposite hand. the upper part of the same arm by the other hand, the back turned and the captured limb drawn across a shoulder, over which the opponent is vigorously shot forward. Until comparatively recently there was a difference between the styles of Cornwall and Devon, the wrestlers of the latter county having worn heavily soled shoes, with which it was legitimate to kick the adversary's shins.

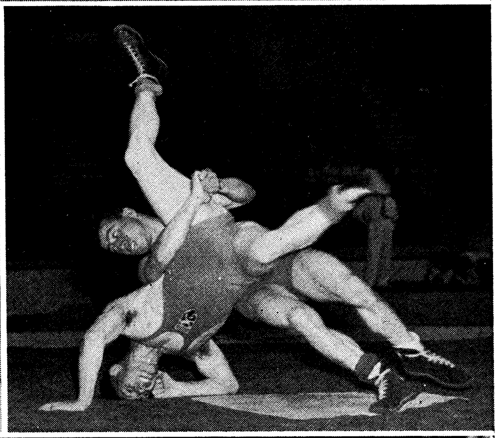
Catch-as-catch-can.—The Lancashire style. generally known as catch-as-catch-can. is practised in Lancashire, throughout Great Britain generally, and is the most popular style in the United States. Canada, Australia. Switzerland and some other countries. It is the legitimate descendant of the ancient Greek upright wrestling combined mith ground struggling. but minus the all-in freedom the Greeks permitted, and undoubtedly is representative of the wrestling of the middle ages. It allows a great amount of action, which includes struggling on the mat, tripping, catching hold of legs and similar tactics. At the beginning of a wrestling match the two opponents face each other, and at the signal to begin each tries to. secure a hold that will enable him to throw his opponent to the mat in an advantageous position.

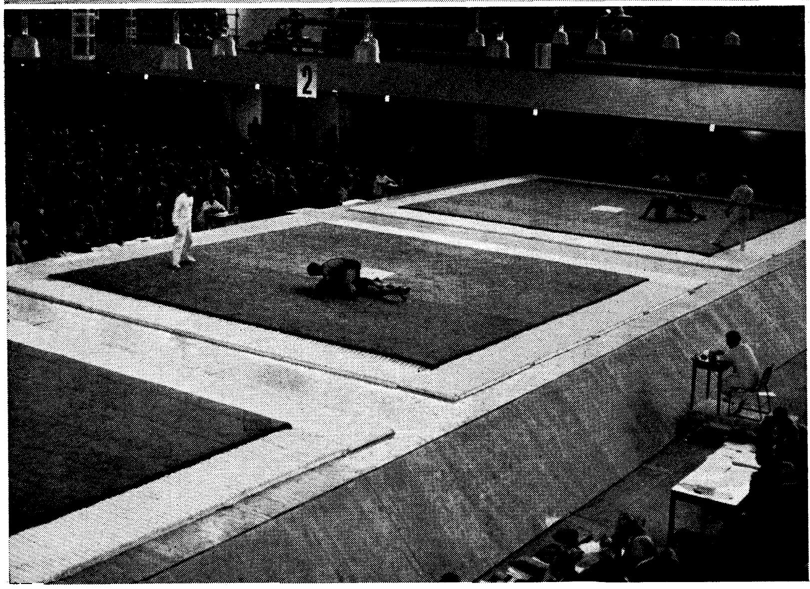
A fall is gained when both shoulders of one wrestler touch the ground together, and very seldom are falls registered from standing throws. This necessitates most contests being completed while struggling on the mat. Much of this down wrestling is admittedly very skillful. No kicking, striking or other foul practices are permitted. Strangle holds or others designed to cut off an opponent's breathing and grips or forms of attack causing acute pain or in-

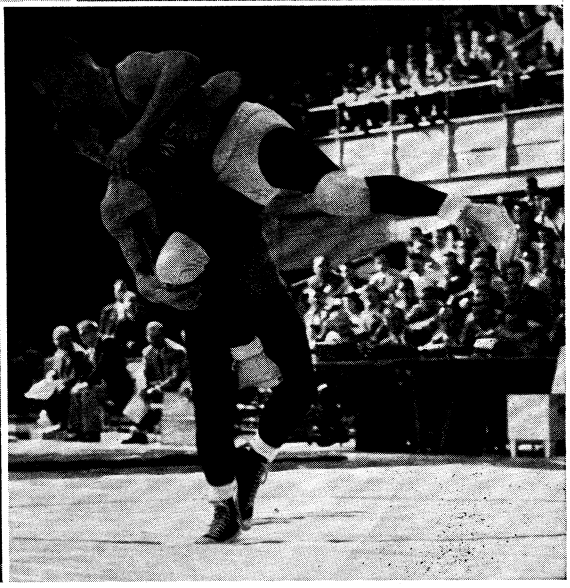












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PROFESSIONAL AND AMATEUR WRESTLING

Top left: Professional heavyweight Billy "Whipper" Watson applying finishing hold on Lou Thesz

Top right: Professional Verne Gagne demonstrating a leg-split

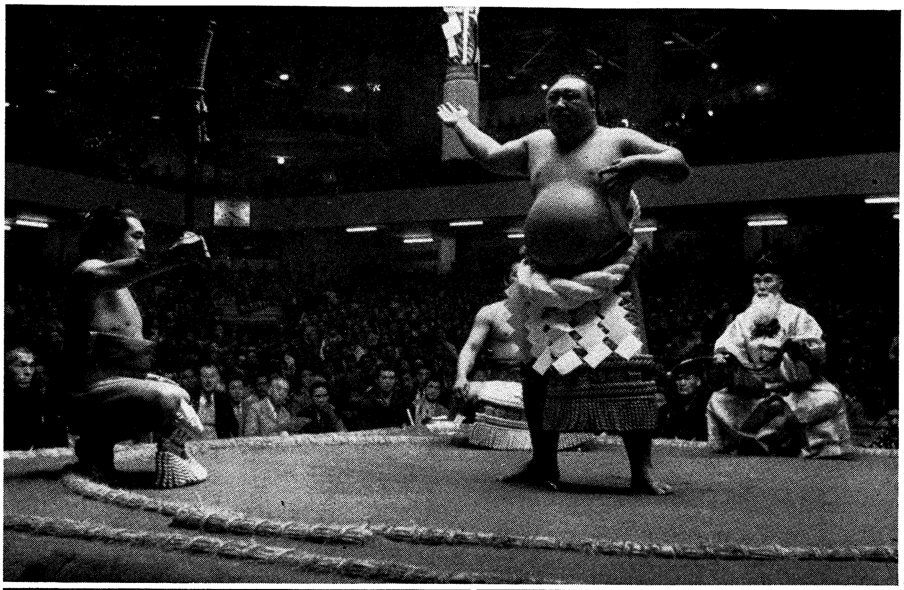
Centre left: Greco-Roman match at a European amateur championship match

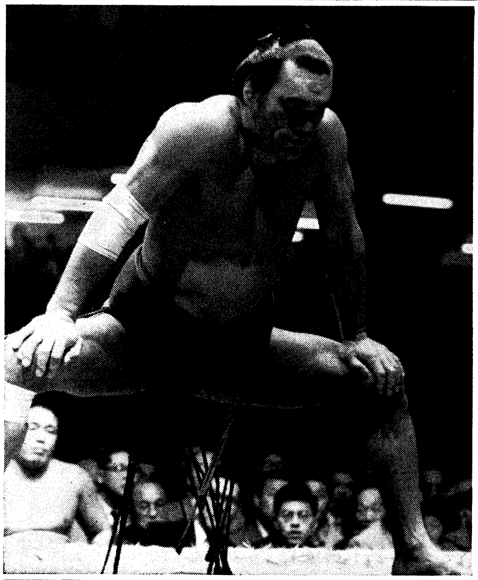
Centre right: Free-style match during an Olympic contest

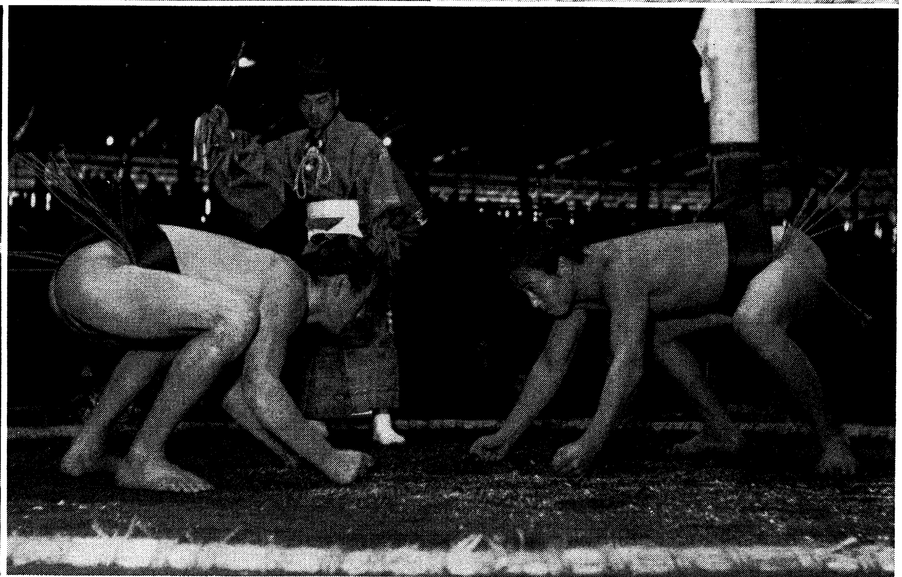
Bottom left: Olympic championship matches being held on pyramidal platform

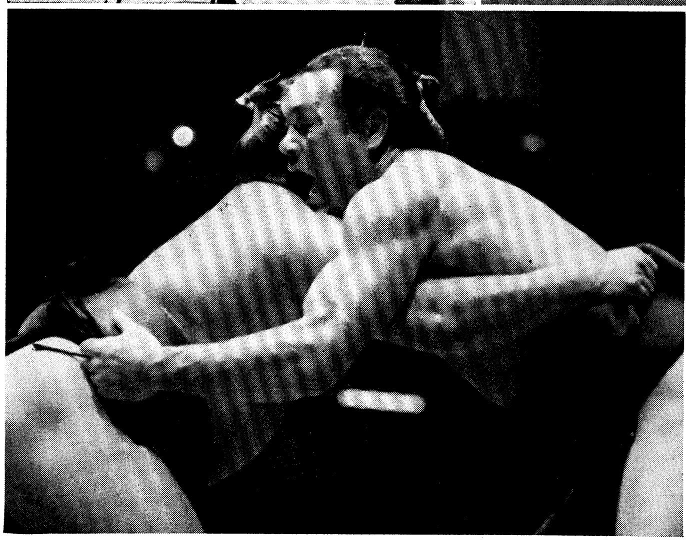
Bottom right: Action during a collegiate "catch-as-catch-can" contest

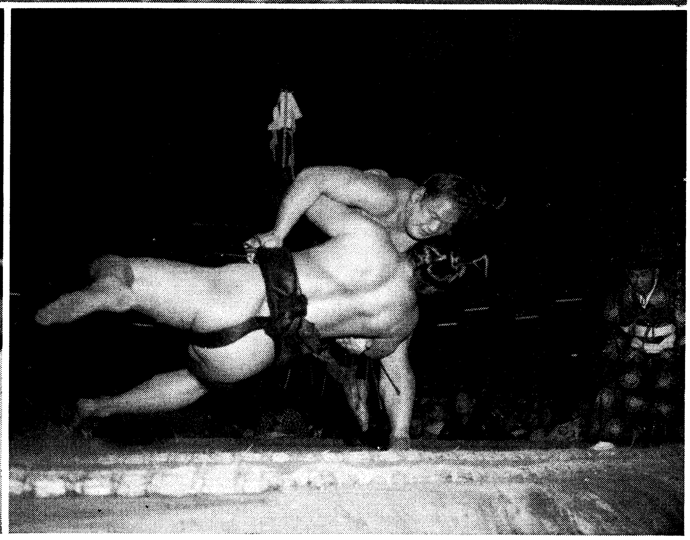
WRESTLING











BY COURTESY OF (TOP LEFT, TOP RIGHT, CENTRE LEFT, BOTTOM LEFT, BOTTOM RIGHT) "PRESS MAINICHI"; PHOTOGRAPH, (CENTRE RIGHT) EAST-WEST

THE JAPANESE SUMO, ANCIENT FORM OF WRESTLING

Top left: A champion wrestler in richly decorated apron during the intermission ceremony of the Sumo

Top right: The sprinkling of salt, a symbol of purification, is part of the traditional formalities before a match

Centre left: Stance of a wrestler before a match begins. Champions are generally about 6 ft. tall and weigh 350 lb.

Centre right: Wrestlers, with fists touching the platform, watching for their first chance to attack. Both contestants must rise for a match at the same moment

Bottom left: The initial hold. The method of wrestling is similar to the modern catch-as-catch-can style

Bottom right: The referee watches closely as a champion throws his rival. A contestant wins a match when he forces his opponent out of the ring, or causes him to touch the ground with any part of his body, except the soles of his feet tended to force the defender to roll on his shoulders to avoid injury by dislocation or fracture are considered illegal holds. The style contains practically all the maneuvers known to other methods with many peculiar to itself; and because of its freedom and opportunity for the display of strategy. skill and strength is, when upstanding wrestling and tripping — the very essence of wrestling — are not neglected. the most preferable.

In Scotland a combination of the Cumberland and Westmorland and catch-as-catch-can style is sometimes practised. In Ireland, the national style is called collar and elbow.

Graeco-Roman Style. — The style chiefly affected by the continental European wrestlers is the Graeco-Roman (so-called. though it bears almost no resemblance to classic wrestling), which arose about 1860. and is a product of the French wrestling schools. It is a very restricted style. neither tripping nor any hold below the hips being allowed. the result being that the bouts consist chiefly of ground struggling. When no time limit is enforced. contests are usually tediously long. British and American wrestlers, accustomed to their own freer styles. seldom compete under Graeco-Roman rules. In Olympic competition the Scandinavian countries won a large number of championships. Sweden was the foremost of these, with strong showings in the games from 1912 to 1948. In the 1950s the Russian team won points in every division. capturing the unofficial team title. For individual records, see OLYMPIC GAMES.

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UNITED STATES

Amateur wrestling in the U.S. antedates the professional sport, although records show that professional wrestling was popular between 1870 and 1880. William Muldoon, the first world's professional champion. was followed after 1900 by Farmer Burns. Tom Jenkins and Frank Gotch. who defended his title against all comers for many years and retired undefeated. Ben F. Roller of Seattle held the world's title from 1913 to 191j when he was defeated by Ed ("Strangler") Lewis. who was finally beaten by Wayne Munn (192j) in Kansas City. During the 1920s interest in professional wrestling was at its peak. Besides Lewis and Munn (top contenders) were Earl Caddock. Stanislaus Zbyszko and Joe Stecher. Lewis regained the crown in St. Louis (1928'1 by defeating Joe Stecher who had previously taken the title from Munn. In Jan. 1929 Gus Sonnenberg. Dartmouth college football star, won a world's championship match in Boston by defeating Lewis, to become the last undisputed titleholder. Professional wrestling by the late 1950s was largely a mixture of showmanship and acrobatics, although its scientific side mas well known to such television practitioners as "Whipper Billy" Watson, Lou Thesz. Antonio Rocca. Verne Gagne. Wladek Kowalski and Edouard Carpentier.

Amateur wrestling during the early colonial days was influenced by various forms predominant in England. The free style used widely in the U.S. was an outgrowth of the Lancashire style. The adaptability of wrestling to the rugged life of the period is reflected in much of the frontier literature. Abraham Lincoln became a well-known competitor by defeating Jack Armstrong, champion of Sangamon county. Ill. The American free style developed gradually, largely as a feature of country fairs and carnivals.

Amateur wrestling is regulated by the Amateur Athletic union. The A.A.U. has principal jurisdiction over wrestling conducted in athletic clubs and Y.M.C.A.'s, but the sport has received its greatest impetus in colleges and high schools.

As far back as 1780 wrestling was a popular intramural sport at Harvard. but the first real effort to promote it on an intercollegiate basis did not come until 1904, when the Eastern Intercollegiate Wrestling association was formed. A tournament was held in 190j and Tale won the first team championship. competing against Columbia, Pennsylvania and Princeton. The E.I.W.A. expanded to 16 competing members, the largest and oldest conference of its kind in the country.

At the national A.A.U. championships held in 1927 it was noted that 103 of 135 participants were college wrestlers, so it was decided that a national collegiate tournament was in order. The National Rules committee of the N.C.A.A. sponsored the first collegiate tourney at Xmes. Ia.. in 1928. Oklahoma A. and M. college (now Oklahoma State university) won the team title and dominated the college scene thereafter. Edward Clark Gallagher (1887–1940) was largely responsible for the amazing success of the Aggies. his teams winning 70 consecutive dual meets and 11 of 13 national titles from 1921 to 1932.

There are major differencesbetween A.A.U. and collegiate rules. The A.A.U. uses international rules in which strength is the important factor. College rules favour speed and maneuverability. The essence of college wrestling is control, and while a wrestler is on top he is scoring points. The man underneath must get out of his predicament and can score points for escaping or reversing the position of advantage. In both systems a fall terminates the bout. In A.A.U. rules a fall is declared when both shoulders touch the mat simultaneously, but in college rules a fall occurs only when both shoulders are held to the mat for a two-second count. (C. M. SL.)

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WREXHAM (Welsh GWRECSAM, in the Anglo-Saxon Chronicle WRIGHTESHAM), a market town and municipal borough in the Wrexham parliamentary division of Denbighshire, Wales, 12 mi S.W. of Chester by road. Pop. (1961) 35,427. Area 4 6 sq.mi. It was given (with Bromfield and Yale, or Iâl) by Edward I to Earl Warenne St Giles's church was finished in 1472, replacing the church destroyed by fire in 1457 The paneled tower bears the date 1506: the interior is Decorated. West of the toner is the tomb of Elihu Yale (1721) first donor of Yale university whose father emigrated to America from the ancestral home of Plas-yn-Iâl, near Corwen. 21 mi from Wrexham. The Wrexham tower in the memorial quadrangle at Yale is a copy of the church tower. Wrexham is the seat of the Roman Catholic bishop of Menevia, whose diocese includes all Wales except Glamorganshire The town grew with the development of the north Wales coal field in the 19th century and after World War II a trading estate with about 30 different industries, including rayon and chemicals. was created Wrexham was incorporated in 1857.

WRIGHT, SIR ALMROTH EDWARD (1861–1947), British bacteriologist, whose most valuable work was that on bacterial infection and in measuring the protective matter of human blood. was born at Rliddleton Tyas. Yorkshire, on Aug. 10. 1861. Educated at Dublin university, he later obtained his scientific and medical training at the universities of Leipzig, Strasbourg and Marburg. He became a demonstrator of pathology at Cambridge (1887), a lecturer in physiology at Sydney (1889). was professor at the army medical school at Netley (1892–1902) and professor of experimental pathology in the University of London (1902–47). He was knighted and elected fellow of the Royal society in 1906.

Wright's work included research in parasitic diseases. He introduced antityphoid inoculation and did much work on the preparing of other vaccines and toxins. In 1918 he was created knight of the British empire. He received the gold medal of the Royal Society of Medicine in 1920. .Among his numerous scientific publications are *Studies in Immunisation* (1909) and *Pathology and Treatment of War Wounds* (1942). He died on April 30, 1947.

WRIGHT, BENJAMIN (1770–1842), chief engineer for the construction of the Erie canal, was born Oct. 10, 1770, in Wethersfield. Conn. As a youth he studied surveying, and after his family moved to the vicinity of Rome, N.Y. in 1789, Wright surveyed aboht 500,000 ac. of land for farmers who were settling the land. Because of his wide acquaintanceship and high standing in the community, Wright was elected county judge in 1813 and to several terms in the state legislature.

In 1811, Wright was hired by the New York state canal commission to propose a route between Rome and Waterford for what was to become known as the Erie canal. Construction of the canal was started in 1817 and completed in 1825, with Wright directing work on the middle and eastern divisions. Because Wright trained many young engineers on the project, he has been called the "father of American engineering."

Wright resigned from the Erie canal project in 1827 and served as chief engineer of the Chesapeake & Ohio canal in 1828–31 and the St. Lawrence canal in 1833. During his career he also was consulting engineer to the Welland. Chesapeake & Delaware. Delaware & Hudson and other canals in Connecticut and Rhode Island. He also made land surveys for railroads in New York, Illinois: Virginia and Cuba.

He died in New York city on Aug. 24, 1842. (W. E. HD.)

WRIGHT, CARROLL DAVIDSON (1840–19091, U.S. statistician whose principal efforts were devoted to the development and improvement of labour statistics was born at Dunbarton, N.H., July 25, 1840, and was educated in the public schools. During the Civil War he served in the Union army; after the war he was admitted to the bar and practised law in Massachusetts for several years. In 1873 he was appointed chief of the Massachusetts bureau of statistics of labour and in 1885 he became the first U.S. commissioner of labour, in which capacity he served until 1905. He was responsible for many early inquiries into economic conditions affecting labour and was an advocate of the principle of collective bargaining and of various then new systems of wage determination. He became president of Clark college in Worcester, Mass., in 1902, serving additionally as professor of statistics and social economics from 1904 until his death there, on Feb. 20, 1909. (FK. L. K.)

WRIGHT, FRANK LLOYD (1869–1959), U.S. architect who became world famous as creator and expounder of "organic architecture." his phrase indicating buildings that harmonize with users and environment. Though a sharp critic of society, Wright won probably more official honours at home and abroad and erected more structures than any other individual architect of his time.

Wright was born June 8. 1869. in Richland Center, Wis. After nearly completing a course in civil engineering at the University of Wisconsin. Madison. he went to Chicago. where he worked under Louis Sullivan from 1888 to 1893. In 1893 he began independent practice. Shunning the artificial revivals then dominant in architecture. he evolved unorthodox forms suited to modern living and to new structural methods and materials. Unlike other leading modernists of the 20th century he retained throughout his career the use of ornamental detail. earthy colours and rich textures. Wright's sensitive use of materials helped to perfect and control his dynamic expression of space. which he called "the reality of the building." His command of space, opening a new area to architectural advance, was probably his greatest achievement.

By 1900 his "prairie style" house was a recognized accomplishment. A Wright residence of those years (*e.g.*, the Coonley house, Riverside, Ill., 1908) showed a wide, low roof over continuous window bands that turned corners, defying conventional boxy structure; main rooms flowed together in uninterrupted space that was, in effect. continued outside. This simple but hard-won form eventually became the basis of 20th-century residential design.

Wright also pioneered in commercial architecture. In 1904 at Buffalo, N.Y., he built for the Larkin company the first mechanically ventilated, steel-furnished office building (demolished 1950). In 1912 he projected the first "slab" skyscraper. a narrow block ,(see the RCA building in New York); and in 1920–24 the lightweight wall of glass and metal later to become common on tall buildings.

In 1929 Wright designed floors cantilevered from a tall central mast. later used in his Johnson laboratory tower (1949), Racine, Wis., and his Price tower (1956), Bartlesville. Okla.

In 1915 the imperial household of Japan invited Wright to build the great Imperial hotel at Tokyo (1916–22); due to its revolutionary, floating cantilever construction, it was the only large building that offered safety in the violent earthquake of 1923. In California. Wright developed a closed, cubical architecture and an inexpensive technique oi reinforced concrete blocks, both being well adapted to the region (*e.g.*, the Millard house. Pasadena, 1923)

The next decade of Wright's career included financial difficulties intensified by the depression of the 1930s and grandiose architectural projects containing the seeds of many of his later accomplishments. These included the dispersal of the roaf plane, executed at the Johnson administration building, Racine (1936–39); triangularly moduled. asymmetric plans, seen in the Hanna house. Palo Alto, Calif. (1937); the spiral, spatial continuity of the Guggenheim museum, New York (1943); and symmetrical, angular forms, 1926 (Beth Sholem synagogue. Philadelphia, 1955).

Wright wrote his lively Autobiography (1932; rev. 1943), initiated a training program for architectural apprentices and developed his ideal regional plan, Broadacre city in the 1930s.

His period of greatest fulfillment began in 1936 and included, besides the six works already mentioned, his most famous residence, Fallingwater, Bear Run. Pa. (1936) ; his own winter quarters and workshop. Taliesin West, near Phoenix, Ariz. (1938) ; Florida Southern college, Lakeland (1938) ; and the First Unitarian church. Madison (1952).

Wright's other books include *An* Organic Architecture (1939); An *American* Architecture (1955); and A Testament (1957).

He died in Phoenix on April 9, 1959.

See also Henry-Russell Hitchcock, In the Nature *of* Materials: *the* Buildings of Frank Lloyd Wright (1942), with illustrations. (ER. K.)

WRIGHT, JOSEPH (1855–1930) English comparative philologist, whose great achievement was the six-volume English Dialect Dictionary, was born on Oct. 31, 1855 at the Yorkshire village of Thackley. From the age of 7 until he was 21 he worked at a woolen factory. He attended evening classes at the Mechanics' institute at Bradford and went to Heidelberg to learn German. After 1876. he taught school in Bradford for three years and studied at the Yorkshire College of Science, forerunner of the present Cniversity of Leeds. In 1877 he matriculated, as an external student. at the University of London; and in 1882 at Heidelberg (Ph.D. 1885). supporting himself by teaching and writing or translating textbooks for students of modern European languages.

From 1887 to 1924 he was at Oxford, at first as a teacher of English and German to women students, and after 1901 as professor of comparative philology. He wrote numerous historical grammars, in part in collaboration with his wife, Elizabeth Mary Lea. whom he married in 1896.

Wright died at Oxford on Feb. 27, 1930.

See the Life of Joseph Wright by Elizabeth M. Wright, 2 vol. (1932) ; an appreciation by J. Whatmough, *Word* Study, xxix, no. 2, pp. 1–4 (Dec. 1953). (J. WH.)

WRIGHT, ORVILLE (1871–1948), U.S. inventor, was born at Dayton, O., on Aug. 19, 1871. He early became associated with his brother: Wilbur (*q.v.*), in the bicycle repair business, and from the first shared his interest in mechanical flight. Shop experiments led to the development of a power-driven heavier-than-air machine which was piloted by Orville Wright on its first successful flight made on Dec. 17, 1903, at Kitty Hawk, N.C. Further experiments led to the development of an airplane which established a new record on Sept. 12, 1908, by remaining in the air 1 hr. 15 min. An accident on Sept. 17 terminated his experiments for that year, but on July 27 and 30, 1909, his demonstrations at Fort Myer, Va., satisfied the tests and secured the acceptance of his machine by the U.S. government. Numerous demonstrations made in Europe during 1908 and 1909 caused many honours to be bestowed on the two brothers. Orville Wright spent much of the rest of his life in research. Wright died on Jan. 30. 1948, at Dayton. See also WRIGHT. WILBUR.

WRIGHT, PATIENCE LOVELL (1725–1786), U.S. wax modeler and Revolutionary War spy, was born in Bordentown, N.J.. in 1725. In 1748 she married Joseph Wright, and at his death in 1769 she opened a waxworks museum in New York city. In 1772 she took her waxworks to London. where she acted as a secret agent for the Americans during the Revolution. She died in London on March 23. 1786. Her son Joseph Wright (1756–93) became a portrait painter, wax modeler and engraver. (A. T. G.)

WRIGHT, SILAS (1795–1847), U.S. senator and state governor, was born at Amherst, Mass., on May 24, 1795. He graduated from Middlebury college, Vermont, in 1815 and was admitted to the bar in 1819. He was a member of the national house of representatives in 1827–29, U.S. senator in 1833–44 and governor of New York in 1844–46.

During his public life Wright became a leader of the Democratic party in New York, Martin Van Buren being his closest associate. He was an influential member of the so-called "Albany regency." a group of Democrats in New York who for many years virtually controlled their party within the state. When Van Buren was elected president in 1836, Wright became his chief lieutenant in the senate. After serving one term as governor of New York state he was renominated, but did not gain re-election in 1846; he then retired to private life. He died at Canton, N.Y., on Aug. 27, 1847. *See* also NEW YORK (STATE): *History.*

The best biography is that by J. D. Hammond, *Life and Times of Silas Wright* (1848), which was republished as vol. iii of that author's *Political History of New York.*

WRIGHT, WILBUR (1867–1912), U.S. inventor, was born near Millville, Ind., on April 16, 1867. In 1890 he joined his brother Orville in publishing a weekly newspaper.

Experiments in Gliding.—Reading of the experiments of Otto Lilienthal in Germany, Wilbur and his brother became intensely interested in gliding as a sport. Lilienthal had balanced his machine by shifting the weight of his body. The brothers, believing this method incapable of expansion to meet the requirements of flight. developed a system in which the centre of gravity remained constant and the equilibrium was maintained by varying the air pressures on different parts of the machine through adjustments of the angles of the wings and auxiliary surfaces. This system. patented by them. is now generally known as aileron control. Having found in their experiments that the existing scientific data was almost altogether untrustworthy, they began investigations of their own. In 1901 they set up a small wind tunnel in their workshop at Dayton, O., in which they experimented with the aerodynamic properties of various airfoils.

The First Motor-driven Airplane.—With these data in their possession they began the design of a motor-driven airplane in Oct. 1902. Tested at Kitty Hawk, N.C., on Dec. 17, 1903, the machine, carrying a man, made four sustained free flights. This machine was exhibited in the Science museum at South Kensington, London, for 20 years. On Dec. 17, 1948, the 45th anniversary of its flight, the plane was formally installed in the Smithsonian Institution in Washington, D.C.

Experiments were continued and on Oct. 5, 1905, Wilbur Wright flew for 38 minutes over a small circular course covering a distance of 24 mi. Believing the machine now to be developed to a stage of practical usefulness, the Wrights spent several years in finding a market for the invention. Wilbur Wright went to Europe in 1908 to make the tests required in the sale of the French rights to a syndicate. While there, his flights at Le Mans and Pau, France, and at Rome attracted world-wide attention. In recognition of his pioneer work he received many honours and medals in European countries and in America.

During the last three years of his life he served as president of the Wright company. Much of this time he devoted to upholding the Wright airplane patents. He died of typhoid fever at Dayton on May 30, 1912. (O. W.; X.)

WRIGLEY, WILLIAM, JR. (1861–1932), U.S. chewing gum manufacturer, was born in Philadelphia, Pa., Sept. 30. 1861. He began work in his father's soap factory at an early age and traveled as a soap salesman. In 1891 he went to Chicago and entered the soap business with $5,000 borrowed from an uncle. His firm, later to become the William Wrigley. Jr., Co., transferred to the manufacture of chewing gum and by 1908 had become the world's leading producer of that product. R'rigley was the owner of several baseball clubs, including the Chicago Cubs of the National league, and he purchased and developed Santa Catalina Island (off California) as a resort. He died Jan. 26, 1932 at his winter home near Phoenix, Ariz. (H. J. SG.)

WRIST, in anatomy, the carpus or carpal articulation in man, the joint by which the hand is articulated with the forearm. *See* JOINTS AND LIGAMENTS; SKELETON, VERTEBRATE: *Appendicular Skeleton.*

WRIT, in law, is a species of formal order from the Crown or a delegated officer to an inferior officer or to a private person. enjoining some act or omission. The word represents the Latin *brevis* or *breve* (sometimes Englished into "brief" in the older authorities), so called from its "shortly" expressing the intention of the framer *(quia breviter et paucis verbis intentionem proferentis exponit).*

History.—The writ in English law still occupies a very important position, which can scarcely be understood without a sketch of its history. The whole theory of pleading depended in the last resort upon the writ, the plaintiff's claim simply expanding its terms.

The *breve* can be traced back as far as Paulus (about A.D 220), who wrote a work *Ad edictum de brevibus,* cited in the Vatican Fragments, § 310. In the *Corpus iuris* the word generally means a note-book or list. The *interdictum* of Roman law sometimes represents the writ of English law; *e.g.,* there is considerable likeness between the Roman *interdictum de libero homine exhibendo* and the English writs of *habeas corpus* and *de homine replegiando.* From Roman lam the *breve* passed into the *Liber feudorum* and the canon law, in both in a sense differing from that at present borne by the writ of English law. The *breve testatum* of the *Liber jeudorum* was an instrument in writing evidencing the transfer of land.

The *breve testatum* in England developed into the deed of grant; in Scotland into the charter, and later into the disposition. In canon law *breve* or *brevilegium* denoted a letter from the pope, sealed with the seal of the fisherman and less formal than a bull. In old English ecclesiastical law a brief—still named in one of the rubrics of the Book of Common Prayer—meant letters patent to church-wardens or other officers for the collection of alms. (For counsel's brief *see* BRIEF.)

The origin of the writ is disputed, but its development was clearly influenced by both Anglo-Saxon and Norman law before the Conquest. The Anglo-Saxon contribution appears in the shape of diffuse royal charters, which were used to express the king's commands or wishes. Next, the form of these charters was infected by royal letters employed primarily for the publication of new laws, which were communicated by such letters to the shire-moots and, presumably, to the hundred-moots and important persons. These documents, cross-bred between charter and writ, show progress, but fall far short of the pure writ, which was concise, secular, practical and implicit with power. Writ-charters similar to those in England existed in Normandy before the Conquest. After that event, the chancery, or royal office which in England framed the king's orders, had some counterpart in Normandy, which did the like. The exact stages by which the writ disembarrassed itself of the charter element are not certain, but at any rate the process was a rapid one. The distinction between the two is known to have existed as early as 1071. The growth of a more robust Central Government hastened the separation, and in Glanvill's book (1187–89) not only are many writs included, but the idea has become so common that the author does not take the trouble to explain it. The writ, as thus developed, was of supreme importance in the growth of law and government. From the latter part of the 13th century to the early 18th century, if a man had no legal remedy he had no legal right. Without a writ he could not, in general, begin an action, and if there were no writ that covered his complaint he had no remedy. Nor was the writ confined to the initiation of litigation. It was also a machine for hosts of executive acts which never passed to the law courts at all. The chancery from which writs were issued was styled *officina brevium,* or "writ-shop." Writs had to be paid for, though occasionally poor men might get them free. Nor did Magna Carta c. 40, make any difference in this respect, except to forbid prohibitive charges for writs in common form ("de cursu," or "of course"). At first new writs could be used freely, but in the Provisions of Oxford, 1258, the chancellor swore that he would seal no writs except those "of course" without the command of the king and his council; and the statute of Westminster II, 1285, while it recognized the power of the chancery clerks to make writs for cases similar *(in consimili casu)* to those already covered by existing writs, impliedly forbade them to create new writs, that being the province of parliament. But this statute did not seriously hamper the chancery, for the clerks showed great dexterity in varying existing writs to meet new circumstances.

Collections of writs were made at an early period. They were entitled *Registra Brevium,* and the oldest one extant is dated 1227. These collections were unofficial, though of course the writs embodied in them originated in the chancery. For three centuries *Registrum Brevium* continuously multiplied in copies and swelled in bulk. The mss. of it are at present beyond computation. Their number and increasing length testify to the industry of the chancery and to the striking import of the writ as one of the modes of keeping law and government reasonably abreast of the needs of the community. *Registrum Brevium* was first printed in 1531. After that it practically ceased to grow, for it was being outgrown by the law itself, which needed something more elastic.

The chief reason why the writ fell into the background as an agency in the growth of our law is that the centre of gravity in legal procedure shifted from the writ to the plaintiff's written "declaration," which specified the details of his claim. It was this rather than the writ which came to determine the form of action. The correct form of action was vital to success in litigation. If the plaintiff chose the urong one, he was, in general, without a remedy. True, a selection of the wrong writ was, even till the 19th century, equally disastrous, but then, in most cases, it had ceased to be compulsory on a plaintiff to begin his action by an original writ, though its existence was always assumed. There were many other ways in which litigation could be begun, and there is reason to think that they were usually preferred to the original writ, which was neither cheap nor convenient. The transference of energy from the writ to the declaration was a gradual process. So long as the pleadings in an action were oral, the writ must of necessity have attracted to itself all the weight which the written word carries as against the spoken word. But by degrees litigants adopted the practice of exchanging written pleadings. This was well recognized in the 16th and 17th centuries, though the seeds of it are traceable some time before. The multiplicity of writs and of other devices for commencing a common law action was remedied with respect to personal actions by the Uniformity of Process in Personal Actions Act, 1832 (2 Will IV. c. 39), which substituted for these methods a simple, uniiorm, writ of summons. Further amendments were made in 1833, by 3 and 4 Will. IV. c. 27, s. 36, which abolished writs in real actions with the exception of those relating to dower, *quare impedit,* and ejectment, and by 3 and 4 Will. IV. c. 42, in connection with the writs of debt and of detinue. The Common Law Procedure Act, 1852, s. 3, dispensed with the need of mentioning any form of action in the writ on a personal action, and the Judicature Acts, 1873–75, contain the complete remodelling of procedure under which English civil law is administered in the Supreme Court of Judicature. The Rules of the Supreme Court, 1883, made in pursuance of this legislation, now require every action in the High Court to be commenced by a writ of summons, indorsed with a statement of the nature of the claim made, or of the relief or remedy required in the action. The writ, therefore, nowadays differs considerably in form from its ancient predecessor. And an equally striking distinction is to be found in its much narrower scope as compared with the writs of *Registrunt Brevium.* They dealt with almost every conceivable matter of executive government as well as with legal procedure. But now the province of writs has shrunk to the institution of litigation except in the realm of constitutional law, where writs still issue for the election of members to the House of Commons and for the attendance of individual members in the House of Lords. Elsewhere, more convenient methods of expressing the will of the executive have ousted the writ; such are Orders in Council, Royal Proclamations, Letters Patent, and regulations made by various Government departments.

The writ, though issuing from the king's chancery, did not, where it was concerned with litigation, necessarily direct the trial of the question in the king's court. In whatever court it was returnable, it frequently called in the aid of the sheriff as executive officer. In such cases, it was either addressed to him or, if addressed to the party alleged to be in default, it concluded with a threat of constraint by the sheriff in the event of disobedience, generally in these terms, *et, nisi feceris, vicecomes de N. faciat ne amplius clamorem audiamus pro defectu iustitiae.* If the writ was returnable in the county court or the lord's court, the sheriff or the lord sat as the deputy of the king; he did not sit by virtue of his own inherent jurisdiction. The writ was not necessary for the initiation of proceedings there or before the justices in eyre.

There are several divisions of writs (excluding those purely financial and political), the most important being that into original and judicial, the former (tested in the name of the king) issued to bring a suit before the proper court, the latter (tested in the name of a judge) issued during the progress of a suit or to enforce judgment. The nature of a third class, *magistralia,* is an unsolved puzzle. Bracton regarded them as writs which were capable of variation in order to meet the plaintiff's grievance; Coke considered them to be a variety of original writs which generated actions upon the case. Possibly the later writers attached more technicality to Bracton's expressions than they were meant to bear, and in any event the use of *magistralia* for purposes of classification was of little import by the time that *Registrum Brevium* was printed, for the primary division there is only twofold, original and judicial.

No ms. register known to the author of this article contains even this twofold division. Coke and other authorities rnention numerous other divisions, but those which have been named appear to be the principal, of writs.

Writs of Historical Interest.—A great number of the older writs are now obsolete. The details relating to them can be found in the printed *Registrum Brevium* and in Sir Anthony Fitzherbert's "New Natura Brevium," a work of the highest authority which ran into 18 editions, or reprints, between 1534 and 1794. Some of these ancient writs had such a great influence on the history of English law that they need brief descriptions here. The *prerogative writs* are treated in the paragraph on "Writs at the present day"; historically they had a large share in securing the administration of justice, and the personal freedom of the subject. In the domain of private law, the *writ of right (breve de recto)* was styled by Fitzherbert "the highest writ in law," and *Registra Brevium* invariably commence with it. It was employed for the recovery of real estate. The principle that no man need answer for his freehold without a royal writ was laid down in Henry II.'s reign. This compelled everyone who demanded freehold land from another person to obtain a writ, in effect the writ of right, if he were asserting title to the land. The insistence on the writ of right had political significance, for it furthered the centralization of justice. The procedure upon it became intolerably clumsy and tedious, and this led first to its disuse and finally to its abolition. No writ had wider effect than the *writ of trespass.* In origin, the word "trespass" covered nearly every wrongful act or default, whether it be what we should now call a crime or a tort. In that sense, it is traceable as early as John's reign, but the writ of trespass did not become a writ "of course" until the latter part of Henry III.'s reign, just after the conclusion of the Barons' war. Very likely it was one of the agencies in clearing up the litter of disorder left by civil strife. The action which the writ of trespass *vi et armis* originated was quasi-criminal. It was aimed at serious and forcible breaches of the king's peace. Though it was begun by the injured individual, it ended in the punishment of the defendant as well as in compensation to the plaintiff. It was more popular than the "appeal of felony" because the same precision in pleading was not required and the trial was not by the detested method of battle. Its scope was also wider, and damages were obtainable. Later, trespass developed on one side into misdemeanours (now one branch of criminal law) and on the other into the law of torts, or civil injuries. In the 14th and 15th centuries, statutes often fixed the action of trespass as an appropriate remedy for the offences created by them, because criminal "appeals" were falling into disuse, there was no organized police, the judges were often corrupt, except in the central courts, and were not always pure even there. The three chief kinds of the writ of trespass *vi et armis,* were for assault and battery, for injury to land *(quare clausum fregit),* and for taking away goods *(de bonis asportatis).* The writ could therefore be employed by any landholder for the recovery of damages done to his possession, but not, at first, for the recovery of possession itself. This extension was not recognized till the middle of the 15th century, and it resulted in the writ of trespass, *de ejectione firmae,* which appears first as a remedy enabling the termor, or lessee for years, to sue anyone who had ejected him, whether his lessor or another person, and then becomes the best remedy of the ejected freeholder. He borrowed this "action of ejectment" from the termor, because his own proprietary and possessory remedies had become so inadequate. A cloud of legal fictions veiled the borrowing, but in spite of the duration of some of these till the Common Law Procedure Act, 1852, the action of ejectment was greatly superior to the dilatory remedies which it thrust in the background. The law of torts, as it is now called, also owes a heavy debt historically to writs of *trespass upon the case,* which were adaptations of the writ of trespass made to meet special cases. The same object was achieved by means of the statute of Westminster II, 1285 *(supra),* for the clerks of the chancery were required by it to issue modified writs *in consimili casu.* It is not clear whether writs of trespass upon the case ought, as a matter of history, to be regarded as springing from this statute or as of independent origin. Certainly, in later law, the sources seem to be distinct. However that may be, trespass upon the case, or "case," was an excellent machine for redressing most civil injuries, nor have judges ceased to speak of "action on the case" even at the present day. Nor was its influence confined to the law of torts. The most notable offshoot of "case" was the variety of it styled *assumpsit,* which became the general form of action by which damages could be recovered for breach of a contract not made under seal. If one undertook (*assumpsit*) to do something and did it ill, he was liable. Gradually it was held that even if he did nothing, he was still liable. This was recognized very early in the 16th century, and the shaping of this action of *assumpsit* by the judges of this and the succeeding century resulted in the curious spectacle of an action upon contract modelled upon an action of pure tort.

Freedom from unwarrantable arrest or imprisonment of the person was secured by the writs *de odio et atia, de homine replegiando, de manucaptione* and *mainprise.* These have long been superseded by the more efficient writs of *habeas corpus,* though, it may be added, these latter also are themselves of very ancient origin.

Writs at the Present Day.—The vast majority of writs at the present day deal with the initiation, progress, or results of litigation; but purely administrative writs still exist, such as those for summoning representatives to parliament, or for assembling an ecclesiastical convocation. Writs are now issued from the central office of the Supreme Court, which was created by the Supreme Court of Judicature (Officers) Act, 1879, and thereby absorbed the Crown office of the Queen's Bench Division. The Crown office is an institution of the greatest antiquity. and the clerk of the Crown in Chancery has important duties relating to parliamentary writs, which are noticed below. Some writs require the Great Seal, *e.g.,* those for summoning new parliaments; writs of summons in actions are under the seal of the court, and are tested in the name of the lord chancellor, but writs issuing from the Crown office side are tested in the name of the lord chief justice of England. Instead of the Great Seal, the Crown Office Act, 1877, allows wafer great seals made on embossed paper, wax, wafer, or any other material, in accordance with rules drawn up by a committee of the Privy Council, to be attached to documents authorized by such rules to be thus validated. As to writs connected with litigation, the commonest type is the writ of summons which originates a civil action in the High Court of Justice. Indeed, it is now the only way in which such an action can be commenced. It is a formal document by which the king commands the defendant to "enter an appearance" within eight days, if he wishes to dispute the plaintiff's claim, and notifying him that, in default, judgment will be signed against him. It must be indorsed with a statement of the nature of the claim made. It may be issued either from the central office of the Supreme Court in London, or from one of the district registries which exist in many of the large provincial towns. Issue consists in taking two copies of the proposed writ to the writ department of the central office or to a district registry, signing one copy and paying 30s., whereupon the official impresses a 30s. stamp on the signed copy, files it, stamps the other with a "seal," and hands it back to the applicant. This then becomes the writ in the action. Technical defects in the writ are no longer fatal, for the plaintiff can amend them with the leave of the practice master in the King's Bench Division or of the chief clerk of the writ in the Chancery Division. Bracton's statement nearly 700 years ago, *non potest quis sine brevi agere,* is true of procedure in the High Court even now, but the great difference between the writs of his day and those of our own is the elasticity of claim which the latter allow. We are not limited to a certain number of actions, each with its appropriate writ, to be chosen rightly at the plaintiff's peril; the writ is always the same except for its indorsement, and, in effect, any claim which it is probable that the courts will enforce can be indorsed on it. If the plaintiff lose his case, it will be either because he has not evidence to support it, or because he fails to satisfy the requirements of the substantive law, and not because he has selected the wrong form of writ. After issue of the writ, it must be served on the defendant. This is done by showing him, or his solicitor, the original, and then leaving with either of them a correct copy of it. As a rule, the writ cannot be served on a Sunday. The entry of appearance by the defendant does not involve his personal presence. This, and all other proceedings on the writ, prior to the trial of the action, can be, and usually are, conducted on behalf of the parties by their respective solicitors. The officials who deal with these preliminary proceedings are the masters of the Supreme Court. No leave for the issue of the writ is necessary, unless the defendant be out of England, or the plaintiff seek to join on his writ causes of action for the joinder of which leave is required. Proceedings in the county court, in which most civil actions for claims of small amount are tried, are begun by the entry of a plaint, followed by a summons to the defendant.

Besides the writ commencing an action, there are others which facilitate it, or give effect to its result. Attendance of witnesses is secured by the writ of *subpoena.* Redress for conrempt of court may be effected by writ of *attachment.* The writs employed for the execution of judgment against an unsuccessful defendant are *fieri facias* against his goods, *elegit* against his lands, *possession* for the recovery of land adjudged to be the plaintiff's, and *delivery* or *attachment,* or *sequestration* for the recovery of any property other than land or money. The writ of attachment also applies where a judgment directs the performance of any specific act other than the payment of money, *e.g.,* the removal of a nuisance, or requires anyone to abstain from doing a thing; and the writ of sequestration also extends to cases in which a person wilfully disobeys an order or judgment which directs him to pay money into court or to do any other act within a limited time; the writ enables his property to be seized.

The *prerogative wits* deserve special notice both for their historical interest and their practical utility. They are extraordinary remedies issued upon cause shown in circumstances where the ordinary legal remedies are inapplicable or inadequate. The most important of those now in use are *certiorari, habeas corpus,, mandamus, procedendo,* and *prohibition.* They usually issue from the Crown office side of the central office of the Supreme Court, and, in general, they are not obtainable as a matter of course. Some probable cause must be shown why such extraordinary remedies should be invoked. A rule *nisi* is issued in the first instance by the court calling upon the party to whom the writ is addressed to show cause why he should not comply with the writ. If he shows sufficient cause, the rule is discharged, otherwise it is made absolute and the party must obey the writ. But in urgent cases, the rule may be made absolute from the first in some of the writs, *e.g., habeas corpus.* The writ of *certiorari* proceeds from a superior court and directs an inferior court, whether civil or criminal, to transmit to the superior court the record of proceedings pending before the inferior court, in order to ensure speedier and better justice to the applicant for the writ. Its object is to give relief against inconvenience arising from the likelihood that the lower court will not dispose of the case as effectually as will the superior. The procedure by this writ must be distinguished from appeals by dissatisfied litigants. These come after judgment, whereas *certiorari* generally deals with cases still pending and, even where it is used for the purpose of getting a conviction quashed, it does not enable the superior court to review the case on its merits, but to deal with some matter like lack of jurisdiction. There are several writs of *habeas corpus,* but the best known variety is the *habeas corpus ad subiiciendum,* which provides for the personal freedom of the subject. *(See* HABEAS CORPUS.) *Mandamus* directs a person, a corporation, or an inferior court of judicature, within the king's dominions, to do some particular thing which appertains to the office or duty of any of them. *(See* PRACTICE AND PROCEDURE.) The writ of *procedendo* is a possible sequel to *certiorari,* for it applies where the superior court considers it expedient or necessary to restore the record to the inferior court whose proceedings are in question. The writ commands the lower court to proceed with the case. The writ of *prohibition* forbids an ecclesiastical or inferior temporal court to continue proceedings therein in excess of its jurisdiction or in contravention of the laws of the land. *(See* PROHIBITION.) Another prerogative writ has taken the place of the writ *de excommunicato capiendo;* this is *de contumace capiendo* for compelling persons duly cited to appear in the ecclesiastical courts and for enforcing compliance with their orders and punishing contempts in the face of such courts. As to writs relating to the assembly of parliament, the king, on the advice of the Privy Council, issues a proclamation expressing the royal pleasure to call a new parliament and announcing an Order in Council to the lord chancellor to issue the necessary writs on the authority of the proclamation. In practice, the clerk of the Crown in Chancery does not receive direct authority from the chancellor for the issue of the writs, but regards the proclamation itself as sufficient for that purpose. Parliament must meet at any time not less than 20 clear days after the proclamation. Individual writs of summons are sent to those who are entitled to sit in the House of Lords; but for the election of members to the House of Commons the writs are sent to the returning officers of the various constituencies. The writs of summons issued to peers of the United Kingdom are of historical note, for adjudication of disputed peerage claims has often centred in the validity or scope of the writ. Even now, though such a peerage is invariably created by letters patent, these are accompanied by a writ of summons, and it rests with the committee for privileges of the House of Lords to decide whether the writ is valid, or indeed whether it can be issued at all; a familiar instance was their refusal to issue the writ to a peeress in her own right *(Viscountess Rhondda's Claim*, Law Reports [1922] 2 Appeal Cases, 339).

Scotland.—"Writ" is a more extensive term than in England. Writs are either judicial or extrajudicial, the latter including deeds and other instruments—as, for instance, in the Lord Clerk Register (Scotland) Act, 1879, and in the common use of the phrase "oath or writ" as a means of proof. In the narrower English sense both "writ" and "brieve" are used. The brieve was as indispensable a part of the old procedure as it was in England, and many forms are given in *Regiam Maiestatem* and *Quoniam Attachiamenta.* It was a command issued in the king's name, addressed to a judge, and ordering trial of a question stated therein. It was drawn by the writers to the signet, originally clerks in the office of the secretary of State. Its conclusion was the will of the summons. In some cases, proceedings which were by writ in England took another form in Scotland. For instance, the writ of attaint was not known in Scotland, but a similar end was reached by trial of the jury for wilful error. Most proceedings by brieve, being addressed to the sheriff, became obsolete after the institution of the court of session, when the sheriffs lost much of that judicial power which they had enjoyed to a greater extent than the English sheriff. *(See* SHERIFF.) An English writ of execution is represented in Scotland by diligence, chiefly by means of warrants to messengers-at-arms under the authority of signet letters in the name of the king. The only brieves in practical use are those for serving a tutor-at-law, for kenning to the terce, and for cognition of insane persons. The two former are rare; the third was substituted by the Court of Session (Scotland) Act, 1868, for the old brieves of furiosity and idiotry. Other kinds of brieve have been superseded by simpler procedure, *e.g.,* the brieve of service of heirs, representing the older *breve de morte antecessoris,* by *a* petition to the sheriff under the Titles to Land Consolidation (Scotland) Act, 1868, and the brieve of perambulation by action of declarator. Writs *eo nomine* have been the subject of much modern legislation. The writs of *capias, habeas, certiorari* and extent were replaced by other proceedings by the Exchequer Court Act, 1856. The writs of *clare constat,* resignation and confirmation (whether granted by the Crown or a subject superior) were regulated by the Titles to Land Act *(supra).* By the same act Crown writs are to be in the English language and registered in the register of Crown writs. Writs need not be sealed unless at the instance of the party against whom they are issued. Writs of progress (except Crown writs, writs of *clare constat* and writs of acknowledgment) were abolished by the Conveyancing (Scotland) Act, 1874. The *clare constat* writ is one granted by the Crown or a subject superior for the purpose of completing title of a vassal's heirs to lands held by the deceased vassal.

(P. H. W.)

United States.—The system of original writs seems never to have obtained in the United States. From the earliest colonial times actions were begun by the issuance of a writ of summons directed to a sheriff or constable, briefly setting forth the character of the claim, and directing that official to summon the defendant. This writ of summons as distinguished from the early English chancery writs was a judicial and not an executive writ. Its issuance was simply a means for securing the presence of the defendant before the court, not as in England giving the court jurisdiction to hear the particular claim. The form of the writ of summons followed in the main the old English writ, briefly stating the cause of action. Probably because of this similarity, despite the absence of original writs, the common law forms of action continued to survive in the United States. Until the adoption of procedural reforms by the codes during the middle of the 19th century, they persisted with all their common law vigour. Under the codes there is usually but one form of action, which is begun by the issuance of a summons prepared by the plaintiff's attorney and served by any one not a party to the suit. The summons is brief, does not disclose the nature of the action, though a copy is commonly attached to and served with the summons.

Writs in the Federal courts are by Act of Congress to be tested in the name of the chief justice of the United States. By State law writs in the State courts are generally bound to be in the name of the people of the State, in the English language, and tested in the name of the chief justice of the State. The common law prerogative writs such as *mandamus,* prohibition, *certiorari, quo warranto* and *habeas corpus* are well known in the United States. The Constitutions or statutes of the several States confer upon their courts power to issue these writs. The cases in which they may issue are generally governed by statute, and the courts issue them as a matter of sound discretion and not as a matter of right. In trying questions of title to real property, writs of entry and other real actions, which before the settlement of the colonies had become nearly obsolete in England, were until the middle of the 19th century the common remedies in the U.S. courts. They were, however, stripped of the cumbrous feudal appendages which made them intolerable in England. The action of ejectment begun by summons in the manner of any personal action has now supplanted them. Two prerogative writs have much importance in the Federal courts. These are the writ of error (now abolished in England) and the writ of *certiorari.* From 1879 until 1914, writ of error was the only means by which a decision of a State court could be reviewed in the Supreme Court of the United States. In that year *certiorari* was added as another method for review, having been available since 1891 as a method for reviewing decisions of the inferior Federal courts in the Supreme Court. In 1928 the writ of error was abolished and appeal substituted in its place. The writ of assistance has its interest in constitutional history. Before the War of Independence it was issued to revenue officers to search premises for smuggled goods. It was on this writ that it was first contended in 1761 that a colonial court had jurisdiction to examine the constitutionality of a legislative Act authorizing the issue of the writ. *(See Quincy's Massachusetts Rep.,* app., *I. 520.)* (J. M. La.)

Bibliography.—For the history of the writ see *Registrum Brevium* and Sir Anthony Fitzherbert, *La nouvelle Natura Brevium* (1534 or 1537; Eng. trans., 1652, 9th ed., 1794), both noticed above; *Natura Brevium,* which changed its name to *Old Natura Brevium* after Fitzherbert's book was published; it exists in a great number of editions, the earliest of which is about 1516, the last 1584; *Novae narrationes; Articuli ad novas narrationes; Returna Brevium;* Simon Theloall, *Le digest des briefs originals* (1579); *Thesaurus brevium* (*c.* 1661); R. Brownlow, *Brevia judicialia* (1662); *Officina brevium* (1679); Sir E. Coke, *Institutes* (1628, many later editions); C. Dufresne du Cange, "Brevis" in *Glossarium* (Leyden, 1688; best ed. Henschel 1840–1850); G. Booth, *Real Actions* (1701); *W.* Tidd, *Practice* (1790–97); *H.* J. Stephen, *Pleadittgs* (1824; 7th ed., 1868); R. J. and A. B. Corner, *Practice of the Crown Side* (1844); M. M. Bigelow, *History of Procedure in England* (1880); *F.* Pollock and F. W. Maitland, *History of English Law Before the Time of Edward I* (1895); W. S. Holdsworth, *History of English Law* (1903 *et seq.* especially vol. ii and iii); W. S. McKechnie, *Magna Carta* (1905; 2nd ed., 1914); T. A. Street, *Foundations of Legal Liability,* vol. iii (1907); F. W. Maitland, *Equity, Also the Forms of Action at Common Law* (edit. *A. H.* Chaytor and W. J. Whittaker, 1909); also *Collected Papers,* vol. ii (edit. H. A. L. Fisher, 1911); W. Stubbs, *Select Charters* (9th ed., 1913); P. H. Winfield, *Chief Sources of English Legal History* (1925); and E. Jenks on "Prerogative Writs" in *The Yale Law Journal* (April 1923).

For current law, there is no book which deals with writs both exclusively and completely. Taken in the aggregate, the following books cover the topic: *The Annual Practice;* W. G. Clay, *The Law and Practice Relating to Writs of Summons* (1894); F. H. Short and F. H. Mellor, *Practice on the Crown Side of the King's Bench Division* (2nd ed., 1908); E. R. Daniell, *Chancery Practice* (8th ed., S. E. Williams and F. Guthrie Smith, 1914), and *Chancery Forms* (6th ed., *R.* White, F. E. W. Nicholls and H. G. Garrett, 1914); T. E. May, Baron Farnborough, *Parliamentary Practice* (13th ed., T. L. Webster, 1921); W. B. Odgers, *Pleading and Practice* (10th ed., 1926); Alduson, *Judicial Writs and Process* (1895); and *see* "Writ" in index to the Earl of Halsbury, *The Laws of England* (31 vol., 1907–17, with supplement, 1910 *et seq.).* (P. H. W.)

WRITING, in the widest sense, is a system of human intercommunication by means of visible conventional markings. The earliest and most universal means of communication available to human beings is speech and gesture. These have two features in common: (1) They are of momentary duration and are therefore restricted as to time; as soon as the word is uttered, or the gesture made, it is gone and cannot be revived except by repetition (2) They can be used only in communication between persons more or less in proximity to each other and are therefore restricted as to space.

The need for finding a may to convey thoughts and feelings in a form not limited by time or space led to the development of methods of communication by means of (1) objects and (2) markings on objects.

Systems of mnemonic signs to keep accounts are known throughout the world. The simplest, commonest ways of keeping records of cattle are with so-called counting sticks—simple wooden sticks with carved notches corresponding to the number of cattle in the custody of a shepherd—and with pebbles in a sack. More complicated is the use, among the Peruvian Incas, of quipu writing, in which accounts concerning objects and beings were recorded by means of strings and knots of various length and color. Reports of the use of the quipu for recording chronicles and historical events are fantasy. Neither the Peruvian nor the modern knot writings in South America and on the Riukiu Islands near Japan have any other aim than to record simple statistical facts. Similar is the use of wampum (*q.v.*) by North American Indians; strings of shell beads, frequently tied together in belts, served as money, ornaments and also as a means of communication. The impracticability of using objects prevented the development of any full system, and such primitive devices are restricted to small geographical areas.

Writing is expressed not by objects themselves but by markings on objects. Writing began when man learned how to communicate his thoughts and feelings by means of visible signs, understandable not only to himself but also to all other persons initiated into the particular system. The relationship between writing and speech was at first very loose, inasmuch as the written message did not correspond to an exact utterance. A message had one meaning and could be interpreted by the reader in only one way, but it could be read, that is, put into words, in several different mays and even in several different languages.

In later periods, systematic phonetization enabled man to express his ideas in a form which corresponded exactly to the spoken units. From that time writing gradually lost its character as an independent mode of expressing ideas and became a tool of language.

While the elements of language include phrases or sentences, words, syllables, distinctive sounds or phonemes and prosodic features, writing systems are concerned chiefly with the visual representation of words, syllables and single sounds. Signs for phrases are rarely found in popular writings, though they form an integral part of all stenographic systems. Of prosodic features, such as quantity, accent, tone and pauses, only the latter are partially expressed in writing by word division and punctuation marks. Commonly, writing fails to indicate adequately the prosodic features. Thus, in a sentence such as "Are you going home?" the interrogation is indicated by the question mark, but it is left to the reader to decide whether the emphasis is on the first, second, third or fourth word. By contrast, phonetic transliterations frequently employ special signs to denote characteristics of prosodic nature, by means of diacritical marks or numbers, as in the writing of *dḗmos* (ˊ denotes quantity and stress), or ku_3 ($_3$ denotes tone). A full indication of tone or pitch has been developed only in the system of musical notation. Table I shows in chart form the various ways of writing linguistic elements.

Table *I.—Ways of Writing Linguistic Elements*

Elements	Written sign	System of signs
[Phrase . . .	Phraseogram or phrase sign	Phraseography or phrase writing]
Word	Logogram or word sign	Logography or word writing
Syllable . . .	Syllabogram or syllabic sign	Syllabary or syllabic writing
Single sound . .	Letter or alphabetic sign	Alphabet or alphabetic writing
[Prosodic feature .	Prosodic sign or mark	Prosodic writing]

The various stages of the development of writing are shown in chart form in Table II. Absurd as it may appear at first glance to designate the three main stages of writing as No Writing, Forerunners of Writing and Full Writing, there are good reasons for this division. A full discussion follows the chart.

Archaic devices from an older period and innovations ahead of the accepted development may be found in a system of writing at any period. Hence in the representation (below), it is impossible to take account of all minor divergences. A long and complicated terminology would only tend to obscure the issue. For this reason, the terminology used in the chart is meant to define only the major characteristics of a writing. English writing, like Latin, is called alphabetic, even though it contains some word signs, as in "3 lb." or "£3" for "three pounds." Many more word signs are used with the Elamite syllabary and the Pahlavi alphabet. The Hittite hieroglyphic syllabary contains a few signs of the type tra, *ara,* outside of the normal development. The Carian alphabet consists of alphabetic signs borrowed from Greek with a number of syllabic signs borrowed from another system of local (Anatolian) origin. In all phonographic ariting, especially in Chinese, are found elements which are normally included under the semasiographic stage of writing.

TABLE 11.—Stages of the Development of Writing

No Writing: Pictures					
Forerunners of Writing: Semasiography 1. Descriptive-representational device 2. Identifying-mnemonic device					
Full Writing. Phonography					
1. Word-syllabic	Sumerian (Akkadian)	Egyptian	Cretan	Hittite	Chinese
2. Syllabic.	Elamite Hurrian	West Semitic (Phoenician) (Hebrew) (Aramaic)	Linear A Linear B Cypro-Minoan Cypriote Phaistos' Byblos?		Japanese
3. Alphabetic .		Greek Aramaic (vocalized) Hebrew (vocalized) Latin Indic			

Pictures.—The fact that pictures are mentioned as the first stage, called No Writing, implies: (1) that what are normally understood as pictures do not fall under the category of writing; but (2) that writing had its origin in simple pictures. There is, however, a very close connection between pictures and writing, for a natural way of communicating ideas by means of visible markings is achieved by pictures. To primitive man a picture in a crude nay takes care of the needs fulfilled in modern times by writing. In time the picture developed in two directions: (1) pictorial art, in which pictures continued to reproduce more or less faithfully the objects and events of the surrounding world in a form independent of language; and (2) writing, in which signs, whether they retained their pictorial form or not, ultimately became symbols for linguistic elements.

Semasiography.—Under Forerunners of Writing are included the various devices by which man first attempted to convey his thoughts and feelings. An all-inclusive term which may be coined for these devices is "semasiography" (Gr. *sēmasía*, "signification," and *graphē*, "writing"). This is the stage in which pictures convey the general meaning intended by the writer. In this stage, visible draan forms—somewhat like gesture language—express meaning directly without an intervening linguistic form. In place of the term semasiography used here, most scholars prefer the terms pictography or ideography.

Primitive communication with visible symbols was achieved by descriptive-representational and identifying-mnemonic devices. As the two devices frequently overlap, it is difficult to assign some primitive writings rigorously to one or the other category.

Descriptive-representational devices are similar to drawings but differ in that they contain only what is important for communication and lack aesthetic embellishment. In the identifying-mnemonic device a symbol is used to depict a person, an animal or an object for the purpose of identifying it individually, or of recording articulate utterances such as proverbs or songs. An illustration of the identifying device is a drawing of a nhite hawk, to represent a man named White Hawk. Mnemonic devices are exemplified by the symbols used to record proverbs among the Ewe Negroes of Togoland, such as a picture of a threaded needle and of a piece of cloth, representing the proverb, "The needle sews great cloth," meaning that small things can achieve greatness. The descriptive-representational device may seem the more developed because it seems to communicate better than identifying-mnemonic devices. A drawing depicting a battle by the descriptive-representational device for instance, tells the story better than one or two identifying-mnemonic signs. It is not the descriptive-representational device, however, which leads to fully developed writing. Pictures drawn for this purpose are bound by the conventions of art, which limit and hinder them as vehicles of human intercommunication.

Identifying-mnemonic devices are also drawn; their aim, however, is not to describe but to help the reader remember and identify an event, object or being. Thus, a complete correspondence is established and gradually conventionalized between certain symbols and certain objects or beings. Since these objects and beings have names in the oral language, the correspondence is further established between the written symbols and their spoken counterparts. Once it was discovered that words could be expressed in written symbols, a new and much better method of human visual communication was established. It was no longer necessary to record an event such as a man killing a lion by drawing the man, spear in hand. killing the lion. Instead, the spoken sentence, "man killed lion," could be recorded by three conventional symbols representing the words "man," "killed" and "lion." Accordingly, "five sheep" could be expressed by two symbols corresponding to two words instead of by the five separate pictures of sheep required in the descriptive-representational device. The introduction in the identifying device of strict order in the signs, following the order of the spoken words, is in direct contrast to the method of the descriptive device and of the picture, in which the meaning is conveyed by the totality of little drawings without any convention as to the beginning of the message or the order in which it should be interpreted.

A device in which individual signs express individual words should naturally lead to a complete system of word signs, that is, word writing or logography. Such a fully developed system has never existed, either in antiquity or in modern times. To create and memorize signs for thousands of words and names is so impracticable that logographic writing either can be used as a limited system or must find new ways to overcome the difficulties.

Primitive logographic writing can develop into a full system only if a sign acquires a phonetic value independent of the meaning of the sign as a word. This is phonetization, the most important single step in the history of writing. In modern usage this step is exemplified by rebus writing, in which the drawing of an eye and of a saw express the phrase "I saw," or that of a man and a date express the word "mandate." Phonetization and its subsequent systematization made possible complete systems of writing in which linguistic forms could be expressed by symbols with conventional syllabic values. Thus full writing originated.

Phonography.—Word-Syllabic *Systems.*—The Sumerians took the important step leading to fully developed writing. The Sumerian state and economy required records of goods transferred from the country to the cities and vice versa. Records were kept in concise ledger form, of the type "five sheep" or, with a personal name, "ten bows, X." The use of one sign for one word resulted in the origin of a logographic system which soon expanded into a phonographic system through the necessity of expressing personal names in an exact way to prevent confusion in the records. The greatness of this achievement lies in the fact that, in creating a full word-syllabic system from the old identifying-mnemonic device, the Sumerians were able to break away entirely from the conventions of the descriptive-representational device. The writing developed into the word-syllabic system, while the identifying-mnemonic device continued undisturbed on seals.

There are seven ancient Oriental systems of writing, of which the oldest is the Sumerian, first attested in southern Mesopotamia around 3100 B.C. From there the main principles of Sumerian writing may have spread eastward, first to the neighbouring Proto-Elamites and then, perhaps via the Proto-Elamites, to the Proto-Indians in the valley of the Indus; one of the Near Eastern writings may, in turn, have been the stimulus leading to the creation of Chinese writing. Around 3000 B.C. Sumerian influence presumably uorked its way westward to Egypt; Egyptian influence, in turn, spread toward the Aegean where, about 2000 B.C., Cretan writing originated, and a few centuries later, Hittite hieroglyphic writing in Anatolia.

Since of the seven systems three—Proto-Elamite, Proto-Indic and Cretan—are undeciphered, the principles of writing can be discussed only as they are found in the remaining four—namely, Sumerian, Egyptian, Hittite and Chinese.

As far as the basic principles of writing are concerned, the unifying characteristics of the four systems are that they are all phonographic almost from the very beginning of their development and that they all contain signs of these three classes: word signs or logograms. syllabic signs and auxiliary signs.

The formation of word signs is identical or very similar in all four systems. One sign or a combination of signs expresses one word or a combination of words. Also the principles of using auxiliary signs, such as determinatives or punctuation marks. are identical, although the various systems may differ in form. Only in the use of syllabic signs are the differences so prominent as to permit classification by types.

Type I.—Sumerian, Akkadian: monosyllables ending in a vowel or consonant: ta, ti, te, tu; at, it, et, ut; tarn, *tim, tem, tum;* and very rarely also dissyllables like ata, *tama.*

'Type 11. — Egyptian: monosyllables and dissyllables ending in a vowel, with differences in vowels not indicated: t^x, $t^x m^x$.

Type 111. — Hittite, and almost certainly Cretan: monosyllables ending in a vowel: ta, ti, te, *tu.*

Type IV.—Chinese: monosyllables ending in a vowel or consonant: ta, ti, te, tu, to; at, it, et, ut, ot; tam, *tim, tem, tum,* tom.

Syllabic *Systems.*—Four types of syllabic systems developed from the four word-syllabic systems discussed above: cuneiform syllabaries, such as Elamite and Hurrian, from Mesopotamian cuneiform; West Semitic syllabaries, such as Sinaitic, Proto-Palestinian, Phoenician, Old Hebrew, Old Aramaic, from Egyptian hieroglyphic; Aegean syllabaries, such as the Cretan and Mycenean Linear A and Linear B (see MINOAN LINEAR SCRIPTS), Cypro-Rfinoan and Cypriote and perhaps the little known Phaistos (Crete) and Byblos (Syria) writings, from Cretan; and, finally, the Japanese syllabary from Chinese.

Of all systems of writing the syllabic is the easiest to evaluate from the point of view of the development of writing: for all syllabic writings are either identical with, or simplified from, the respective syllabaries of the word-syllabic writings from which they are derived. Syllabic writings exhibit the following four types:

Type I.—Elamite and Hurrian cuneiform: monosyllables ending in a vowel or consonant: ta, ti, te, tu; at, it, et, ut; tam, *tim,* tern, *tum.*

Type 11. — West Semitic: monosyllables ending in a vowel, with differences in vowels not indicated: t^x.

Type 111. — Linear A, B and Cypriote: monosyllables ending in a vowel: In, ti, te, tu, to.

Type IV.—Japanese: monosyllables ending in a vowel: ta, ti, te, tu, to; *(da,* di, de, *du,* do).

Only two of the four types here mentioned employ syllabic signs exclusively, namely the West Semitic and the Cypriote. The derived cuneiform syllabaries, and most of the Aegean syllabaries, carry with them a limited number of word signs borrowed from the Mesopotamian cuneiform and Cretan hieroglyphic respectively; the Japanese syllabic system (kana) is used normally side by side with a number of word signs derived from Chinese (*kanji*).

Alphabetic *Systems.*—If by the word "alphabet" is understood a writing which expresses the single sounds of a language. then the first alphabet was formed by the Greeks. Although throughout the second millennium B.C. several attempts were made to indicate vowels in syllabaries of the Egyptian-Semitic type, none developed into a full vocalic system. The usual way was to add phonetic indicators as helps in reading the vowels, which normally were left unindicated in the Semitic systems of writing. But while the Semites sparingly employed these *matres lectionis,* as they are called, as in the case of m^a-l^a-$k^{(a)}$-t^i-$\underset{\frown}{i}^i$ for *malaktī* "I reigned," the Greeks used them systematically after each syllabic (*i.e.,* consonantal) sign. Thus, following the principle of reduction, it was seen that in t^i-$\underset{\frown}{i}^i$ since the second sign did not stand for a separate syllable $\underset{\frown}{i}^i$ but for a vowel i, the first sign must stand for a consonant t and not for a syllable t^i.

The Greeks, therefore, having accepted in full the forms of the West Semitic syllabary, evolved a system of vowel signs which, attached to the syllabic signs, reduced the value of these syllabic signs to simple consonants and thus for the first time created a full alphabetic system of writing. From the Greeks the Semites in turn learned the systematic use of vowel marks and consequently developed their own alphabets.

There are three types of alphabets in use, characterized by three different methods of indicating vowels:

Type I. — Greek, Latin: vowels indicated by separate signs: t-a, *t-i,* t-e, t-u, t-o.

Type 11. — Aramaic, Hebrew, Arabic: vowels indicated by separate diacritical marks: $\underline{t}$, *t*, t, t, *t*, or the like.

Type III.—Indic, Ethiopic: vowels indicated by diacritical marks attached to the sign or by internal modification.

During the last 2,500 years alphabets have reached to the farthest corners of the earth but the principles of writing have not changed. Hundreds of alphabets throughout the world, different as they may be in outer form, use the principles first and last established in Greek writing.

See ALPHABET: BOUSTROPHEDON; CALLIGRAPHY; CUNEIFORM; HANDWRITING: HIEROGLYPHS; INSCRIPTIOSS; PALAEOGRAPHY; PICTOGRAPHY; RUNE. See also Index references under "Writing" in the Index volume. (I. J. G.)

WROCLAW (Old Polish WRACISLAW, German BRESLAU), a city of southwestern Poland, chief town of Lower Silesia and the see of a Roman Catholic bishopric, is situated 394 ft. above sea level in a wide and fertile plain on both banks of the navigable Oder (Odra), 352 mi. from its mouth. Administrative area 86.9 sq.mi. Pop. (May 1939 census) 615,006; (1950 census) 308,-925; (1960 census) 429,200.

The oldest part of the city, which existed in the 10th century, is situated on two islands, the bigger Cathedral Island and the much smaller Sand Island, lying between two arms of the Oder which there flows in a westerly direction. This old town, destroyed by the Tatars in 1241, was later rebuilt, but in the meantime a new town had grown up on the left bank round a Market square from which main streets radiated north, east, south and west. The new town received its municipal autonomy in 1261 and in 1327 it absorbed the old town. A semicircle of moats and walls was built and these city defenses were kept until 1807. Their demolition on Napoleon's order favoured the city's extension, which became particularly rapid after 1871. In 1910 the city's administrative area was almost 19 sq.mi. with a population of 512,105, including 303.378 Protestants, 183,542 Roman Catholics and 20,212 Jews. On the eve of World War II it was four times larger and its east-west axis was 15.5 mi. long. It was destroyed in 1945 to the extent of 68%, some outer sections being reduced to rubble. In Wroclaw the Germans defended themselves for three months, demolishing many blocks of houses in the old town in order to build an emergency airstrip; the Russian heavy artillery did the rest.

In the old town are several medieval buildings of great interest. The cathedral, dedicated to St. John the Baptist, was built in Romanesque style in 1158–80 on an older foundation. The present Gothic cathedral, incorporating some of the former, was begun in 1234 and completed in the 15th century. Destroyed at the beginning of 1943 to the extent of 70%, it was carefully rebuilt in 1946–51. The Gothic church of the Holy Cross nearby (dating from 1288) and that of Our Lady of the Sand (1334–1412) were both heavily damaged in 1945 and have been rebuilt since. The most remarkable Gothic churches of the new town are St. Elizabeth and St. Mary Magdalen, near the Market square; both date from the 13th century. were damaged in 1935 and have been rebuilt since. The town hall. which stands in the middle of the Market square, is a Gothic building dating from the 13th century and rebuilt in the 15th century; it now houses the Historical museum. In front of it stands the monument of Count Alexander Fredro, transferred there from Lwow. Two Renaissance houses in the same square and several baroque houses scattered through the old town escaped destruction in World War II. The university, a baroque building facing the Oder, was built in 1728–36 as a Jesuit college. Damaged in 1035 and repaired since, it contains a magnificent hall (Aula Leopoldina), richly ornamented with frescoes. Besides the university. Wroclaw had in the 1950s seven other institutions of higher education, an opera house (a 19th-century neoclassic building) and three other permanent theatres. There are many public parks and gardens, including a botanical and a zoological garden, all situated on the outskirts of the city.

Wroclaw has the largest railway carriage plant in Poland; machine tools, electrical equipment, chemicals and many processed foodstuffs are manufactured there. More than a half of the population is employed in industry.

Wroclaw is an important communication centre. It is linked by rail with Cracow, Berlin, Szczecin and Danzig (through Poznan), and the main Warsaw-Prague international line passes through the city. It has three railway stations and large river ports. It is linked by an airline with Warsaw, Danzig and Lodz, the airport, Maly Gadow, being $2\frac{1}{2}$ mi. from the city.

History.—From the end of the 10th century Wroclaw was part of Poland. It was an administrative and commercial centre (a mint existed there in the 11th century) and a fortified town. In A.D. 1000 King Boleslaw I the Brave founded a bishopric there, subject to the archbishopric of Gniezno. When Boleslaw III Wrymouth died in 1138 he divided the kingdom among his four sons. Wladyslaw, his eldest son, inherited Silesia. with the overlordship of the whole. and became the head of the Silesian line of the Piast dynasty. Wroclaw was first the capital of the whole of Silesia, but as a result of further subdivisions among the members of this prolific line, it became in the 14th century the chief town of a small principality of Wroclaw, without losing, however, its leading economic importance. Henry VI, prince of Wroclaw (1311–35), left his principality to the Bohemian crown. In 1526 it passed, with all Bohemia, to the Habsburgs, although all the Piast Silesian princes were left the status of *principes* Poloniae (princes of Poland). In 1742 Wroclaw, with the major part of Silesia, mas incorporated with Prussia. At that time the town's population was bilingual, but the Germans exercised the political and economic control. In 1821 a concordat between Prussia and the Holy See subjected the bishopric of Wroclaw directly to the pope. By the end of the 19th century the city was completely German. On May 7, 1945, Wroclaw was conquered by the Soviet army. Soon after the Potsdam agreement of Aug. 2, 1945, the Soviet military authorities transferred the city to Polish administration. As all the Germans left the city its population, quickly rising, was almost exclusively Polish. In March 1957 the German minority comprised 2,776 (0.7%).

WROUGHT IRON: see IRON AND STEEL.

WRYNECK (Jynx torquilla), a bird, so called from its way of writhing its head and neck. It summers in most parts of Europe, generally arriving a few days before the cuckoo, and is often known as "cuckoo's leader" and "cuckoo's mate." Its ninter habitat is the Mediterranean area.

The unmistakable note of the wryneck is merely a repetition of what may be syllabled *que,* que, que, many times in succession, rapidly uttered at first, but gradually slowing and in a continually falling key. This is only heard during a few weeks, and for the rest of the bird's stay in Europe it seems to be mute. It feeds mainly on insects on the ground, especially on ants. It is larger than a sparrow with beautifully variegated plumage of black, brown, buff and gray. The wryneck lays its translucent white eggs on the bare wood of a hole in a tree and it is one of the few wild birds that can be induced to go on laying by removing its eggs day after day, and thus more than 40 have been taken from a single hole—but the proper complement is from 6 to 10. When disturbed on the nest. the female writhes and hisses like a snake. In Great Britain, the bird is most common in the southeast, its numbers decreasing rapidly toward the west and north. Other species of the genus are found in various parts of Africa. The wrynecks form a subfamily Jynginae of the Picidae, a family which includes piculets and woodpeckers. They differ from other members of this family in coloration and in not having stiffened tail quills, nhich serve as props for the climbers.

WRYNECK (TORTICOLLIS), a congenital or acquired deformity characterized by the affected side of the head's being drawn downward tow-ard the shoulder together with deviation of the face toward the sound side. There are various forms, including the congenital, caused by a lesion of the sternomastoid muscle; the rheumatic, caused by exposure to a draft or cold and commonly known as stiffneck; and the nervous or spasmodic, the result of irritation of the spinal accessory nerve or its roots. Many cases are the result of hysteria and some of spinal caries. (F. L. A.)

WU-CH'ANG, a member city of the tri-city conurbation of Wu-han on the right bank of the Yangtze at the mouth of the Han river in Hupeh province, China. It was merged in 1950 with the adjacent cities of Han-yang and Hankow to form the single metropolis of Wu-han. See WU-HAN.

WUCHOW (WU-CHOU, TS'ANG-WU), former treaty port in eastern Kwangsi province, China, on the north bank of the Hsi Chiang (West river) at its junction with the Kuei Chiang. It is 220 mi. above Canton and can be reached all year by vessels of 8-ft. draft, and in high water, of 15-ft. draft. During summer floods the water pent up by the downstream gorges rises 50–60 ft. Because of its location, Wuchow was long the principal trade focus of the Kwangsi basin and western Kwangtung, shipping out large cargoes of tung oil (for which the city is named), timber, spices, sugar, hides and matting. The city mas the site of a U.S. air base and repeatedly was bombed during World War II; it was occupied briefly by the Japanese late in 1944. Its trade dominance over southwest China may be threatened or greatly reoriented with the operation since 1955 of the railway from Li-t'ang to Chan-chiang farther west. Pop. (1953) 110.800. (TE. H.)

WU-HAN, the greatest metropolis of central China and capital of Hupeh province. It is a tri-city conurbation comprising Hankow, Han-yang and Wu-ch'ang. Hankow (Han-k'ou) lies on the north side of the Yangtze at the mouth of the Han Shui (Hankow means "mouth of the Han"). Immediately opposite, in the angle of junction, is the older city of Han-yang and a little below the confluence, on the south bank of the Yangtze, is the ancient metropolis of Wu-ch'ang. Under the Communist regime in 1950 the three cities were merged into a single city called Wu-han. Pop. (1953) 1,427,300; (1957) 2,146,000.

Communications.—This triple city of Wu-han has an almost unrivaled geographical centrality which gives its site immense commercial significance. The Hupeh basin in which it lies is preeminently the central basin of China, the very heart of the country, and the converging point of routes from every point of the compass. If a line is drawn connecting the chief emporia along the periphery of China proper, (Peking, Sian, Chengtu, K'un-ming, Canton, Shanghai) there is a roughly circular area with Wu-han nearly in the centre. The Yangtze (*q.v.*), the greatest of China's arterial waterways, is navigable for large ocean-going vessels, except during the winter dry season, up to the site of Hankow which can therefore be considered as the head of ocean navigation, although 600 mi. from the coast. Upstream betneen Hankow and I-ch'ang, at the outlet of the Yangtze gorges, it is navigable for vessels of considerable size, and midway in this stretch, at Yoyang, (Yueh-yang), the river is the outlet for the large Tung-ting lake into which the Hsiang Chiang, the main artery of Hunan flows from the south, and from the southwest the Yuan Chiang, affording the water route to Kweichow and southwest China generally. To the east, the P'o-yang lake, strictly analogous to the Tung-ting lake, receives the waters of the Kan Chiang, the second of the two great river routes to the south through the south China highlands. Chiu-chiang, at the Yangtze outlet of this system, may be regarded largely as a feeder of Wu-han uhich is centrally placed in relation to the twin basins of Tung-ting and P'o-yang.

To the west of the Hupeh basin is the trough of the Yangtze gorges. difficult to navigate, but the only practicable route by which the Yuan Chiang or Red river basin of Szechwan can be brought into relation with the heart of China and the ocean. The construction of special steamers for negotiating the gorges even during the dry season formerly greatly facilitated trade between Chungking and Hankow. From the northwest comes the Han Chiang, navigable for 300 mi. above Hankow and the chief water route to Sian and northwest China.

The importance of this convergence of river routes was increased by the fact that the main north-south trunk railroad of China, the line linking Peking and Canton, intersected the Yangtze there. The railway was at first in two sections: the northern section from Peking to Hankow, and the southern section from Wu-ch'ang to Canton. Under the Communist regime, in 1957, a double-decker rail-and-road bridge was completed between the north and south banks of the Yangtze river, thus providing for the first time direct through traffic along the trunk railway. The importance of the Wu-han cities as a railroad hub was further increased since the southern section of the main line had branches leading eastward to Hangchow and southwest to Kwangsi province and North Vietnam. As the meeting point of maritime, river and rail transportation, Wu-han has almost unique advantages as a collecting and distributing centre, a position comparable to that of Chicago in the Cnited States. Wu-han is connected by regular steamer services with Shanghai, Chungking and other river ports and is the focus of an active junk traffic. It is the chief entrepôt for the central Yangtze provinces and for west and southwest China, particularly for tea, cotton, silk, timber (from western Hunan by the Yuan Chiang), tung oil and hides.

Industries. — Hankow was one of the first inland cities of China to be opened to foreign trade (1858) and its development as a port in close contact with Europe brought it early under the influence of western industrialism. Concessions were once held by Great Britain, France, Germany, Russia and Japan. Han-yang was selected by the viceroy Chang Chih-tung in 1891 as the site of the first modern steel plant in China. In 1908, the plant became the property of the Han-yeh-ping Iron and Steel company, which was named for the Han-yang plant, and the Ta-yeh iron mines and Ping-hsiang coal mines that supplied the steel plant with raw materials. The company was largely financed by Japanese loans. After World War I, Japanese interests obtained a share in the management of the company, closed down the steel furnaces and concentrated on shipping iron ore and pig iron to Japan. After 1925 the pig iron output gradually ceased. In 1938, during the Chinese-Japanese War, the Han-yang plant was dismantled and removed by Yangtze river junks to Chungking. The steel industry of the Wu-han area was gradually revived under the Communist regime after 1949. A medium-sized steel plant was built in the early 1950s on the basis of former Japanese installations at Huang-shih, downstream from Wu-han. In the tri-city area itself which has become a major industrial complex of China, construction of a large steel plant began in the mid-1950s on the south bank of the Yangtze and 15 mi. east of Wu-ch'ang. The first large blast furnace of this plant was in operation in the late 1950s.

Wu-han mas also an important centre of textile manufactures, although ranking far behind Shanghai. The cloths produced were mainly plain cloths, including woolen and cotton mixtures, and fancy cloths, including artificial silk and brocades, the demand for which was increasing. Dependent on this industry were a large number of dye works, the dyers in the majority of cases being weavers as well. American varieties of cotton yielded much better results in the Hupeh basin than in the Yangtze delta and the area under cotton in the region surrounding Wu-han was steadily increasing.

Another large industry based on local production was represented by the rice mills, employing modern machinery. In addition there were several oil mills, utilizing the large local supplies of beans. and many important refineries of wood or tung oil, which, as a substitute for linseed and other oils, had a large American and European market. There were also flour mills, cement works, soap and albumen factories, distilleries and a large number of miscellaneous industries. Hankow was also a great banking centre.

Prior to the political disturbances of 1926–27, the rapid increase in Hankow's foreign trade was remarkable, and after the settlement of the political issues described below Hankow retained its position as one of the leading Chinese trade centres.

History.—Wu-ch'ang, the oldest of the Wu-han cities, dates from several centuries B.C. It was capital of both the Chou (300 B.C.) and Wu (A.D. 300) kingdoms. An ancient cultural centre, it is the seat of Wu-han university and location of various commercial, industrial and art institutes, including those of medicine, agriculture and technology.

Both because of its intrinsic importance and its situation in relation to the chief routes, the Wu-han group of cities figured prominently in the troubled political history of modern China. The revolution of 1911 broke out in the barracks at Wu-ch'ang; the low ridges, particularly the Serpents' ridge, which there cross the marshy basin, mere of great strategic importance in the subsequent fighting. The line of heights overlooking the Han Shui was the scene of the principal struggle between the imperial and revolutionary troops, the main objective being the government arsenal at Han-yang. The capture of Hankow by the Nationalist armies, advancing northward from Kwangtung (Dec. 1926), marked the extension of Nationalist power to the middle Yangtze. It was followed by a serious mob onslaught on the British concession, the charge of which passed into the hands of the Chinese, and for a time business was completely suspended. Finally an agreement was concluded providing for the dissolution of the British municipal council and the setting up of a Chinese municipality modeled on that already set up for the former German concession in Hankow but Chinese-British in composition. After the fall of Nanking in 1937 the Chinese government withdrew temporarily to Hankow which became the base of Chinese resistance, defended by several "booms" on the Yangtze and strong fortifications and troop concentrations. The battle for Hankow started June 12 and ended with a final Japanese breakthrough north of the city which caused the evacuation on Oct. 12 and the fall of the city on Oct. 25, 1938. Japan occupied Wu-han until 1945. Control of the Chinese Nationalist government after World War II was short lived, however, and the cities fell to Chinese Communist troops in 1949. (T. SD.)

WU HOU (WU TSE T'IEN) (A.D. 625–705), empress of China in the T'ang dynasty was born in 625. She entered the palace at the age of 14 as a concubine to the Emperor T'ai Tsung and at his death in 649 obtained from his successor, Kao Tsung, who was deeply in love with her, the right to remain in the palace. After bearing the emperor a son she obtained the rank of empress. At Kao Tsung's death in 683 the empress, who had dominated the court for 30 years, deposed her son Chung Tsung. after a month's reign, and had herself enthroned (in 690) as empress and sovereign, a position never held before by a woman in China. She died in 705. Ruthless, cruel and ambitious, she had great ability and ruled well. The consolidation of the dynasty and empire were due to her.

See C. P. Fitzgerald, ***Empress Wu*** (1956). (C. P. F.)

WU-HU, an important port in Anhwei province, China, on the east bank of the Yangtze about 50 mi. S.W. of Nanking. East from Wu-hu the Yangtze delta is predominantly flat land, lakes and canals. The city mas a treaty port, 1877–1943, and is freely reached by deep-draft shipping carrying out the rice, silk, cotton, tea, wheat, feathers and eggs brought in via the network of canals. Wu-hu is a leading market for rice which is shipped regularly to the lower Yangtze and Canton areas. The city is connected by road, rail and river to Nanking. Across the river is Yu-ch'i-k'ou, a rail terminus with connections to Ho-fei and the Hwainan coal mines. Wu-hu has a large modern cotton-spinning factory and a power and light morks. Pop. (1953) 242.100. (TE. H.)

WULFENITE, a mineral consisting of lead molybdate. has been a minor source of molybdenum. Crystals usually have the form of thin square plates, sometimes beveled by pyramidal planes. They have a resinous to adamantine lustre, and are usually yellow to orange in colour. It crystallizes in the tetragonal pyramidal class of the tetragonal system, and the formula is $PbMoO_4$. The hardness is 3, and the specific gravity about 6.8, being lower when there is replacement of lead by calcium, and higher nith replacement of molybdenum by tungsten. It occurs in the oxidized zone of lead and molybdenum deposits. Fine crystals have been found at Pribram, Bohemia, and brilliant orange-red crystals in Yuma county, Ariz. (L. S. RL.; X.)

WULFHERE (d 675), king of the Mercians, a younger son of King Penda. was concealed for some time after his father's death in 655, but in 658 or 659, when the Mercians threw off the supremacy of Oswy, king of Korthumbria, Wulfhere became king. He did much to spread Christianity inside and outside his kingdom.

In 657 R'ulihere gained Lindsey from Northumbria, and he was successful against Wessex, extending his borders in all directions. Wulfhere married Eormenhild, a daughter of Erconberht, king of Kent, and was succeeded by his brother Ethelred. His only son, Coenred, became king in 704, in succession to Ethelred, and his daughter. St. Werburga or Werburh, was abbess of Ely.

WULFSTAN, ST. (*c.* 1012–1095), bishop of Worcester, born at Little Itchington near Warwick and educated in the monastic schools of Evesham and Peterborough, became a monk at Worcester and schoolmaster and prior in the cathedral monastery there.

Chosen bishop of Worcester in 1062, Wulfstan accepted with some reluctance, and was consecrated at York in September. He submitted to William the Conqueror, and helped to check the rebellious barons during the revolt of 1075. He was equally loyal to William II in his struggle mith the Welsh. Wulfstan's relations with his ecclesiastical superiors were not so harmonious, and at one time both Lanfranc of Canterbury and Thomas of York unsuccessfully demanded his removal.

Wulfstan died on Jan. 18, 1095. In 1203 he was canonized by Pope Innocent III.

WULFSTAN (d. 1023), bishop of London. 996–1002, archbishop of York, 1002–23, and bishop of Worcester, 1002–16, the author of many Old English homilies. treatises and law codes. He sometimes used the nom de plume Lupus. He was a product of the Benedictine revival and probably had some early connection with one of the Fenland abbeys, but nothing is known of him mith certainty before he became a bishop.

Wulfstan wrote in a distinctive style, which has enabled the canon of his work to be established. From 1008 he drafted the laws of Ethelred and those of Canute, and it was probably he who inspired the latter to reign as a Christian king and thus prevented the Danish conquest from being a disaster to Anglo-Saxon civilization. He was interested in problems of government and the arrangement of society. as is shown by the work known as *Institutes of Polity* and some short legal compilations made by him. He was also deeply concerned with the reform of the church. He studied canonical literature, asked Aelfric to write two pastoral letters for him and was himself the author of the text known as *The Canons of Edgar.*

His most famous work, the *Sermo Lupi ad Anglos,* is an impassioned appeal to call his countrymen to repentance and reform in 1014, after Ethelred had been driven out by Swegn's invasion. He interpreted his country's misfortunes as retribution for sin, and in a passage which illustrates his emphatic style as well as his zeal as reformer and preacher, claims that

> Things have not gone well now for a long time at home or abroad, but there has been devastation and famine, burning and bloodshed in every district again and again; and stealing and killing, sedition and pestilence, murrain and disease, malice and hate and spoliation by robbers have harmed us very grievously, and monstrous taxes have afflicted us greatly, and bad seasons have very often caused us failure of crops . . . Lo, what is there in all these events except God's anger clear and visible over this people?

Of his other homilies, some are denunciatory, some eschatological, some straightforward instruction in the Christian faith. He had a wide acquaintance with Latin writers, especially with Frankish authorities, and also with Gregory and other fathers, with the *Benedictine Rule,* with Bede, Aldhelm, Alcuin and the various ecclesiastical documents of the English church. Several surviving manuscripts of Latin writings derive from collections made by or for him.

Wulfstan's style is distinguishable in some entries in the northern recension of the Anglo-Saxon Chronicle, and in an Old English version of the Benedictine office. He died at York on May 28, 1023, and was buried at Ely.

A. Napier's edition of Wulfstan's homilies (1883) includes many not by him. Dorothy Bethurum's edition of the genuine homilies (1957) has a full bibliography, pp. 106–112. *See* also *Sermo Lupi* ad *Anglos,* edited by *D.* Whitelock, Methuen's Old English Library, 2nd ed. (1952); James M. Ure, *The Benedictine Office* (1957). *Institutes of Polity* was edited by Benjamin Thorpe, in *Ancient Laws and Institutes of England,* vol. ii, pp. 304–341 (1840). (D. WK.)

WUNDT, WILHELM MAX (*1832–1920*), German philosopher and psychologist, the father of experimental psychology and founder of the first psychological laboratory, was born in Neckarau, a suburb of Mannheim in Baden, on Aug. 16, 1832.

The son of a Lutheran pastor, he was privately tutored and prepared for the Gymnasium. He was a studious and sober youth, had no childhood friends and never developed any habits of play or interest in games. After completing his preparatory study, he went in 1851 to Tübingen from which after one year he transferred to Heidelberg to study medicine. Though little interested in the art of healing, Wundt soon became deeply interested in the medical sciences, particularly physiology. He obtained his M.D. degree in 1856 and, after spending the spring semester of that year at Berlin studying with Johannes Müller, he returned to Heidelberg for his habilitation as a *Privatdocent* in physiology. Even by that time he was showing signs of his future productivity: he had published two papers during his student days and three during the year following his graduation. In 1858 he published his first book, *Lehre von den Muskelbewegungen,* and the first section, the one on touch, of *Beiträge zur Theorie der Sinneswahrnehmung.*

In the autumn of 1858 Wundt was appointed assistant to Hermann von Helmholtz (*q.v.*) and placed in charge of the laboratory course in physiology. He held this position until 1864, when he was appointed assistant professor in physiology. In 1861 the section of his *Beitriige* appeared; in 1862 the last two sections, with a reprinting of the first two and the addition of an introduction, were published in a single volume. This book, particularly the introduction, foreshadows the program of Wundt's life work. During the same year he offered a new course on psychology from the point of view of the natural sciences, and published the lectures in 1863 under the title *Vorlesungen über die Menschen- und Thierseele.* With this record behind him, he was Helmholtz' logical successor at Heidelberg when the latter left in 1871 for Berlin, but did not receive the appointment. Spurred by this disappointment, he applied himself to the writing of his *Grundzuge der physiologischen Psychologie* (1873–74), a two-volume work that turned out to be one of the most important in the history of psychology. This book, which went through six revised and greatly enlarged editions was responsible for the call that Wundt received from Zürich in the autumn of 1874. He accepted but remained there only for one year; he then went to Leipzig to a chair in philosophy, a position he retained until he retired in 1917.

In 1879, carrying out the program outlined in his *Beitrage,* Wundt established at Leipzig a psychological laboratory, the first in the world. To meet the publication needs of the laboratory, Wundt founded in 1881 the *Philosophische Studien,* the first journal in the world devoted to psychology. The last two of the 20 volumes (1902, 1903) constitute a *Festschrift* prepared by his former students for the occasion of his 70th birthday. After one year without it, he founded the *Psychologische Studien* (1905–18), and carried it through ten volumes until after his retirement.

During the decade of the 1880s, Wundt's writings were chiefly philosophical. He published three huge encyclopaedic books during this period: *Logik* (1880), *Ethik* (1886) and *System der Philosophie* (1889), each of which went through three revised and enlarged editions. It was also during this period (1889) that he served as rector of the university. Revising his earlier books became by the 1890s a major task. Despite its magnitude, he did this and continued to bring out new books, the most important of which are: *Grundriss der Psychologie* (1896); *Völkerpsychologie* (1900–20), a ten-volume work upon which he concentrated his energies during the final years of his life; *Einleitung in die Philosophie* (1901); and *Einfuhrung in die Psychologie* (1911). Wundt's output in publication was tremendous. His bibliography contains over 500 titles.

Wundt regarded description as the problem of science, hence of scientific psychology, and observation as its method. He mas consequently concerned with observables and with the contents of consciousness and not with the act or functions that cannot be observed but only inferred. His psychology. therefore, has been designated as the content school in contradistinction to the schools that concern themselves with the acts or functions of consciousness. He died at Crossbothen, a village near Leipzig, on

Aug. 31, 1920, two weeks after his 88th birthday.

BIBLIOGRAPHY.—*See* the biographical sketch by E. B. Titchener in *Amer. J. Psychol.* 32:161 ff. (1921); Wundt's autobiography, *Erlebtes und Erkanntes* (1920). For his bibliography, *see* Eleonore Wundt, *Wilhelm Wundts Werk* in *Abhandlungen* sachische *staatliche Forschungsinstitute,* no. 28 (1927). (K. M. D.)

WU PEI-FU (1873–1939), Chinese general, was horn in Shantung. He joined the 3rd army division, commanded by Tsao Kun, distinguished himself in several minor campaigns, and was rewarded by Tsao Kun in 1916 with the command of a division. By 1917 he was the Peking government's chief bulwark against the monarchists, Sun Yat-sen's independent republic at Canton and the ambitions of Marshal Chang Tso-lin, the governor general of Manchuria. Sun Tat-sen was not in a position to take the offensive, but Chang Tso-lin invaded Chihli in the spring of 1922 and. being defeated by the forces of Wu Pei-fu, launched another attack in 1924. Wu Pei-fu was defeated in a great battle near Tientsin in October and fled, after which he remained in retirement at Yochow.

WUPPERTAL, a town in the *Land* North Rhine-Westphalia, Germany. lies in a valley among the hills northeast of Düsseldorf and about 20 mi. S. of Essen and the Ruhr valley. It extends for a distance of 10 mi. along both banks of the Wupper river, a small right-bank tributary that joins the Rhine between Düsseldorf and Cologne. Pop. (1950) 363,224; (1959 est.) 410,255.

Formed by the amalgamation (in 1929) of several towns and communities, Wuppertal has remained a place of contrasts. Its special character lies in the proximity of the countryside which, seen from the hills above. seems to penetrate to its centre. The high narrow houses are built on the slopes of the valley in parallel terraces which are connected by flights of steps. A monorail suspension railway, built at the turn of the 20th century, is the only one of its kind in the world. An opera house is one of the town's modern buildings and there are good sports facilities. There are several colleges for specialized study including theological and technical colleges. a teachers' training college and advanced schools in engineering. industrial design, etc.

Communications and Industry.— The layout of the town with its many flights of steps presents serious traffic problems, but external communications are by a main arterial road through the valley and by roads connecting Wuppertal with the Cologne-Kamen and Cologne-Ruhr *Autobahnen.* Manufactures include machines. vehicles. tools and electrical equipment. The pharmaceutical and rubber factories are world famous. and the town has breweries. printing works and publishing houses. Wuppertal is the textile centre ior the region; artificial silk. ribbons. braid and lace are made.

History.—Wuppertal was created on Aug. 1. 1929, under the name of Barmen-Elberfeld, these being the names of two previously independent towns which now form the eastern and central sections respectively. First mentioned in the 11th and 12th centuries, Barmen and Elberfeld jointly received in 1527 the monopoly in yarn bleaching for the *Bergische Land.* (This monopoly was repealed under the French civil code in 1810.) The introduction of silk weaving (1760) and red dyeing (1785) gave an added impetus to the textile industries which rose to their greatest heights in the 19th century when Barmen textiles became famous. In both Barmen and Elberfeld during the Napoleonic War local government on the French pattern took the place of the existing form of municipal government. In 1815 both towns reverted to Prussia. The system of civic poor relief introduced in Elberfeld in 1853 was long regarded as a model throughout the world. In 1929 the towns of Vohwinkel, Ronsdorf, Beyenburg and Cronenberg were united with Barmen and Elberfeld to form Barmen-Elberfeld. The name was changed to Wuppertal in 1930. The town suffered severe bomb damage during World War II.

(GD. H.; E. G. WR.)

WURTTEMBERG, a former state of Germany. forming a compact mass in the southwest angle of the country. In the south it was cleft by the long narrow territory of Hohenzollern, belonging to Prussia: and it enclosed several small enclaves of Baden and Hohenzollern, while it owned some small exclaves within the limits of these two states. Its total area was 7,530 sq.mi. It was hounded on the east by Bavaria, and on the other three sides by Baden, with the exception of short distances on the south. where it touched Hohenzollern and Lake Constance.

In 1945 Württemberg was divided into Württemberg-Baden, comprised of northern Württemberg and part of Baden (in the U.S. zone of occupation) and Württemberg-Hohenzollern (formerly southern Wiirttemherg and Hohenzollern in the French zone). The two *Länder* joined the German Federal Republic in 1949; in March 1952 they were combined with the *Land* of Eaden, in accordance with a plebiscite in Dec. 1951, to form the new southwestern state (*land*) of Baden-Württemberg. Area 13,803 sq.mi.; pop. (1950) 6,430,225, (1959 est.) 7,505,900.

The chiei mountains are the Black Forest (*q.v.*) on the west, the Swabian Jura or Rauhe Alb stretching across the middle of the country from southwest to northeast and the Adelegg mountains in the extreme southeast, adjoining the Algäu Alps in Bavaria. The Rauhe Alb or Alp slopes gradually down into the plateau on its south side. but on the north it is sometimes rugged and steep, its line broken by isolated projecting hills. The highest summits arc in the southwest, viz., the Lemberg (3,330 ft.), Ober-Hohenberg (3,317 ft.) and Plettenberg (3,287 ft.). South of the Rauhe Alb the plateau of Upper Swabia stretches to Lake Constance and eastward across the Iller into Bavaria. Between the Alb and the Black Forest in the northwest are the fertile terraces of Lower Swabia, continued on the northeast by those of Franconia.

The principal river is the Neckar, which flows northward to join the Rhine, and with its tributaries the Kerns. Kocher, Jagst, Ens, etc., drains much of the country. The Danube flows from southwest to northeast across the south half of former Württemberg, a distance of 65 mi. Just above Ulm it is joined by the Iller, forming the boundary between Bavaria and Württemberg for about 35 mi. The Tauber in the northeast joins the Slain; the Argen and Schussen in the south enter Lake Constance. The lakes of Württemberg, with the exception of those in the Black Forest, all lie south of the Danube. The largest is the Federsee (1 sq.mi.) near Huchau. Mineral springs are abundant; one of the most famous spas is Wildbad, in the Black Forest.

The climate is temperate. and colder among the mountains in the south than in the north. The mean temperature varies at different points from 43° to 50° F. The abundant forests induce much rain, most of which falls in the summer.

Tomns include Stuttgart (capital of the former kingdom of Württemberg and of Baden-Württemberg), Karlsruhe, Ulm, Heilbronn, Esslingen, Reutlingen, Ludwigsburg, Göppingen, Gmund, Tübingen, Tuttlingen and Ravensburg.

Württemberg was essentially an agricultural state. 64% of its total area was under cultivation and 31% was under forest. There are rich meadowlands, cornfields, orchards, gardens and hills covered with vines. The chief agricultural products include oats. spelt, rye. wheat, barley, hops. To these must be added wine (mostly of excellent quality). peas and beans, maize, fruit, chiefly cherries and apples, beets and tobacco and garden and dairy produce. Oi livestock, cattle, sheep and pigs are reared and attention has been paid to horse breeding.

After World War II industrial production increased, and by the mid-1950s about 40% of the population depended on it and only 20% on agriculture and forestry.

The salt industry was developed at the beginning of the 19th century. The iron industry is of great antiquity but was hampered by the absence of coal. Other products are granite, limestone, ironstone and fire clay. Linen, woolen and cotton fabrics are made at Esslingen and Göppingen, and paper at Ravensburg, Heilbronn and other places in Lower Swabia. The manufacturing industries assisted by the government developed rapidly during the later years of the 19th century, notably metalworking, especially such branches of it as require exact and delicate workmanship. Of particular importance are iron and steel goods, locomotives, machinery, motorcars, bicycles, small arms, all kinds of scientific and artistic appliances. pianos, organs and other musical instruments. photographic apparatus, clocks (in the Black Forest), electrical apparatus and gold and silver goods. There are also extensive chemical works. potteries, cabinetmaking workshops, sugar factories, breweries and distilleries. Water power and gasoline largely compensate for the lack of coal.

The Neckar, the Schussen and Lake Constance are all navigable for boats; the Danube begins to be navigable at Ulm. The oldest roads of Württemberg are Roman.

There are various tourist attractions in the area, including the Swabian and Black Forest rerions, the university town oi Heidelberg in the Neckar valley and famous spas. The iederal supreme and constitutional courts of the German Federal Republic sit in Karlsruhe.

HISTORY

Origins.—The origin of the name Württemberg is uncertain. Early forms of it are Wirtenberg, Wirtembenc, Wirtenberc, Wirtemberg and Wirtemberg. In 1806 Württemberg was adopted as the official spelling. As far as we know, the first inhabitants of the country were the

Celts, and then the Suebi. In the 1st century A.D. the Romans included it in the area defended by the *Limes Germanicus* (*q.v.*). Early in the 3rd century the Alamanni drove the Romans beyond the Rhine and the Danube, but in their turn they were conquered by the Franks under Clovis, the decisive battle being iought in 496. In the 9th century it was incorporated with the German duchy of Smabia.

The duchy oi Swabia mas ruled by the Hohenstaufen family until the death of Conradin in 1268, when a considerable part of it fell to the count oi Württemberg, the representative of a family first mentioned about 1080, a certain Conrad von Beutelsbach, having called himself after his ancestral castle of Wurttemberg. The earliest count about whom anything is known is Ulrich, who ruled from 1241 to 1265. Under his sons, Ulrich II and Eberhard I, and their successors the power of the family grew steadily. Eberhard (d. 1325) doubled the area of his county and transferred his residence from Württemberg to Stuttgart. His successors all added something to the area of Württemberg. The lands of the iamily mere several times divided, but in 1482 they were declared indivisible and were united under Count Eberhard V. In 1495 the county was raised to the rank of duchy.

The long reign (1498–1jjo) of Duke Ulrich I, who succeeded to the duchy while he was still only a child, was a most eventful period for the country. His extortions excited a rising known as that of the *arme Konrad* (poor Conrad) and in 1514 by the treaty of Tübingen the people undertook to pay the duke's debts in return ior various political privileges, which in effect laid the foundation of the constitutional liberties of the country. A few years later Ulrich quarreled with the Swabian league, and its forces expelled him and sold his duchy to the emperor Charles V. Charles handed over Wurttemberg to his brother, the German king Ferdinand I, but discontent caused by the oppressive Austrian rule, disturbances in Germany leading to the Peasants' War and commotions aroused by the Reformation gave Ulrich an opportunity to recover it. Aided by Philip, landgrave of Hesse, and other Protestant princes, he fought a victorious battle against Ferdinand's troops at Lauffen in May 1534, and then by the treaty of Cadan he mas again recognized as duke, but was forced to accept his duchy as an Austrian fief. He now introduced the reformed doctrines and proceeded to endow Protestant churches and schools throughout his land. Ulrich's connection with the League of Schmalkalden led to another expulsion, but in 1547 he was reinstated by Charles V, although on somewhat onerous terms.

Ulrich's son and successor, Christopher (1515–68), completed the work of converting his subjects to the reformed iaith. He introduced the system oi church government known as the *Grosse Kirchenordnung*. Frederick I (1557–1608), by paying a large sum of money, induced the emperor Rudolph II in 1599 to free the duchy from the suzerainty of Austria. Thus once again Wurttemberg became a direct fief of the empire. Under the reign of the next duke, John Frederick (1582–1628), Wurttemberg suffered severely from the Thirty Years' War. His son and successor Eberhard III (1614–74) plunged into the war as an ally of France and Sweden in 1633, but after the battle of Nordlingen in 1634 the duchy was occupied by the imperialists and he himself was for several years an exile. He was restored by the peace of Westphalia to a depopulated and impoverished country. During the reign of Eberhard IV (1676–1733),Wurttemberg suffered from French invasions.

Alexander, who became duke in 1733, embraced the Roman Catholic faith. His favourite adviser was the Jew Suss Oppenheimer, and it was thought that master and servant were aiming at the suppression of the diet and the introduction oi the Roman Catholic religion. The sudden death of Charles Alexander in March 1737 put an abrupt end to these plans, and the regent. Charles Rudolph, had Oppenheimer hanged.

Frederick Eugene (d. 1797) educated his children in the Protestant faith. Thus when his son Frederick II became duke in 1797, the ruler of Wiirttemberg was again a Protestant and the royal house adhered to that iaith thereafter. During Frederick Eugene's short reign the French invaded Wiirttemberg, compelled the duke to withdraw his troops from the imperial army and to pay a sum of money.

French Wars.— Frederick II (1754–1816) took part in the war against France against the wishes of his people, and when the French again invaded and devastated the country he retired to Erlangen, where he remained until after the conclusion of the peace of Lunéville in 1801. By a private treaty with France (March 1802) he ceded his possessions on the left bank of the Rhine, receiving in return nine imperial towns, among them Reutlingen and Heilbronn, and some other territories, amounting altogether to about 850 sq.mi. and containing about 124,000 inhabitants. He also accepted from Kapoleon the title of elector. In 1805 Wurttemberg took up arms on the side of France, and by the peace of Pressburg in Dec. 1805 the elector was rewarded with various Austrian possessions in Swabia and with other lands in the neighbourhood. On Jan. 1, 1806, Frederick assumed the title of king and abrogated the constitution.

In 1806 he joined the confederation of the Rhine and received further additions of territory containing 160,000 inhabitants; a little later, by the peace of Vienna in Oct. 1809, about 110,000 more persons were placed under his rule. In return for these favours Frederick joined Napoleon in his campaigns against Prussia, Austria and Russia. After the battle of Leipzig he deserted the French emperor, and by a treaty made with Metternich at Fulda in Kov. 1813 secured the confirmation of his royal title and of his recent acquisitions of territory, while his troops marched with those oi the allies into France. In 1815 the king joined the Germanic confederation. He died on Oct. 30, 1816.

The new king, William I, granted a new constitution in Sept. 1819. A democratic constitution, proclaimed during the revolution of 1848, was abrogated as soon as the movement had spent its force and the constitution of 1819 was restored.

Charles I (1823–91) succeeded his father William as king in July 1864. In 1866 Wurttemberg took up arms on behalf of Austria, but three weeks aiter the battle of Königgrätz its troops were decisively beaten at Tauberbischoisheim, and the country was at the mercy of Prussia. The Prussians occupied the northern part of Wurttemberg and peace was made in Aug. 1866; Wurttemberg paid an indemnity of 8,000,000 gulden and concluded a secret offensive and defensive treaty with Austria's conqueror.

On the outbreak of the Franco-Prussian War in 1870 its troops took a creditable part in the battle of Worth and in other operations of the war. In 1871 Wurttemberg became a member of the new German empire, but retained control of its own post office, telegraphs and railways. It had also certain special privileges with regard to taxation and the army. On Oct. 6, 1891, King Charles died suddenly, and was succeeded by his cousin William II (b. 1848), who continued the policy of his predecessor. The reform of the constitution continued to be discussed. and the election of 1895 was memorable because of the return of a poweriul party of democrats.

20th Century.— Between 1900 and 1910 the political history of Wurttemberg centred round the settlement of the constitutional question. The constitution was revised in 1906. No further changes were made until Oct. 1918, when the Weizsacker ministry, which held office during World War I, resigned, and revolution broke out on Nov. 9. On Nov. 11 a coalition was formed, from which the Spartacists were excluded, and representatives of the bourgeois parties admitted. The king abdicated on Nov. 30. The Spartacist rising of Jan. 1919 had its echo in Wurttemberg chiefly in the form of industrial disturbances, after which the Independent Social Democrats left the ministry. A new republican constitution was adopted in 1919, but this mas superseded in 1933 by a national socialist regime.

Wurttemberg mas occupied by Allied troops in 1945. For subsequent political changes, *see* above.

WURTZ, CHARLES ADOLPHE (1817–1884), French chemist, is credited with making the very significant discovery of the amines and subsequently the compound ureas. Born at Rolfisheim, near Strasbourg, on Nov. 26. 1817. he studied medicine and in 1839 was appointed *chef des travaux chimiques* at the Strasbourg faculty of medicine. In 1842 he studied at Giessen under Justus von Liebig (*q.v.*). He graduated in medicine in 1843. In 1844 he went to Paris and after a period under Antoine Balard, he became assistant in 1845 to J. B. A. Dumas (*q.v.*) at the École de Médecine. In 1852 Wurtz was appointed to the combined chairs of organic chemistry and of mineral chemistry and toxicology at the faculty of medicine as successor to Dumas. In 1875 he became the first occupant of the chair of organic chemistry at the Sorbonne. He died in Paris on May 12, 1884.

Wurtz's first published paper was on hypophosphorous acid (1842), and the continuation of his work on the acids of phosphorus (1845) resulted in the discovery of phosphorus oxychloride, as well as of copper hydride. Investigation of the alkyl isocyanates (1848) led him to the discovery of the amines (1849), and later (1851) the compound ureas. In 185j he showed that the combination between two hydrocarbon radicals could be brought about by the action of sodium on the alkyl iodides; this important reaction is known by his name. Electrolysis of mixed salts of aliphatic acids produced new simple and mixed radicals. About the same time he reached the conclusion that glycerol is a body of alcoholic nature formed on the type of three molecules of water. as common alcohol is on that of one! and was thus led (1856) to the study of the glycols, compounds related to both glycerol and alcohol. By oxidation of the glycols he produced homologues of lactic acid.

WÜRZBURG, a university town and episcopal see of Bavaria, Germany. capital of the province of Lower Franconia, situated on the Main, 60 mi. by rail S.E. from Frankfurt and at the junction of main lines to Bamberg and Nuremberg. Pop. (1950) 78.443. The site of the Leistenberg was occupied by a Koman fort, and was probably fortified early in the 13th century. Wircebirgum is the old Latin form of the name of the town; Herbipolis ("herb town") first appears in the 12th century. The bishopric was probably founded in 741, but the town appears to have existed in the previous century. About the 12th century the bishops had ducal authority in eastern Franconia. Quarrels broke, out between the bishops and the citizens, and, after long struggles, the citizens. submitted in 1400. Several imperial diets were held in Wurzburg, chief among these being the one of 1180 when Henry the Lion was placed under the ban. By the peace of Lunéville the bishopric was secularized, and in 1803 Wurzburg passed to Bavaria. The peace of Pressburg in 1805 transferred it to Ferdinand, formerly grand-duke of Tuscany, who joined the confederation of the Rhine and took the title of grand-duke of Würzburg. In 1815 the congress of Vienna restored Wiirzburg to Bavaria. The bishopric of Wurzburg at one time embraced an area of about 1,900 sq.m. and had about 250,000 inhabitants. A new bishopric of Würzburg was created in 1817.

An ancient stone bridge (1474–1607), 650 ft. long and adorned with statues of saints, and two modern bridges connect the two parts of the town on each side of the river. On the Leistenberg stands the fortress of Marienberg, which from 1261 to 1720 was the residence of the bishops. Many of the houses are interesting specimens of mediaeval architecture; and the numerous old churches recall the fact that it was long the capital of an ecclesiastical principality. The principal church is the imposing Romanesque cathedral, a basilica with transeptg, begun in 1042 and consecrated in 1189. The four towers, however, date from 1240, the (rococo) façade from 1711–19, and the dome from 1731. The transepts terminate in apses. The exterior was restored in 1882–83. Other interesting buildings are the Marienkapelle, the Haugerstifts church, the Neumunster church, the church of St. Burkhard, the palace, formerly the residence of the bishops and grand-dukes of Wurzburg, and the Julius hospital, and the town hall dates in part from 1456. Walter von der Vogelweide is buried in the cloisters adjoining the Neumunster church.

A university was founded at Würzburg in 1403, but it only existed for a few years. The present university was founded by Bishop Julius in 1582. There W. K. Rontgen discovered the "Rontgen rays" in 1896. Wurzburg was long the Jesuit stronghold in Germany, and the Roman Catholic theological faculty attracted large numbers.

Würzburg is surrounded by vineyards. Its principal industries are the manufacture of tobacco, furniture. machinery, scientific instruments and railway carriages. It has also breweries. and produces bricks, marmalade: pianos, sugar, malt and chocolate.

WURZEN, a town of Germany in the district of Leipzig. on the Mulde. 15½ mi. E. of the city of Leipzig by rail on the main line (via Riesa) to Dresden. Pop. (1950) 26.456. Wurzen was founded by the Sorbs, and was a town early in the 12th century. when the bishop of Meissen founded a monastery there. In 1581 it passed to the elector of Saxony. It has a 12th-century cathedral and a castle. at one time a residence of the bishops of Meissen and now utilized as law courts.

WYANDOTTE, a city of Wayne county, Mich., U.S., 10 mi. S. of Detroit on the Detroit river. The city was named for the Wyandots, a branch of the Huron tribe which fled from Ontario to Michigan in the early 18th century. It was at the Indian village Monguaga on the present site of Wyandotte that Pontiac, the famous Ottawa chief, planned a surprise attack on Detroit in 1763. His plans. however, were discovered and the plot failed. Settled in 1820. Wyandotte was incorporated as a village in 1854 and as a city in 1867. Ironworks and rolling mills were established in 1853 and in 1864 the first Bessemer steel in the United States was made there. Shipbuilding developed also and in 1887 vast salt beds were discovered under the city, assuring the development of chemical industries. Manufactures. in addition to chemicals, include cleaning products! gaskets, toys, paints, cement and screw machine products. Wyandotte is part of the Detroit standard metropolitan statistical area. For comparative population figures see table in MICHIGAN: *Population.* (P. P. M.)

WYANDOTTE CAVE, a cave in Crawford county, southern Indiana. It is but one of the many caves of southern Indiana dissolved and eroded in the relatively pure, massive, horizontally bedded Mississippian limestones that extend southward into the cavebearing regions of Kentucky and Tennessee. Like Mammoth cave, Ky., Wyandotte cave owes its early history to the demand for nitre for gunpowder in the War of 1812, the nitrate industry beginning in that year and terminating in 1817. The entrance is about 200 ft. above the Blue river. The "old cave" constitutes that portion of the cave discovered before 1850. In that year a new cave was discovered, a long extension with many passages and chambers. The mouth of the old .cave is 20 ft. wide and 6 ft. high. One hundred feet within the entrance the gallery widens into a spacious corridor known as Faneuil Hall, from which issues the Columbian Arch, a semicylindrical tunnel 75 ft. long, which in turn opens into Washington Avenue, a grand passageway, 275 ft. long, 30 ft. wide, and 40 ft. high. This passage terminates in a low gallery which expands into Banditti Hall, the common entry into both the old and new caves. The old cave ends in the Senate Chamber, an imposing rotunda like, but not quite so large as, Rothrock's cathedral with its magnificent Wallace's Grand Dome rising above Monument mountain, beyond Rothrock's Straits in the new cave.

The Senate Chamber is a vast elliptical amphitheatre, 145 ft. long and 56 ft. wide, converging upward to a gigantic dome. In the centre of the chamber a mass of fallen rock constitutes Capitol Hill, 32 ft. high, out of the centre of which rises the massive, fluted column of satin spar, or calcite, known as the "Pillar of the Constitution." Quite cylindrical, 25 ft. in diameter, this majestic column extends to the centre of the dome far above. A relatively sparse cave fauna and a few evidences of Indian activity are found in the cave. (W. E. E.)

WYANT, ALEXANDER HELWIG (1836–1892), U.S. painter, whose landscapes evolved from the tight realism of the Hudson River school to the subjectivism of the Barbizon school, was born at Port Washington, O., on Jan. 11, 1836. He studied with Hans Gude in Karlsruhe, and traveled in England and Ireland before returning to the United States. A trip with a government exploring expedition in the far west in 1873 left him with a physical infirmity that restricted his activity and in his later years nearly immobilized him.

Wyant died in New York city on Nov. 29, 1892.

Wyant's early landscapes, of which the best is "The Mohawk Valley" (1866; Metropolitan Museum of Art, New York city); were characterized by their near-photographic faithfulness to the subject, romanticism and a wide, panoramic effect. His mature art is marked by considerably more freedom and shows his relationship to Corot. This may be seen in "Moonlight and Frost" (Brooklyn museum) and "Landscape in the Adirondacks" (Metropolitan).

WYAT, SIR THOMAS (1503–1542), English poet and statesman, elder son of Henry Wyat, or Wiat, afterwards knighted, and his wife Anne, daughter of John Skinner of Reigate, Surrey, was born at Allington Castle, near Maidstone, Kent, in 1503. His father (1460–1537) belonged to a Yorkshire family, but bought Allington about 1493. He was an adherent of the Lancastrian party, and was imprisoned and put to the torture by Richard III. The family records (in the possession of the earl of Romney) relate that during his imprisonment he was saved from starvation by a cat that brought him pigeons. At the accession of Henry VIII he became knight of the Bath (1509), knight banneret (1513) and held various offices at court. His son, Thomas Wyat, was admitted at St. John's College, Cambridge, when about twelve years of age, took his B.A. degree in 1518, and proceeded M.A. in 1522. An early marriage with Elizabeth Brooke, daughter of Lord Cobham, proved unhappy, for a letter from the Spanish ambassador Chapuys to Charles V. (Feb. 9, 1542) speaks of her having been repudiated by her husband. As early as 1516 Wyat was server extraordinary to the king, and in 1524 he was at court as keeper of the king's jewels. He was one of the champions in the Christmas tournament of 1525. His father had been associated with Sir Thomas Boleyn as constable of Norwich Castle, and he had thus been early acquainted with Anne Boleyn. He appears to have been generally regarded as her lover. He was employed on missions to Francis I. (1526), to the papal court (1527), and from Rome was sent to Venice. From 1528 to 1530 he was acting as high marshal at Calais.

During the following years he was constantly employed in Henry's service, and was apparently high in his favour. He was, however, sent to the Tower in 1536, perhaps because it was desired that he should incriminate the queen. His father's correspondence with Cromwell does not suggest that his arrest had anything to do with the proceedings against Anne Boleyn, but the connection is assumed *(Letters and Papers of Henry VIII.* vol. x. No. 919) in the letters of John Hussey to Lord Lisle, deputy of Calais. Nicholas Harpsfield makes a circumstantial statement *(Pretended Divorce . . .* Camden Soc. p. 253) that Wyat had confessed his intimacy with Anne to Henry VIII. and warned him against marrying her; but this, in view of his continued favour, seems highly improbable. He was released after a month's imprisonment, and in the autumn of that year took part in the suppression of the Lincolnshire rising. In March 1537 he was knighted, and a month later was sent abroad as ambassador to Charles V. In 1j38 he was joined by Edmund Bonner, then a simple priest, who wrote to Cromwell (2nd Sept. 1538) a long letter (Petyt MS. 47, Middle Temple; first printed in the *Gentleman's Magazine,* June 1850) in which he accused Wyat of disloyalty to the king's interests, and of many personal slights to himself. So long as Cromwell ruled no notice was taken of Bonner's allegations. He was recalled in April 1539, but later in the same year he was employed on another embassy to the emperor. After Cromwell's death Wyat's enemies renewed their attacks, and he was imprisoned (Jan. 17, 1541) in the Tower on the old charges, with the additional accusation of treasonable correspondence with Cardinal Reginald Pole. He was released at the intercession of the queen, Catherine Howard, on condition that he confessed his guilt and took back his wife, from whom he had been separated for fifteen years, on pain of death if he were thenceforth untrue to her *(see* Chapuys to Charles V., March 1541). He received a formal pardon on March 21, and received during the year substantial marks of the king's favour. In the summer of the next year he was sent to Falmouth to meet the ambassadors of the emperor. The heat brought on a fever to which he succumbed at Sherborne, Dorset, on Oct. 11. A Latin elegy on his death was written by his friend John Leland. "Naenia in mortem Thomae Viati equitis incomparabilis"; and Henry Howard, earl of Surrey, celebrated his memory in some well-known lines beginning "Wyat resteth here, that quick could never rest," and in two sonnets.

Wyat's work falls readily into two divisions: the sonnets. rondeaus, and lyric poems dealing with love; and the satires and the version of the penitential psalms. The love poems probably date from before his first imprisonment. A large number were published in 1jjj in *Songes and Sonettes (Tottel's Miscellany).* Wyat's contributions number 96 out of a total of 310. These have been supplemented from mss. He was the pioneer of the sonnet in England. Wyat wrote in all thirty-one sonnets, ten of which are direct translations of Petrarch. The sentiment is strained and artificial. Wyat shows to greater advantage in his lyrical metres, in his epigrams and songs, especially in those written for music[1], where he is less hampered by the conventions of the Petrarchan tradition, to which his singularly robust and frank nature was ill-fitted. Wyat wrote three excellent satires—"On the mean and sure estate," dedicated to John Poins, "Of the Courtier's Life," to the same, and "How to use the court and himself." They are written in *terza rima* and in form and matter owe much to Luigi Alamanni. In the "Penitential Psalms" each is preceded by a prologue describing the circumstances under which the psalmist wrote, and the psalms themselves are very freely paraphrased, with much original matter from the author. They were published in 1549 by Thomas Raynald and John Harrington as *Certayne Psalmes . . . drawen into English meter by Sir Thomas Wyat Knyght.*

None of Wyat's other poems were printed until fifteen years after his death, in *Songes and Sonettes.* There are editions of his *Works* by *G. F.* Nott (1816); of the *Songes and Sonnettes* by *E.* Xrber (1870); and of the *Poems* (2 vols.) by A. K. Foxwell (1913). *See A.* K. Foxwell, *Study of Wyat's Poems* (1911). *See* also Brewer and Gardiner, *Letters and Papers of Henry VIII.* (especially from 1534 to 1542).

[1] One of the most musical of the pieces printed in his works, however, "The Lover complayneth the unkindnes of his Love," beginning "My lute, awake," is sometimes attributed to George Boleyn, Lord Rochford *(see* E. Bapst, *Deux Gentilshommes poètes de la cour de Henri VIII.,* p. 142).

WYAT, SIR THOMAS (THE YOUNGER) (d. 1554), English conspirator, son of the preceding. led a rebellion against Queen Mary. He was over 21 in 1543, but the date of his birth is uncertain. Somewhat wild in his youth. he was imprisoned with the young earl of Surrey for breaking Londoners' windows (1543). He fought at Boulogne (1544) and then served abroad till 1550. In 1542 he inherited the family property of Xllington castle and Boxley abbey in Kent on the death of his iather.

In 1554 he joined with the conspirators who combined to prevent the marriage of Queen Mary with Philip, the prince of Spain. On Jan. 22. 1j54, he summoned a meeting of his friends at his castle of Allington, and the 25th was fixed for the rising. On the 26th Wyat occupied Rochester, and issued a proclamation to the county. Lord Abergavenny and Sir Robert Southwell. the sherifi of Kent. were deserted by their men. who either disbanded or went over to Wyat. A detachment of the London trainbands sent against him by Queen Mary, under the command of the duke of Norfolk, followed their example. The rising now seemed so formidable that a deputation was sent to Wyat by the queen and council to ask his terms. He insisted that the Tower should be surrendered to him, and the queen put under his charge. The insolence of these demands caused a reaction in London. where the reformers were strong and were at first in sympathy with him. When he reached Southwark on Feb. 3, he found London bridge occupied in force, and was unable to penetrate into the city. He was driven from Southwark by the threats of Sir John Brydges (or Bruges; afterward Lord Chandos), lieutenant of the Tower, who was prepared to fire on the suburb with the guns of the Tower. Wyat then marched up the river to Kingston. where he crossed the Thames, and made his way to Ludgate with a part of his following. Some of his men were cut off. Others lost heart and deserted. His only hope was that a rising would take place, but the loyal forces kept order, and after attempting to force the gate Wyat surrendered. He was brought to trial on March 15, and could make no defense. Execution was delayed. in the hope that in order to save his life he would compromise the queen's sister, the princess Elizabeth. He was executed on April 11. and on the scaffold expressly cleared the princess of all complicity in the rising. His estates were afterward partly restored to his son George. the father of the Sir Francis Wyat (d. 1644) who was governor of Virginia during 1621–26 and 1639–42.

WYATT, JAMES (1746–1813). English architect of country houses and designer of the Pantheon, London, was born at Burton Constable. Staffordshire. on Aug. 3, 1746. In 1762 he went to Italy, where he remained six years. The opening of the Pantheon in 1772 (burned 1792, rebuilt, remodeled three times and finally demolished 1937), designed by him as a "\Tinter Ranelagh," made him one of the most fashionable architects in England almost overnight. Although he succeeded Sir William Chambers as surveyor general he is chiefly remembered for his domestic architecture. In point of originality his classical works were surpassed by his Gothic. among which Lee Priory, Kent. Fonthill Abbey, Wiltshire, and Ashridge Park, Hertfordshire, were the most notable. He was killed in a coach accident near Marlborough on Sept. 4, 1813. and is buried in Westminster abbey.

See A. Dale, *James Wyatt* (1956). (Ms. W.)

WYCHERLEY, WILLIAM (c. 1640–1716), English dramatist. was born about 1640 at Clive, near Shrewsbury, where for several generations his family had been settled on a moderate estate of about £600 a year. Like Vanbrugh, Wycherley spent his early years in France. whither, at the age of fifteen, he was sent to be educated in the very heart of the "precious" circle of Mme. de Montausier. on the banks of the Charente. This lady effected the first of his successive conversions from Protestantism to Catholicism. Later at Oxford. Bishop Barlow reclaimed him. and under James II. he returned to Catholicism once more. In fact. the deity he worshipped was the deity of the "polite world" of his time—gentility. Moreover. as a professional fine gentleman, at a period when, as the genial Major Pack says. "the amours of Britain would furnish as diverting memoirs, if well related, as those of France published by Rabutin, or those of Nero's court writ by I'etronius," Wycherley was obliged to be a loose liver.

As a fellow-commoner of Queen's College, Oxford, Wycherley lived (according to Wood) in the provost's lodgings, being entered as "Philosophiae Studiosus" in July 1660. And he does not seem to have matriculated or to have taken a degree. He left Oxford and settled in the Inner Temple; but not, naturally, to engage seriously in the study of the law. Pleasure and the stage were alone open to him, and probably early in 1671 was produced, at the Theatre Royal, Love in a Wood. It was published the next year. With regard to this comedy Wycherley told Pope that he wrote it the year before he went to Oxford. But we need not believe him: the worst witness against a man is mostly himself. To pose as the wicked boy of genius has been the foolish ambition of many writers, but on inquiry it will generally be found that these inkhorn Lotharios are not nearly so wicked as they would have us believe. It is not so much that, as Macaulay insists, "the whole air and spirit of the piece belong to a period subsequent to that mentioned by Wycherley," but that "the whole air and spirit of the piece" belong to a man—an experienced and hardened young man of the world—and not to a boy who would fain pose as an experienced and hardened young man of the world. The real defence of Rycherley against his foolish impeachment of himself is this, that Love *in* a *Wood,* howsoever inferior in structure and in all the artistic economies to The Country *Wife* and The Plain Dealer, contains scenes which, not for moral hardness merely, but often for real dramatic ripeness, are almost the strongest to be found amongst his four plays. The play was dedicated to Charles II.'s mistress, the duchess of Cleveland, whose favours Wycherley forthwith enjoyed. His fortune as a dramatist was made. Voltaire (in his Letters on the *English Nation*) has a picturesque description of the duchess's visits to Wycherley's chambers in the Temple.

Whether Wycherley's experiences as a naval officer, which he alludes to in his lines "On a Sea Fight which the Author was in betwixt the English and the Dutch," occurred before or after the production of Love in a Wood is a point upon which opinions differ, but on the whole we are inclined to agree with Macaulay, against Leigh Hunt, that these experiences took place not only after the production of *Love* in a *Wood* but after the production of The Gentleman Dancing Master, in 1673. We also think, with Macaulay, that he went to sea simply because it was the "polite" thing to do so—simply because, as he says in the epilogue to The Gentleman Dancing Master "all gentlemen must pack to sea."

This second comedy was published in 1673, but was probably acted late in 1671. It is inferior to Love *in* a Wood. In *The* Relapse the artistic mistake of blending comedy and farce damages a splendid play, but leaves it a splendid play still. In The Gentleman Dancing *Master* this mingling of discordant elements destroys a play that would never in any circumstances have been strong—a play nevertheless which abounds in animal spirits, and is luminous here and there with true dramatic points.

It is, however, on his two last comedies—The Country Wife and The Plain Dealer—that must rest Wycherley's fame as a master of that comedy of repartee which, inaugurated by Etheredge, and afterwards brought to perfection by Congreve and Vanbrugh, supplanted the humoristic comedy of the Elizabethans. *The* Country Wife, produced in 1672 or 1673 and published in 1675, is so full of wit, ingenuity, animal spirits and conventional humour that, had it not been for its motive, it would probably have survived as long as the acted drama remained a literary form in England. So strong, indeed, is the hand that could draw such a character as Marjory Pinchwife (the undoubted original not only of Congreve's Miss Prue but of Vanbrugh's Hoyden), such a character as Sparkish (the undoubted original of Congreve's Tattle), such a character as Horner (the undoubted original of all those cool impudent rakes with whom our stage has since been familiar), that Wycherley is certainly entitled to a place alongside Congreve and Vanbrugh.

Scarcely inferior to *The* Country *Wife* is The Plain Dealer, produced probably early in 1674 and published three years later,—a play of which Voltaire said, "Je ne connais point de comédie chez les anciens ni chez les moderns où il y ait autant d'esprit." This comedy had an immense influence, as regards manipulation of dialogue, upon all subsequent English comedies of repartee, and he who wants to trace the ancestry of Tony Lumpkin and Mrs. Hardcastle has only to turn to Jerry Blackacre and his mother, while Manly (for whom Wycherley's early patron, the duke of Montausier, sat), though he is perhaps overdone, has dominated this kind of stage character ever since.

It was after the success of The Plain Dealer that the turning-point came in Wycherley's career. The great dream of all the men about town in Charles's time, as Wycherley's plays all show, was to marry a widow, young and handsome, a peer's daughter if possible—but in any event rich, and spend her money upon wine and women. While talking to a friend in a bookseller's shop at Tunbridge, Wycherley heard The Plain Dealer asked for by a lady who, in the person of the countess of Drogheda, answered all the requirements. An introduction ensued, then love-making, then marriage—a secret marriage, probably in 1680, for, fearing to lose the king's patronage and the income therefrom, Wycherley still thought it politic to pass as a bachelor. But the news reached the royal ear, and Wycherley lost the royal favour for ever. He never had an opportunity of regaining it, for the countess seems to have really loved him, and Love in a Wood had proclaimed the writer to be the kind of husband whose virtue prospers best when closely guarded at the domestic hearth. Wherever he went the countess followed him, and when she did allow him to meet his boon companions it was in a tavern in Bow Street opposite to his own house, and even there under certain protective conditions. In summer or in winter he was obliged to sit with the window open and the blinds up, so that his wife might see that the party included no member of a sex for which her husband's plays had advertised his partiality. She died, however, in the year after her marriage and left him the whole of her fortune. But the title to the property was disputed; the costs of the litigation were heavy—so heavy that his father was unable (or else he was unwilling) to come to his aid; and the result of his marrying the rich, beautiful and titled widow was that the poet was thrown into the Fleet prison. There he remained for seven years, being finally released by the liberality of James 11.—a liberality which, incredible as it seems, is too well authenticated to be challenged. James had been so much gratified by seeing The *Plain* Dealer acted that, finding a parallel between Manly's "manliness" and his own, such as no spectator had before discovered, he paid off Wycherley's execution creditor and settled on him a pension of £200 a year. Other debts still troubled Rycherley, however, and he never was released from his embarrassments, not even after succeeding to a life estate in the family property. In coming to Wycherley's death, we come to the worst allegation that has ever been made against him as a man and as a gentleman. At the age of seventy-five he married a young girl. and is said to have done so in order to spite his nephew, the next in succession.

Wycherley wrote verses, and, when quite an old man, prepared them for the press by the aid of Alexander Pope, then not much more than a boy. But, notwithstanding all Pope's tinkering, they remain contemptible. Pope's published correspondence with the dramatist was probably edited by him with a view to giving an impression of his own precocity. The friendship between the two cooled, according to Pope's account, because Wycherley took offence at the numerous corrections on his verses. It seems more likely that Wycherley discovered that Pope, while still professing friendship and admiration, satirized his friend in the Essay on Criticism. Wycherley died on Jan. 1, 1716, and was buried in the vault of the church in Covent Garden.

Wycherley's complete works were edited by M. Summers in 4 vols. (Nonesuch Press, 1924). See C. Perromat, *William* Wycherley, *sa vie,* son oeuvre **(1921).** (T. W.-D.; X.)

WYCLIFFE (or WYCLIF), **JOHN** (*c.* 1320–1384), English reformer, was born, according to John Leland, at Ipreswel (evidently Hipswell), in Yorkshire[1]. The Wycliffes were connected

[1] The form of spelling of the name Wycliffe adopted in this article is that of the village Wycliffe-on-Tees, from which Leland says that he "drew his origin" (*Collectanea* ii. 329); it is also preferred by the editors of the Wycliffe Bible, by Milman and by Stubbs. "Wyclif" has the support of Shirley, of T. Arnold and of the Wyclif Society; **while "Wiclif"** is the popular form in Germany.

with Balliol College, Oxford, which had been founded by their neighbours, the Balliols of Barnard Castle; John Wycliffe went there, and some time after 1356 was elected master. Confusion with contemporaries makes it not easy to trace his Oxford life; it has been said that he was a fellow of Merton College in 1356. In 1361 he accepted the living of Fillingham in Lincolnshire. In the same year a "John de Wyclif of the diocese of York, M.A." was a suppliant to the Roman Curia for a provision to a prebend, canonry and dignity at York (Cal. of Entries in the *Papal* Registries, ed. Bliss, Petitions, i. 390). This was not granted, but Wycliffe received instead the prebend of Aust in the collegiate church of Westbury-on-Trym. In 1365 one "John de Wyclif" was appointed by Simon Islip, archbishop of Canterbury, to the wardenship of Canterbury Hall, which the archbishop founded for a mixed body of monks and secular clergy, and then filled exclusively with the latter. In 1367, his successor, Simon Langham, replaced the intruded seculars by monks. The displaced warden and fellows appealed to Rome, and in 1371 judgment was given against them. The question of the identity of the warden of Canterbury Hall with the reformer is still a matter of dispute. It may have been referred to by Wycliffe himself (De *ecclesia,* cap. xvi. pp. 370 sq.), and was assumed by the contemporary monk of St. Albans (Chron. Angl. "Rolls" ser. p. 115) and by Wycliffe's opponent William Woodford (Fasc. *Zizan.* p. 517), who found in Wycliffe's resentment at this treatment the motive for his attacks on the religious orders; it has likewise been assumed by a series of modern scholars, including Loserth (*Realencyklopädie,* 1908 ed., vol. xxi. p. 228, § 35), who only denies the deductions that Woodford drew from it. Dr. Rashdall, following Shirley, brings evidence to show that the Wycliffe of Canterhury Hall was the same person as the fellow of Merton, this being the strongest argument against the identification of the latter with the reformer.

Long before Wycliffe had become a power outside Oxford his fame was established in the university. He was acknowledged supreme in the philosophical disputations of the schools, and his lectures were crowded, but it was not until he was drawn into the arena of the politico-ecclesiastical conflicts of the day that Wycliffe became of world-importance. It has been assumed that this happened first in 1366, and that Wycliffe published his Determinatio quaedam de *dominio* supporting parliament in refusing the tribute demanded by Pope Grban V.; but Loserth has shown that this work must be assigned to a date some eight years later. Wycliffe, in fact, for some years to come had the reputation of a good "curialist." Had it been otherwise, the pope would scarcely have granted him (January 1373) a license to keep his Westbury prebend even after he should have obtained one at Lincoln (Cal. *Papal* Letters, ed. Bliss and Twemlow, iv. 193). Moreover, it is uniformly asserted that Wycliffe fell into heresy after his admission to the degree of doctor (*Fasc. Ziz.* p. 2), and the papal document above quoted shows that he had only just become a doctor of theology, that is in 1372.

But Wycliffe's tendencies may already have called attention to him in high places as a possibly useful instrument for the antipapal policy of John of Gaunt and his party. On the 7th of April 1374, he was presented by the crown to the rectory of Lutterworth in Leicestershire, which he held until his death; and on the 26th of July he was nominated one of the royal envoys to Bruges to confer with the papal representatives on the long vexed question of "provisions" (*q.v.*). He may have been attached to this mission as theologian—a proof that he was not yet considered a persona *ingrata* at the Curia. His name stands second, next after that of the bishop of Bangor, and he was paid at the princely rate of twenty shillings a day. The commission was appointed because of repeated complaints from the Commons; but the king was interested in keeping up the papal system of provisions and reservations, and the negotiations were practically fruitless.

After his return Wycliffe lived chiefly at Lutterworth and Oxford, making prolonged visits to London, where his fame as a popular preacher was established. It is from this period that dates the development of his systematic attack on the established order in the church. It was not at first the dogmatic, but the political elements in the papal system that provoked his censure. The negotiations at Bruges had strengthened his sympathy with the anti-curial tendencies in English politics from Edward I.'s time onwards, and a final impulse was given by the attitude of the "Good Parliament" in 1376; in the autumn of that year he was reading his treatise on civil lordship (De *civili* dominio) to his students at Oxford. Of Its propositions some, according to Loserth, were taken bodily from the 140 titles of the bill dealing with ecclesiastical abuses introduced in the parliament; but it may perhaps be that Wycliffe inspired the bill rather than the bill Wycliffe. For the first time he now publicly proclaimed the doctrine that righteousness is the sole indefeasible title to dominion and to property, that an unrighteous clergy has no such title, and that the decision as to whether or no the property of ecclesiastics should be taken away rests with the civil power.

If the position at which Wycliffe had now arrived was originally inspired, as Loserth asserts, by his sympathy with the legislation of Edward I., *i.e.,* by political rather than theological considerations, the necessity for giving to it a philosophical and religious basis led him to criticism of the doctrinal standpoint of the church. As a philosopher Wycliffe was no more than the last of the conspicuous Oxford scholastics, and his philosophy is important in so far as it determined his doctrine of *dominium,* and the direction in which his political and religious views were to develop. In the controversy between Realism and Nominalism he was on the side of the former, though his doctrine of universals showed the influence of Ockham and the nominalists. To Wycliffe the doctrine of arbitrary divine decrees was anathema. The will of God is his essential and eternal nature, by which all his acts are determined; God created all things in their primordial causes, as genera and species, or else in their material essences, *secundum* rationes *absconditas seminales* (ibid. p. 66). The world is therefore not merely one among an infinity of alternatives, but is the only possible world; it is, moreover, not in the nature of an eternal emanation from God, but was created at a given moment of time—to think otherwise would be to admit its absolute necessity, which would destroy free-will and merit. Since, however, all things came into being in this way, it follows that the creature can produce nothing save what God has already created. This leads to predestination and free-will. Wycliffe takes a middle position. God does not will sin, for He only wills that which has being, and sin is the negation of being; He necessitates men to perform actions which only become right or wrong through man's free agency. All human lordship is derived from the supreme overlordship of God and is inseparable from it, since whatever God gives is part of himself. But, in giving, God does not part with the lordship of the thing given; whatever lordship the creature may possess is held subject to due service to the supreme overlord. Thus, as in feudalism, lordship is distinguished from possession. Property is the result of sin; Christ and his apostles had none. The service by which lordship is held of God is righteousness and its works; it follows that the unrighteous forfeit their right to exercise it, and may be deprived of their possessions by competent authority.

The question follows as to what this authority is, and this Wycliffe sets out to answer in the Determinatio quaedam de dominio and the De *civili* dominio. Briefly, his argument is that the church has no concern with temporal matters at all, that for the clergy to hold property is sinful, and that it is lawful for statesmen (*politici*)—who are God's stewards in temporals—to take away the goods of such of the clergy as no longer render the service by which they hold them. That the church was actually in a condition to deserve spoliation he refused to affirm; but his theories fitted in too well with the notorious aims of the duke of Lancaster not to rouse the bitter hostility of the endowed clergy.

Hitherto Wycliffe had made no open attack on the doctrinal system of the church. Early in 1377, however, Archbishop Sudbury summoned him to appear before the bishop of London, and on Feb. 19 Wycliffe made his appearance at St. Paul's, accompanied by the duke of Lancaster, by Lord Percy, marshal of England, and by four doctors of the four mendicant orders. Before Wycliffe could open his mouth, the court was broken up by a rude brawl between his protectors and Bishop Courtenay, the affair developing into a general riot.

Wycliffe had escaped for the time, but probably before this his enemies had set their case before the pope; and on the 22nd of May five bulls were issued by Gregory XI., condemning eighteen of Wycliffe's "conclusions." All the articles but one are taken from his *De civili dominio*. The bulls truly stated Wycliffe's intellectual lineage; he was following in the error of Marsilius of Padua; and the articles laid against him are concerned entirely with questions as to how far ecclesiastical censures could lawfully affect a man's civil position, and whether the church had a right to hold temporal endowments. The bulls were addressed to the archbishop of Canterbury and the bishop of London, the university of Oxford, and the king. The university was to send Wycliffe to the prelates, who were to examine the truth of the charges and to report to the pope, Wycliffe being meanwhile kept in confinement. The execution of the papal bulls was impeded by three separate causes—the king's death on the 21st of June, the tardy action of the bishops, who enjoined the university to make a report; and the unwillingness of the university to admit the pope's right to order the imprisonment of any man in England. The convocation of the university merely directed Wycliffe to keep uithin his lodgings at Black Hall for a time.

As soon as parliament met in the autumn of 1377, Wycliffe was consulted by it as to the lawfulness of prohibiting that treasure should pass out of the country in obedience to the pope's demand. Wycliffe's affirmative judgment is contained in a state paper still extant; and its tone is plain proof that his views on the main question of church and state had the support of the nation He had laid before this same parliament his answer to the pope's bulls, with a defence of the soundness of his opinions. His university, moreover, confirmed his argument; his tenets, it said, were orthodox though their expression might admit of a wrong interpretation. Early in 1378 Wycliffe appeared at Lambcth Palace to clear himself before the prelates who had summoned him. A more cautiously worded defence was laid before the council; but its session was rudely interrupted, not only by a crowd of citizens, but also by a messenger from the princess of Males enjoining them not to pass judgment against IVycliffe; and thus a second time he escaped. Meanwhile his "protestatio" was sent on to Rome, but before any further step could be taken Gregory XI. died.

In the autumn of this year IVycliffe was once more called upon to prove his loyalty to John of Gaunt, who had violated the sanctuary of Westminster by sending armed men to seize two squires who had taken refuge there. One of them was murdered, together with a servant of the church. The bishop of London excommunicated all concerned in the crime (except only the king, his mother and his uncle), and preached against the culprits at Paul's Cross. At the parliament held at Gloucester in October, in the presence of the legates of Pope Urban VI, Wycliffe read an apology for the duke's action, pleading that the men were killed in resisting legal arrest. The paper, which forms part of the *De ecclesia,* maintains the right of the civil power to invade the sanctuary to bring escaped prisoners to justice.

The schism in the papacy, owing to the election of Clement YII in opposition to Urban VI, accentuated Wycliffe's hostility to the Holy See and its claims. He did not object to a visible head of the church so long as this head possessed the essential qualification of righteousness. It was later that Wycliffe definitely branded the pope, *qua* pope, as Antichrist. (*See* vol. ii. of the *Sermones*. Book iii of his *Opus evangelicum* is entitled *De Antichristo.*) Wycliffe's criticism of the established order and of the accepted doctrines he now determined to carry into the streets. Tor this purpose he instituted "simple" priests to preach his doctrines throughout the country; and, secondly, he translated the Vulgate into English. with the aid of his friends Nicholas Hereford and John Purvey (*see* BIBLE, TRANSLATIONS OF). This version of the Bible. and his numerous sermons and tract>,established Wycliffe's position as the founder of English prose.

Wycliffe had been on good terms with the friars, whose ideal of poverty appealed to him but he had come to recognize that all organized societies within the church were liable to the same corruption, while he objected fundamentally to a special standard of morality for the "religious." His itinerant preachers were meant to supplement the services of the church by religious instruction in the vernacular, and among them were men who held or had held respectable positions at Oxford. The common people were rejoiced by their plain and homely doctrine which dwelt chiefly on the simple "law" of the gospel, while they no doubt relished the denunciation of existing evils in the church. The feeling of disaffection against the rich and careless clergy, monks and friars was widespread but undefined. Wycliffe turned it into a definite channel.

In addition, Wycliffe was appealing to the world of learning in a series of Latin treatises, which followed each other in rapid succession, and collectively form his *summa theologiae.* J. Loserth, in his paper "Die Genesis von Wiclifs Summa Theologiae" (*Sitzungsber. der k. Akad. dcr Wissensch.,* Vienna, 1908, vol. 156) gives proofs that the *Summa* was written to provide weapons in the controversies of the time. During the years 1378 and 1379 Wycliffe produced his works on the truth of Holy Scripture, on the church, on the office of king, on the papal power. The *De officio regis* is practically a declaration of war against the papal monarchy, an anticipation of the theocratic conception of national kingship as estabiished later by the Reformation. (See *De officio regis* ed. A. W. Pollard and Charles Sayle, from Vienna mss. 4514, 3933, Wyclif Soc. 1887—cap. vi. p. 119.) Wycliffe now passed from an assailant of the papal to an assailant of the sacerdotal power. In 1379 or 1380 Wycliffe began a formal public attack on what he calls the "new" doctrine in a set of theses on the Eucharist propounded at Oxford. (1381 is the date given in Shirley's edition of the *Fasciculi Zizaniorum*. F. D. Matthew. in the *Eng. Hist. Rev.* for April 1890, v. 328, proves that the date must have been 1379 or 1380.) There followed sermons, tracts, and, in 1381, his great treatise *De eucharistia.* Finally, at the close of his life, he summed up his doctrine in the *Trialogus*.

The language in which he denounced transubstantiation anticipated that of the Protestant reformers; it is a "blasphemous folly," philosophically it is nonsense, since it presupposes the possibility of an accident existing without its substance; it overthrows the very nature of a sacrament. Yet the consecrated bread and wine are the body and blood of Christ, for Christ himself says so (*Fasc. Zizan.* p. 115); we do not, however, corporeally touch and break the Lord's body, which is present only *sacramentaliter, spiritualiter et virtualiter*—as the soul is present in the body. The real presence is not denied; what Wycliffe "dares not affirm" is that the bread is after consecration "essentially, substantially, corporeally and identically" the body of Christ. His doctrine approximates to the Lutheran doctrine of consubstantiation, as distinguished from the Zwinglian teaching accepted in the xxviii, Article of Religion of the Church of England.

The theologians of the university were at once aroused. The chancellor, William Barton, sat with twelve doctors (six of whom were friars), and solemnly condemned the theses. Wycliffe appealed, not to the pope, but to the king. But the lay magnates, who u-ere perfectly ready to help the church to attain to the ideal of apostolic poverty, shrank from the responsibility of supporting obscure propositions, which involved undoubted heresy and the pains of hell. John of Gaunt hastily sent a messenger enjoining the reformer to keep silence. The rift thus created between Wycliffe and his patrons in high places was widened by the Peasants' Revolt of 1381, the result of which was to draw the conservative elements in church and state together.

With the Peasants' Revolt it has been supposed that Wycliffe had something to do. One of its leaders, John Ball, when condemned, confessed that he learned his subversive doctrines from Wycliffe. We have, however, not only the repeated testimony of Knyghton that he was a "precursor" of Wycliffe, but also documentary evidence that he was excommunicated in 1366, long before Wycliffe exposed himself to ecclesiastical censure. Wycliffe's communistic views are theoretical and confined to his Latin scholastic writings. They could not reach the people directly. Possibly his followers translated them in their popular discourses, and thus fed the flame that burst forth in the rebellion.

In the spring after the Revolt his old enemy, William Courtenay, who had succeeded the murdered archbishop Sudbury as archbishop of Canterbury, resolved to stamp out Wycliffe's crowning heresy. He called a court of bishops, theologians and canonists at the Blackfriars' convent. This proceeding was met by a manifestation of university feeling on Wycliffe's side. The chancellor, Robert Rygge, though he had joined in the condemnation of the theses, stood by him, as did also both the proctors. The Council decided that out of 24 articles extracted from Wycliffe's works, ten were heretical and fourteen erroneous. The reply of the chancellor was to deny the archbishop's jurisdiction within the university, and to allow Philip Repington, disciple of Wycliffe, to preach before the university. The chancellor and proctors were now summoned to appear before the Blackfriars' court on the 12th of June. Though they were, with the majority of regent masters at Oxford, on the side of Wycliffe, the main question was for them one of philosophy rather than faith, and they made formal submission to the authority of the Church.

Wycliffe himself remained at large and unmolested. That his strength among the laity was undiminished is shown by the fact that an ordinance passed by the House of Lords alone, in May 1382, against the itinerant preachers was annulled on the petition of the Commons in the following autumn. The reformer, however, was growing old and now occupied himself in writing numerous tracts and two of his most important works. The *Trialogus* is a summing up of his arguments and conclusions on philosophy and doctrine. It was the most influential of all Wycliffe's works, and was the first to be printed (1525). All the only four known complete mss. of the work, preserved in the Imperial Library at Vienna, are of Hussite origin. The note of both the *Trialogus* and of the unfinished *Opus evangelicum,* Wycliffe's last work, is their insistence on the "sufficiency of Holy Scripture."

In 1382, or early in 1383, Wycliffe was seized with a paralytic stroke. On the 28th of December 1384, he had a final stroke, from the effects of which he died on the New Year's eve. He was buried at Lutterworth; but by a decree of the council of Constance, May 4, 1415, his remains were ordered to be dug up and burned, an order which was carried out, at the command of Pope Martin V., by Bishop Fleming in 1428.

A sober study of Wycliffe's life and works justifies a conviction of his complete sincerity and earnest striving after what he believed to be right. When he conceives the Church as consisting exclusively of the righteous, he may seem to have gone the whole length of the most radical reformers of the 16th century. And yet, powerful as was his influence in England, his doctrines in his own country were doomed to become for a century and a half the creed only of obscure sectaries. *(See* LOLLARDS.) It was otherwise in Bohemia, whither his works had been carried by the scholars who came to England in the train of Richard II.'s queen, Anne of Bohemia. Here his writings were eagerly read and multiplied, and here his disciple, John Huss (*q.v.*) raised Wycliffe's doctrine to the dignity of a national religion. Extracts from the *De ecclesia* and the *De potestate Papae* of the English reformer made up the greater part of the *De ecclesia* of Huss, *a* work for centuries ascribed solely to the Bohemian divine, and for which he was condemned and burnt. It was Wycliffe's *De sufficientia legis Christi* that Huss carried with him to convert the council of Constance; of the fiery discourses now included in the published. edition of Wycliffe's *Sermones* many were likewise long attributed to Huss. Finally, it was from the *De eucharistia* that the Taborites derived their doctrine of the Lord's Supper, with the exception of the granting of the chalice to the laity. To Huss, Luther and other continental reformers owed much, and thus the spirit of the English reformer had its influence on the reformed churches of Europe.

BIBLIOGRAPHY.—The documentary materials for Wycliffe's biography are to be found in John Lewis's *Life and Sufferings of J. Wiclif* (new ed., Oxford, 1820), which contains a valuable appendix; Foxe's *Acts and Monuments,* vol. iii., ed. 1855, with app.; Forshall and Madden's preface to the Wycliffe Bible, p. vii. note, Oxford, 1851; W. W. Shirley's edition of the *Fasciculi Zizaniorum,* a collection of contemporary documents (1858); and H. T. Riley's notices in the appendices to the *Second* and *Fourth Reports* of the Historical Manuscripts Commission. The narrative of a monk of St. Albans published under the title of *Chronicon Angliae,* by Sir *E.* Maunde Thompson (1874), and in a modified version in Walsingham's *Historia Anglicana* (ed. *H.* T. Riley, 1863, 1864). Knyghton's chronology in *De eventibw Angliae* is faulty (ed. J. R. Lumby, 1889–95). There are valuable notices in the *Eulogium historiarum* (vol. iii., ed. F. S. Haydon, 1863), in the *Chronicle* of Adam of Usk (ed. E. M. Thompson, 1876), and in the continuations of Higden. The controversial works of Wodeford and Walden are important, but must be used with caution.

Of modern biographies that by G. V. Lechler *(Johann von Wiclif und die Vorgeschichte der Reformation,* 2 vols., Leipzig, 1873; partial Eng. trans., by P. Lorimer, 1878, 1881 and 1884) is by far the most comprehensive. Shirley's introduction to the *Fasciculi Zizaniorum,* and F. D. Matthew's to his edition of *English Works of Wyclif hitherto unprinted* (1880), as well as Creighton's *History of the Papacy,* vol. i., 1882, and Sir H. C. Maxwell Lyte's account in his *History of the University of Oxford* (1886), contain valuable criticism. *See* also Mr. R. L. Poole, *(Illustrations of the History of Mediaeval Thought,* 1884); *J.* Loserth (*Hus und Wiclif,* Prague, 1884; also Eng. trans.). G. M. Trevelyan, *England in the Age of Wycliffe* (London, 1899); Oman, *History of England 1377–1485* (London, 1906); W. W. Capes, "History of the English Church in the 14th and 15th Centuries," in *Hist. of the Eng. Church,* ed. Stephen and Hunt (London, 1900); J. Loserth's article "Wiclif," in Herzog-Hauck, *Realencyklopädie* (3rd ed., 1908), xxi., pp. 225–227; H. B. Workman, *John Wyclif* (1926).

Wycliffe's works are enumerated in a *Catalogue* by Shirley (Oxford, 1865). Of his Latin works only two had been published previous to 1880, the *De officio pastorali,* ed. *G.V.* Lechler (Leipzig, 1863) and the *Trialogus,* ed. Lechler (Oxford, 1869). Under the auspices of the Wyclif Society the following have been published.—Polemical *Tracts,* ed. R. Buddensieg (2 vols., 1883); *De civili dominio,* vol. i. ed. R. L. Poole, vols. ii.–iv., ed. J. Loserth (1885–1905); *De composicione hominis,* ed. *R.* Beer (1884); *De Ecclesia,* ed. Loserth (1886); *Dialogus sive speculum ecclesiae militantis,* ed. *A.* W. Pollard (1886); *Sermones,* ed. Loserth, vols. i.–iv. (1887–90); *De oficio regis,* ed. A. W. Pollard and C. Sayle (1887); *De apostasia,* ed. M. Dziewicki (1889); *De dominio divino,* ed R. L. Poole (1890); *Quaestiones. De ente praedicamentali,* ed. R. Beer (1891); *De eucharistia tractatus major,* ed. Loserth (1893); *De blasphemia,* ed. Dziewicki (1894); *Logica* (3 vols., ed. Dziewicki, 1895–99); *Opus evangelicum,* ed. Loserth (4 vols., 1898), parts iii. and iv. also bear the title *De Antichristo; De Simonia,* ed. Herzberg-Frankel and Dziewicki (1898); *De veritatae sacrae scripturae,* ed. R. Buddensieg (3 vols., 1905); *Miscellanea philosophica,* ed. Dziewicki (2 vols., 1905) (vol. i. has an introduction on Wycliffe's philosophy); *De potestate papae,* ed. Loserth (1907).

For his works in English see *Select English Works,* ed. *T.* Arnold (3 vols., 1869–71), and *English Works hitherto unprinted,* ed. F. *D.* Matthew (1880). *The Wicket* (Nuremberg, 1546; reprinted at Oxford, 1828) is not included in either of these collections. (R. L. P.; X.)

WYE, a river of Wales and England, famous for its scenery. It rises on the eastern slope of Plynlimmon, close to the source of the Severn, Its length is 130 mi. Running at first S.E. it passes Rhayader and receives the Elan, in the basin of which are the Birmingham reservoirs. At Pipton, 12 mi. S.E. of Builth Wells, it turns to flow N.E. and after Hay reaches a level of 250 ft.. 55 mi. from its source. 2,000 ft. high. As it enters Herefordshire it bends S.E.. flows through Hereford, receives the Lugg from the north and turns S.E. when the course becomes sinuous. winding in big curves. *e.g.*, at Symonds Yat (*q.v.*). The valley narrows into a gorge, often wooded and often overhung with great crags of mountain limestone. This reach of the river, from Ross to Chepstow. has made the Wye famous for its beauty. It passes Monmouth, where it receives the Monnow on the right Tintern and finally Chepstow. 2 mi. above its junction with the Severn estuary. The Wye valley, with border castles at Hereford, Monmouth and Chepstow, has long been the main route from mid-Wales into England. The high tides of the Severn estuary are experienced to just above Chepstow.

The name of Wye belongs also to two smaller English rivers—a tributary of the Derbyshire Derwent and a tributary of the Thames.

WYLIE, ELINOR MORTON (1885–1928), U.S. poet and novelist, whose polished intense poems matched her own beauty and life, was born in Somerville. N.J., on Sept. 7, 1885. Educated at private schools in Bryn Mawr, Pa.. and Washington, D.C., where her father Henry Hoyt went in 1903 as solicitor general, she married Philip Hichborn in 1905, but in 1910 eloped with Horace Wylie, 15 years her senior. They lived in England until 1915. Her literary life began when they moved to New York city in 1921. In 1923 she divorced Wylie and married William Rose Benét. She wrote four novels: *Jenifer Lorn: a Sedate Extravaganza* (1923), *The Venetian Glass Nephew* (1925), *The Orphan Angel,* published as *Mortal Image* in England (1926), and *Mr. Hodge and Mr. Hazard* (1928). Four volumes of poems published between 1921 and 1928 were republished as *Collected Poems* edited with a foreword by W. R. Benét (1932).

She died in New York city on Dec. 16, 1928. *Last Poems* was published in 1943.

WYMAN, JEFFRIES (1814–1874), U.S. scientist notable for the wide range of his studies and for his pioneer work on museums, was born in Chelmsford, Mass., on Aug. 11, 1814. He graduated at Harvard in 1833, and in 1837 also received his medical degree there. He began medical practice in Boston and became a demonstrator of anatomy at Harvard, subsequently going to Europe for a short period of study in London and Paris. Upon his return he was for four years professor of anatomy and physiology at Hamptbn-Sidney college, Richmond, Va., and was then recalled (1847) to Harvard as Hersey professor in anatomy. He began the task of building a museum of comparative anatomy at Harvard, one of the first in the United States, and traveled widely in search of specimens, his trips ranging along the Atlantic coast from Labrador to Florida, and including expeditions to Europe, to Guiana and, notably, up the La Plata. Uruguay and Parana rivers and across the pampas and Andes to Santiago, Chile. In 1866 he was made a trustee of the museum of archaeology and professor of archaeology and ethnology on the George Peabody foundation. Wyman's scientific papers embrace a wide range of studies, including human, comparative and microscopic anatomy, physiology, paleontology and ethnology. Especially notable were his papers on "Observations on the Crania" *(Proceedings,* Boston Society of Natural History, 1868); on the nervous system of the bullfrog and the changes undergone during metamorphosis *(Contrtbutions,* Smithsonian institution, 1852); the first account of the osteology of the gorilla *(Memoirs,* Boston Society of Natural History, 1847); and "Unusual Methods of Gestation in Certain Fishes" (*Silliman's Journal).* He died at Bethlehem, N.H., on Sept. 4, 1874.

There is a memoir and complete bibliography of his writings in the *Biographical Memoirs,* National Academy of Sciences, vol. ii (1886). His colleague, Oliver Wendell Holmes, wrote a biographical sketch in the *Atlantic Monthly* (Nov. 1874).

WYMONDHAM, an urban district in the South Norfolk parliamentary division of Norfolk, Eng., 9 mi. S.W. of Norwich. Pop. (1951) 5,665. Area 17.1 sq.mi.

A Benedictine priory, founded in the 12th century as a cell of St. Albans abbey by William d'Albini, became an independent abbey in 1448. The abbey church of SS. Mary and Thomas possesses a 12th-century east tower and a west tower which was added by the townspeople when they were allotted the nave about 1448. The 1 jth-century St. Thomas a Becket chapel is a public library. In the centre of the town is a market cross (1618) with an octagonal half-timbered upper chamber on posts. The chief industry is brush making.

WYNAAD, a highland plateau, 60 mi. long and 30 mi. broad, partially in Mysore and partially occupied by a subdivision of the same name in the Malabar division of Madras state, Republic of India; chief town. Manantoddy.

The plateau, set back from the Arabian sea by a 25-mi.-wide plain, has an average elevation of 3,000 ft., but in places rises to 6,000 ft. The chief rivers are the Kabbani and Rampur, tributaries of the Cauvery (*q.v.*).

The annual rainfall is 130 in. The principal crops include tea, coffee, pepper, rice and cardamoms. The forests contain teak and blackwood.

WYNDHAM, SIR CHARLES (CHARLES CULVERWELL) (1837–1919), English actor, whose association and business partnership with his wife was an important one, was born in Liverpool on March 23, 1837, the son of a doctor. He was intended for medicine, but went on the stage, appearing in London in 1862. In that year he went to the United States and served as brigade surgeon in the Federal army. resigning in 1864 and appearing on the stage in New York. He returned to the London stage in 1866 as Sir Arthur Lascelles in *All that Glitters Is Not Gold.* His first big success was in F. C. Burnand's burlesque of *Black-Eyed Susan,* as Hatchett (with dance). At the St. James's theatre he appeared with Henry Irving and with Ellen Terry and also in *Still Waters Run Deep.* He made a great success as Charles Surface in Sheridan's *School for Scandal.* In 1876 he took control of the Criterion theatre, running it successfully for many years and producing and playing in many notable plays. From 1885 onward his leading lady was Mary Moore, whom he subsequently married Between them they built and opened Wyndham's theatre in 1899—with a revival of *David Garrick,* his most famous part—and the New theatre in 1903. Wyndham was knighted in 1902 and died in London on Jan. 12, 1919. (W. J. M.-P.)

WYNDHAM, GEORGE (1863–1913), British politician and man of letters, was born Aug. 29, 1863, the eldest son of Percy Scawen Wyndham, and grandson of the first Lord Leconfield. His mother was Madeline Caroline Frances Eden, daughter of Sir Guy Campbell, bart., and through her he was great-grandson of Lord Edward Fitzgerald, the Irish rebel. He was educated at Eton and Sandhurst, obtained a commission in the Coldstream Guards in 1883, and served through the Suakin campaign of 1885. He left the army in 1887, married Sibell Mary, daughter of the 9th Earl of Scarborough, widow of Earl Grosvenor. He became private secretary to A. J. Balfour, at the time Irish Secretary, and in 1889 entered Parliament as Conservative member for Dover, a seat which he retained till his death.

After serving, from 1898–1900, as financial secretary to the war office, he was appointed in 1900 chief secretary for Ireland. His early work in Ireland met with general approval. He developed enormously the Conservative policy of land purchase; and the act which he carried in 1903 for that end was the most comprehensive measure of the kind ever submitted to Parliament. He hoped to arrange a form of local government which should sufficiently meet Nationalist demands, and with this in view appointed in 1902 an eminent Anglo-Indian, Sir Antony (afterwards Lord) MacDonnell to the under-secretaryship. The Unionist party, both in Ireland and in England, became suspicious of the tendencies of his administration, and he was driven in 1905 to resignation. He never held office again, but was active in support of tariff reform and woman suffrage; he was a keen critic of Haldane's army reforms, and threw himself vigorously into the "Diehard" campaign against the Parliament Bill in 1911.

He was also a man of letters. Here his genius was stimulated by his friendship for W. E. Henley, who dedicated a book to "George Wyndham, soldier, courtier, scholar." His principal published work was an edition of *Shakespeare's Poems* (1898); but he wrote also on North's *Plutarch* and *Ronsard.* The Admirable Crichton of his day, handsome and debonair, he was keen alike on field sports and the arts, a working railway director and an efficient colonel of yeomanry, the pet of society and the recipient of honorary distinctions from several universities. On June 8, 1913, at the comparatively early age of 50, he died in Paris.

See his *Life and Letters,* ed. J. W. Mackail and Guy Wyndham (2 vols., 1925).

WYNDHAM, SIR WILLIAM, BART. (1687–1740), English politician, was the only son of Sir Edward Wyndham, Bart., and a grandson of William Wyndham (d. 1683) of Orchard Wyndham, Somerset, who was created a baronet in 1661. Educated at Eton and at Christ Church, Oxford, he entered parliament in 1710 and became secretary-at-war in the Tory ministry in 1712 and chancellor of the exchequer in 1713. He was closely associated with Lord Bolingbroke, and he was privy to the attempts made to bring about a Jacobite restoration on the death of Queen Anne; when these failed he was dismissed from office. In 1715 the failure of a Jacobite movement led to his imprisonment, but he was soon set at liberty. Under George I. Wyndham was the leader of the opposition in the House of Commons, fighting for his High Church and Tory principles against Sir Robert Walpole. He was in constant communication with the exiled Bolingbroke, and after 1723 the two were actively associated in abortive plans for the overthrow of Walpole. He died at Wells on June 17, 1740. Wyndham's first wife was Catherine, daughter of Charles Seymour, 6th duke of Somerset. By her he had two sons, Charles, who became 2nd earl of Egremont in 1750, and Percy, who took the name of O'Brien and was created earl of Thomond in 1756.

The Wyndham Family.—Sir John Wyndham, a Norfolk man, was knighted after the battle of Stoke in 1487 and beheaded for high treason on May 2, 1502. He married Margaret, daughter of John Howard, duke of Norfolk, and his son Sir Thomas Wyndham (d. 1521), of Felbrigg, Norfolk, was vice-admiral of England under Henry VIII. By his first wife Sir Thomas was the father of Sir John Wyndham, who married Elizabeth, daughter of John Sydenham of Orchard, Somerset, and founded the Somerset branch of the family, and also of Sir Edmund Wyndham of Eelbrigg, who was sheriff of Norfolk at the time of Robert Ket's rebellion. By his second wife Sir Thomas was the father of the seaman Thomas Wyndham (c. 1510–53), an account of whose voyage to Morocco in 1552 is printed in Richard Hakluyt's Voyages.

WYNTOUN, ANDREW OF (?1350–?1420), author of a long metrical history of Scotland, called the *Orygynale Cronykil* of Scotland, was a canon regular of St. Andrews, and prior of St. Serf's in Lochleven. He wrote the *Chronicle* at the request of his patron, Sir John of Wemyss, whose family, at Wemyss castle, Fifeshire, retained possession of the oldest extant manuscript of the work. The subject is the history of Scotland from the mythical period (hence the epithet "original") down to the accession of James I in 1406. The earlier books are of no historical value, but the later have in all outstanding matters stood the test of comparison with contemporary records. The philological interest is great, for few works of this date, and no other of like magnitude, are extant in the vernacular.

The test is preserved in eight manuscripts, of which three are in the British museum, the Royal (17 D. xx), the Cottonian (Nero D. xi) and the Lansdowne (197); two in the Advocates' library, Edinburgh (19, 2, 3 and 19, 2, 4), one at Wemyss castle (*u.s.*); one in the university library at St. Andrews, and one, formerly in the possession of the Boswells of Auchinleck, now the property of John Ferguson, Duns, Berwickshire. The first edition of the *Chronicle* (based on the Royal manuscript) was published by David Macpherson in 1795; the second by David Laing, in the series of "Scottish Historians" (Edinburgh, 1872). Both are superseded by the elaborate edition by Amours for the Scottish Text society (1906).

WYOMING, popularly known as the "Equality state," is one of the central western states of the United States. It is bounded north by Montana, east by South Dakota and Nebraska, south by Colorado and Utah and west by Utah, Idaho and Montana. Including Yellowstone National park (over which the federal government has exclusive jurisdiction and control; area 3,186 sq.mi.), Wyoming has an area of 97,914 sq.mi., of which 503 sq.mi. are water surface; among the states it ranks ninth in size. East and west the state has an extreme length of 355 mi., and north and south an extreme breadth of 277 mi. In shape it is an exact rectangle. The name "Wyoming," originally bestowed upon the Wyoming valley in Pennsylvania, is a corruption of a word of the Delaware Indians meaning "upon the great plain"; it is not known who first applied it to the state. The nickname "Equality state" derives from the fact that Wyoming was the pioneer in woman suffrage. Wyoming was admitted to the union in 1890 as the 43th state. The state flower is the Indian paintbrush (*Castilleja linariaefolia*), the state bird: the meadow lark (*Sturnella neglecta*). The flag has a blue field bordered in white and in red; the field bears a white silhouetted buffalo on which is represented the great seal of the state. The capital of Wyoming is at Cheyenne.

PHYSICAL GEOGRAPHY

Physical **Features.**—Wyoming is situated between approximately 104° 3' and 111° 3' W. and 41° and 45° N. The Great Plains. with an elevation of from 5,000 to 6,000 ft. over much of the state, consist of flat or gently rolling country, barren of tree growth but often covered with nutritious grasses and possessing a soil rich in the mineral elements necessary for plant life which it produces abundantly when it receives sufficient moisture. Erosion buttes and mesas occasionally rise as picturesque monuments above the general level of the plains, and in the vicinity of the mountains the plains strata, elsewhere nearly horizontal, are bent sharply upward and carved by erosion into hogback ridges. These features are well developed about the Bighorn mountains (*q.v.*), an outlying range of the Rockies which boldly interrupts the continuity of the plains in north central Wyoming.

Notwithstanding high elevations in both the northern and southern portions of the state: the low central portion makes a distinct break in the continuity of the northern and southern ranges of the Rockies, giving a broad. relatively low pass through which went the Oregon and Overland trails in the early pioneer days and later the Union Pacific railroad. In this central region the plains are interrupted by minor mountain groups, volcanic buttes and lava flows. In the northeast are outlying spurs of the Black hills (*q.v.*), the Little Missouri buttes and the Devils Tower. the latter a prominent erosion remnant of volcanic intrusion. The higher levels of the Bighorn range have been modified by local glaciation, giving glacial cirques, alpine peaks and many mountain lakes and waterfalls. Several small glaciers still remain about the shoulders of Cloud peak (13,165 ft.), the highest summit in the range.

The various ranges in the northwestern part of the state form some of its most magnificent scenery. A vast portion of this has been set aside as Yellowstone National park, but areas in the Absarokas. east of the park, are also beautiful. Just south of the park, the Teton mountains rise abruptly from Jackson Hole to elevations of 12,000 and 13.000 ft. In the Wind River range, farther southeast, are Gannett peak (13,785 ft.), the highest point in the state. and Fremont peak (13,730 ft.).

In addition to the hot springs of the Yellowstone region, mention should be made of large hot springs (temperature about 135° F.) at Thermopolis and Saratoga.

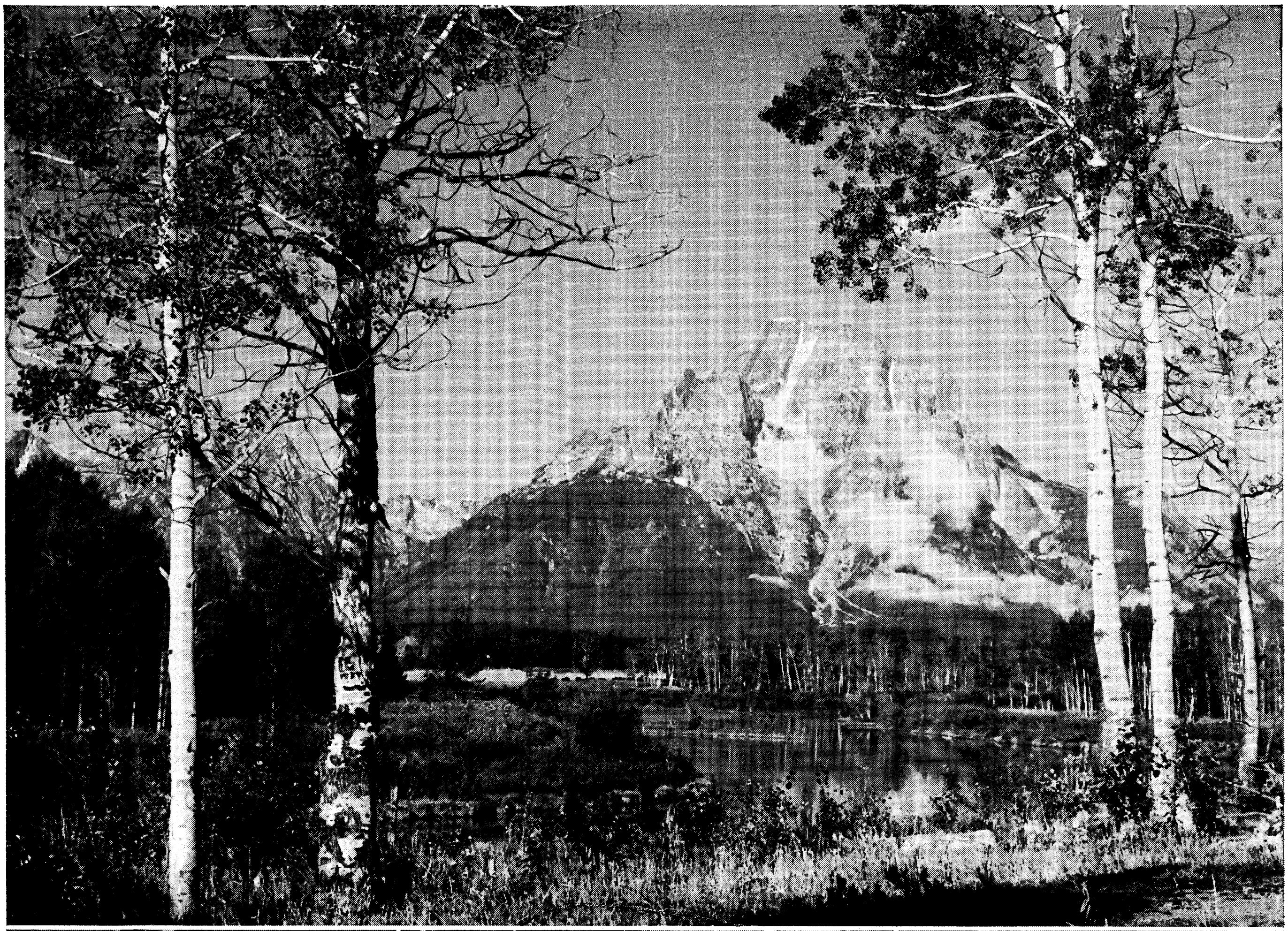
About two-thirds of Wyoming is drained by branches of the Missouri river, the most important being the Yellowstone, Bighorn and Powder rivers, flowing north, and the Cheyenne and North Platte, flowing east. The Green river, a branch of the Colorado. drains the southwestern part of the state. The Snake river, flowing into the Columbia, heads in the southern part of Yellowstone National park and flows southwest through the beautiful valley known as Jackson Hole into Idaho. Along the western border the Bear river takes its course a short distance, draining ultimately into the Great Divide basin. Southwest of the centre of the state is an area with no outward drainage, the streams emptying into desert lakes.

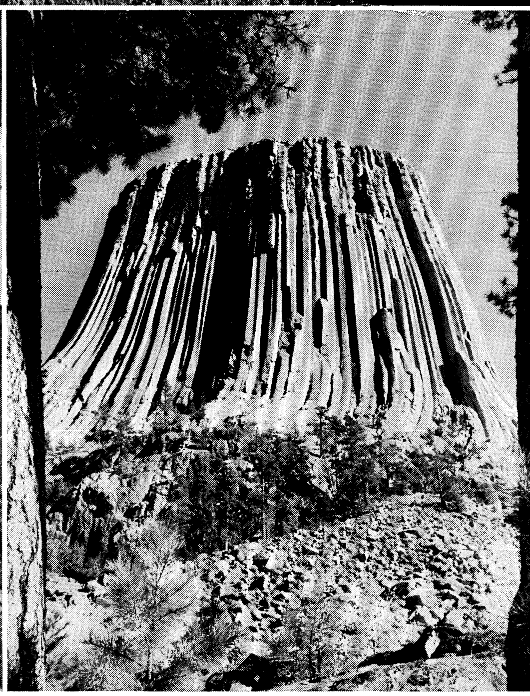
Wyoming soils are thin but fertile when irrigated. Gray or brown arid-region soils predominate. More than one-third of the state is organized in soil-conservation districts. There is some overgrazing in drought years but otherwise grazing is well controlled in the state.

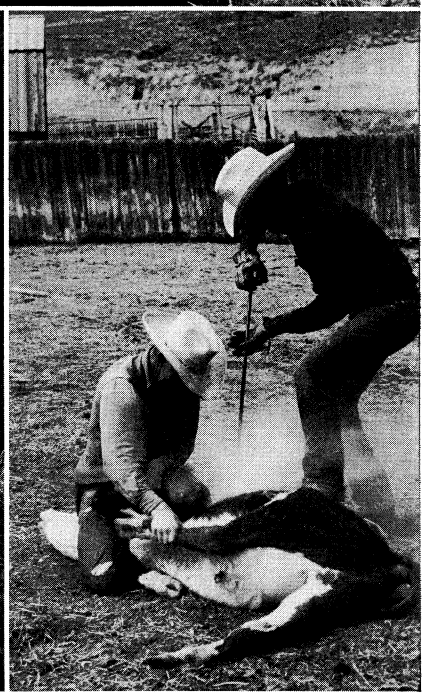
Climate.—It is difficult to generalize about Wyoming's climate, since the varied and rugged topography makes corresponding local variations. Precipitation for the state averages 14.79 in. annually, but it varies from about 6 in. in the lower Bighorn basin, Sweetwater county and lower Wind river valley, the driest portions, to 35 in. in the mountains bordering on Yellowstone National park. In the agricultural region of the southeastern counties the average annual rainfall is 13.99 in. East of the continental divide about 70% of the precipitation occurs between April and September. The cool summer months of the mountain regions lower the average temperature of the state materially. The annual mean for the valleys is 46° F. and for the mountains, 36°. The average of 243 weather stations, well distributed over the state, gives a day average for July of 83° and a night average of 50°: for Tanuary the averages are, respectively, 31° and 6°. The portion of the state west of the divide has a lower average and longer winters than that east of the divide. The cold spells are not severe, since their chilling effect is modified by the normally low humidity.

Vegetation and Animal Life.—On the treeless plains there are short, tough grasses of many varieties. In drier areas sagebrush, greasewood and other shrubs are found.

Wyoming still abounds in game animals, most of them (except the antelope) concentrated in the forested areas. The game population of the state is estimated at nearly 300.000, including 35.000 elk, 125,000 mule deer, 5,000 white-tailed deer, 110,000 antelope







PHOTOGRAPHS, (TOP) GRANT M. HAIST, (BOTTOM LEFT) SCREEN TRAVELER FROM GENDREAU, (BOTTOM CENTRE) RAY ATKESON, (BOTTOM RIGHT) DAVID W. CORSON FROM A. DEVANEY

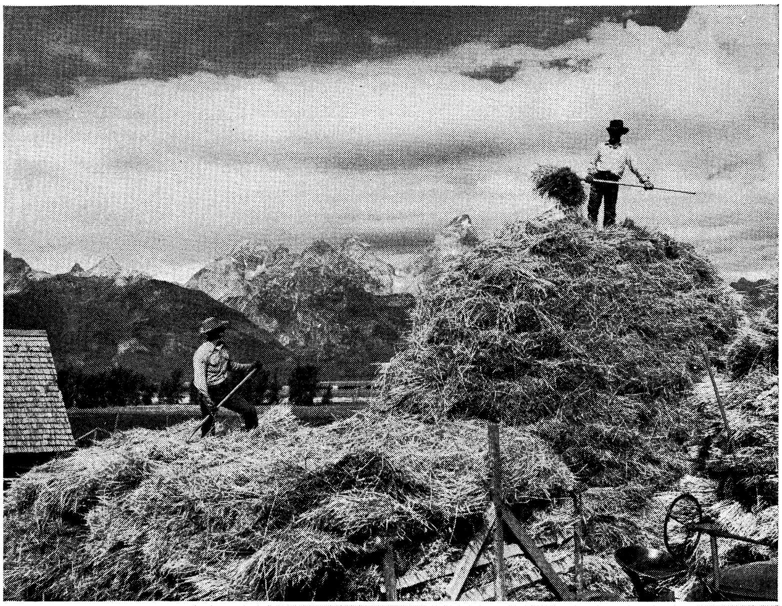
LAND AND WORK IN WYOMING

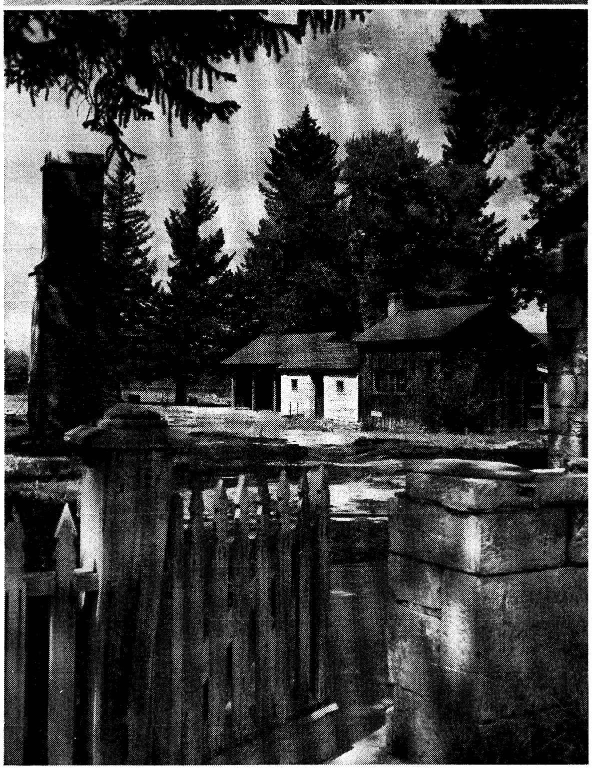
Top: Mt. Moran, across the Snake river, one of the Grand Teton mountains which rise from Jackson Hole, Wyoming

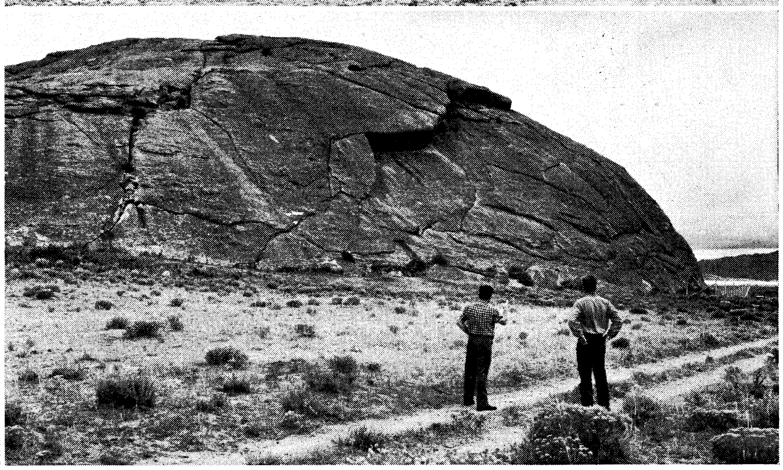
Bottom left: Shearer at work on a sheep ranch. Wyoming is one of the largest sheep-producing areas in the U.S.

Bottom centre: The Devil's Tower, a mass of igneous gray rock 600 ft. high is based upon a ridge of sedimentary rock which itself rises 600 ft. above Belle Fourche river. President Theodore Roosevelt in 1906 made the tower area the first U.S. national monument

Bottom right: Cowboys branding a calf after a round-up near Jackson







PHOTOGRAPHS (TOP LEFT) ERNST PETERSON, (TOP RIGHT) H ARMSTRONG ROBERTS, (CENTRE RIGHT) CHARLES J. BELDEN, (BOTTOM LEFT) DAVID W. CORSON FROM A. DEVANEY, (BOTTOM RIGHT) JOSEF MUENCH

PARKS AND MOUNTAINS IN WYOMING

Top left: Old Faithful geyser in Yellowstone National Park, so-called because of the regularity of the eruptions which occur at intervals averaging 65 minutes

Top right: Stacking oats at Kelly, the Grand Teton mountains in the background

Centre *right:* Cowboys' saddle horses graze on mountain pastures

Bottom *left:* Fort Bridger, founded in 1842 by Jim Bridger, mountain guide and pioneer, was later a stagecoach stop and military station. The Post Trader's store now is a museum and the site a state park

Bottom right: Independence rock, a gray-brown granite monolith on the north bank of the Sweetwater river. Pioneers traveling westward inscribed their names upon the rock and thousands of these names remain clearly readable (pronghorn), 5,000 moose, 10,000 black bears, 80 grizzly bears and 3.000 mountain sheep. Streams and lakes in all sections of the state have excellent trout fishing, principal varieties being the native cutthroat, brook, rainbow, brown, Mackinaw and golden. Warm-water species, such as bass, crappie, sunfish and catfish, also are available in certain waters. The sage grouse is the state's most widely distributed game bird. Several other species of grouse inhabit the mountains, and pheasant, chukar, Hungarian partridge and wild turkey have been introduced. Among small mammals, ground squirrels, grasshopper mice, wood rats, pocket gophers, kangaroo rats, ferrets and moles are common in the sagebrush and greasewood flats; cottontails, jack rabbits and prairie dogs are found in the plains area.

Parks, Historic Sites and Recreation.—One-fourth of Wyoming's area is given over to national parks and forests and the Wind River Indian reservation. Yellowstone and Grand Teton National parks and Devils Tower National monument are perhaps the greatest tourist attractions in the state, but its history is reflected in many other monuments. Ft. Laramie. a fur-trading (1834–49) and military post (1849–90), located in the eastern part of the state, 80 mi. N. of Cheyenne, has been restored by the national park service since it was made a national monument in 1938. Ft. Bridger, where the mountain man Jim Bridger erected a trading post in 1843, is now a state park with a museum in southwestern Wyoming. Independence rock is located in the central part of the state. 55 mi. S.W. of Casper; on this landmark many Oregon trail travelers carved their initials, as they did on Register cliff. near Guernsey. South pass, the great gateway to the west, in west central Wyoming, is crossed by a good paved highway.

What is usually recognized as the first dude ranch in the west uas established by the Eaton brothers west of Sheridan in 1904. Thereafter, dude ranches, specializing in the entertainment of paying guests, multiplied. Many residents of the state gain a livelihood by catering to the requirements of dudes or the multitude of other tourists who visit the state every summer. The rodeo (*q.v.*) is a favourite state sporting event, the most famous being that held at the annual Frontier days celebration in Cheyenne.

HISTORY

Wyoming contains land from all four of the principal annexations nhich made up the territory of the U.S. west of the Mississippi river. Except for a small portion in Sweetwater and Carbon counties. the land east of the continental divide was acquired from France by the Louisiana Purchase of 1803. The remaining portion came from Mexico in 1848 and Texas in 1845 and 1850. The northwestern corner of the state, drained by the Snake river into the Columbia, formed a part of the old "Oregon country." held jointly by the U.S. and Great Britain until the British relinquished their claims in the treaty of 1846. The portion of the state drained southwest into the Colorado river or into the Great Divide basin was secured by the Mexican cession of 1848.

Exploration and Fur Trade.—There are legends of Spanish exploration of Wyoming, but so far they are unconfirmed by documentary evidence. The Verendrye brothers traveled southwest from the Mandan villages in 1742–43 and may have reached the Bighorn mountains, but the vagueness of their journals makes it impossible to determine the fact with certainty. John Colter, a member of the Lewis and Clark expedition (1804–06) who left that body on their homeward trip and plunged back into the wilderness as a free trapper, is the first white man known definitely to have entered the state. Doubtless there mere other wanderers before him whose tales are forever lost. Colter trappd to the east and south of Yellowstone National park, and finally, in 1807, crossed that wonderland itself and brought to the norld the first news of its strange phenomena. Four years later an expedition of more than 50 men, commanded by Wilson Price Hunt and bound overland to the mouth of the Columbia to begin the American fur trade in that region, entered northeastern Wyoming, proceeded south and west around the Bighorn mountains, across the continental divide through Union pass and on by the Snake river valley into Idaho. In 1812 several of the same party, led by Robert Stuart, returned over a more southerly route, passing near if not actually through South pass before striking the Sweetwater and continuing eastward along the North Platte river.

In the following years a number of free trappers and employees of the various St. Louis fur companies trapped in eastern Wyoming, but not until the spring of 1824 was the continental divide again crossed, this time by Thomas Fitzpatrick, leading a detachment of William Henry Ashley's fur traders across to new grounds. Fitzpatrick is often given the credit for the discovery of South pass, and he was the first to make it knonn. In the period 1825–40. the era of the mountain men, a fur-trade rendezvous was held each year at a predetermined place in Wyoming, Utah or Idaho. Twelve of these assemblies were held in the neighbourhood of South pass in Wyoming. The rendezvous was a gathering of Indians, fur traders and company employees for the purpose of meeting the pack trains of the company and exchanging the furs for next year's supplies. Hundreds of tents and tepees would dot the river bottoms during the frontier's one great social event. In 1834 Ft Laramie was built by the traders at the confluence of the Laramie and North Platte rivers in eastern Wyoming, and it served as a centre for the fur trade until 1849 when the U S. government purchased it to use as a military post for the protection of emigrants.

Overland Emigration and Railways.—Overland emigration through Wyoming began in 1841 when the first train of settlers passed over the Oregon trail (*q.v.*). Movements increased steadily during the next few years, and in 1847 they were swelled by the Mormon emigration, which followed the Oregon trail over the pass and then branched southwest past Ft. Bridger, built by Jim Bridger on Black's fork of the Green river.

The first rush to California came in 1849, the forty-niners following the Oregon trail through Wyoming and branching southnest after they entered Idaho. The first stagecoach line over this route, a monthly service to Salt Lake City, started in 1851. In 1858 a daily line from Atchison to San Francisco was traveling the trail. In 1860 the pony express (*q.v.*) was established, and in the folloning year the first telegraph line to the Pacific was constructed across Wyoming along this route.

By 1862. however, Shoshone and Sioux depredations were so constant that it became necessary to move the stage line to a southern route nearly parallel with the present Union Pacific railroad. Government troops were detailed to protect the stage stations, emigrant trains and freighting trains. Indian hostilities increased thereafter, reaching a climax in 1865 and 1866. In the latter year troops were sent north of Ft. Laramie to establish garrisons for the purpose of keeping open the Bozeman road to the Montana gold mines. The garrisons at Ft. Reno, Ft. Phil Kearny and Ft. C. F. Smith were in the hunting ground of the Sioux. In Dec. 1866 Col. William J. Fetterman and 81 men were ambushed and killed near Ft. Phil Kearny. War continued with the Sioux until a precarious peace was made in 1868 with their chief, Red Cloud. At that time garrisons were withdrawn from the Bozeman road, and few whites ventured into northern Q'yoming until the army campaigns of 1876 made the area safe.

The Union Pacific railroad began to build across the state in 1867 and pushed rapidly forward. Cheyenne and Laramie (*qq.v.*) were founded at this time.

Territory and State.—In order to protect and govern new settlements along the railway the territory of Wyoming was organized, including parts of the Dakota territory, Utah and Idaho. The Wyoming Organic act was approved July 25, 1868, but the territorial government was not formally inaugurated until April 15, 1869, when the governor and secretary took the oaths of office. Cheyenne was designated the territorial capital.

For years most of the people of the territory lived in towns along the Union Pacific railroad in southern Wyoming, and the only sizable community, other than Indian, at a distance from the railroad was in the South pass region where gold discoveries in 1867 and 1868 served as a magnet to settlers. The first land office was opened in Cheyenne in 1870, and the first homestead entry was completed in 1871.

The Wyoming constitutional convention met at Cheyenne in Sept. 1889 and drew up the constitution that was subsequently adopted at a special election on Nov. 5, 1889. On July 10, 1890, Wyoming was admitted to the union as the 44th state in spite of its deficiency of population (only 62,500).

Range Wars.—Wyoming did not at first prove attractive to homesteaders except in the best valleys along the Union Pacific. Instead it was discovered that the bunch and buffalo grass of the plains made excellent feed for cattle. Not only did they fatten on it in the summer, but the thick ripe bunches, retaining all their nutritious food elements, penetrated the thin snows of the windswept plains, enabling the herds to live and thrive all winter without extra food or care. Also. cattle could be grazed at a distance from the railroad and, when ready for market, transported themselves. Soon great herds mere on the way north from the overstocked ranges of Texas, cowboys driving them up the "long trail" to the tune of

Whoopee ti yi yo, git along little dogies,
For you know Wyoming will be your new home,

and other trail songs. By the early 1880s the ranges of Wyoming were well stocked. Herds increased rapidly and almost without expense. Only a "home ranch" for headquarters was necessary, and the herds ranged far and wide on the public domain.

The cattle industry then entered an era of troubles. The range became overstocked. Market prices dropped. Thieves, called rustlers, made inroads on the herds. The latecomers—many of them Englishmen, Scots and Americans from the eastern seaboard—found their expectations of profit unrealized. Absentee ownership spread. Then came the worst blow of all: during the dreadful winter of 1886–87, one-sixth of the 'cattle perished from lack of water and feed. When those cattlemen who were not bankrupt began to rebuild the industry, they proceeded more cautiously.

The territorial governor, Thomas Moonlight (1887–89), insisted that the open range be broken up into small farms. Though he could not force the legislature, which was still dominated by the cattlemen, to legislate on this, many small settlers accumulated in northern Wyoming, particularly in Johnson county. Many of these small settlers, or nesters, had come before the winter of 1886–87, needing no invitation from a sympathetic governor. Cattlemen who had herds in Johnson county attributed part of their losses to rustling by some of the small settlers. Unable to secure convictions in the local courts, the cattlemen in 1892 dispatched an expedition of more than 50 armed men from Cheyenne to the trouble area, carrying a list of names of men who were to be murdered. After two of the "rustlers" had been killed. however, the cattlemen's party was besieged by a numerically superior Johnson county force led by the sheriff. Hostilities were terminated abruptly by the arrival of U.S. troops. Thereafter the cattlemen, as a group, permitted the constituted authorities to control rustling, although a few, as individuals, hired the notorious Tom Horn to shoot down intruders on cattle ranges.

With the decline of cattle raising, sheep raising began to increase. The first large herds reached the state in the late 1880s. A long feud mas also waged between the cattlemen and the sheepmen, for the sheepmen tried to force their way into ranges already occupied. Cattlemen claimed that cattle would not go where sheep had grazed, and that the sheep destroyed the range and polluted the water holes. An imaginary "dead line" was drawn by the cattlemen beyond which sheep must not go. Herders violated this arbitrary law at their own peril; the annals of Wyoming record several cases in which wagons were burned, herders killed and sheep scattered or killed. After five cattlemen were convicted and sent to the penitentiary in 1909 for killing two sheepmen and a herder in the Tensleep raid, the attacks upon sheepmen ceased.

Federal Lands.—Spokesmen for the cattlemen and sheepmen early found a common enemy in officials of the federal government, although their hostility never involved violence. Public-land policies of the federal government annoyed the livestock men. In particular the government was alleged to be too arbitrary and too niggardly in its distribution of permits for grazing on the public lands. Fear that grazing privileges would be lost was one of several iactors in the bitter opposition to Pres. Franklin D. Roosevelt's creation of the Jackson Hole National monument of 221,610 ac. in 1943. The controversy was settled by compromise in 1950 when most of the land in dispute was added by congressional action to the Grand Teton National park and grazing use of federal lands within the park was permitted.

Politics.—Except during the New Deal era of the 1930s. Republicans usually have dominated Wyoming state politics but in the 1958 elections the Democrats recaptured control of the statehouse for the first time in 20 years. In presidential elections from 1896 on the voters supported the winner, whether Republican or Democrat, except in 1944 when they preferred Thomas Dewey to Franklin D. Roosevelt and 1960 when they chose Richard M. Nixon over John F. Kennedy. Voters of the state often have been ready to support the man rather than the party. Despite changing fortunes of the two major parties the state was represented in the U.S. senate by Francis E. Warren (Republican) for 37 years before he died in 1929; by John B. Kendrick (Democrat) from 1917 until his death in 1933; and by Joseph C. O'Mahoney (Democrat), 1934–53, 1955–61.

GOVERNMENT

Wyoming is governed under the constitution approved in 1889, as amended. Every citizen over 21 years of age who has lived in Wyoming one year, in the county where he is to vote 60 days and in the election district 10 days, who can read the constitution of the state and who is not insane, an idiot or a person convicted of infamous crimes (unless restored to his civil rights) has the right of suffrage.

At the first territorial legislature, held in Cheyenne in Dec. 1869, women of Wyoming mere given the right to vote at all elections. This right was confirmed by an equal suffrage clause in the state constitution. Wyoming thus was the first state to grant full woman suffrage. Congressional approval of the constitutional provision recognized the success of the experiment that had been carried on for 21 years in the territory and that had attracted widespread attention. Wyoming's pioneering in woman suffrage has been attributed variously to the determined efforts of Esther Hobart Morris, to the legislative leadership of Col. W. H. Bright, to a desire for free publicity for the territory and to the scarcity of women.

Executive Branch.—The chief executive officer is the governor. Other elective executive officers are the secretary of state, auditor, treasurer and superintendent of public instruction. All hold office for four years. Not only do they direct their own departments but, together with appointed officers, they also serve on many executive boards, such as the state board of land commissioners, state board of pardons, board of state supplies, state farm loan and fiscal board and state historical board. A number of executive officers are appointed by the governor and are responsible to him.

Legislature.—The legislature is composed of a senate of 27 members and a house of representatives of 56 members. Four of the 23 counties have two senators, the others one. The number of representatives in the lower house varies from one to six per county, Laramie and Natrona counties having six. The state constitution makes reapportionment mandatory after each decennial census, but no reapportionment bill was passed in the 1940s or 1950s. Consequently rural areas were overrepresented.

The regular sessions of the legislature meet in Cheyenne on the second Tuesday in January every odd-numbered year and may continue 40 days. The governor has the power to veto any bill, but if upon reconsideration it is repassed by a two-thirds majority in each-house it becomes a law without the governor's signature. The governor may veto any item in the appropriations bill. Special laws are not to be passed where a general one may be made applicable.

Judiciary.—The supreme court of Wyoming has four justices, elected by the voters for terms of eight years. Two terms of the supreme court are held annually, one in April and the other in October. A special term can be held when two justices so vote. There are seven judicial districts and 11 district judges, four districts having 2 judges each. Regular terms are held in each district. Each of the district judges is elected by his district for a six-year term. The counties are also divided by the county commissioner into judicial districts for which the voters of the district elect a justice of the peace. Incorporated towns and cities have municipal courts and police justices.

Finance.—Chief sources of government revenue in Wyoming are sales and use taxes (the 2% excise tax on retail sales was introduced in 1935), liquor commission revenues from liquor wholesaling, and state property taxes. Each person betneen the ages of 21 and 50 is subject to a $2 school poll tax. A state tax of four cents per gallon is levied on all gasoline used or sold for domestic consumption. Of the state's bonded debt a large proportion represents bonds issued for construction of buildings at the University of Wyoming; it nas planned that these would be retired from building revenues and from oil royalties from federal lands in the state.

POPULATION

The population of Wyoming in 1870 was 9.118; in 1890 it was 62,555; in 1910, 145.965; in 1940, 250.742: in 1950, 290.529; and in 1960, 330,066. This last figure represented an increase of 13.6% over the population in 1950. The population per square mile in 1960 was 3.4, as compared with 3.0 in 1950 and 2.6 in 1940, and with 49.6 for the U.S. in 1960.

*Wyoming: Places of 5,000 or More Population (1960 Census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	330,066	290,529	250,742	194,402	92,531
Casper	38,930	23,673	17,964	11,447	883
Cheyenne	43,505	31,935	22,474	13,829	14,087
Laramie	17,520	15,581	10,627	6,301	8,207
Rawlins	8,968	7,415	5,531	3,969	2,317
Riverton	6,815	4,142	2,540	2,023	—
Rock Springs	10,371	10,857	9,827	6,456	4,363
Sheridan	11,651	11,500	10,529	9,175	1,559
Worland	5,806	4,202	2,710	1,225	—

*Populations are reported as constituted at date of each census.
Sote: Dash indicates place did not exist during reported census, or data not available.

Of the 1960 population. 187.551 or 56.8% lived in incorporated places of 2.500 or more, as compared with 49.8% in 1950 and 37.3% in 1910.

The number of occupied dwelling units (or households) in 1960 was approximately 99,187, as compared with 84,000 in 1950 and 69,000 in 1940. The average population per household had declined from 3.6 in 1940 to 3.5 in 1950 and to 3.3 in 1960.

The population of the state was distributed by colour and nativity in 1950 as follows: 97.8% white; and 2.2% nonwhite, mainly Indians. There were 113.4 males per 100 females in the white population; 6.3% of the population was 65 years old or over. Of the total number of employed males in 1950, 24.6% were engaged in agriculture, 10% in mining, 10.6% in construction, 7% in manufacturing, 14.9% in transportation, etc., and 14% in wholesale and retail trade.

In mid-19th century many Sioux: Cheyenne, Arapaho. Crow and Shoshone Indians still lived in the Wyoming country. Only the eastern Shoshone and the northern Arapaho remain. These two tribes share the Wind River reservation in the west central part of the state. In 1956 there were 1,652 Shoshone and 2,040 Arapaho on the reservation.

EDUCATION

Public Schools.—In territorial Wyoming the great distances, small population and meagre resources meant slow development for education. There were few children, the greater part of the population consisting of unmarried males. The first territorial legislature provided for school districts and school boards, and in 187i school attendance for at least three months each year was made compulsory. In outlying districts the schoolhouse became the community social centre. The teacher was often a young woman from the east who was courted by cowboys of the neighbourhood. Few women teachers in either town or country remained long unmarried.

In the territorial period, first the auditor and later the librarian served as exofficio superintendent of public instruction. After statehood, the department of education was headed by an elective superintendent of public instruction (generally a woman) who appoints, with the approval of the governor, a state board of education of six members who serve without salary for six-year terms. Two are appointed in each odd-numbered year. The superintendent also appoints three assistant superintendents, for instruction, administration and special services, who supervise the work of the three divisions of the department.

A school-district reorganization law was enacted in 1947 which permitted county committees to arrange for redistricting. In 1948 the electorate passed a constitutional amendment permitting a property-tax levy for the support of public schools. The legislature in 1955. in order to raise standards and to aid poorer school districts, established a Foundation program, which equalizes educational opportunity, both assets and expenses being considered in the formula for distributing state aid. The fund from which money is distributed includes money from oil royalties and from the state's levy for public schools.

In 1959 the legislature passed an enabling act permitting the acceptance of National Defense Education act funds, stipulating, however. that the federal aid could be accepted only if the state board of education resolved that there nas need for federal funds that could not be met in the state, and if the federal government budget was in balance for the year concerned.

The cost of education per child in Wyoming is fourth highest in the nation; school cost per adult is second. By the late 1950s about 75,000 children were enrolled annually in the public schools.

Higher Education.—The University of Wyoming (established in 1886), the only four-year institution of higher learning in the state, is at Laramie. Its eight colleges are agriculture, arts and sciences, commerce and industry, education, engineering, law. pharmacy and nursing. The university registers about 4,000 students annually and has a full-time faculty of more than 250. The main library has 300,000 volumes, exclusive of documents. After World War II an extensive building program was carried on at the Laramie campus.

Five junior colleges were established after World War II, at Casper, Sheridan. Powell. Torrington and Rock Springs. They became community colleges, supported mainly by local school districts, nith some additional funds derived from state legislative appropriation.

HEALTH, WELFARE AND CORRECTIONS

The state board of charities and reform, composed of the five elective officials of the state government, supervises the state institutions: a penitentiary at Rawlins, training school for delinquent boys at Worland, training school for delinquent girls at Sheridan. hospital for the mentally ill at Evanston, hospital for the mentally deficient and epileptic at Lander, sanatorium for the tubercular at Basin. home for the aged at Thermopolis, home for dependent children at Casper and soldiers' and sailors' home at Buffalo. There is also a small prison farm at Riverton, and the legislature in 1959 established a state school for the deaf at Casper. The blind are cared for at state expense in schools of neighbouring states.

The state department of public welfare, also made up of the five elective state officials, disburses funds for all public-welfare programs, almost one-half of the money going for old-age assistance.

THE ECONOMY

Agriculture.—One-half of Wyoming, or about 31,000.000 ac., is classed as ranch and farm land; less than 10% of this is crop-producing, the remainder being grazing land. Scanty rainfall and limited irrigation-nater resources preclude any considerable increase in cropland. Of the 3,000,000 ac. of cropland, about 2,000,000 ac. have the benefit of irrigation; the balance is dry-farmed. Dry-land farming is carried on mainly in the eastern part of the state. while production of irrigated crops occurs in many small areas scattered over the state along the river systems. Chief crops are hay. wheat, oats. barley, potatoes, rye and corn.

The extensive grazing lands of Wyoming, with insufficient rainfall for profitable cultivation, favoured livestock raising from territorial days (see *History*, above). Until the disastrous winter of 1886–87 cattle were most important: there were about

2,000,000 cattle in the territory in 1886, a total never approached since that time. On the other hand the number of sheep increased from approximately 500,000 in 1886 to about 6,000,000 in 1909, peak for sheep in Wyoming history. In 1909 there mere approximately 765,000 cattle. In the half century after 1909 labour shortages and less promise of profit in sheep caused a preference for cattle most of the time. In the early 1960s there were about 1,000,000 cattle and calves and 2,250.000 sheep and lambs. Not much of the old antagonism between sheepmen and cattlemen remained, and some leading stockmen had both cattle and sheep, or moved from one to the other with changing price patterns.

Wyoming has long ranked among the leading states in wool production, usually being second only to Texas. Some sections of the state, notably the Red desert in the south central part. provide excellent forage for sheep but are not suitable for cattle. The state made strenuous efforts after World War II to obtain wool-processing industries, which would stimulate wool growing, but these efforts failed.

Hogs have never been numerous in Wyoming; there were only about 45,000 in the late 1950s, at which time there were 50,000 horses and mules (the smallest number in recent history) and 450,000 chickens. Turkeys, which were numerous in the 1920s and 1930s, virtually disappeared thereafter. Marketing problems and the high price of feed restricted the expansion of dairying; there were only about 40,000 milk animals in the state in the late 1950s. Goshen county in the eastern part of the state and Star valley in Lincoln county in the western part stress the dairying industry; there are, of course, small dairy herds in the vicinity of every town.

The average size of Wyoming farms and ranches is over 3,000 ac.

Mining. — Spurred on by rich discoveries in neighbouring territories, prospectors searched Wyoming thoroughly for gold and silver in the 19th century. They found barely enough to keep their hopes alive. Their greatest success was in the South pass region where gold valued at $2,000,000 was produced in the boom period 1867–73. Wyoming's principal mineral resources proved to be petroleum and coal, and petroleum came to be of most importance.

The presence of oil was recognized long before the name Wyoming was applied to the area. Oil springs were noted by Capt. Benjamin Bonneville in 1832, and not many years thereafter travelers on the Oregon trail were scraping up some of this oil and mixing it with flour to make axle grease. Not until 1883 was a well drilled. Marketing difficulties held the industry back until World War I when a boom developed that lasted until 1923. Output reached a peak of 44,785,000 bbl. in that year, with the greatest activity in the Salt Creek field in Natrona county north of Wyoming's "oil capital," Casper. Subsequently production dropped off to 13,650,000 bbl. in 1935. In the 1940s higher prices and more favourable government leasing policies stimulated the industry. Intensive geophysical search and widespread wildcatting brought many new discoveries. A second peak in production was attained with 115,393,000 bbl. in 1958, highest on record. Wyoming geologists had concentrated on the search for domes, but in the 1940s it was learned that much Wyoming oil lay trapped under diverse geological conditions, and fields were developed on the ends of domes in areas long rejected by geologists; also, traps formed by variations in sands were located. Deep drilling became an important factor. A well producing from a depth below 10,000 ft. was drilled in 1946, and many other deep-producing wells were drilled thereafter; one produces at 15,920 ft. in the West Poison Spider field. By 1958, 21 of the state's 23 counties were producing oil, the leading counties, in order, being Park, Hot Springs, Fremont, Big Horn and Natrona. The state's cumulative production to 1959 was 1,659,232,000 bbl. of oil. and proved underground reserves totaled 1,499,000,000 bbl. in that year; in the latter respect Wyoming ranks fifth among the states.

Part of Wyoming's crude oil is processed in refineries within the state, and part is piped to refineries in other states. Various abortive attempts were made beginning in 1924 to establish a severance tax. Such a tax proposal was a principal issue in the gubernatorial campaign in 1950, and legislators regularly considered but rejected severance-tax bills thereafter.

Oil-shale reserves occur in southwestern Wyoming and neighbouring states At the end of World War II the U S bureau of mines built a $500,000 oil-shale laboratory at Laramie where experiments were begun on the extraction of oil from shale.

Next to petroleum. coal has been the most important mineral in Wyoming. The U.S. geological survey in 1950 reported that Wyoming was first among the states in coal reserves with 121,000.000.000 tons, including 13,000,000,000 tons of soft coal and 108,000,000,000 tons of subbituminous coal. Production of coal declined, however, after World War II.

Other minerals produced in Wyoming include uranium, iron ore, trona and bentonite. Minerals such as gold and silver. which stirred the imagination of many people in Wyoming's early history, were not produced in the second half of the 20th century. Mines in the Encampment area had produced copper to the value of $2,000.000 in the first years of the 20th century, but no copper was produced in the late 1950s. Wyoming ranks second among the states in uranium ore reserves, and its production from these reserves is expected to increase.

Forests and Lumber. — One-seventh of Wyoming's area is in nine national forests: Bighorn, Bridger, Medicine Bow, Shoshone, Teton, Black Hills, Caribou, Targhee and Wasatch. The first five named forests lie entirely within Wyoming, the other four only partly.

About 60% of the timber is lodgepole pine. The next most abundant varieties are Engelmann spruce and alpine fir. which displace lodgepole pine at between 6.000 and 9,000 ft. above sea level. In addition to these main types are Douglas fir and limber pine, both restricted in their distribution to favoured localities, the Douglas fir between the lodgepole pine and spruce line, especially on moist north slopes, and the limber pine on exposed rocky sites rising toward the timber line. where it usually takes the frontier stand Little timber is cut except in the national forests, where lumbering is supervised by the U.S. forest service. Under permits, ranchers pasture cattle, horses, sheep and goats in the national forests.

Industry. — Except for petroleum refining, manufactures are of little importance in Wyoming, most of them being local in character and dependent on local products for their raw material. Many efforts have been made since territorial days to bring manufacturing industries to the state, with little success. There are 12 oil refineries which employ more than one-third of the persons employed in manufacturing and pay more than half the wages and salaries so earned. Other manuiactures include food and kindred products. dairy products, lumber and products, printing and publishing and stone, clay and glass products.

Transportation and Communication.—Wyoming's early development was caused by the Union Pacific railroad. which was laid across the territory in the years 1867–69. Various lines were built thereafter. but north-and-south railway transportation remained inadequate, with no prospect for any extension. The two most important systems are the Union Pacific and the Chicago, Burlington and Quincy.

In the late 1950s there were more than 33,000 mi. of roads and highways in the state, of nhich about 5,725 mi. were surfaced. Nearly 1,000 mi. of Wyoming highways mere included in the 41,000-mi. national system of interstate and defense routes.

Cheyenne aspired to national prominence as an air terminal in the 1920s but lost its early leadership. Two local air lines provide limited service for most of the larger communities of the state. The state has 10 daily and 34 weekly newspapers, and there are television stations in Cheyenne, Casper and Thermopolis.

Bibliography.—The most important official state reports are the biennial reports of the treasurer, secretary of state, state geologist, Board of Equalization, Public Service commission, Highway commission, department of public meliare, Board of Charities and Reform, department of education and Game and Fish commission. The Wyoming Cooperative Crop and Livestock Reporting service issues many reports; the University of Wyoming offers a variety of publications; the Wyoming State Historical department publishes the *Annals of Wyoming* twice a year. *See* also the bulletins of the state geologist, bulletin no. 17 being a *Bibliography and Index of Wyoming Geology 1823–1916* and bulletin no. 45 being Frank W. Osterwald and Doris B. Osterwald, *Wyoming Mineral Resources.* Miscellaneous circular no. 28

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WYOMING VALLEY, a valley on the north branch of the Susquehanna river in Luzerne county, Pa., that was the scene of land disputes from colonial times until the end of the 18th century. The area was small, only about $3\frac{1}{2}$ mi. wide and 25 mi. long. Seeds for a boundary dispute were planted when Charles II approved the colonial charters of Connecticut in 1662 and Pennsylvania in 1681. The Connecticut charter, with the South sea (Pacific ocean) as the western limit, placed the southern boundary of the colony at 41° N. latitude. Yet Charles II recognized 42° N. latitude as the northern boundary of William Penn's proprietorship. Thus, when the Connecticut grant was extended westward, it overlapped territory placed under Penn's control.

In 1754 a group of Connecticut land promoters (the Susquehanna Land company) obtained title to the Wyoming valley from the Six Nations (Iroquois). The French and Indian War interfered with settlement for a number of years. In spite of protests by the Penn proprietors against the invasion of their charter rights, Connecticut settlers moved into the valley in 1762. They were driven out by an Indian attack in Oct. 1763.

The Iroquois repudiated the 1754 agreement with the Connecticut company and in 1768 resold their rights to the Penns. From 1765 to 1786 there were frequent clashes between Connecticut settlers and groups representing Penn interests, the most serious being the first and second Pennamite-Yankee Wars of 1769–1771 and 1775.

An even more devastating and tragic event in the history of the valley came in July 1778, during the American Revolution, when the Tory leader Col. John Butler and his Indian allies attacked the settlers and perpetrated the Wyoming massacre.

Near the end of the war with England a congressional commission convened to examine the Connecticut-Pennsylvania dispute. It rejected Connecticut's charter claim and on Dec. 30, 1782, unanimously upheld the Pennsylvania claim. Pennsylvania extended political jurisdiction over the area but refused to recognize the land titles of the Connecticut settlers, thus bringing on the third Pennamite-Yankee War in 1784. In 1787, and again in later years, the Pennsylvania legislature passed laws confirming the land titles; settlement thereafter went ahead and the economic resources of the valley were rapidly developed.

In addition to agriculture the Wyoming valley became the scene of extensive coal-mining operations in the 19th century.

(H. I. Be.)

WYRE FOREST, the remains of an ancient forest in southeastern Shropshire and northwestern Worcestershire, Eng. It lies on high ground west of Bewdley and the Severn river and contains some fine scenery. It covers the southern portion of the Severn valley coal fields and was an early centre of development for the midland iron industry.

WYSPIAŃSKI, STANISLAW (1869–1907), Polish painter and dramatist, was born in Cracow in 1869. His paintings reveal a genius for dramatic construction, but the loss of the use of his hand forced him to turn to writing. *Wesele* (*The Wedding*) is usually regarded as his greatest work and has a high place in Polish literature. The three tragedies *A Warsaw Song, Lelewel* and *November Night* constitute a vivid and powerful portrayal of the November revolution of 1830. In these plays and in *The Legion, Deliverance* and *The Acropolis* he gives voice to the national aspirations of his countrymen and concentrates on the causes of weakness in his nation which put off the hour of its delivery. *The Curse* and *The Judges* are concerned with the lot of the peasants, their ignorance and passions and the pathos of their lives. They adapt the form of the Greek tragedies, the people of the village forming the chorus which comments on the actions of the principal characters. *Boleslas the Bold, The Church on the Rock, King Casimir* are historical dramas. Wyspianski seems to have felt prophetically the approach of a stormy era of war and sacrifice which his people must prepare to meet. World War I greatly increased his influence and Polish drama of recent times has remained under his spell.

WYSS, JOHANN RUDOLF (1782–1830), Swiss writer, famous for his connection with *The Swiss Family Robinson*, was born March 13, 1782, at Berne, where in 1805 he became professor of philosophy at the academy and later chief librarian of the municipal library.

He was a collector of Swiss tales and folklore, writing *Idyllen, Volkssagen, Legenden und Erzählungen aus der Schweiz* (1815) and editing the *Alpenrosen* almanac (1811–30) with the collaboration of the best Swiss writers of his time. He completed and edited *Der schweizerische Robinson* (1812–27), a manuscript originally written by his father, Johann David Wyss (1743–1818), a pastor attached to the minister in Berne, for and with his four sons. The book was translated into English (*The Swiss Family Robinson*, 1820) and other languages and was still popular in the 20th century.

J. R. Wyss was also the author of the Swiss national anthem, "Rufst du, mein Vaterland" (1811). He died at Berne on March 21, 1830. (A. Bx.)

WYTHE, GEORGE (1726–1806), American jurist, a signer of the Declaration of Independence and pioneer professor of law, among whose students were Thomas Jefferson, John Marshall and Henry Clay. Born in the county of Elizabeth City, Va., in 1726, he was elected to the house of burgesses in 1758. In 1764 he was placed on a committee to prepare a petition to the king and remonstrances to both houses of parliament against the Stamp act. Wythe drew up the remonstrance to the house of commons in such strong language that it required considerable modification before it could be sent. In 1775 he was sent to the Continental Congress, where he remained to sign the Declaration of Independence. In 1776 he was appointed, with Jefferson and Edmund Pendleton, to revise the laws of Virginia to make them more appropriate for an independent state. He was an important member of the Constitutional Convention in 1787, and in the following year, of the Virginia convention which ratified it. In 1778 Wythe was appointed a judge of the court of chancery. He was one of the first U.S. judges to lay down the principle (*Commonwealth v. Caton*, 1782) that a court can annul a law deemed to conflict with the constitution.

Wythe is perhaps best remembered as a teacher of law. Jefferson studied in his chambers at Williamsburg. In 1779 — through the influence of Jefferson, then governor of the commonwealth and a member of the board of visitors of the College of William and Mary—Wythe was appointed "professor of law and police," the first chair of municipal law in any college in the nation. He held this position for ten years, teaching principally from the English texts, but introducing into the course a series of moot courts and moot legislatures held by the students and judged by the faculty. Among his pupils during this period was John Marshall, later chief justice of the United States. In 1788 Wythe became sole chancellor of Virginia, and in 1789 the burdens of this position made it necessary for him to resign from the college faculty and move to Richmond. The move did not, however, end his teaching career, for he opened a private school of law in Richmond. Among his pupils in Richmond, and clerk of his court, was Henry Clay.

Wythe died in Richmond on June 8, 1806, from poison, under circumstances which led to the arrest and trial for murder of his grandnephew, the residual legatee under his will. The trial resulted in an acquittal by the jury.

See Thomas Jefferson, *Writings*, Monticello ed., vol. i (1904); L. S. Herrink, "George Wythe" in *John P. Branch Historical Papers*, vol. iii (1912). (J. D. Ls.)

WYTTENBACH, DANIEL ALBERT (1746–1820), German-Swiss classical scholar. was born at Berne on Aug. 7, 1746. He studied Greek under Heyne at Gottingen, and dedicated his first work to Ruhnken, who wrote that he had not expected to find in Germany such knowledge of Greek and such critical powers. Heyne recommended him to Ruhnken and Valckenaer, and in 1770 he went to Leyden. He obtained a professorship in 1771, and began his *Bibliotheca Critica,* which continued to appear for about 30 years. He became professor of Greek at the Athenaeum at Amsterdam in 1785. He edited the *Moralia* of Plutarch for the Clarendon Press, the second portion of which underwent strange adventures during the war between Holland and Great Britain. and was eventually found at Hamburg. The book was finished in 1805. He went to Amsterdam in 1799 on Burmann's death and published his charming *Vita Ruhnkenii* (Leyden. 1799). During his last years he became nearly blind. His only important work was his edition of the *Phaedo.* He died of apoplexy on Jan. 17, 1820.

Hemsterhuis, Valckenaer, Ruhnken and Wyttenbach, more than any others after Bentley, laid the foundations of modern Greek scholarship. The precise study of grammar, syntax and style, and the careful criticism of texts by the light of the best manuscript evidence, were upheld by these scholars in the Netherlands when they were almost entirely neglected elsewhere on the continent, and were only pursued with partial success in England.

X This letter has no prototype in the Semitic alphabet. where; however, a letter of the same shape was the source of Greek T. X first appears after the differentiation of the Greek alphabet into eastern and western types, and its divergent use is one of the most striking marks of difference between them. In the eastern alphabets it represented a voiceless velar aspirate (*ch* or *kh*), and with essentially this value it became part of the Ionic alphabet of later classical Greek, whence it passed into both the later Greek and the Cyrillic alphabets. With its value as standing for the combination ks it passed from the western Greek into the Etruscan and Latin alphabets. Meanwhile the east Greek alphabet used a sign Ξ for *ks*, while the west Greek alphabet used Ψ or Y for the velar aspirate. The western use of X as *ks* may have originated in part through shortening of the combination Xϟ, which was used with this value in early inscriptions of several localities.

Initial *x*, the occurrence of which in English is almost entirely limited to words of Greek origin, is pronounced like *z* (*e.g.*, xylophone). See also ALPHABET. (J W. P.)

XANTHINE: see PURIKES.

XANTHUS (mod. GÜNÜK), an ancient city of Lycia, on the Xanthus river (Eshen Chai) about 8 mi. above its mouth. It was besieged by the Persian general Harpagus (546 B.C.), when the acropolis was burned and all the inhabitants perished. The city was rebuilt; and in 42 B.C. it was beseiged by the Romans under M. Junius Brutus. It was taken by storm and set on fire. and the inhabitants perished in the flames. The well-preserved theatre is remarkable for a break in the curve of its auditorium. which has been constructed so as not to interfere with a sarcophagus on a pedestal and with the "Harpy monument." In front of the theatre stands the famous stele of Xanthus inscribed on all four sides in Lycian and Greek. Behind the theatre is a terrace on which probably the temple of either the Xanthian Apollo or Sarpedon stood. (D. G. H.)

XAUEN (CHAUEN), a town of northern Morocco. lies 31 mi. S. of Tetuán on the main road to Melilla. Pop. (1950) 12.302. It stands 1.970 ft. above sea level in a picturesque setting at the foot of precipitous cliffs of the Djebel Tissouka (6.890 ft.). Its white houses are roofed with the round tiles familiar in southern European countries but rare in Morocco. From the square in the town's centre the 15th-century kasbah raises its red battlemented walls. Below the native town is a new quarter laid out on a geometrical plan by the Spanish. An abundant and constant spring flows from the foot of the mountain in the old city and provides water for the channels which run through the town and its rich gardens. A holy city. founded at the end of the 15th century by a sherif of Djebel Alam to resist the Portuguese, and peopled by Moors expelled from Granada. it still contains a dozen mosques. Xauen was long closed to non-Moslems and was not occupied by the Spanish until 1920. After Moroccan independence (1956) the town was for two years the headquarters of a province with a governor, but in 1958 all administrative services were transferred to the province of Tetuán. Other spellings are Xexauen. Chechaouene and Shishawen. (G. . M.)

XAVIER, SAINT FRANCIS (FRANCISCO DE YASU Y XAVIER) (1506–1552) Jesuit missionary, styled the "Apostle of the Indies," was the youngest son of Juan de Yasu, a high official of the kingdom of Navarre and of his wife, Maria Aznarez de Sada. Xavier y Azpilcueta. Francis was born on April 7, 1506, at the castle of Xavier in Kavarre and received his early education from the castle's chaplain. Meanwhile, in the struggle between France and Spain for the mastery of Navarre, the Xaviers. who had espoused the cause of the French, came upon evil days. In 1515 Francis' father died of sorrow over the destruction of the kingdom and his elder brothers Juan and Miguel were branded as traitors. The prudent mother was able to save but little from the wreck of the family fortunes.

Francis, cadet (younger son) of a noble family, was destined for the church and early received the tonsure. He was naturally inclined to study, and learning was a way to honours and wealth. His father had received the doctor's degree at Bologna while his uncle Martin de Azpilcueta (1493–1586) was already making a name for himself in canon law and moral theology. Francis determined to follow this example and in 1525 he matriculated at the University of Paris, taking quarters at the Collège de Ste. Barbe, then under the protection of the King of Portugal and frequented especially by Spanish and Portuguese students. Soon after his arrival Xavier made a friend of Peter Favre, a Savoyard, and they became roommates. In 1530 the friends finished their philosophical course and received the title of *magister*, roughly the equivalent of the 20th century Ph. D. In October of that year Xavier began his theological studies, at the same time lecturing on Aristotle to the students of the Collège de Dormans-Beauvais.

In 1528 there had arrived at Paris a man who was destined to change the whole outlook of Xavier and his friend Favre. This was the ex-soldier Ignatius Loyola (see LOYOLA, IGNATIUS OF). Xavier and Favre were among his first permanent disciples. Ignatius did not win Xavier without a struggle and he afterward stated that Xavier was the stiffest clay he had ever moulded. But by 1533 Ignatius had won Xavier completely to the service of Christ. He was among the six first companions of Ignatius who on Aug. 15, 1534, pronounced vows and formed a union which was to result in the foundation of the Society of Jesus six years later. Xavier remained in Paris until the end of 1536 and during this period he made the "Spiritual Exercises" under the guidance of Loyola. In Jan. 1537 the companions met in Venice, hoping to be able to make a pilgrimage to the Holy Land. During the following spring they went to Rome where Paul III received them with kindness, blessed their plan of pilgrimage, and authorized the ordination of those who were not already priests. Xavier was ordained at Venice on June 24, 1537. While waiting for an opportunity to sail to Palestine, Ignatius and his companions led a life of poverty, self-denial and zealous apostolic endeavour in the cities of Italy. Xavier laboured in Venice, Monselice near Padua, Vicenza and Bologna. At the close of 1538 Ignatius concluded that it was vain to wait any longer for an opportunity to make the pilgrimage which they had vowed. He accordingly summoned the companions to Rome to deliberate about their future. Xavier took an active part in the conferences which led to the foundation of the Society of Jesus, of which he was the first secretary. At the same time he showed himself active in works of zeal among the Romans. When, however, Paul III formally approved the Society of Jesus in Sept. 1540, Xavier was no longer at Rome.

John III of Portugal on the advice of the rector of the Collège de Ste. Barbe had asked the pope for six companions of Ignatius for work in the immense Portuguese colonial empire in the East. Paul III granted the request but reduced the number to two. Ignatius assigned Rodrigues and Bobadilla to the mission. When Bobadilla fell sick, Xavier was named to replace him. Two days later on March 16, 1540, Xavier took leave of Ignatius and set out for Portugal. While waiting at Lisbon for transportation to the east, Xavier and Rodrigues laboured with so much spiritual success that John III wished to retain both in Portugal and actually succeeded in retaining Rodrigues.

Mission in the Portuguese East Indies: — On his 35th birthday, April 7, 1541, Francis Xavier set sail from Lisbon and, after wintering in Mozambique where he was seriously ill of fever, arrived at Goa, capital of the Portuguese Indian Empire on May 6, 1542. His first act was to present himself to the bishop, the Franciscan Juan de Albuquerque, and show his credentials, among which was a papal brief, obtained by John III, and appointing Xavier papal legate for the Indies. Xavier promised to make use of these powers according to the directions of the bishop. Dominicans and Augustinians, as well as Franciscans.

were already at work in the vast mission field and Xavier looked upon himself as their collaborator. Goa was to be his headquarters and was the scene of his first labours in the east. For five months he devoted himself exclusively to the welfare of the Portuguese and their servants in the capital. He went into the streets and gathered a crowd about him by ringing a small bell. Children, workingmen and slaves would gather sometimes to the number of 300. Xavier would lead them to the principal church and give them instruction in Christian doctrine. By this and other means he sought to rouse the consciences of the Christians of Goa.

In Oct. 1542, Xavier went to the southern tip of the peninsula to work among the Paravas of the Fishery coast. These pearl fishers had accepted Portuguese protection against the Moslem and with it baptism. Much remained to be done, however, to make them a truly Christian people. For two years, 1542–44, Xavier was principally occupied, assisted by some priests, catechists and interpreters, in completing the instruction of the baptised, building churches and chapels, settling disputes among the villages, organizing the defense against, and making peace with, external enemies. At the same time he preached to crowds and baptised thousands. In the last month of 1544 he baptised ten thousand fisher folk of Macua in the neighbouring kingdom of Travancore, writing that his arm had grown lame from pouring the baptismal waters. Schurhammer estimates that in all he baptised about 30,000 in southern India.

In 1545 after visiting Cochin, San Thomé near Madras (with its shrine of St. Thomas the Apostle) and Ceylon, Xavier set out for the east, arriving in September at Malacca. Here he worked to revive the faith of the Portuguese while he planned a voyage to the Spice Islands. On Jan. 1, 1546 Xavier sailed for Amboina where he passed the spring. The summer was spent at Ternate. Later Halmahera and Morotai were visited. In May 1547 Xavier left the Moluccas and returned to Malacca.

Mission to Japan.—In Malacca Xavier was presented to Hachiro (Yajiro, Anjiro), a native of newly discovered Japan. What he learned from this Japanese and from the Portuguese who had visited the island empire filled the heart of Xavier with joy. The simple fisher folk of southern India and the barbarous natives of the Moluccas seemed incapable of being the foundation stones of the church in the far east. But Japan was a populous country with an ancient culture and its inhabitants, could they be won for Christianity, would probably afford ideal material for the development of Christianity. Xavier felt that he was called by God to evangelize Japan and accordingly began his preparations. Hachiro and two other Japanese were despatched to Goa for instruction and baptism. Xavier himself also returned to India, visiting Ceylon, Cochin and the Fishery coast as well as Goa, and all the time preparing for the Japanese expedition.

In 1549, accompanied by three Japanese and two other Jesuits, Xavier set out on the long hazardous voyage to Japan. On Aug. 15, 1549 the little expedition landed at Kagoshima, the country of Hachiro. Xavier was the first Christian missionary to Japan of whom there is any record. The *daimyo* of Kagoshima received the party in a friendly manner and converts were made. Until Nov. 20, 1551, Xavier remained in the country preaching at Hirado, Kyoto, the capital, Yamaguchi and Bungo, as well as at Kagoshima. During this time he baptised about two thousand; most of them were members of the lower classes but some, particularly in Yamaguchi, belonged to the military caste. Actual converts were the least part of Xavier's work in Japan. He explored and organized a new field of missionary labour, which was destined to show tremendous results. The spiritual quality of the Japanese promised a brilliant future for Christianity in Japan, a promise which was, however, obliterated in blood at the turn of the century.

Voyage to China.—On his way to Japan Xavier had touched at Canton. In Japan he had met Chinese and had formed a high opinion of their capabilities. He knew that no pagan land could be compared to China in population and wealth. He saw that the Japanese esteemed Chinese culture. It was inevitable then that Xavier should make an attempt to penetrate into the Chinese empire, then closed to foreigners.

But other business had to be despatched first. Xavier learned at Malacca that Ignatius Loyola, as general of the Society of Jesus, had separated India and the east from the jurisdiction of the Provincial of Portugal and formed it into a new "province" of the society. The first provincial was to be Xavier himself. It is probable that Loyola had taken this step to free the great missionary from fetters imposed by nationalistic feeling among the Portuguese. Studying the reports from the missions he had inaugurated, Xavier learned that his companions and successors on the Fishery coast, in Thana near Bassein, in Quilon, at San Thomé, in Ternate and the Moluccas (except Amboina) and finally in Ormuz were struggling heroically to advance the work against great difficulties. Almost everywhere progress was reported. Xavier was finally able to make satisfactory arrangements in the College at Goa, which was destined to furnish native priests for the missions. This task occupied Xavier until April 1552.

When his duties as provincial had been attended to, Xavier turned toward China. In India he elaborated a plan for an embassy to the Emperor of China by which he hoped to negotiate an alliance between Portugal and China and so be enabled to begin a Christian mission among the Chinese.

At Malacca the Commandant Alvaro de Ataide firmly refused to allow the embassy, which he considered an infringement of his rights, to depart. Xavier then decided to go alone. He sailed to Sancian (Shang Ch'uan) an island off the south coast of China not far from Canton. Here he arrived during the last days of Aug. 1552 and for more than three months tried in vain to obtain passage to the mainland. Toward the end of November, Xavier, who was practically abandoned, fell seriously ill.

On Dec. 3, 1552 (not Nov. 27) he died before the closed doors of the great empire he longed to convert. Xavier deserves to be ranked as one of the greatest Christian missionaries with Patrick, Boniface, Columba and Anskar. The first Jesuit missionary and founder of the Christian mission to the Japanese, he was a pioneer of modern missionary method by his careful examination and occupation of the mission field. He favoured the study of the languages, religions and customs of the natives, made use of native collaborators, endeavoured to create a mission literature in the vernacular and strove to organize his missions thoroughly. Xavier was canonized in 1622.

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XENOCRATES (396/395–314/313 B.C.), Greek philosopher, the successor of Speusippus as head of the Greek Academy (*see* Academy, Greek), was a pupil of Plato. After Plato's death he left Athens (in the company of Aristotle). He was elected head of the Academy in 339 or 338.

Xenocrates' writings are lost except for fragments. His doctrines were closely related to those of Plato as reported by Aristotle. Among them is the "derivation" (a kind of timeless emanation) of all reality, sensible and suprasensible, from the interaction of two opposite principles, "the One" and "the indeterminate dyad," responsible for the presence of unity and multiplicity, the determinate and the indeterminate, good and evil, rest and motion, etc., in the universe, with numbers (equated with Plato's ideas) and geometrical magnitudes as the first products of this derivation (*see* Speusippus). Xenocrates also dissected all reality into three spheres: (1) the sphere of sensibles, objects of sensation; (2) the sphere of intelligibles and of the prime principles, objects of true knowledge—specifically of wisdom—and "transcelestial" (just as Plato's ideas or Aristotle's gods in *On the Heavens*); and (3) mediating between them, the sphere of the heavens with its bodies. objects of sensation on one hand and of knowledge (namely astronomy) on the other and so. in this dual capacity, termed by Xenocrates objects of "opinion."

This tripartite division seems to express a tendency of the Academy toward bridging the gap. characteristic of some works of Plato. between ideas and sensibles ancl the attendant two modes of cognition. The same tendency seems to underlie Xenocrates' definition of the soul as a self-changing (self-moving) number, a definition closely related to the doctrine of the genesis of the soul in Plato's *Timaeus* (which, together with its cosmogony. Xenocrates interpreted as a mere didactic device explaining the timeless structure of the world).

Another threefold division was that into gods, men and "demons," the last named representing semihuman, semidivine beings, some good. others evil. To these demons Xenocrates attributed much of what popular religion attributed to gods; and rites. mysteries. etc.. were actually instituted to propitiate them. especially the evil ones. Though it is uncertain how literally Xenocrates took it (he may have used it to promote a more spiritual concept of the gods), this demonology had great influence; *cf.* the identification of pagan deities with evil demons by early Christian writers.

Whether the triple distinction of mind, soul and body, with the attendant doctrine of a first and a second death (the latter taking place on the moon and consisting in the mind's separating froin the. soul to ascend to the sun). belongs to Xenocrates or to the Stoic Poseidonius is controversial. Xenocrates' division of gods into Titanic and Olympic ones has a Neoplatonic flavour. His identification (or assimilation) of abstract principles (e.g., "the One" and "the dyad"), parts of the spatial universe, elements, etc., with some deity also show his theological interests, whatever their ultimate meaning.

The "atomism" of Xenocrates was perhaps a reaction to the "paradoxes of the continuum" revealed by the Eleatics. The five elements and even mathematical magnitudes are supposed to consist of indivisible units: lines, for instance, consist of indivisible lines.

In the field of acoustics he traced this atomism (what we perceive as one sound actually consists of discrete sounds) to Pythagoras—an example of the Pythagorizing tendencies of the old Plato. shared by the Academy.

Xenocrates said that philosophy (which he divided into logic, physics and ethics) origiriated in man's desire to resolve his anxieties; this implies the primacy of ethics over speculation. Happiness Xenocrates defined as the acquisition of the perfection peculiar or proper to inan, so that he can enjoy things natural to him. This doctrine foreshadows the Stoic derivation of the ethical norm from nature; and it is possible that Zeno the Stoic attended Xenocrates' lectures. Xenocrates. however. admitted, as the Stoics never did, that external goods are important for happiness. His definition of the (Platonicj idea as the paradigmatic cause of what is natural might point in the same direction as his definition of happiness.

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(PP. M.)

XENON, an inert and extremely rare gaseous element represented by the symbol Xe and classed as the fifth member of the helium family or Group 0 of the periodic system. It has an atomic number of 54 and an atomic weight of 131.3. Its isotopes. listed in the order of decreasing abundance. have the mass numbers 132. 129. 131. 134 136. 130. 128, 124 and 126.

Radioactive isotopes produced by the fission of uranium and by other nuclear reactions are also known In the normal state of the atom there are eight electrons ($5s^2$, $5p^6$) in its outermost level.

Xenon occurs in slight traces in gases within the earth and it is present to an extent of about 0.0000085 by volume in dry air. It is produced on a small commercial scale by the fractional distillation of air (*see* NEON) and is the most expensive of the inert gases of the atmosphere. The element was discovered in 1898 by Sir William Ramsay and RI. W. Travers.

The following physical constants for the element have been selected from the technical literature: density of the gas at 0° C. and 1 atrn. pressure. 5.896 g. per litre; density of the liquid at $-109.1°$ C., 3.06 g. per millilitre; melting point, $-112.0°$ C.; normal boiling point. $-108.06°$ C.; critical temperature, 16.6° C.: critical pressure. 58.2 atm.; heat of vaporization at $-108°$ C.. 23.0 cal. per gram: ionization potential. 11.5 v.; solubility in water at O' C. and 1 atm.. 0.242 ml. of gas per millilitre of water; ratio of specific heat at constant pressure to specific heat at constant volume, 1.666 at 19° C. Solid xenon belongs to the face-centred cubic system and one edge of the unit cell has a length of 6.24×10^{-8} cm. at 88° K. This means that the monatomic molecules behave in the solid as would spheres of 2.206×10^{-8} cm. radius when packed together as closely as possible.

The element is used to a small extent in gaseous tube lighting and in negative glow lamps. It is also used in lamps which produce flashes of light of extremely short duration such as are desired for high-speed photography.

During f orld War II xenon was utilized in rectifiers in place of mercury. At the low temperatures encountered in the North Atlantic. mercury-vapour rectifiers did not always operate efficiently, but xenon-filled tubes worked nicely.

While xenon is highly inert cheniically, it forms a few crystalline compounds in which the xenon atoms are bound by the weak type of attraction called van der Waal's forces. Notable among these compounds are a hydrate, $Xe.nH_2O$ (n is about 5 or 6), and a compound with phenol, $Xe.2C_6H_5OH$. The decomposition temperatures of these substances under 1 atm. pressure are $-1.3°$ C. and 4° C., respectively. Such compounds of the helium family gases increase in stability with increasing atomic weight of the elements.

Xenon is recognized qualitatively by its characteristic spectrum. It may be determined quantitatively by concentrating the gas by fractional adsorption on activated charcoal followed by spectroscopic quantitative determination of the element in the concentrate.

For bibliographical references, *see* the articles, NEON and KRYPTON.

(G. H. CA.)

XENOPHANES (6th–5th century B.C.), Greek religious thinker and poet, the reputed founder of the Eleatic school (*q.v.*) of philosophy, was probably born about 570 B.C., a native of Colophon in Ionia. An exile from home, he resided for a time in Sicily (at Zancle and at Catana) and then settled. it is said, at Elea in southern Italy. In one of the extant fragments of his poems (no. 8 in the edition by H. Diels and W. Kranz), he speaks of himself as having begun his wanderings 67 years before, when he was 25 years of age; so that he must be taken to have been not less than 92 when he died. His teaching found expression in poems, which he recited rhapsodically in the course of his travels. In the more considerable of the elegiac fragments. he ridicules the doctrine of the transmigration of souls (no. 7); asserts the claims of wisdom against the prevalent athleticism, which seemed to him to conduce neither to the good government of states nor to their material prosperity (no. 2); reprobates the introduction of Lydian luxury into Colophon (no. 3): and recommends the reasonable enjoyment of social pleasures (no. 1). Of the epic fragments, the more important are those in which he attacks contemporary anthropomorphism and the acceptance of Hotneric mythology. Xccording to Aristotle (*Metaphysics,* A5), "the first of the Eleatics was careful not to say whether the unity that he postulated was finite or infinite; but, contemplating the whole firmament. declared that the One is God." It must remain open to dispute whether Xenophanes was a monotheist whose assertion of the unity of God suggested to Parmenides (*q.v.*) the doctrine of the unity of being; or a pantheist whose assertion of the unity of God was also an assertion of that of being, in which case he anticipated Parmenides; or a polytheist whose "one God" was only the supreme god among others.

Other fragments may be classified as dealing (1) with theology, (2) with cosmology and (3) with theory of knowledge:

1. "There is one God, greatest among gods and men, who neither

in shape nor in thought resembles mortals. . . He is all sight. all mind. all ear [*i.e.,* not a composite organism] . . . Without effort he shakes all things by thought. . . I-Ie abides ever in the same place motionless, and it does not befit him to wander hither and thither. . . Yet men imagine gods to be born and to have raiment and voice and body. like themselves. . . Even so the gods of the Ethiopians are swarthy and flat-nosed, the gods of the Thracians fair-haired and blue-eyed. . . Even so Homer and Hesiod attributed to the gods all that is a shame and a reproach among men—theft. adultery. deceit and other lawless acts. . . Even so oxen, lions and horses. if they had hands wherewith to grave images. would fashion gods after their own shapes and make them bodies like to their own."

2. "From earth all things are and to earth all things return. . . From earth and water come all of us. . . The sea is the a-ell whence water springs. . . Here at our feet is the end of the earth where it reaches unto air, but, below. its foundations are without end. . . The rainbow which men call Iris, is a cloud that is purple and red and yellow."

3. "No man has perceived certainty. nor shall anyone perceive it, about the gods and all whereof I speak; for, however perfect what he says may be. yet he does not know it; all things are matters of opinion. . . What I say is opinion resembling truth. . . The gods did not reveal all things to mortals in the beginning; but in long searching man finds that which is better."

There is little secondary evidence to record. "The Eleatic school." says the Stranger in Plato's *Sophist, 242D,* "beginning with Xenophanes and even earlier, starts from the principle of the unity of all things." Aristotle's testimony has already been cited. Theophrastus (in Simplicius, *Ad Physica,* 5) sums up Xenophanes' teaching as "the all is one and the one is God." Timon (in Sextus Enipiricus. *Hypotyposes,* i, 224), ignoring Xenophanes' theology, makes him resolve all things into one and the same unity.

The demonstrations of the unity and the attributes of God. with which the treatise De *Melisso, Xenophane* et Gorgia accredits Xenophanes. are plainly framed on rather later Eleatic proofs of the unity and the attributes of reality.

Xenophanes was primarily neither a philosopher nor a natural philosopher (in the sense of looking. as Anaximander or Parmenides did. for abstract principles underlying natural change). He was a poet and a religious reformer who applied to popular notions of God more or less philosophical and scientific conceptions. As such he must be counted a pioneer in the Greek development of monotheism and of theology itsclf. His doctrine here was chiefly negative, as he was concerned to deny attributes which he considered unbefitting to divinity.

While he vaguely distinguishes between knowledge of nature and knowledge of the divine; his attitude to nature was one of empiricism combined, so far as we can tell, with an uncritical acceptance of popular writings; when he is sceptical this does not seem to follow from any philosophical principle. The "wisdom" that he recommended appears to be further from the sophisticated Eleatic philosophy of appearance and reality than the later Greek tradition supposed.

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(A. C. LD.)

XENOPHBN (c. 430 B.C.–after 355 B.C.). Greek historian arid man of letters, author of the famous *Anabasis,* was born in Athens, the son of Gryllus, a wealthy and well-born Athenian citizen. Oi his boyhood and youth nothing is known; it is inferred that he early fell under the two influences that most shaped his life and works, war and Socrates. These years saw Athens and Sparta at grips in their struggle for supremacy: they saw in Athens itsclf Socrates at the height of his powers, to the young who conversed with him an intellectual stimulus of a rare order. Perhaps it needed such a stimulus to make a writer of Xenophon, for though he wrote much he wrote no single work that conclusively ansners the question, why he ever wrote at all. He gives the impression of a man of action and a country gentleman who by some accident wrote books

Xenophon probably saw active service in some of the war's later campaigns, but his great chance came when he was invited in 401 to join the expedition of the younger Cyrus in rebellion against his brother Artaxerxes II of Persia. The circle of Socrates in Xthens was by then under a cloud, and Athens no longer a great poner. Xenophon was one of the "Ten Thousand" Greeks who nent to Asia to seek their fortune, unaware, till it mas too late to withdraw, that Cyrus meant to win the Persian empire by a blow directed deep into its heart.

The story of the expedition Xenophon told in his *Anabasis* ("Upcountry March"). When the plan of Cyrus miscarried at Cunaxa (401), the Greeks. isolated in hfesopotamia and deprived by treachery of all their original commanders except one, elected new ones, and among them Xenophon, nho did most (according to his own account) to rally the troops and enable them to meet the perils of the retreat northward up the Tigris making for the Black sea. Harassed first by the Persian cavalry and later by hostile tribesmen through the mountains of Kurdistan and Armenia, they reached the Greek colony of Trapezus (Trebizond) after a five months' march, a triumph of discipline and improvization for which there is no reason to doubt that Senophon was in great part responsible. The return to civilization presented difficulties of its own. Xenophon would have liked to found a new colony on that coast, but he could not win the necessary support from the army. and after vicissitudes the survivors, including himself, took service first with the Thracian king Seuthes and presently with Sparta, then at war with Persia and commencing operations in Asia Minor (399).

In this campaign Xenophon really did manage to make his fortune (by holding to ransom a rich nobleman and his family). but it cost him his Athenian citizenship, for in his absence decree of exile was passed upon him as a friend of Sparta. It was about this time that he married Philesia, who gave him two sons. Gryllus and Diodorus. His meeting with the Spartan king Agesilaus (396) was decisive for his future. When Agesilaus was recalled to Greece (394) Xenophon accompanied him, and settled at Scillus in Elis, near Olympia, on an estate provided by the Spartan government.

There he lived until 371. when the collapse of Spartan power after the battle of Leuctra enabled the Eleans to resume possession of the lands at Scillus. The Athenians, now allies of Sparta (369), repealed the decree of exile, and his son Gryllus was killed fighting for Athens in 362. Xenophon himself lived for some years at Corinth. and whether he ever returned to Athens is not certain; but indications in book vii of the *Hellenica,* and especially the subject and treatment of his last work on the revenues of Athens, make it likely that he did, perhaps in 365. His death may be presumed not long after the completion of this work (355).

Principal Works.—The *Anabasis,* written at Scillus and published first under a pseudonym (Themistogenes of Syracuse); is deservedly the most popular of Xenophon's writings. Its first two-thirds is an entertaining narrative with few occasions for reflection or analysis (in which Xenophon does not shine). but lively, practical and full of detail both colourful and exact. He must certainly have kept a diary at the time. The last third contains signs of self-justification which may be in reply to a published account of these events that he considered unfair! and which may have been added later. It was the *Anabasis* that prompted J. B. Bury to write of Xenophon that he would have made his fortune as a war correspondent.

The *Cyropaedia,* a sort of historical novel with a moral and political purpose, describes not only the boyhood and training of Cyrus the Great but his whole career and thus contains the story of the founding of the Persian empire. Into a narrative framework is interwoven much material that represents Xenophon's views on government and education for government. The book was written quite late in Xenophon's life. Plainly discernible are elements of the Spartan institutions and system, but its high moral standards could derive from Socrates. if not from Xenophon himself. If it was also a deliberate reaction against the intellectual approach and method of Plato's *Republic,* the form was the only one of which its author was capable, for he was no philosopher. The *Cyropaedia* might be called a philistine's alternative to philosophy, on these subjects.

The Hellenica (history of Greece from 411 to 362 B.C.) is invaluable as the only surviving history of this period by a contemporary, except for the fragment (Hellenica *Oxyrrhynchia*) by an unidentified author. Comparison of the two where they cover the same ground is not to Xenophon's advantage. His work was clearly undertaken to continue and conclude the unfinished History of Thucydides. Books i–ii retain in a modified form Thucydides' annalistic scheme: they cover the years 411–403: and may even have been written before Xenophon's departure to Asia in 401. Books iii–v. 3 were written much later, at Scillus, and books vi and vii probably in the last years of his life, when additions were made also to the earlier parts. Xenophon had few of the qualities of a good historian, except that of being readable. The theme of the *Hellenica,* the hegemony in Greece first of Sparta and then of Thebes, is disfigured by his propensity to accept the Spartans at their own valuation, and even by his neglect of the duty to seek out information from all available sources. And what shall be said of the historian who omitted to record the most important single development of his period, the founding of the Second Athenian confederacy, presumably because he did not like it? Even the fall of Sparta, which he came to admit was deserved, he explains in terms more theological than historical (v. 4.1). Not all the pleasing writing, the spirited speeches, the mastery (usually j of military affairs can make up for the inability even to recognize the elements of a historian's task.

The *Memorabilia* ("Recollections of Socrates'!) were held in antiquity to be based upon notes taken by Xenophon of Socratic conversations at which he was present in his youth; but modern opinion doubts this. Of the four "books" the first two, written probably in the Scillus period, open as a defense of Socrates against his accusers (in particular, it is thought, the sophist Polycrates) both at his trial and after his death; but they digress into questions of mainly private morals! and they could have been designed primarily for the edification of his two young sons. The last two books were written, to judge by internal evidence, right at the end of Xenophon's life: they contain much that is reminiscent of passages in his earlier works, and are concerned primarily with the state of Athens and its improvement. One suspects that the whole work reveals more of Xenophon than of Socrates.

Minor Works.—Of Xenophon's minor writings, the *Apologia Socratis* ("Defense of Socrates") has often been adjudged spurious, but it is probably genuine, written at Scillus, and the earliest of his Socratic works. The severe judgment on Anytus may be intended as a corrective to the favourable picture in Plato's *Meno.*

The *Oeconomicus* deals with household and estate management, and gives a charming glimpse of the married life of fairly well-to-do Greeks, and especially of the wife's duties and status. It is in the form of a Socratic dialogue, but is a unique one in that it shows Socrates not only displaying interest in things of the countryside, but in the end actually prepared to listen while his companion does nearly all the talking.

The *Symposium* ("Banquet") is a brilliant little dialogue in which Socrates is the main figure. He is represented at a lively Athenian supper party, at which there is much drinking, with flute-playing and a dancing-girl from Syracuse, who amuses the guests with the feats of a professional conjuror. The table talk of Socrates includes a serious disquisition on the superiority of heavenly to earthly love.

In the essays on horsemanship. *Hippike* (De *re equestri*), and hunting (*Cynegeticus*), Xenophon deals with matters of which he had a thorough practical knowledge. He writes with the zest of an enthusiastic sportsman, and observes that those nations whose upper classes have a taste for field sports will be most likely to be successful in war. The strange epilogue (*Cynegeticus,* ch. 13) in which he finds fault with the sophists (academic intellectuals), their methods of education and their values, seems out of place, but is suggested perhaps by the contrasting practical and physical side of education which hunting fosters. Both these treatises may still be read with interest.

The *Hipparchicus* explains the duties of a cavalry officer, dwelling on the moral qualities needed and the necessity for attention to religion. It is not, according to modern ideas, a very scientific treatment, and it shows that the art of war was but imperfectly developed and that the cavalry operations of the Greeks were on a somewhat petty scale.

The *Agesilaus* is a brief panegyric, written presumably at the time of his death, of the Spartan king who was Xenophon's personal friend and benefactor, and to some extent his hero.

The Hieron, a dialogue between Hieron I of Syracuse and the poet Simonides, is an entertaining and readable debate on autocratic rule; as it affects the happiness first of the ruler and secondarily of his subjects.

The short essay on the constitution of the Lacedaemonians gives an interesting if unsystematic account of Spartan institutions and customs as seen by an admiring observer. In chapter 14, however, presumably written in a time of disillusion, Xenophon emphasizes the failure of the Spartans to observe their own admirable laws, with consequences disastrous to themselves.

The essay on the constitution of Athens is not the work of Xenophon, but of an Athenian oligarch who wrote while Xenophon was still a boy.

The essay on the revenues of Athens (De *vectigalibus*) written in 355 at a time of financial stringency, contains practical suggestions for relieving it and improving the city's position by permanently increasing the revenues and by promoting a foreign policy more in keeping with its resources. The work's genuineness has been questioned, but without good cause.

Status. — In antiquity Xenophon owed his high reputation to his pure Attic style, which found admirers and imitators in the so-called Attic revival of the Roman period. To the moderns, everything that he wrote seems deficient in intellectual quality, and consequently his successes (and most notably the *Anabasis*) are deemed to succeed by virtue of other qualities. His wide interests and curiosity and his versatility will commend him to all save those who find him in everything a bore. As a man, he was orthodox, pious, a little old-fashioned, honest to all appearances and yet capable of intellectual dishonesty, with a very good opinion (one suspects) of himself and of all his works: in spite of his faults Xenophon was a very likeable man—and in spite of some of his virtues.

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XERXES (the Greek form of the Pers. *Khshayārshā;* Old Testament Ahasverus, *Akhashverosh—i.e.,* Ahasuerus [*q.v.*]—with wrong vocalization and substitution of y for v, instead of *Akhshavarsh;* in Aramaic inscriptions and papyri from Egypt the name is written Khshai'arsh), the name of two Persian kings of the Achaemenid dynasty.

1. Xerxes I, son of Darius I and Atossa, the daughter of Cyrus the Great, and thereiore appointed successor to his father in preference to his eldest half-brothers, who were born before Darius had become king (Herod. vii. 2 f.). After his accession in 486 B.C. he suppressed the revolt that had broken out in Egypt, appointed his brother Achaemenes as satrap and "brought Egypt under a much heavier yoke than it had been before" (Herod. vii. 7). His predecessors, especially Darius, had not been successful in their attempts to conciliate the ancient civilizations. This probably was the reason why Xerxes in 484 abolished the "kingdom of Babel" and took away the golden statue of Bel (Marduk, Merodach), the hands of which the legitimate king of Babel had to seize on the first day of each year, and killed the priest who tried to hinder him[1]. Therefore Xerxes does not bear the title of "King of Babel" in the Babylonian documents dated from his reign, but "King of Persia and Media," or simply "King of countries" (*i.e.,* of the world). This proceeding led to two rebellions, probably in 484 and 479; in the Babylonian documents occur the names of two ephemeral kings, Shamash-irbā and Tarziya, who belong to this time. One of these rebellions was suppressed by Megabyzus, son of Zopyrus, the satrap whom the Babylonians had slain[2].

Darius had left to his son the task of punishing the Greeks for their interference in the Ionian rebellion and the victory of Marathon. From 483 Xerxes prepared his expedition with great care: a channel was dug through the isthmus of the peninsula of Mount Athos; provisions were stored in the stations on the road through Thrace; two bridges were thrown across the Hellespont. Xerxes concluded an alliance with Carthage, and thus deprived Greece of the support of the powerful monarchs of Syracuse and Agrigentum. Many smaller Greek states, moreover, took the side of the Persians ("Medized"), especially Thessaly, Thebes and Argos. A large fleet and a numerous army were gathered. In the spring of 480 Xerxes set out from Sardis. At first Xerxes was victorious everywhere. The Greek fleet was beaten at Artemisium, Thermopylae stormed, Athens conquered, the Greeks driven back to their last line of defence at the Isthmus of Corinth and in the Bay of Salamis. But Xerxes was induced by the astute message of Themistocles (against the advice of Artemisia of Halicarnassus) to attack the Greek fleet under unfavourable conditions, instead of sending a part of his ships to the Peloponnesus and awaiting the dissolution of the Greek armament[3]. The battle of Salamis (Sept. 28, 480) decided the war. (*See* Salamis.) Having lost his communication by sea with Asia, Xerxes was forced to retire to Sardis; the army which he left in Greece under Mardonius was in 479 beaten at Plataea (*q.v.*). The defeat of the Persians at Mycale roused the Greek cities of Asia.

Of the later years of Xerxes little is known. He sent out Sataspes to attempt the circumnavigation of Africa (Herod. iv. 143), but the victory of the Greeks threw the empire into a state of languid torpor, from which it could not rise again. The king himself became involved in intrigues of the harem (*cf.* Herod. ix. 108 ff.—compare the late Jewish novel of *Esther,* in which a remembrance of the true character of the king is retained) and was much dependent upon courtiers and eunuchs. He left inscriptions at Persepolis, where he added a new palace to that of Darius, at Van in Armenia, and on Mount Elvend near Ecbatana; in these texts he merely copies the words of his father. In 465 he was murdered by his vizier Artabanus (*q.v.*) who raised Artaxerxes I to the throne.

2. Xerxes II, son and successor of Artaxerxes I, mas assassinated in 424 after a reign of forty-five days by his brother Secydianus or Sogdianus, who in his turn was murdered by Darius II (*q.v.*).

See Ctesias, *Pers.* 44; Diod. xii., 64, 71, and the chronographers; neither of the two ephemeral kings is mentioned in the canon of Ptolemy nor in the dates of Babylonian contracts of this time.

The name Xerxes was also borne by a king of Armenia, killed about 212 B.C. by Antiochus the Great (Polyb. viii. 25; Johannes Antiochenus, p. 53; his name occurs on copper coins); and by a son of Mithradates the Great of Pontus (Appian, *Mithr.* 108, 117). (Ed. M.)

[1]Herod. i. 183, by Ctesias changed into a plundering of the tomb of Belitanas or Belus: *cf.* Aelian, *Var. Hist.* 13, 3; Aristobulus *ap.* Arrian vii. 17, 2, and Strabo xvi., p. 738.

[2]Ctesias, *Pers.* 22; his legendary history is transferred by Herodotus, iii. 150 ff., to the former rebellion against Darius.

[3]*See* G. B. Grundy, *Great Persian War* (1901), and in criticism W. W. Tarn, "The Fleet of Xerxes," in *Journal of Hellenic Studies* (1908), 202–234; also Macan's notes on Herod. iv.–vi. (1895), and authorities for Plataea, Salamis.

XINCA, a group of about 10,000 Indians living in southern Guatemala along the Rio de los Esclavos, including most of the departments of Santa Rosa and Jutiapa. They were first encountered by the Spaniards under Pedro de Alvarado in 1524 and were finally subdued two years later by Pedro Portocarrero. On account of their stubborn resistance many of them were branded and sold as slaves, whence the name of the river that cuts their territory. The Xinca may be the remnants of an ancient population which preceded the Maya and Nahua. The Maya regarded the Xinca as barbarians, a feeling very generally entertained in Guatemala to-day.

See D. G. Brinton, On *the Xinca Indians* of *Guatemala* (American Philosophical Society, *Proceedings,* Philadelphia, 1884); Walther Lehmann, *Zentral-Amerika,* 1 Teil, ii. Band (1920).

XIPHILINUS, JOANNES, epitomator of Dio Cassius, lived at Constantinople during the latter half of the 11th century A.D. He was a monk and the nephew of the patriarch of Constantinople of the same name. (Migne, *Patrologia Graeca,* cxx.) The epitome (ἐκλογαί) of Dio which was prepared by order of Michael Parapinaces (1071–78), comprises books 36–80, the period included being from the times of Pompey and Caesar down to Alexander Severus. Book 70 appears to have been missing in his copy, while in books 78 and 79 a mutilated original must have been used. Xiphilinus divided the work into 'sections, each containing the life of an emperor. He omitted the name of the consuls and hence sometimes falls into chronological errors. The epitome is valuable as preserving the chief incidents of the period for which the authority of Dio is wanting.

See J. Melber's Dio in Teubner series; C. Wachsmuth, *Einleitung in das Studium der alten Geschichte* (1895); W. Christ, *Geschichte der griechischen Literatur* (1898).

XIPHOSURA, marine arthropods commonly known as king crabs or horseshoe crabs. Originally classified as crustacea, later placed as an order in the class Arachnida, the Xiphosura are now generally recognized as an independent class. Geologically an old group, already in existence in the Devonian, the Xiphosura are represented by only five species forming a single family Xiphosuridae. Formerly these five species were all reierred to a single genus *Limulus.* They are now divided among three genera and the old genus *Limulus* has been completely abolished. *Xiphosura polyphemus* is found along the Atlantic coast from Maine to Yucatan; *Carcinoscorpius rotundicauda,* in southern Japan; *Tachypleus gigas,* in Malaysia; *Tachypleus hoeveni,* in the Moluccas; and *Tachypleus tridentatus,* from north Borneo t~ China and southern Japan. King crabs live in shallow water; feed on worms and molluscs, reach the maximum size of about 60 cm. and are supposed to have a life spa!? of eight years. The females lay from 200 to 300 eggs which they bury deep in the sand. After three weeks of development little "trilobite"-laıvae emerge from the eggs. They have a relatively large abdomen and their tail or telson is quite small, so small that it does not project beyond the edge of the abdomen. The larva does not ingest any food, but lives at the expense of the embryonic yolk which fills its mid-gut. In a month the yolk is completely digested, the larva moults and assumes the appearance of a small, young "limulus." From now on the creatures are able to eat. They moult at more or less regular intervals, increasing in size with every moult.

External Anatomy.— The body of a king crab is clearly divided into a cephalothorax and an abdomen, the latter broadly and movably joined to the former and bearing a long, hard and pointed tail or telson. The dorsal surface of the cephalothorax is covered by a hard, convex, almost horseshoe shaped chitinous shield, the carapace, on which a pair of small, closely approximated simple eyes or ocelli and a pair of large, widely separated compound eyes are situated. The shield extends to the ventral surface where it becomes concave and protects the appendages, hiding them from view when the animal is moving in its normal position on the ground. The abdomen is also covered with a single, chitinous shield extending to its ventral surface. It has on each side a row of six movable spines representing the remnants of its original segmentation. The tail or telson is considerably longer than the abdomen to which it is movably joined. If the animal is turned on its back, it rights itself by stemming the end of the tail in the ground and lifting the end of the abdomen thus forming an appreciable angle between the body and the tail, trying at the same time to get hold of some object with the legs and swinging sideways until the edge of the carapace reaches the bottom.

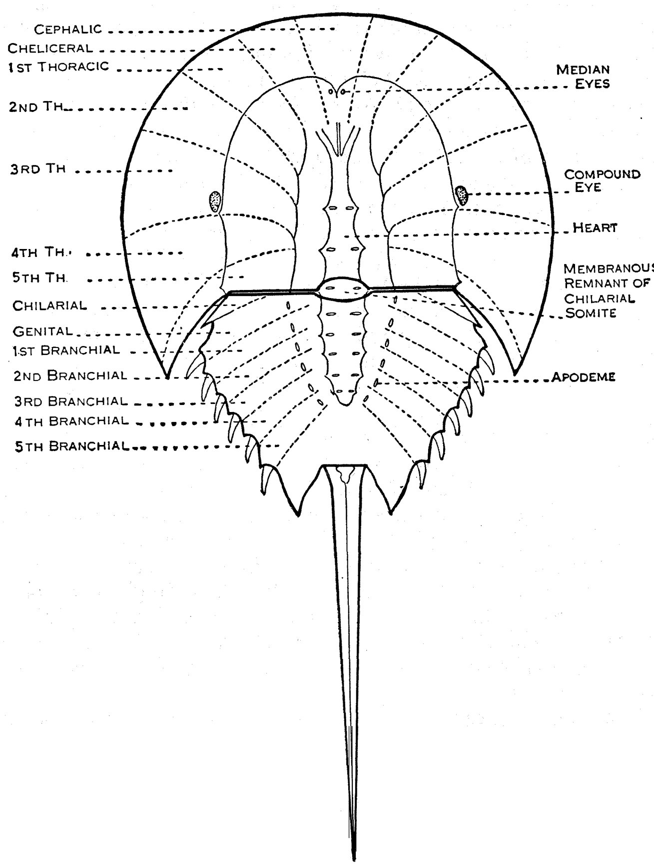

FIG. 1.— SEGMENTATION IN XIPHOSURA. DORSAL ASPECT

The dotted lines represent the limits between the somites. The heart is shown in the position in which it lies under the carapace

The middle portion of the ventral surface is occupied by the appendages. The first pair of these are the three-jointed, chelate chelicerae. The following five pairs of appendages are walking legs. They are six-jointed and except for minor differences are all built on the same plan. Their coxae (first segment of the leg nearest the body) have gnathobases and are used as mouth-parts. The legs of the first pair are undoubtedly homologous with the pedipalpi of Arachnida and are still often called that way, although they are in no way different from the following pair and like the latter end in a chela. The fifth legs alone are appreciably different from the other four pairs. Their basitarsus has four flat, spatulate, movable spines and their tarsus is considerably more slender and ends in a pair of pointed, movable spines. Moreover, the gnathobase is almost rudimentary and the coxa has a flat, movable flabellum interpreted as an exopodite. Furthermore, unlike the preceding appendages this pair has no chela and therefore cannot be used for grasping. Instead, they are used for removing sand from the underside of the carapace by spreading the four basitarsal spatulae and closing them over the grains of sand.

The knee in all five pairs of walking-legs is formed by the articulation between the femur and the tibia, but the latter is the result of a complete fusion of the patella with the tibia, as still evidenced by the articulation line which remains visible in all but the first pair.

The last pair of cephalothoracic appendages are single-jointed and are called the chilaria. Embryologically representing the first pair of abdominal appendages, the chilaria become later incorporated in the cephalothorax and are situated in the adult between the coxae of the fifth pair of legs. Their function is not clear.

The ventral depression of the abdomen is occupied by six flat plates representing as many pairs of appendages grown together in the middle line. The first pair form the genital operculum, the following five are gill-books. Each anterior gill-book overlaps the following one almost completely while the operculum covers the whole lot of them and protects them from injury.

There are six openings on the ventral side of the animal, but only two of these can be easily seen: the mouth, situated between the coxae of the second and third .pairs of legs and the anus opening to the outside at the end of the abdomen, immediately in front of the telson. A pair of excretory openings of the so-called coxal glands are near the base of the fifth pair of coxae, and a pair of genital openings are on the posterior surface of the operculum, facing the body.

Segmentation.— The segmentation of the adult king crab does not correspond exactly with the original segmentation of the developing embryo, even if one disregards the later fusion of the body into an undivided cephalothorax and an equally undivided abdomen and considers only the appendages. Nor does our present knowledge, especially our knowledge of the nervous system and embryology of the king crab as well as of other arthropods, support the interpretation still found in the majority of textbooks. It is now definitely known that the portion of the brain called the deutocerebrutn is wanting in Xiphosura as in Arachnida and must have been lost at an early period of their evolutionary history. It is also known that the nerves supplying the upper lip or rostrum (camerostome), and formerly interpreted as belonging to a neuromere of their own and representing a lost segment, do not have that significance. On the other hand the absence of the deutocerebrum clearly indicates the disappearance of the corresponding segment because the deutocerebrum persists in other arthropods and the tritocerebrum of the king crab is identical with the tritocerebrum of those arthropods. The cephalic portion of the cephalothorax is therefore composed of at least three somites, possibly even four, if the median ocelli and the compound eyes represent separate somites and if the deutocerebrum is included in the count. Moreover, this count includes also the somite represented by the tritocerebrum the nerves of which supply the chelicerae. These appendages are clearly preoral in adult arachnids and king crabs, the mouth in all cases moving backward during embryological development, in Xiphosura even farther backward than in Arachnida. Yet the tritocerebrum of Arachnida forms a part of the brain proper, while in Xiphosura it still belongs to the ventral portion of the nerve ring and forms the first neuromere of the suboesophageal ganglionic mass.

There has already been mentioned the incorporation of the chilarial segment in the cephalothorax although the chilaria represent embryologically the first abdominal somite. On the dorsal surface of the embryo this somite is restricted to a small, lens-shaped area retained in the adult as a soft membrane between the cephalothoracic and the abdominal shields. The second abdominal somite of the embryo becomes the anterior portion of the adult abdomen and is represented by the genital operculum on the ventral side, by the first pair of movable spines on the sides of the abdomen and by a narrow strip across the abdominal dorsal surface, including the first pair of apodemes. Next follow five branchial somites represented by the gill-books on the ventral side, by five pairs of movable spines and dorsal apodemes. The rest of the abdomen shows no traces of segmentation even in the embryo. Whether it represents five somites, bringing the total number of abdominal somites up to 12 as in Arachnida, must be left unanswered at the present state of our knowledge.

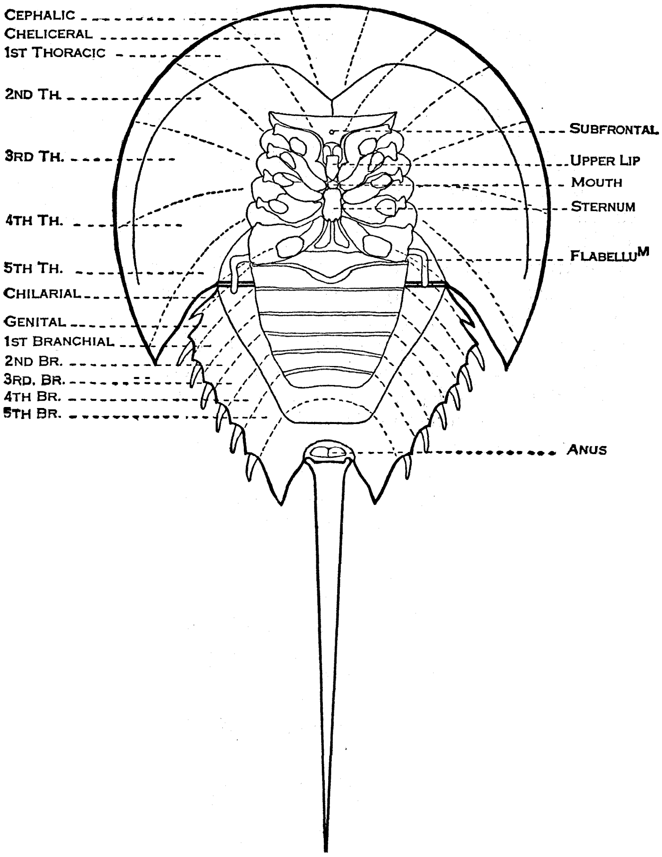

FIG. 2.— SEGMENTATION IN XIPHOSURA. VENTRAL ASPECT

The appendages are omitted so as not to obscure the rest of the body. Only their coxae are shown. The gills are also omitted, only their attachment to the ventral abdominal wall represented. The dotted lines represent the limits between the somites

It is clear that segmentation in Xiphosura has many features in common with Arachnida, yet presents unmistakable and important differences. The original number of cephalothoracic appendages is the same, and both the Arachnida and the Xiphosura exhibit a tendency of the first abdominal somite to considerable reduction in size. In spiders it forms the slender petiolus by which the abdomen is attached to the cephalothorax. In scorpions it disappears completely during development, so that the broad juncture of the abdomen to the cephalothorax is accomplished by the second abdominal somite which now appears as the first abdominal segment. In Xiphosura the first abdominal somite fuses with the cephalothorax and is represented by the chilaria, *i.e.*, by a pair of appendages which have no homologous counterpart in Arachnida. The shape of the cephalothorax is also very different from that of any known arachnid, recent or fossil, and has a counterpart only among Trilobita and some lower crustacea, such as *Apus*. It cannot possibly be regarded either as homologous with or ancestral to the arachnid cephalothorax.

Endoskeleton.—The endoskeleton consists of a complex mesodermal connective tissue plate suspended in the cephalothorax between the oesophagus and the mid-gut and known as the endosternite; six endochondrites in a median row on the floor of the abdomen, and seven pairs of ectodermal apodemes or endapophyses, formed as invaginations and serving for the attachment of muscles. The first pair of the apodemes arises from the posterior edge of the carapace, and the muscles attached to these apodemes help to keep the endosternite in suspension. These apodemes are, therefore, not homologous with the mid-dorsal apodeme of the Arachnida to which the dorsal dilators of the gizzard are attached. They belong to the chilarial somite, that is, are not really cephalothoracic, but primarily abdominal and only secundarily incorporated in the cephalothorax. The following six pairs are abdominal and are invaginations of the dorsal wall of the abdomen. Several muscles are attached to each of these apodemes.

Muscular System.—This system is very complicated in Xiphosura, differing in many respects from the corresponding system of Arachnida. It consists of many dozens of paired and single muscles. The muscles holding the endosternite in suspension were already mentioned. There are several pairs of them. The muscles moving the cephalothoracic appendages arise some from processes of the endosternite, others from the carapace. Six pairs of branchiothoracic muscles also arise from the carapace, run downward and backward and are attached to the abdominal ventral apodemes. Other branchial muscles situated in the abdomen, help to move the gill-books. Several powerful muscles situated in the posterior portion of the abdomen move the telson up and down and to a lesser degree laterally.

Digestive System.—Except for the tremendous development of the cephalothoracic, endodermal digestive glands usually called "the liver," the digestive system is comparatively simple. The mouth opens immediately behind the upper lip, called camerostome or rostrum, about two-thirds from the anterior edge of the cephalothorax, has the shape of a slit, and extends posteriorly to the fifth pair of coxae. The mouth leads directly into the oesophagus. A pharynx. such as is present in all arachnids, is wanting. The oesophagus runs forward and opens into the large, muscular gizzard. Here the ingested food is broken up into smaller particles. A valve separates the gizzard from the mid-gut which runs as a straight tube backward above the endosternite until it reaches almost the end of the abdomen. A short rectum opens with an anus situated ventrally at the end of the abdomen. A pair of immense digestive glands, already mentioned, occupy the free space in the cephalothorax, extending to the very edge of the carapace. These glands open by means of two pairs of short ducts into the mid-gut behind its anterior third and close to its dorsal surface. Fine food particles passed from the gizzard into the mid-gut are subjected here to the action of several enzymes, namely a proteinase, a carboxypolypeptidase, an amylase and a lipase at the optimum pH 8.0. The chyle is now passed into the digestive gland where it is subjected to further action of a dipeptidase. Interstitial tissue holding together the individual ampullae of the digestive gland serve as storage place for fat, protein and glycogen. Undigested remnants are returned to the mid-gut where they are enveloped in slime and finally emptied as excretory cylinders.

Excretory System.—The excretory system is represented by a pair of coxal glands which are situated in the cephalothorax. They are modified nephridia, consist of a sacculus into which four urinary glands open, a labyrinth and a terminal duct. The two ducts open to the outside at the base of the coxae of the last walking leg. Preceding the embryonic development of the coxal glands, six pairs of coelomic sacs are formed, corresponding to the original six cephalothoracic somites. The first and sixth pair disappear, the fifth pair forms the two sacculi, while the second, third and fourth pair give rise to the urinary glands and the labyrinths. In life the coxal glands are brick-red.

Circulatory System.—This system in Xiphosura is distinguished by many peculiarities not found in any other arthropods. As in higher crustacea it consists of both arteries and veins, but the similarity is upset by the many peculiarities. The arterial system reminds more that of Arachnida, but here, too, the similarity is upset by features lacking in Arachnida. Moreover, Arachnids have no veinous system.

The heart is a muscular tube situated partly in the abdomen, partly in the cephalothorax. Its posterior end is blind. Laterally it is perforated by eight pairs of dorsoventral slits, called ostia and serving as valves. The first and second pair of ostia are in that portion of the heart which extends into the cephalothorax and which has rather thin walls. The abdominal portion of the heart with its five pairs of ostia has much thicker muscular walls. The entire heart is surrounded by a pericardium into which six pairs of veins open. Anteriorly the heart forms an aorta which splits almost immediately into three vessels, a median anterior artery and a pair of aortic arches. The median artery runs to the edge of the carapace, divides here into a right and left branch which fuse with corresponding branches of the second lateral arteries, thus forming the so-called marginal arteries. The two aortic arches turn ventrally at the sides of the gut and open into the sinus-ring of the ventral arterial sinus inside which the entire nervous system lies enclosed. The arteries leading into all cephalothoracic appendages arise from the ring-sinus. That portion of the sinus which extends into the abdomen in the shape of a vessel is known as the ventral artery and gives off five pairs of branchial arteries supplying the gills. One of the most characteristic features of the arterial system in Xiphosura is the presence of a pair of longitudinal collateral arteries connected with the heart by short. transverse vessels and united behind the heart into a single, median dorsal abdominal artery which runs to the very end of the telson. The lateral arteries which supply with blood the organs situated in the cephalothorax and in the abdomen arise from the collateral arteries. We have already mentioned the branch of the second artery, which forms with the branch of the median dorsal artery the marginal artery. An inner branch of the same second artery runs forward on the corresponding side of the heart to the digestive gland, which it supplies with blood, and is known as the hepatic artery.

The veinous system consists of a pair of anterior and a pair of posterior hepatic veins opening into a pair of large. longitudinal ventral veins which give off branchial veins carrying the blood to the gills. Five pairs of branchio-cardiac veins carry the blood from the gills to the pericardium, from which it enters the heart through the ostia. The blood is propelled by the heart forward and a counterflow is prevented by a cardio-aortic valve.

Although the veinous system is highly developed, the circulatory system of Xiphosura is an open one as in all arthropods, both the arterioles and the venules opening directly into the body cavity.

The blood is a slightly bluish, milky fluid containing a considerable quantity of haemocyanin in solution and blood-corpuscles of the leucocyte type in suspension.

Body Cavity.—The body cavity of Xiphosura, in which the various organs are situated and which extends into all appendages, is a haemocoele. It is at least in part derived from the confluent cavities of several coelomic pouches, is bounded on the outside by the basal membrane of the hypodermis—except where muscles are attached to the body mall—and seems, therefore, to be what is now appropriately called a "myxocoele." The cavity is fully occupied by the organs. A diaphragm, such as found in scorpions, does not exist in king crabs.

Respiratory System.—Respiration in Xiphosura is strictly of the aquatic type. The appendages of the third to seventh abdominal somites of the embryo become modified and function as gills from the earliest larval stage and throughout the life of the animal. The appendicular nature of the gills is clearly visible even in the adult. Each pair of appendages grown together in the median line, forms a plate on the posterior surface of which the right and left gill-books are situated Each gill-book is composed of up to one hundred and fifty lamellae, The gill-books are regarded as being homologous to the lung-books of Arachnida, but the attempt of Verluys and Demoll to derive the gill-books from the lung-books, instead of vice-versa, has nothing to recommend it and remains only as an example of futile speculation.

Nervous System.—This system in Xiphosura is characterized by two peculiarities. The first of these, namely the absence of a deutocerebrum in the adult, it shares with other Chelicerata. The second peculiarity, that the entire nervous system is enclosed in the ventral sinus, is restricted to the Xiphosura. Owing to the shape of the body the brain lies not above, but on the same level with the suboesophageal ganglionic mass with which it forms a compact ring perforated by the oesophagus and surrounded by the ring-sinus. The brain is formed only by the protocerebrum. It gives rise to the following nerves: a median optic nerve leading to the ocelli and originating by a pair of roots; a pair of ventral nerves supplying the ventral body wall; a pair of originally ventral eye nerves which later serve as olfactory nerves and finally a pair of optic nerves leading to the compound

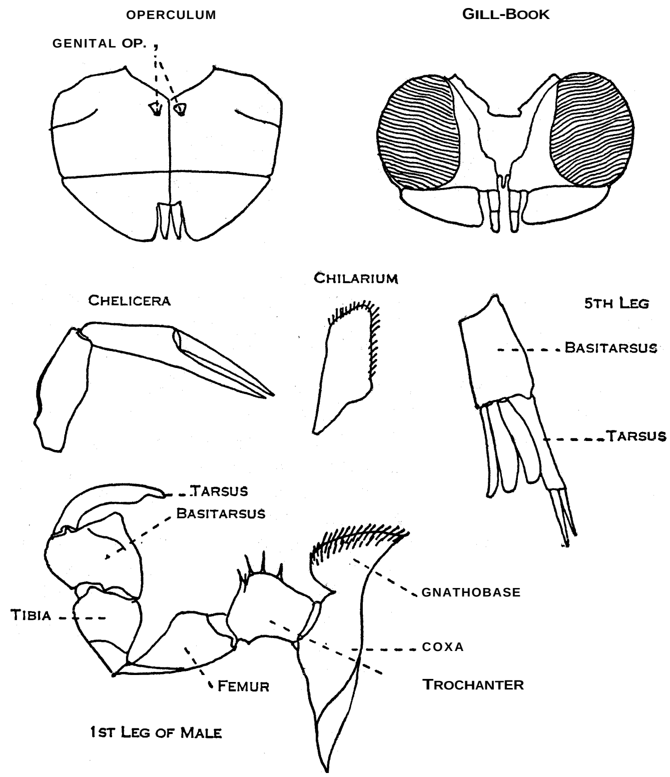

FIG. 3.—APPENDAGES OF XIPHOSURA POLYPHEMUS

The genital opercuium and the gill-book are drawn in their posterior aspect

eyes. The postoral portion of the nerve ring, *i.e.,* the suboesophageal ganglionic mass is composed of eight neuromeres. The first of these corresponds to the tritocerebrum of other arthropods and gives off the cheliceral nerves, the following five pairs supply with nerves the thoracic appendages, the seventh neuromere gives off the chilarial nerves and the eighth the opercular (genital) nerves. Posteriorly, the nerve ring forms the ventral nerve cord enclosed in the longitudinal sinus (ventral artery). The cord presents four pairs of ganglia followed by a ganglionic mass composed of three pairs of fused ganglia. Each ganglion gives off two nerves, an anterior motor and a posterior sensory nerve.

Sense Organs.—King crabs possess a pair of median ocelli, a rudimentary ocellus. a pair of compound eyes. a rudimentary compound eye and a ventral rudimentary eye which is later replaced by the olfactory lobe. Supposed organs of taste have been described on the gnathobases of the appendages.

Reproductive System.—The sexes are separate, and the plan of structure of the reproductive organs is the same in both. The originally paired reproductive glands form a network between the lobes of the digestive gland. A pair of ducts—vasa deferentia in the male. oviducts in the female—open to the outside on the posterior surface of the genital operculum. The males are easily distinguished by the swollen appearance of the basitarsus of their first pair of legs, but copulatory organs of any kind are wanting. The spermatozoa have a tail. The eggs are globular, rich in yolk. from 2 to 3 millimetres in diameter. They are inseminated by the male sitting on the back of the female while she lays them in a batch of 200 or 300 in a hole in the ground.

Paleontology.—Fossil remains of Xiphosura occur already in the Devonian, where they are represented by the family Belinuridae. Representatives of this same family are known also from the Carboniferous of Europe and Pennsylvanian of North America. An aberrant family Cyclidae is found in the Carboniferous. Representatives of the family Xiphosuridae (formerly called Limulidae) first appear in the lower strata of the Triassic. Supposed relatives of the Xiphosura belonging to the orders Syn-

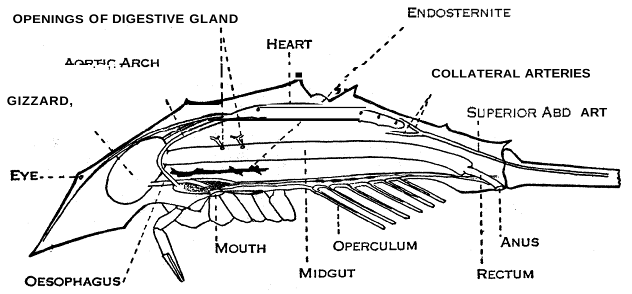

FIG. 4.—DIAGRAMMATIC LONGITUDINAL SECTION THROUGH XIPHOSURA POLYPHEMUS, SHOWING THE RELATIVE POSITION OF THE DIGESTIVE ORGANS. HEART. VENTRAL SINUS AND NERVOUS SYSTEM

xiphosura and Limulava appear already in the Cambrian. These orders together with the Xiphosura and Eurypterida are often united by palaeontologists in a single Class Merostomata. Their affinities are however, disputed by other investigators and, in absence of all knowledge of their internal anatomy, it seems safer to leave the Xiphosura in a separate class.

Characters of the Class.—In view of the persistent tendency on the part of some zoologists to follow Ray Lankester's interpretation of Limulus as an Arachnid those characters of Xiphosura which are peculiar to them and are not found in Arachnida may be summarized here.

Xiphosura differ from Arachnida in that:

1. Their segmentation is different, the first abdominal somite having been incorporated in and forming an integral part of the cephalothorax.
2. Their entire central nervous system is enclosed in the ventral blood-sinus.
3. Their brain is formed only by the protocerebrum, the tritocerebrum forming the first neuromere of the suboesophageal ganglionic mass.
4. They possess a venous system.
5. Their heart ends blindly behind.
6. They possess a pair of longitudinal collateral arteries from which lateral arteries arise and which unite posteriorly to form the posterior median artery.
7. Their organs of respiration are aquatic gill-books.
8. Their genital openings are paired.
9. They have a "trilobite" larval stage.
10. They have a pair of compound eyes.

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XOSA, a group of Bantu-speaking peoples occupying the eastern half of the Cape Colony. Their subsistence is derived from a combination of cattle-keeping with agriculture. Socially they are organized into patrilineal exogamous clans. Marriage is polygamous and involves the payment of a bride price; and both the sororate and the levirate are practised. Ancestor worship is the main form of religious cult.

X-RAYS are a form of electromagnetic radiation, produced by the discharge of a stream of electrons against a target in a tube in which the enclosed air or gas has been reduced to a near vacuum. In this process, electrons within the atoms of the target are disturbed by the bombarding electrons so as to cause the atoms to emit certain nell-defined wave lengths in the X-ray spectrum characteristic of those atoms Most of the X-radiation, however, the so-called continuous spectrum. is caused by the sudden stopping of the bombarding electrons as they collide with the heavy atomic nuclei in the target. The rays have the power of penetrating solid substances to varying degrees. They have almost the shortest wave length in the electromagnetic spectrum, of the order of 250,000,000 or more naves to the inch, as compared with 50,000 to the inch for waves of visible light.

The discovery of X-rays pointed the way for the exploration of the structure of the atom. The relationship of X-rays to the problem of the nature of matter is discussed in this article under *Particle-Wave Dualzty*. Their place in applied science is described below under *Modern Industrial Applications*.

This article is divided into the following sections:

I. Historical Background
  1. Scattering
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I. HISTORICAL BACKGROUND

Few events in the history of science have had so powerful an impact as the news of the discovery of the X-ray by Wilhelm Conrad Rontgen, a professor of physics at the University of Würzburg. Within a year after the first announcement, 49 books and pamphlets had been published on the subject, and over 1,000 articles had appeared in various journals.

In a paper published in the *American Journal of Physics* in commemoration of the 50th anniversary of the discovery, G. E. M. Jauncey pointed out: "November 8, 1895 [the date of the discovery] may be taken as the date of a new era in physics. Before this notable date, it may be said, physicists were living in the classical era. . . . All physicists were clinging for dear life to the classical ideas of the existence of the luminiferous ether and the nonexistence of anything smaller in mass than the hydrogen atom or ion. A great jolt was needed to shake the minds of physicists loose from these ideas."

Rontgen's achievement was the outgrowth of experiments with highly evacuated tubes excited by induction coils. When the tubes are so activated, cathode rays (so called because the electric discharge emanates from the cathode, or negative terminal) are produced.

Cathode ray experiments had long been familiar when Rontgen entered the field. However, the existence of X-rays, which are produced by cathode rays but have diiferent properties, was unsuspected.

As early as 1858. Julius Plucker reported that a part of the glass wall of the discharge tube became phosphorescent during the discharge, and that the location of the phosphorescence could be changed by a magnet. Sir William Crookes devised an improved tube, and in 1878 published a mass of experimental data on the physical properties of cathode rays. He described the rays as streams of molecules in flight; they are now known to be streams of electrons. In 1892, Heinrich Hertz demonstrated that cathode rays could penetrate thin metallic foils. In 1894, Philipp Lenard constructed a discharge tube equipped with a thin aluminum window. He found that the penetration of cathode rays was slight; they were diffused in a few centimetres of free air.

Rontgen's contribution began with a repetition of the experiments of his predecessors. A detailed account of this work is given in Dr. W. C. *Röntgen,* by Otto Glasser (2nd ed., Springfield, Ill., Charles C. Thomas, 1958) Glasser tells that Rontgen's interest was first turned to cathode ray experiments in June: 1894: that he became absorbed in these; and, some time in Oct. 1895, decided to devote all his laboratory time to them.

When Rontgen began, it was already known that a screen painted with barium platinocyanide would become fluorescent if placed very close to a Lenard tube. This phenomenon had not been observed in experiments with heavier-walled Hittorf-Crookes tubes. However, says Glasser, Rontgen suspected that the fluorescence "might possibly be obscured by the strong luminescence of the excited tube. This idea fascinated Rontgen. . . . he determined to test the ability of a Hittorf-Crookes tube, that is, an all glass tube without a thin window, to produce fluorescence on the barium platinocyanide screen. Selecting a pear-shaped tube from the rack, he covered it with pieces of black cardboard. carefully cut and pasted together to make a jacket similar to the one used previously on the Lenard tube, and then hooked the tube onto the electrodes of the Ruhmkorff coil. After darkening the room in order to test the opacity of the black paper cover, he started the induction coil and passed a high tension discharge through the tube. To his satisfaction no light penetrated the cardboard cover.

"He was prepared to interrupt the current to set up the screen for the crucial experiment when suddenly. about a yard from the tube, he saw a weak light that shimmered on a little bench he knew was located nearby. It was as though a ray of light or a faint spark from the induction coil had been reflected by a mirror. Not believing this possible, he passed another series of discharges through the tube, and again the same fluorescence appeared. this time looking like faint green clouds moving in unison with the fluctuating discharges of the coil. Highly excited, Rontgen lit a match and to his great surprise discovered that the source of the mysterious light was the little barium platinocyanide screen lying on the bench."

Rontgen realized that he was contending with a new phenomenon, since he had verified the fact that cathode rays could not penetrate beyond a few centimetres of air. "Then in succeeding weeks of feverish activity, he devoted himself exclusively to identifying more properties of the emanation."

Rontgen called the newly discovered rays X-rays, to indicate that their nature was unknown.

In his first historic report, dated Dec. 28, 1895, Rontgen was able to describe accurately most of the basic qualitative properties of X-rays:

1. All substances were more or less transparent to X-rays. Named in order of decreasing transparency were, for example, wood, aluminum and lead glass.

2. Many substances beside barium platinocyanide, such as calcium compounds, uranium glass and rock salt, emitted light (fluoresced) when exposed to X-rays.

3. Photographic emulsions were found susceptible to X-rays.

4. Reflection and refraction of X-rays were investigated with negative result (these effects are slight and difficult to reveal) and Rontgen concluded, therefore, X-rays could not be concentrated with lenses.

5. By means of pinhole photographs, X-rays were shown to travel in straight lines and to be undeflected by magnetic fields.

6. X-rays were shown to discharge electrified bodies independent of the sign of the charge (through ionization of the surrounding air which thereby becomes an electrical conductor). (This effect was independently discovered and explained by Sir. J. J. Thomson in 1896. who pointed out its importance as a quantitative measure of X-ray intensity. Time has not diminished this importance.)

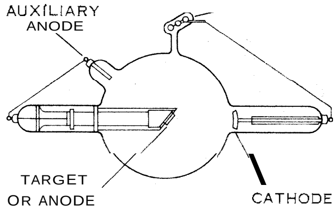

FIG. 1.—ORDINARY GAS X-RAY TUBE
Shown are concave focusing cathode, metal target and regulator for liberating gas by electrical discharge when, after prolonged use, the tube becomes too hard through gradual absorption of residual gas

7. X-rays, Rontgen showed, were generated wherever and whenever the cathode rays of the discharge tube struck any solid body as a target. A heavy element, such as platinum, when so used as a target, was found to yield X-rays more efficiently than a light element such as aluminum. The Crookes tube was soon replaced by one in which the cathode rays were focused to bombard a metallic anticathode or target (invented by Sir Herbert Jackson and shown in fig. 1).

1. Scattering.— Although X-rays are riot reflected specularly by ordinary mirrors, they are scattered diffusely. when they encounter a material scattering body. to different degrees depending on the angle of scattering, measured between the forward directions of incident and scattered rays.

In 1906, Charles Barkla and C. A. Sadler, by measuring the scattering coefficient of carbon for X-rays, correctly determined the number of electrons in the carbon atom as six. The determination was based on a theory of J. J. Thomson which yields a quantitative value of the X-ray scattering coefficient for a single free electron under certain assumptions which happened fortuitously to be approximately fulfilled in the Barkla-Sadler experiment (see below).

Barkla's work formed a strong support for the supposition that X-rays were of the same nature as other known electromagnetic radiations, especially as J. J. Thomson had found the same number of electrons (in the carbon atom) by a quite independent method using β-rays (fast bombarding electrons from naturally radioactive substances).

2. Polarization.— At about the same time. Barkla showed by scattering a beam of X-rays twice in succession. each time through 90° scattering angle, that this radiation, like light. could be polarized. at least partially, and that it was therefore. in all probability. a transverse wave propagation similar to other electromagnetic radiations.

3. Fluorescence.— Barkla and his co-workers over a period (1908–12) observed in their scattering experiments that certain X-radiations characteristic of the scatterer and of less penetrating quality than the primary X-radiation were emitted from the scattering body. more especially when heavier elements. such as silver, were used as scatterers. The scattering body thus becomes a secondary emitter of X-rays. By ingenious experiments in which the penetrating power of these characteristic X-rays n-as studied for different secondary emitting substances and with absorbing screens of different materials the existence of a spectrum of X-rays and of their undulatory properties was distinctly foreshadowed.

4. Undulatory Nature of X-Rays.— Numerous attempts were made to reveal an undulatory nature in X-rays and to estimate tiie wave length by searching for diffraction fringes (similar to those observed with visible light) when a beam of X-rays passed through a narrow slit. In 1902 H. Haga and C. H. Wind showed a slight broadening of the image formed by the narrow end of a tapering

slit. A careful repetition of this experiment in 1908 by B. Walter and R. W. Pohl led these investigators at first to conclude no such effect existed, but careful photometric measurements about four years later by P. P. Koch on Walter's and Pohl's plates showed that with softer X-rays the blackening of the photographic slit image fell off more gradually than for hard X-rays A. Sommerfeld at Munich in 1912 estimated from these results an average wave length (from a medical X-ray tube) of the order of 0.4×10^{-8} cm.

At this time Max von Laue, then in Munich, was profoundly interested in these results and searched in his mind for a method of revealing and measuring with greater certainty the wave lengths of X-rays. Something like the diffraction gratings used for visible light but on a much finer scale was needed. Coming one day for a talk with A. Sommerfeld he found him discussing with P. P. Ewald the theoretical work the latter was doing on the transmission of light waves through a molecular lattice. Von Laue here heard for the first time the hypothesis that crystals were regular latticework atomic structures with a spacing between atoms of the order of 10^{-8} cm. Here were the gratings needed for X-ray diffraction ready-made by nature herself, and Von Laue, realizing this, in great excitement lost no time in suggesting to his associates, W. Friedrich and P. Knipping, what proved to be an epoch-making experiment, for it (1) revealed the nature and structure of crystals as three-dimensional latticework patterns of atoms; and (2) led to the study of X-ray spectra which unlocked the secrets of atomic structure. Von Laue suggested that a fine pencil of X-rays collimated by passage through pinholes in two lead screens be allowed to fall on a crystal of zinc sulfide. A photographic plate. placed a short distance behind the crystal, received the original X-ray beam which had passed directly through the crystal and in addition after a long exposure, there was found on the plate a regular pattern of spots coming from subsidiary X-ray beams reflected to the plate by the structure of the crystal at considerable angles to the primary beam.

The analytical explanation of these spots by Von Laue became much easier to understand intuitively after the work of William Bragg in England in the next year. (Von Laue showed in a later paper the identity of the two modes of description, Bragg's being the common-sense intuitive one but Von Laue's being the more rigorous and general method of treatment. Still more elaborate treatments have been made of the physical optics of X-rays in crystal lattices by C. G. Darwin, P. P. Ewald and Von Laue himself.) Bragg's work suggested to Von Laue that the atomic lattice planes in the crystal were the agents which reflected the X-rays to form the Laue spots. Fig. 2 shows how these spots appeared on the Von Laue photograph. Moreover, in a crystal. each such plane, be it horizontal, vertical or oblique, will be a member of a large family of such planes, all of the same orientation, all equidistant and rigorously parallel to each other like a geological stratification, and each studded with atoms in the same pattern and density. These in a crystal are the atomic lattice planes. Fig. 3 should help the reader to imagine them.

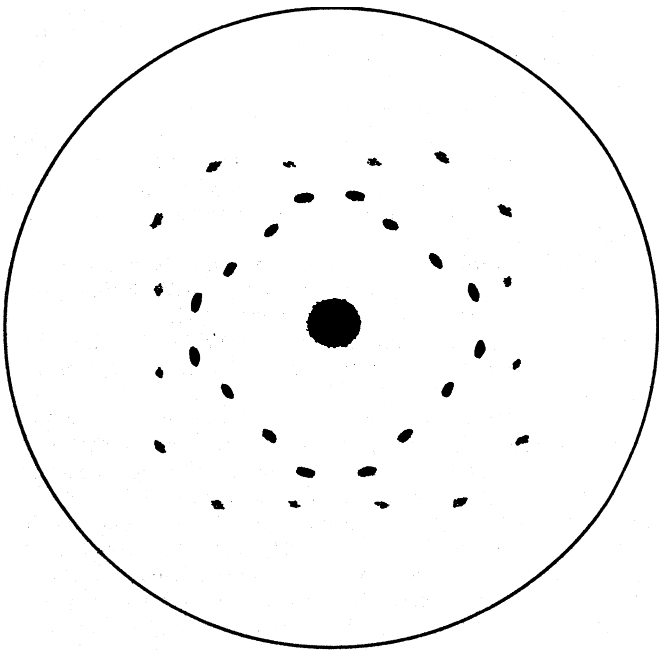

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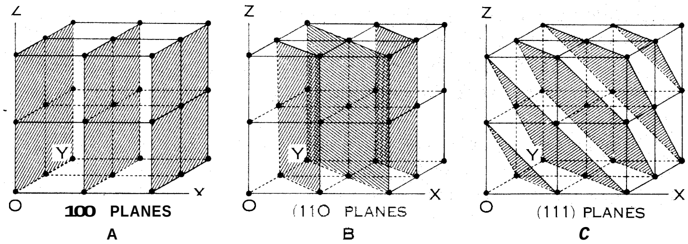
FIG. 2.— DIAGRAM OF VON LAUE, FRIEDRICH AND KNIPPING'S PHOTOGRAPH SHOWING THE LAUE SPOTS REFLECTED FROM VARIOUSLY ORIENTED ATOMIC LATTICE PLANES IN A ZINC SULFIDE CRYSTAL

The large central spot shows where the primary beam of X-rays passing through the crystal fell on the photographic plate. The surrounding reflected spots are not quite symmetrically disposed because the primary beam was imperfectly aligned with one of the axes of symmetry of the crystal



BY COURTESY OF THE BLAKISTON CO, REDRAWN FROM J. D. STRANATHAN, "THE PARTICLES OF MODERN PHYSICS"

FIG. 3.— THE (100); THE (110); AND THE (111) PLANES OF A CUBIC CRYSTAL

The three parenthetical digits are Miller indices. They are proportional to the reciprocals of the intercepts of the plane on the three principal axes of the crystal

X-rays are not reflected from ordinary mirrors. On the minute scale of X-ray wave lengths, ordinary polished surfaces are insufficiently flat, smooth and uniform in properties. In the case of a single atomic crystal plane the fraction of an incident beam of X-rays specularly reflected therefrom is very minute indeed, and were it not for the fact that in a crystal such planes, whatever their direction: occur in myriads of parallel uniformly spaced duplicates, the reflections would probably be too weak to be observed. The atomic lattice planes approach perfect flatness much closer than any polished mirror but it is the uniformity of interplanar spacing which is the especially favourable factor. Actually, out of a heterogeneous primary X-ray beam, containing a continuous spectral distribution of wave lengths, only one extremely small spectral region of these wave lengths is selectively reflected by a given family of planes of specified common interplanar spacing, d, but this reflection is extremely efficient because of constructive interference between the reflections from the different planes when the wave length and the angle of reflection are properly related, as Sir William Bragg showed immediately after the experiment of Von Laue. Friedrich and Knipping.

5. Selective Reflection, the X-Ray Spectrometer.—Sir William Bragg showed, in 1912. that if the wave length λ of the X-radiation, the interplanar spacing d, and the angle θ of reflection (or its equal the angle of incidence) measured between the beam and the crystal plane satisfied the relationship

$$n\lambda = 2d\sin\theta \qquad (1)$$

wherein n is a smaller integer known as the order number, a very strong reinforcement of reflection through constructive interference was to be expected. This is known as the Bragg law and it forms the foundation upon which all X-ray crystal spectrometers are dependent. (For further details, see SPECTROSCOPY, X-RAY). It soon became evident through X-ray spectroscopy that the radiation from ordinary X-ray tubes was of two types, a continuous spectrum and a line spectrum, the latter characteristic of the target material in the tube.

From measurements of the diffraction angles θ Bragg was able to compute with moderate quantitative accuracy the wave lengths in centimetres of the X-ray lines in the spectra he formed by crystal diffraction. The key to this was the value of, d, the interplanar atomic spacing in the crystal used for forming the spectra according to equation (1). This spacing he was able to compute from (1) the newly obtained knowledge of the geometry of the crystal lattice; (2) the measured density of the crystal; and (3) the absolute weight (in grams) of a single atom. (The word weight is strictly incorrect since mass is really meant. Chemical usage, however, has followed this error when atomic weights, really the relative scale of masses of atoms, are spoken of.) The last quantity was, even at that time, known with moderate accuracy from (1) studies of the Brownian motion (Perrin); and (2) the famous oil-drop measurement of the elementary unit of electricity, the electron, by Robert Millikan (1909). Either of these experiments yields the Avogadro number ($N = 6.023 \times 10^{23}$), the absolute number of atoms in one gram-atomic-weight of any element, a universal constant. The absolute weight of any atom is merely the quotient of its chemical atomic weight divided by N.

From such considerations as these, Rragg was able to assign absolute as well as relative values to the wave lengths of all of his X-ray spectral lines. The absolute scale of X-ray wave lengths was later established with very much higher precision by diffraction of X-rays from artificial ruled gratings used in grazing incidence (J. A. Bearden, E. Backlin, A. H. Compton, J. Thibaud) so that by a reversal of the process the most precisely reliable values of the electronic charge and of Avogadro's number have been calculated. This use of ruled gratings is difficult, however, and natural crystals still remain the best agents for general X-ray spectroscopy.

6. Moseley's Law. — In 1914, H. G. J. Moseley, in two classic papers, presented a systematic study of the characteristic line spectra emitted by targets of various metals when excited by cathode-ray bombardment in an X-ray tube of special construction which permitted rapid substitution of several different target materials. Unlike optical spectra the X-ray characteristic spectra are relatively simple, consisting, for a given element, of widely spaced groups of but a few lines. Following the original nomenclature of Barkla, the groups of spectral lines for each element are designated in order of their increasing wave length location in the spectrum as K, L, M, etc. The pattern of lines in each group is very similar for a wide range of elements save for the actual wave-length position in the spectrum and it is of extreme significance that as we pass from element to element in the so-called periodic table of the elements (arranged in increasing order of atomic weight) the wave length of a given homologous spectrum line (such as $K\alpha_1$), observed successively in the spectrum of each element, varies in a uniform way, if it is plotted not as a function of the atomic weight of the atom which characteristically emits it but as a function of an ordinal number Z (the atomic number, as Moseley called it) of the atom in the periodic or Ylendeleyev table. Moseley showed that if the square root of the frequency v of a given identifiable X-ray line, as we examine it from element to element, is plotted against the atomic number Z of that element, a linear relationship is obtained over a wide range of frequencies and atomic numbers (Z = 13 to $Z = 30$) whereas no such linearity exists when the atomic weight is used as the parameter for plotting (see fig. 4). The importance of the atomic number, which actually turns out to be nothing more nor less than the number of fundamental units of positive electricity possessed by the nucleus of the atom, was thus for the first time brought to light. Moseley assigned atomic numbers as follows: H-1, He-2, Li-3, Be-4, B-j, C-6, N-7, O-8, F-9, Ne-10, Na-11, Mg-12, Al-13, Si-14, P-1j, S-16, Cl-17, Ar-18, K-19, Ca-20, etc., to Zn-30. This assignment actually requires in some cases a reversal of the general order of increasing atomic weights.

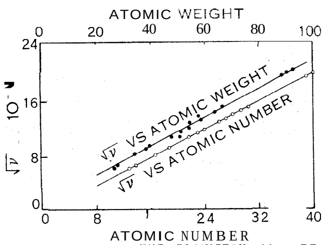


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FIG. 4. — MOSELEY'S CURVE ILLUSTRATING THE MORE REGULAR DEPENDENCE OF $\sqrt{\nu}$ ON ATOMIC NUMBER AS CONTRASTED TO ATOMIC WEIGHT, FOR ELEMENTS $Z = 13$ TO $Z = 30$

7. The **Rutherford-Bohr** Atom. — Sir Ernest Rutherford had shown from his experiments on the scattering of alpha particles passing through thin foils that the atom must consist of an extremely tiny, heavy, positively charged nucleus, about 10^{-12} cm. in diameter (in which the great bulk of the weight of the atom resided), surrounded by a swarm of relatively light negatively charged electrons presumably executing orbits in the central field of attraction of the nucleus somewhat like the planets about the sun. In the normal electrically neutral atom from which none of the electrons have been lost the number of attendant negative electrons is just equal to the number of elementary positive charges on the nucleus, in short the atomic number, Z. (The positive and negative elementary units of which electricity consists are exactly equal, but opposite in sign, though they are, in the electron and the proton, associated with very different masses. The numerical value of this elementary charge is about 4.803×10^{10} electrostatic units [E.S.U.]. The mass of the electron is about 0.91×10^{-27} g, while the mass of the proton is 1.836 times larger. See ELECTRON for the methods whereby its charge and mass were determined.) Rutherford's experiments had further shown that the nuclear charge for a given atom is approximately half its atomic weight; and Barkla had shonn from experiments on the scattering of X-rays, mentioned earlier, that the number of electrons surrounding the nucleus is also approximately half the atomic weight. It was these considerations which guided Moseley. In 1913, Niels Bohr had proposed a quantitative model of the hydrogen atom based on Rutherford's general model with certain additional hypotheses drawn from the existing rudimentary quantum theory and from an effort to explain the regularities in the characteristic spectral lines emitted by the simplest of all atoms, hydrogen (atomic number Z = 1). Bohr's theory predicted that the frequency ν of a spectral line should obey the formula

$$\nu = Z^2 \frac{2\pi^2 me^4}{h^3} \left\{ \frac{1}{n_2^2} - \frac{1}{n_1^2} \right\}$$

In this formula Z is the atomic number; m, the mass of the electron; e, the elementary electrical charge unit; and h, Planck's constant, all of which quantities were known with reasonable accuracy at the time (1913). The numbers n_1 and n_2 are simply small integers which Bohr called quantum numbers.

Now the really astonishing success of Moseley's investigation (and of Bohr's theory) was that whereas Moseley's plot of the square roots of the frecluencies, $\sqrt{\nu}$, of spectral lines against the atomic numbers of the elements emitting them, gave the numerical relation for elements from Z = 13 to Z = 30,

$$\nu_{K\alpha} = 0.248 \times 10^{16} (Z - 1)^2 \qquad (3)$$

the entirely theoretical formula of Bohr, yielded upon substitution of the known values of m, e, h and the integers $n_2 = 1, n_1 = 2$

$$\nu = 0.246 \times 10^{16} Z^2 \qquad (4)$$

Even the discrepancy between Z in one expression and $Z - 1$ in the other had a perfectly logical explanation, as we shall see.

Bohr's picture of the atom contained a new and revolutionary idea. It seemed a safe guess at the time that the swarm of electrons about the nucleus must be in rapid motion, for a mathematical theorem developed much earlier by S. Earnshaw gave convincing proof that no system of point charges could ever be in static equilibrium under the action of their own fields. On the other hand, according to the electromagnetic theory of radiation propounded by C. Maxwell and extended by H. A. Lorentz, any such system of moving charged electrons must, according to the then known macroscopic laws of electricity and magnetism, radiate electromagnetic waves with attendant loss of energy at the expense of their motion until the electrons would eventually fall into the nucleus just as planets would fall into the sun if their total orbital energies could be sufficiently reduced. After such a catastrophe, were it possible! very little of the atom that could be detected would remain. That this does not happen is obvious since the sizes of atoms, the space they occupy in crystals, for example, never change, and there is every evidence that it is the size or extent of the electron swarm about the nucleus that defines the space an atom must occupy among its neighbours. Bohr's revolutionary new concept asserted that for the orbital electrons there were certain orbits, and total electron energies associated therewith, which he called permitted or stationary states. He laid down a precisely definite mathematical condition defining such states or orbits. In any one of these, for some then mysterious reason, the electron might play forever without radiating its energy. For such orbits or states the classical laws of electromagnetism were somehow abrogated. Only when the electron passed from one such stationary state to another of lesser total energy did it emit electromagnetic radiation and the quantum of energy thus emitted was just the difference in energy between the two stationary states. The integers, n_1 and n_2 in Bohr's formula referred to the tno states, initial and final from which and to which the atom passed in the transition.

For the simple mathematical reasoning leading to Bohr's derivation of formula (2) above, see ATOM: *Bohr's Atomic Theory.* At the time, the justification for his entirely mysterious postulate was the dazzling success with which it explained (1) the exact frequencies of lines in the spectrum of hydrogen; and (2) the frequencies of the lines in X-ray spectra of higher atomic number elements. The latter success was of the unforeseen variety, hence doubly convincing. After 1913, the meaning of Bohr's nonradiating orbits or stationary states became much clearer.

II. BASIC THEORY

The spectrum of electromagnetic radiation is subdivided into about seven regions which, named in order of decreasing wave length (or increasing frequency) are: radio waves; radiant heat; infrared radiation; visible light; ultraviolet light; the far ultraviolet or Millikan region; X-rays; and gamma rays. These are all manifestations of identical basic nature, the difference being only one of wave length λ, or frequency $v = c/\lambda$. Here, c is the velocity of light *in vacuo,* very nearly 2.998×10^{10} cm. per second. The spectrum extends over the range from radio waves, thousands of metres in length, down to gamma rays much less than 10^{-9} cm. (0.000,000,001 of a centimetre). An octave is that range which separates two wave lengths (or frequencies) which stand in the ratio 2:1, and the complete electromagnetic spectrum contains well over 50 octaves. (The choice of gamma ray wave lengths as the upper limit of the electromagnetic spectrum is completely arbitrary. If we wish to include electromagnetic radiations associated with cosmic rays, there is no known upper limit.) The relatively minute portion of this spectrum which is visible to the human eye is a little less than one octave in extent, ranging through wave lengths which give the subjective effectsof the colours, red, orange, yellow, green, blue and violet. or from h = $7{,}000 \times 10^{-8}$ cm. to $\lambda = 4{,}000 \times 10^{-8}$ cm. The X-ray region may perhaps be said to start at wave lengths of about $\lambda = 1{,}000 \times 10^{-8}$ cm. and to extend down to wave lengths of about $\lambda = 0.1 \times 10^{-8}$ cm., a stretch, therefore, of about 14 octaves, commencing about 2 octaves shorter in wave length than the visible region. The X-ray wave lengths in common use for the diagnostic examination of the human body are of the order of $\lambda = 0.2 \times 10^{-8}$ cm. to $\lambda = 0.1 \times 10^{-8}$ cm. (The frequently used unit of length, 10^{-8} cm. or 0.000,000,01 cm. is called an ångstrom, while the $\frac{1}{1{,}000}$ part of this or 10^{-11} cm. is approximately an x-unit.)

If a source of high-voltage direct current is connected to the terminals in a glass bulb, fig. 5, known as a Crookes tube (the cathode negative), and the tube is then evacuated to progressively lower air pressures, one observes the following effects: Around 0.0013 atm. the tube is filled with an almost uniform pink glow. At lower pressure a dark space appears in the neighbourhood of the cathode. Between 0.00013 and 0.000,001,3 atm. a bluish beam is seen extending from the cathode. This is the beam of cathode rays, a stream of electrons, the ultimate indivisible negative charges of electricity made visible by the excitation of the air molecules with which they collide. At still lower pressure the cathode rays, though still present, fade from view. except where they strike the walls of the tube, because their collisions with air molecules become infrequent. The glass wall at the end of the tube opposite the cathode now becomes luminescent with a brilliant apple-green light. Upon introducing a metal obstacle at some distance in front of the cathode, its shadow formed by obstruction of the invisible cathode rays can be clearly seen in the midst of the apple-green luminescence, showing that the rays move away from the cathode. This proves them to be negatively charged particles and this can be shown also by the bending of the cathode rays in a magnetic field. By the degree of bending in a magnetic field of known strength the ratio of the charge to the mass of the electrons can be measured.

If a fluorescent screen of barium platinocyanide is held near the Crookes tube, operating at the stage just described. X-rays will be found to be coming from the glass walls wherever they are bombarded with the cathode rays. as evidenced by luminescence in the barium platinocyanide crystals. It will be found necessary to increase the voltage applied to the terminals of the tube in order to maintain the discharge as the pressure is reduced. With improving vacuum and increasing voltage applied to the tube the X-rays, at first described as soft, become more and more penetrating until with a potential of 100,000 v. even the bones in the hand cast only a faint shadow on the fluorescent screen. The rays are now described as hard. Heavy materials such as barium, lead, gold or platinum when used as screens are found to absorb the X-rays much more than light materials such as carbon or aluminum. The glass wall of the Crookes tube where the electrons strike and from which the X-rays come will be found to be hot and may in this way easily be melted. The impact of the electrons heats the glass just as heat is generated by the blows of a hammer upon an anvil. For this reason a metal target was soon introduced to replace the glass wall as the point of electron impact. Such targets can readily be brought to incandescence by the bombardment unless they are provided with ducts for coolants.

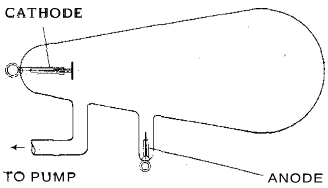


FIG. 5.—A CROOKES TUBE, THE TYPE OF VACUUM TUBE WITH WHICH RONTGEN DISCOVERED X-RAYS

Below 4×10^{-7} atm pressure it is no longer possible with voltages usually available to pass a discharge through the tube, and the X-rays consequently cease. However, if the cold metal cathode is replaced by an incandescent filament, electrons will be emitted from this and we have the pure electron discharge tube of Coolidge nhich with appropriate design can be operated at 1,000,000 v. and higher. The current is readily controlled by varying the temperature of the incandescent cathode.

It is the very abrupt stoppage of a certain small fraction of the bombarding electrons in the close vicinity of the nuclei which produces the bulk of the X-radiation. the so-called continuous spectrum. It is a fundamental law of the electromagnetic field, well known to radio engineers, that when an electrical charge experiences an acceleration or a deceleration, it radiates energy in the form of electromagnetic waves. Targets of heavy materials are more efficient in producing them. Targets also emit a characteristic X-ray line spectrum of different origin.

The quality of the X-rays, that is to say their varying degrees of penetrating power for material screens starting with soft X-rays emitted at operating voltages from 1.000 to 20,000 v. and passing on to medium hard X-rays from tubes operating at 20,000 to 50,000 v. and hard X-rays for voltages in the hundreds of thousands or even up to 1,000,000 v., has been shown to be associated on the one hand with the wave lengths (or frequencies) of the X-radiation and on the other hand with the quantum energy of the photons associated with these wave lengths about which we are to be here much concerned. The penetrating power of soft X-rays is so low that X-ray tubes must be provided with special windows of very thin glass or of very light materials such as beryllium in order to let them out. *See* Table I.

1. Danger From Exposure to X-Rays.—Mention should be made here of the great danger from overexposure of living tissues to X-rays. The photoelectron., (see below) ejected (from atoms of the tissue) with energies of thousands of volts destroy the structure of tissue cells in flesh, bone and blood. producing a general effect on the organism and a local effect of at first erythema, then severe lesion very difficult to heal, like a burn. The danger to the reproductive cells is an even greater hazard. No X-ray equipment should ever be operated by uninstructed or unskilled persons.

2. Particle-Wave Duality.—Chiefly because of the rectilinear propagation of visible light, Isaac Newton in 1675 proposed the. hypothesis that light consisted of tiny particles projected from the luminous source into the eye of the observer. His contemporaries, Christiaan Huygens and Robert Hooke, on the contrary, believed light to be undulatory in nature. The wave theory of light, through the work of Thomas Young, Augustin Jean Fresnel and many others. held undisputed suay throughout the 19th century. One of the most astonishing results of 20th-century scientific research is that both points of view, contradictory as they may at first seem, turn out to be complementary aspects of the same phenomenon. Not only do light and all electromagnetic radiations exhibit this duality (of particles and waves)—it has been found to be also a general property of all the elementary particles of nature, a universal duality applicable to all forms of energy-matter. It is not for us to rebel against this weirdness merely because the gross behaviour of familiar objects furnishes nothing analogous to help our understanding. Rather we must remember that the behaviour of familiar things is only to be understood in terms of this duality which we must accept as fundamental, a stubborn fact of observation.

It was the unique distinction of X-rays to be the tool which (1) first unlocked the secrets of atomic theory; (2) revealed the family relationship between the chemical elements and the quantized nature of their atomic dynamics; and (3) brought into accented relief (through the Compton effect) the mysterious particle-wave duality principle. This story, unfolding from 1895 over a half century, is one of the most exciting chapters in the whole of human intellectual progress.

The nature of X-rays is so closely associated with the nature of the atoms which emit and absorb them that it is impossible to explain one without the other. We can never examine radiation in transit. Assumptions regarding that which is propagated through empty space from the atoms ahich emit radiation to the atoms in the photographic plate. the retina of the eye or the X-ray ionization chamber are merely convenient models which help us to understand radiant phenomena by analogy with grosser and more familiar phenomena (such as bullets and nater waves).

For the present, let us picture radiation, including X-rays, in terms of both particles and waves, the waves guiding the particles to their appropriate destinations. Light, the quantum theory has taught us, always acts as though its energy were in bundles (quanta) whose sizes are proportional to the frequency v of the light. The constant of proportionality $h = 6.62 \times 10^{-27}$ erg seconds was first measured at the opening of the 20th century by Max Planck who, from the laws of black body radiation, inferred and proposed the famous law of light quanta which bears his name,

$$W = h\nu \qquad (5)$$

wherein W is the energy of a light quantum (or photon) in ergs for the case of light of frequency v cycles per second (or $\lambda = c/\nu$ cm. wave length in *vacuo*). At that time, however, it was not yet known that the energy of each quantum frequently appears to be extremely localized in space. Instead of spreading out in all directions from the source. as the energy associated with water ripples would do, a photon of light frequently makes all of its energy manifest in its action on a single atom, be that atom 1 cm. or 1,000,000 light-years distant from the source. In connection with this strange phenomenon, Sir William Bragg commented: "It is as if one dropped a plank into the sea from a height of 100 feet, and found that the spreading ripple mas able, after travelling 1,000 miles and becoming infinitesimal in comparison with its original amount, to act upon a wooden ship in such a way that a plank of that ship flew out of its place to a height of 100 feet."

In the case of radiation this is no wild stretch of the imagination; it is an event which the physicist or the astronomer can reproduce at will. Nevertheless, it is incorrect to reject the spreading wave picture of radiation. The interference of light waves forbids such a simplification. The simplest case occurs when monochromatic light from a source passes through two closely adjacent fine slits and then farther on, falls upon a screen. At certain points on the screen where the light waves which have traversed the two paths differ in phase (upon arrival at the screen) by exactly one-half cycle, the superposition of the two lights produces darkness At intermediate points between these dark fringes there is brilliant reinforcement of the light, ascribed to the arrival of light by the two paths in phase coincidence. Such regions of destructive and constructive interference can readily be observed by anyone.if water ripples are made to pass through small uniformly spaced adjacent openings in a barrier dividing the surface of a quiet pool. In the case of electromagnetic radiation the photons manifest their energy, hv, upon an absorbing atom of the screen only at the bright fringes of constructive interference. Thus the wave aspect of light forces itself upon our acceptance. The waves guide the particles to their correct destinations but when the energy is made manifest by absorption in an atom it appears localized at one point, not spread out over the entire wave front.

III. X-RAYS AND WAVE MECHANICS

1. De **Broglie's** Wave Electrons.—In 1923 Louis de Broglie made a bold suggestion regarding electrons, namely, that they might also possess undulatory properties, exhibiting thus the same duality as the photons of radiation. It has turned out that a particle moving from free space down a potential gradient into a field of (attractive) force and a wave propagating from empty space into a region of greater refractive index are two complementary aspects of the same phenomenon; there is a quantitative equivalence principle between field of force and change of refrac-

TABLE I.—*X-Ray Characteristics*

Operating kilovolts	Shortest wave length in cm.	Thickness in cm. of screen to reduce X-rays of shortest wave length to half intensity*					Technical and medical applications
		Air at 0° C., 760 mm.	Water	Aluminum	Copper	Lead	
1,000	0.0124×10^{-8}		10.0	4.15	1.35	0.865	Deep cancer therapy; radiography of steel castings and welding
124	0.1 "		4.3	1.6	0.21	1	
62	0.2 "		3.9	0.92	0.051	0.013	Radiography of the human body
41.2	0.3 "		2.4	0.55	0.018	0.0044	
31	0.4 "		1.6	0.23	0.0078	0.0020	Studies of crystal structure; radiography of light materials; therapeutic treatment of the skin
24.8	0.5 "	1120	1.1	0.13	0.0040	0.0011	
20.6	0.6 "	720	0.69	0.076	0.0024	0.00068	
17.7	0.7 "	410	0.46	0.050	0.0016	0.00044	
15.5	0.8 "	340	0.33	0.035	0.0011		NOTE: At certain X-ray wave lengths characteristic of each absorber there is an abrupt reduction in absorption as we pass toward longer wave lengths. The intervals where these occur are marked in this table with horizontal lines.
13.7	0.9 "	260	0.25	0.023	0.00078		
12.4	1.0 "	210	0.18	0.017	0.00059		
6.2	2.0 "	26	0.025	0.0025	0.00071		
4.1	3.0 "	8.5	0.0082	0.00082	0.00025		
3.1	4.0 "	3.8	0.0036	0.00034	0.00013		
2.5	5.0 "	2.0	0.0020	0.00020	0.000069		
1.24	10.0 "	0.31	0.0003	0.00048			

*The law of X-ray absorption is such that if the thicknesses given above are doubled the intensity will be halved a second time; *i.e.*, reduced to one-quarter of its original value, if n thicknesses are used the reduction factor is $(\frac{1}{2})^n$.

tive index. De Broglie arrived at a quantitative formulation of his ideas by applying a famous principle from the theory of relativity.

Albert Einstein had asserted, as a consequence of his relativity theory, that mass and energy are equivalents according to the law

$$W = mc^2 \tag{6}$$

w

in which W is the energy in ergs, m the mass equivalent to that energy in grams and c the velocity of light in *vacuo.* According to this law a small amount of mass, m, could be conceivably annihilated, as such, and converted (for example) into radiation of energy $W = mc^2$ (one gram thus yielding 25,000,000 kw.hr.). (The conversion of mass into energy need not necessarily take the form of radiation. The law of equivalence of mass and energy is a very general one and the conversion may be to energy in any of its forms or manifestations.) (See also RELATIVITY.)

On a huge scale in the form of the atomic bomb first used in 1945 the partial control of this conversion of mass into energy no yields a stupendous source of energy which also promises possibilities of great practical utility. De Broglie made the daring assumption for that time that the total energy equivalent (mc^2) of the electronic mass m was associated with a frequency of vibration v according to the quantum law $h\nu = mc^2$. The vibration or pulsation (of what, he left undefined) was supposed, for a stationary electron, to occur in the same phase throughout all space or at least in an undefined region in the vicinity of the electron. Applying the laws of the Lorentz-Einstein relativity transformation to such a state of affairs to see how it would appear when in motion, he arrived very simply at the result that the electron vibration would appear as a set of plane waves[1] normal to the direction of motion of the electron corpuscle and of wave length λ given by the formula

$$\lambda = h/(mv) \tag{7}$$

in which mv is simply the momentum of the moving electron. These waves would travel with a phase velocity, u, greater than light velocity while their group velocity, less than light velocity, was to be identified with v the particle velocity of the electron: v and u were related by the equation

$$uv = c^2 \tag{8}$$

De Broglie's superlative insight (like Einstein's) was regarded as idle fantasy—but not for long. Four years later, at the American Bell Telephone laboratories, C. J. Davisson and L. H. Germer discovered that electrons, when reflected from the clean surface of a crystal (nickel), exhibit selective reflection from the atomic planes of the crystal lattice in complete analogy to the behaviour of the waves of X-rays observed earlier by Von Laue and Bragg. The wave lengths of electrons thus determined, with an appropriate small correction for the index of refraction of the electrons inside the force field of the crystal, were found to depend on the velocity of the electrons in complete quantitative confirmation of the De Broglie law, $\lambda = h/(mv)$. Moreover, it was later shown that the principle is a perfectly general one including all the fundamental particles of nature, such as protons or neutrons, and O. Stern and his collaborators demonstrated (1930) that such a complex particle as a helium atom is undulatory and obeys the De Broglie law completely. But no particle ever exhibits both the particle and the wave characteristics in the same experiment; we cannot see both sides of the coin at once.

It was Louis de Broglie's original suggestion that the stationary or nonradiating orbits of Bohr's atom model were those around which the electron waves according to the above formula could just fit with an exactly integral number of them in one circumference, in analogy to the standing waves set up on a violin string, or in still closer analogy to a ring of some sonorous metal excited by a blow to vibrate in its characteristic modes. These analogies fail only to the extent that they exhibit some dissipation of the wave energy whereas the electron in its nonradiating orbit loses no energy whatever. The quantum numbers of Bohr (n_1 and n_2 in formula 2) were supposed to correspond to the number of these complete waves in one circumference for the electron in the initial and final states of a radiative transition. The idea was almost right but it needed a little refinement which was supplied by Erwin Schrödinger who laid down the general wave equation for an electron in a potential field and gave the highly successful wave mechanical solution of the hydrogen atom.

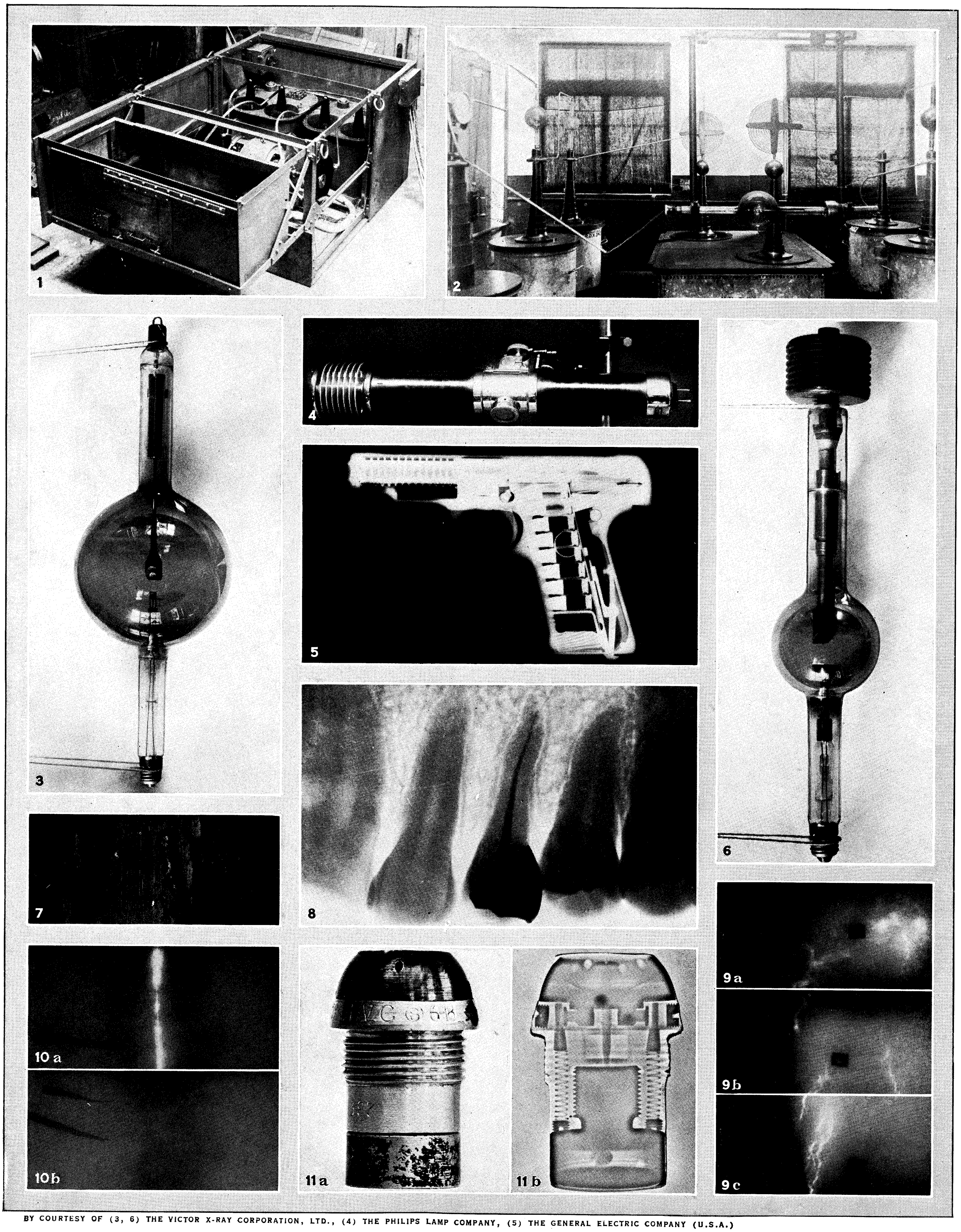
Schrodinger's wave equation mas an approximate one formulated only to describe electrons moving at nonrelativistic speeds. P. A, M. Dirac in 1928 succeeded in fusing the principles of relativity and quantum mechanics into a more general wave-mechanical description with the result that three distinct experimentally observable phenomena became co-ordinated. These were (1) the property of electron spin first suggested earlier by G. E. Uhlenbeck and S. Goudsmit to explain certain fine structure effects in atomic spectra; (2) the existence of a positively charged counterpart of the negative electron (in this case not discovered till four years later in 1932 by C. D. Anderson; and (3) the possibility of the creation and annihilation of matter in the form of pairs of positive and negative electrons by conversion from or into radiant energy, processes which are now firmly established facts.

As a consequence of the third phenomenon just named, Dirac's contribution in its turn has been shown, on a still higher level of precision, to be a slightly inadequate description through the discovery of the Lamb shift (Willis Lamb, Jr.. and R. C. Retherford, c. 1949) and its theoretical interpretation in terms of the modern quantum electrodynamics of R. Feynman, S. Tomonaga, J. Schwinger and others. None of these improvements invalidate the approximate applicability of the earlier interpretations within their limited fields of applicability, however.

2. Atomic Structure.—As the result of extensive investigations in nuclear physics there is strong evidence that the nuclei of atoms consist of only two kinds of heavy particles, protons and neutrons, sticking tightly together in a tiny droplet not more than 10^{-12} cm. in diameter. Protons and neutrons have almost exactly the same mass, about 1.66×10^{-24} grams, but the neutron as its name implies exhibits no electrical charge, while the proton has one fundamental unit of positive charge (4.802×10^{-10} E.S.U. in magnitude). Hydrogen, the lightest atom of all, then has a nucleus consisting of just one proton with one attendant outer negative electron (if the atom is neutral or unionized as are by far the great majority under ordinary terrestrial conditions). Helium has two protons and two neutrons in its nucleus, hence a positive nuclear charge of two units but a mass equal to about four protons. Neutral helium atoms then have two attendant outer electrons. Lithium nuclei consist of three protons and four neutrons, hence have a charge of three units and a mass equal to about seven protons. Three electrons, therefore, form the outer structure of neutral lithium. In this way we can proceed up the atomic table to the heaviest natural atom, uranium, with 92 protons and 146 neutrons tightly packed in its nucleus and hence with a nuclear charge of 92 units and with 92 negative electrons undulating in its outer structure when neutral. We must here omit many interesting details such as isotopes and changes in the total mass of a nucleus ascribable to its energy of formation from its constituent particles. The important thing for us is the regular progression in steps of one unit of the nuclear charge (atomic number Z) as we pass from element to element, attended with the addition of one more outer electron at each step. The characteristic X-rays emitted by these elements come from changes in this outer electronic structure. How do these electrons arrange themselves as we pile more and more of them around the nucleus in going to higher and higher atomic numbers?

The interesting answer is that they arrange themselves in shells, that is to say groups of electrons such that the members of a group are all at about the same radial distance from the nucleus, differing rather widely from the radial distances of other groups. (The radial distance has, of course, the indefiniteness of a wave function but we refer to the radial distance of greatest density.) More important still, the energy of extraction of the electrons in the different groups or shells is about (but not ab-

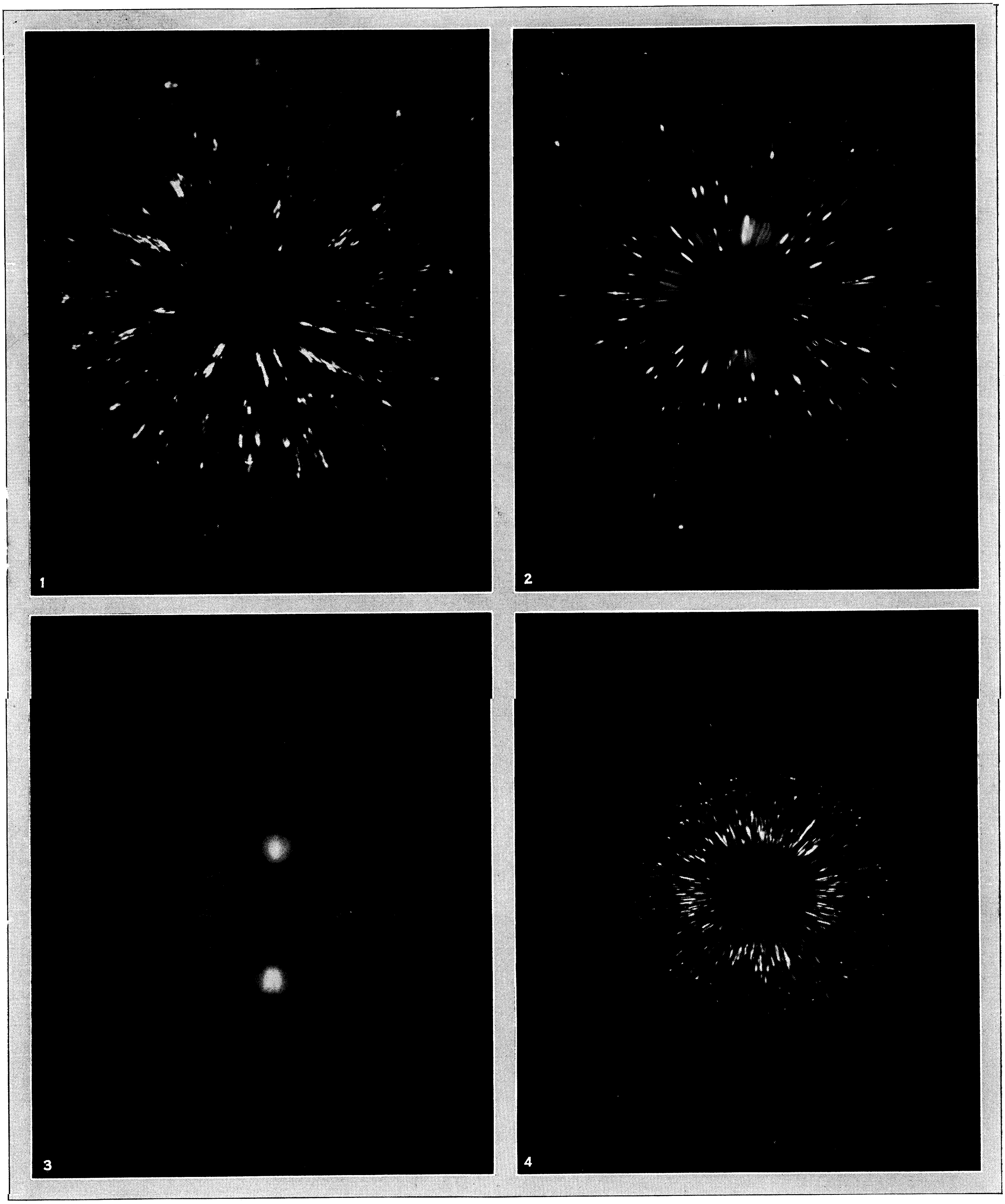
[1]De Rroglie waves should not be confused with their offspring, electromagnetic radiation.



BY COURTESY OF (3, 6) THE VICTOR X-RAY CORPORATION, LTD., (4) THE PHILIPS LAMP COMPANY, (5) THE GENERAL ELECTRIC COMPANY (U.S.A.)

X-RAY APPARATUS, AND SPECIMENS OF RESULTS OBTAINED

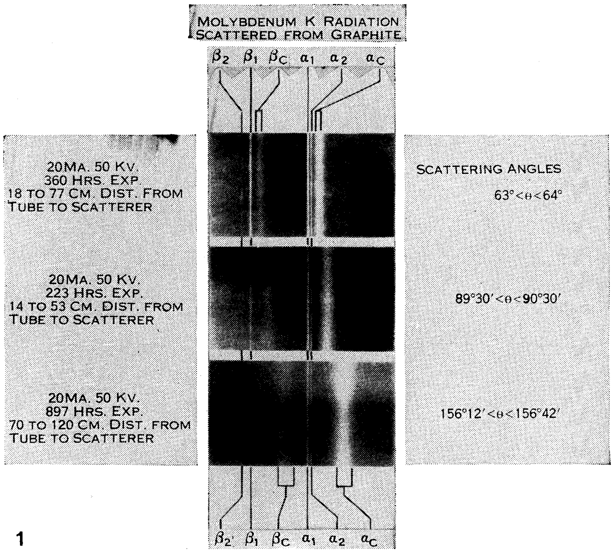
1. Self-contained and self-protecting 200,000 volt X-ray installation, as used for the routine examination of castings. **2.** A 400,000 volt X-ray installation, showing transformer, in centre four valve rectifiers, and high Power Coolidge tube. 3. Coolidge tube. 4. "Metaiix" hot-cathode X-ray tube. 5. X-ray photograph of an automatic pistol. 6. Cooildge tube radiator, with heat-radiating fins at top. **7.** Common photograph of butt weld, apparently sound. **8.** Radiograph of the human teeth, revealing a metallic filling. **9.** Radiograph illustrating hidden cracks in **casting.** 10. (Upper) Radiograph of poor butt weld. (Lower) Radiograph of good weld. **11.** Ordinary and X-ray photographs of a fuse



BY COURTESY OF THE AMERICAN ROLLING MILL CO.

X-RAY DIFFRACTION OF IRON AS IT PROGRESSES FROM THE INGOT TO ONE OF THE FINAL PROCESSES IN MANUFACTURE

1. Piece of ingot of typical cast structure photographed by the usual Laue procedure. The grains are quite large and have been very much strained in cooling
2. Thin bar from the continuous mill showing a considerable reduction in grain size, and amount of strain, as evidenced by the smaller and more uniform spots. The fine radial streaks near the center show the presence of some fragmentation of grains. The slight tendency towards the appearance of groups of spots on the central band indicates the beginnings of a preferred orientation of grains
3. Very fine grained structure of nicely oriented crystals in highly cold rolled iron. The absence of individual spots proves the smallness of the crystals, while the large spots on the various rings show the cubic iron crystals to be, to a very considerable extent, arranged in the sheet with a cube face parallel to the surface of the sheet and a face diagonal parallel to the rolling direction
4. The thoroughly annealed sheet, heat treated after the severe cold roll, is shown completely re-crystallized into slightly strained grains of quite uniform size. No crystal fragments are present and the preferred crystal orientation caused by the cold rolling has completely disappeared, leaving a structure with practically no directional properties



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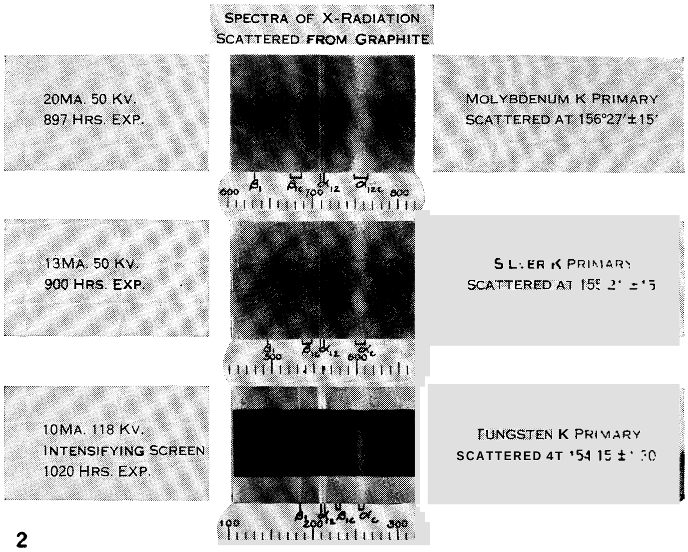
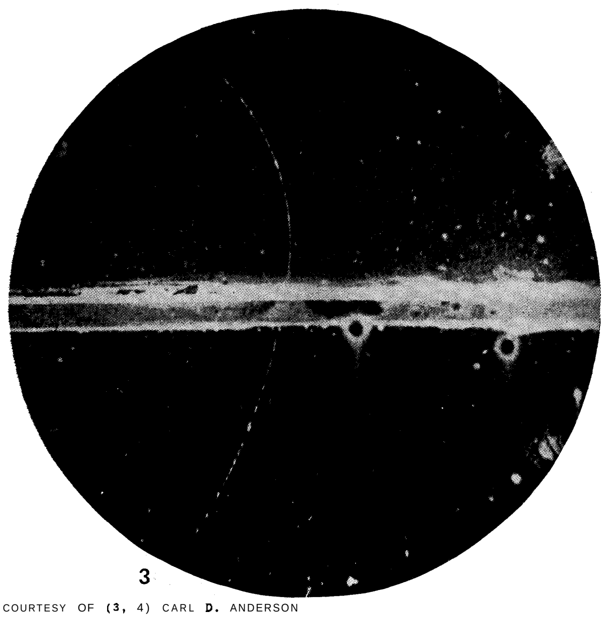


2

COURTESY OF (1, 2) JESSE W. M DUMOND

1. Spectra of molybdenum K-lines scattered by carbon at three different scattering angles θ illustrating both the Compton shift and the DuMond-Kirkpatrick broadening in their dependence on θ. The unmodified α_1, α_2 and β_1 lines of the molybdenum K spectrum are clearly visible and testify by their sharpness to the high resolving power. The broad shifted β and shifted α lines show increasing shift and increasing breadth as the scattering angle increases in complete quantitative accord with the theory as photometric measurements show. The broadening is evidence of the motion in the atom of the electrons which are the scattering agents. The shifted α line is a superposition of the shifted α_1 and shifted α_2 lines and is therefore a little broader than the shifted β_1 line

2. Spectra of scattered X-rays of three different wave-lengths λ scattered by carbon at about 155 degrees scattering angle θ illustrating both the Compton shift and the DuMond-Kirkpatrick broadening in their dependence on λ. The wave-lengths in x-units are shown on the scales. The unmodified β and α lines can be clearly seen in the first (molybdenum) spectrum but with diminishing primary wave-length the unmodified scattering becomes too faint to be seen so that reference lines have been made on the edge of the tungsten spectrum by means of an auxiliary exposure with direct radiation to establish their positions. The broadened and shifted β and α lines of the scattered spectrum can be seen in all three cases. The constant shift and the diminishing broadening (in wave-length units) can be clearly seen and photometric measurements show both effects to be in good accord with the theory of the scattering process and of the motion of the scattering electrons in the atoms of the scattering substance



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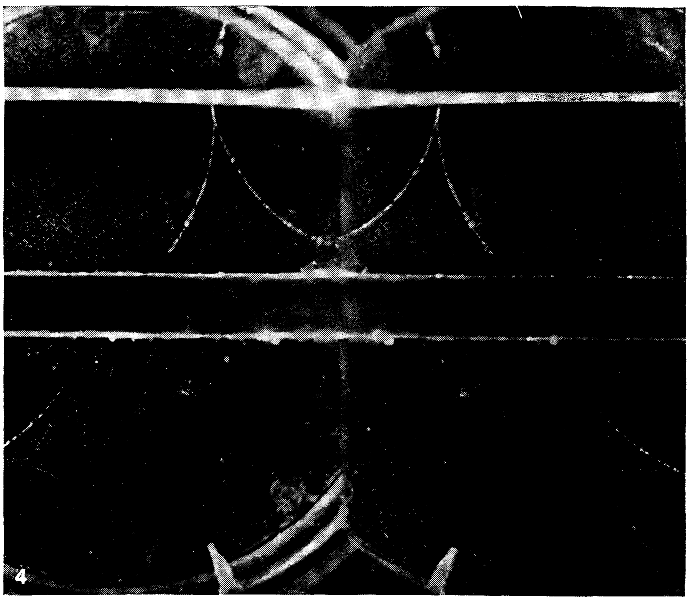


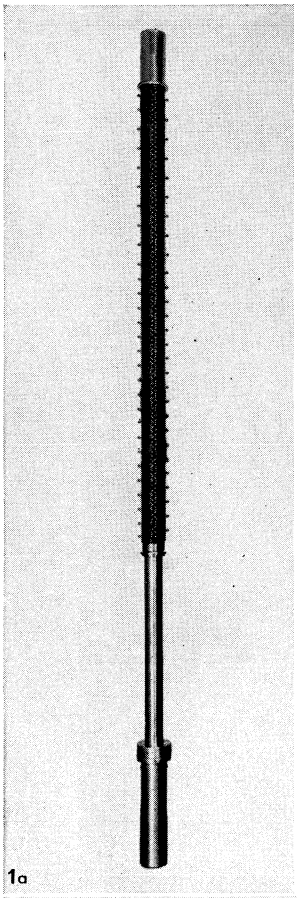
4

COURTESY OF (3, 4) CARL D. ANDERSON

3. A photograph of great historical interest made by C. D. Anderson in 1933 with the Wilson cloud chamber provided with a strong magnetic field capable of deflecting fast electrons. He inserted a 6-mm. thick lead septum horizontally across the chamber. In this picture the track is one left by a positron. This positron possessed an energy of 63,000,000 electron volts before entering the lead plate from below as shown by its curvature in the known magnetic field. After penetrating the plate its curvature shows that it proceeded with an energy of 23,000,000 electron volts. The change of energy, in good accord with the loss to be expected for such an electron in 6 mm. of lead, proves definitely the direction of motion of the particle and, therefore, with the kncwn direction of the magnetic field enforces the conclusion that it is positively charged. The low specific ionization as attested by the density of the track and also the low energy loss in the lead exclude the possibility that the particle could be a proton. This was one of the first clinching evidences for the positron. This photograph is reproduced from Anderson's Nobel Prize lecture

4. The creation of an electron-positron pair in a lead plate by hard gamma rays from Th C'' shown in a Wilson cloud chamber photograph by C. D. Anderson. This photograph is reproduced from Anderson's Nobel Prize lecture. The two particles responsible for these tracks produce equal specific ionizations as judged by the track density and hence have the same mass. From the known direction and intensity of the magnetic field in which the chamber was operated (800 gauss) one concludes that the track of greater curvature was made by a negative electron of about 0.7 million electron volts energy while the track of lesser curvature was made by a positron of 0.8 million eiectron volts energy. Anderson and Neddermeyer have photographed thousands of similar examples of the same process wherein the hard gamma rays from Th C'' (of known quantum energy, $h\nu=2.62$ M.E.V.) falling on lead, aluminum or carbon produced the same result. In no case did the aggregate kinetic energies of pairs so produced exceed 1.6 M.E.V. thus leaving just the required margin of energy (1.02 M.E.V.) for the creation of the two masses. in this photograph the direct image is at the left; the right hand reversed image, taken with a mirror, is for stereoscopic observation. Stereoscopic viewing shows that the third track near the bottom of the picture is of entirely independent origin

X-RAYS



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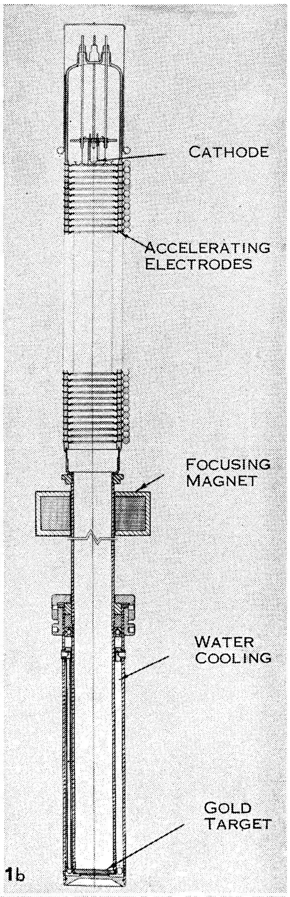

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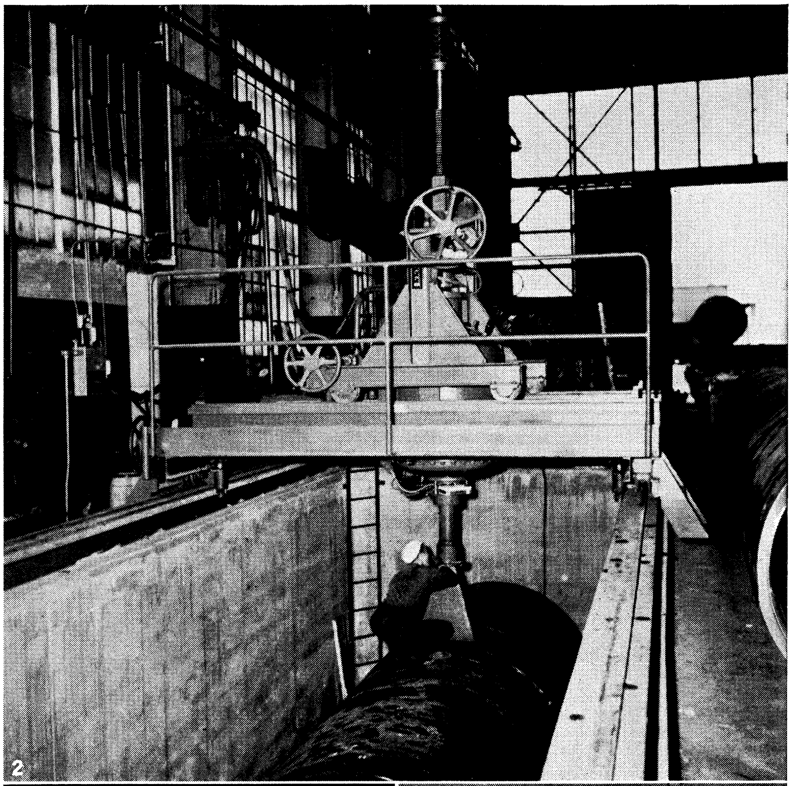

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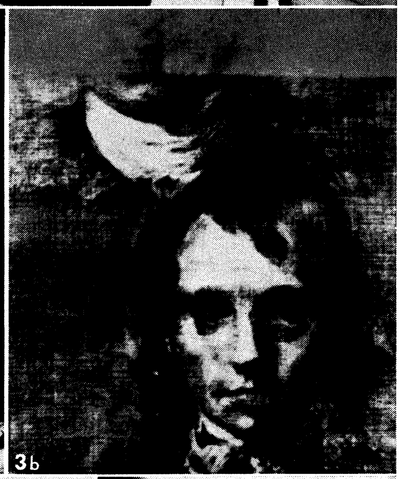

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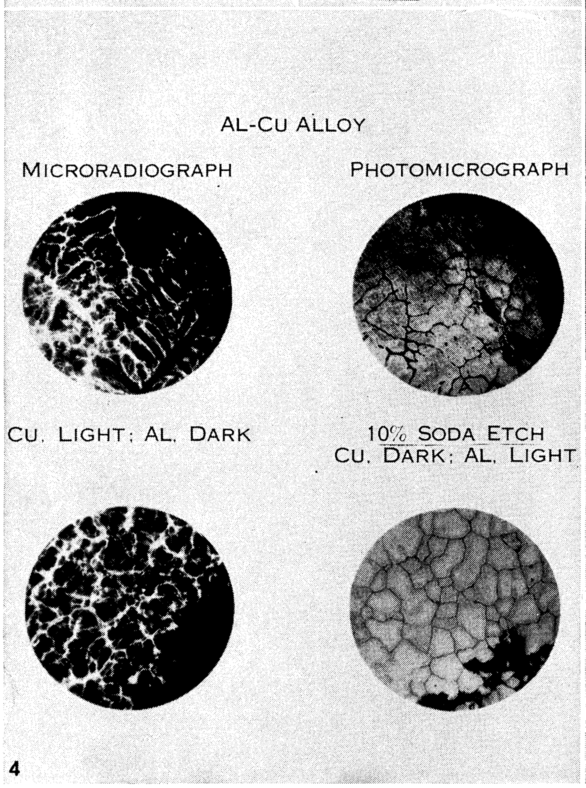

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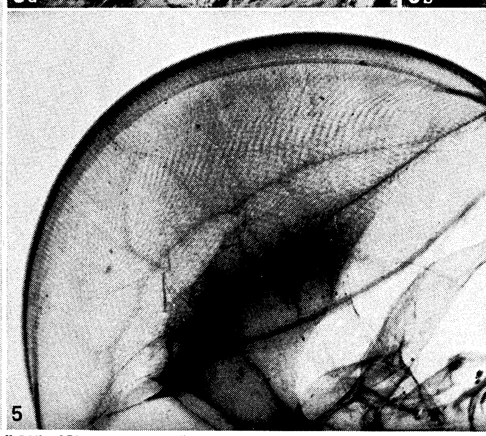

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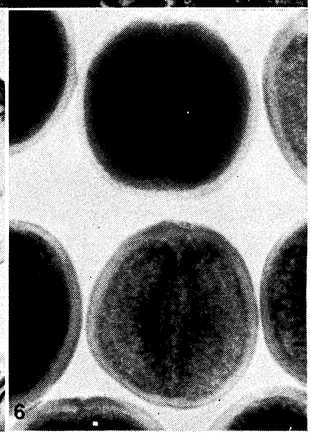
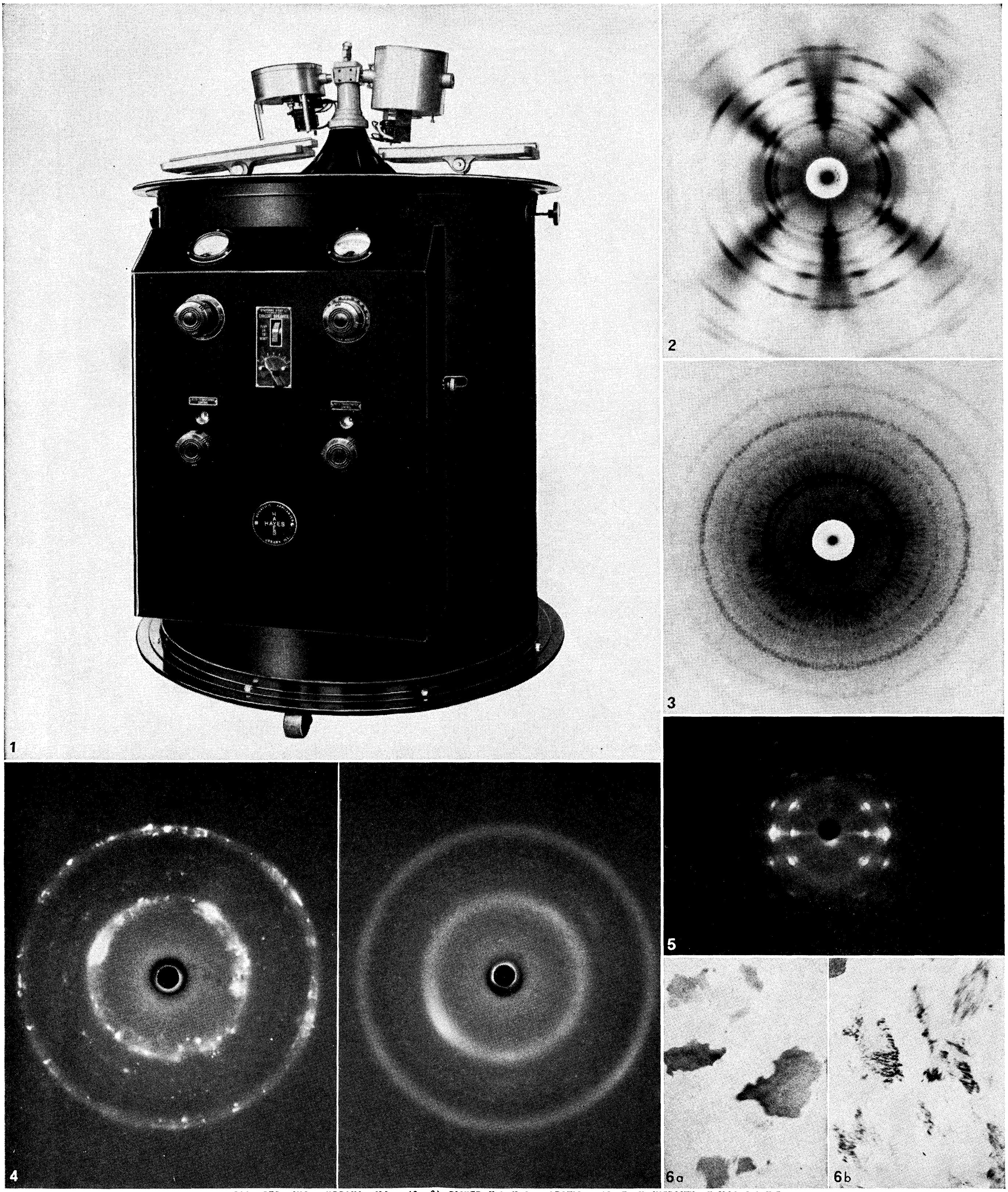


6

BY COURTESY OF (1) MACHLETT LABORATORIES, INC., (2, 6) GENERAL ELECTRIC X-RAY CORPORATION, (3) HENRY E. HUNTINGTON ART GALLERY, SAN MARINO, CALIF., (4, 5) UNIVERSITY OF ILLINOIS X-RAY LABORATORY

1. X-ray tube for operation at 2,000,000 volts producing beam capable of penetrating 12 inches of steel; and diagram of construction
2. Million-volt radiographic unit in use in plant of Babcock & Wilcox, Barberton, Ohio
3. X-ray examination of Gainsborough's "Blue Boy," showing (right) hidden painting of man with white stock above head in visible painting, which accounts for light shadow (pentimento)
4. Microradiographs of aluminum-copper alloy used in aircraft construction, compared with corresponding photomicrographs. Magnification, 100 diameters
5. Microradiograph of eye of common housefly. Magnification, 150 diameters
6. Radiographic classification and sorting of oranges; upper, juicy, high quality; lower, pithy, low quality



BY COURTESY OF (1) HAYES SCIENTIFIC APPLIANCES, INC., URBANA, ILL., (2, 3) PICKER X-RAY CORPORATION, (4, 5) UNIVERSITY OF ILLINOIS X-RAY LABORATORY, (6) DR. C. S. BARRETT, CARNEGIE INSTITUTE OF TECHNOLOGY

1. Multiple X-ray diffraction apparatus, showing two types of cameras supported from head of diffraction tube
2. Diffraction pattern of rolled aluminum sheet showing high degree of preferred orientation of crystal grains in sheet
3. Diffraction pattern of well annealed sheet steel with complete absence of preferred orientation introduced in rolling. and grain growth from spotted rings
4. Back reflection patterns from two sections of same aluminum alloy aeroplane motor castings, showing great difference in texture. With this method as a guide. casting techniques were improved until all sections, thin and thick, gave the same patterns and thus differential strains and failures were eliminated
5. Diffraction pattern of stretched rubber, showing crystallization and parallel arrangement of giant molecules; this behaviour has served as a guide in production of satisfactory synthetic rubber
6. Diffraction micrographs by new Barrett technique; A. individual grains in strain-free sheet of pure aluminum; B. effect of strain in grains introduced by 20% elongation of specimen

solutely) the same for all electrons in a shell but differs widely for the different shells. By the energy of extraction me mean the energy which must be supplied from outside sources to remove one of the electrons completely from the atomic structure so that it is just free but possessed of no kinetic energy in that free state. Unlike the radial distances: very sharply determinate, experimentally measured values can be assigned to the energies of extraction. They can be plotted as a diagram of different energy levels. Following the original terminology of Barkla, the shells, named in order of increasing radial distance from the nucleus and decreasing energy of extraction of their electrons. are called K, L. M, N, O, P and Q. As we pass from element to element toward increasing atomic numbers Z, each new electron is (usually) added in the outermost shell (though quite frequently the addition may be to the penultimate shell) until a limiting number, the capacity as it were of that shell, is reached and then a new shell is started.[1] The number of electrons needed to complete a shell. named in shell order, K, L, M, N, etc., are 2, 8, 18, 32. In the elements above $Z = 36$ there are also O and P shells and in radium. actinium. thorium: protactinium and uranium ($Z = 88$ to 92) there is even a Q shell. The highest number of electrons observed in these shells occurs for uranium, namely 18, 12, and 2 in O, P and Q respectively but it can be said with certainty that some of these might be increased if the table went higher. It does not do so in the natural elements because of some sort of nuclear instability when Z exceeds 92. Artificial transuranic elements have been produced by transmutation.

An atomic structure from which an electron in some specified shell has been extracted, has had work done on it (the work of extraction) and is, by just that amount, at a higher total energy level than before. It is now momentarily an ionized atom. not neutral, because of the absence of one electron. There is in this condition a very strong tendency for an electron from some shell of larger radius than the ionized one to fall down and occupy the vacancy. In doing so the atom as a whole passes to a lower energy level and the difference in energy is radiated in the form of a photon of frequency ν according to the equation

$$W_1 - W_2 = h\nu \tag{9}$$

wherein $W_1 - W_2$ is the difference between the initial and final energy levels of the atom and h is Planck's constant. It is worthy of note here that P. Auger has shown by experiments nith the Wilson cloud chamber that this is not the only mechanism whereby the downward atomic energy transitions (of an atom ionized in an inner shell) can expend their energy. The atom may choose to emit not a photon but another one of its electrons, in which case the available energy is expended on this electron in part to do its work of extraction W_e and the remainder to give it kinetic energy W_{kin} in the free state. The equation of energy balance is

$$W_1 - W_2 = W_{kin} + W_e \tag{10}$$

This is called the Auger effect, first revealed in 1925 by P. huger.

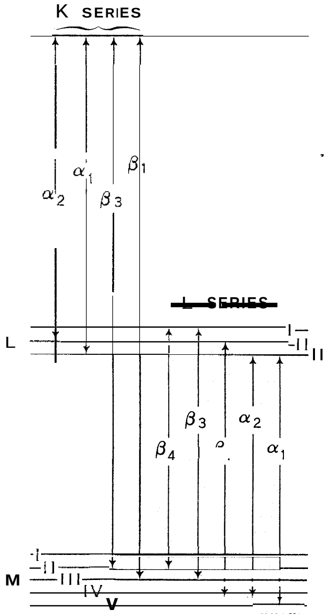
3. The Exclusion Principle.—XI1 we have said implies that save for its outermost shell there is a close-packed quality about the structure of a neutral many-electron atom in its lowest energy state. In spite of the grouping of electrons in rather widely separated shells the entire structure is as dense as its wave-mechanical quantum laws permit. These laws require the formation of the wide intershell spacings (in both radius and energy), and their essence is summed up in what is known as Pauli's principle of exclusion, which in one of its forms asserts that for no two electrons in an atomic structure can all of the quantum numbers required to describe their states be identical. Since space does not here permit a discussion of the detailed significance of the different quantum numbers, this form of Pauli's principle will be less significant to the reader than another one which has been used with great success by Fermi, Thomas and others when the electron swarm has to be treated statistically without detailed knowledge of the complicated force fields in which the electrons find themselves (their own fields and those of the nuclei). This statistical form of the statement must be made in terms of a phase space (a concept due to the U.S. physicist Josiah Willard Gibbs) of six dimensions: three, the position co-ordinates x, y, z of an electron; the other three, its momentum co-ordinates, p_x, p_y, p_z. Pauli's principle asserts that in such a space a small cell of volume $\Delta x\Delta y\Delta z\Delta p_x\Delta p_y\Delta p_z = h^3$ at the point x, y, z, p_x, p_y, p_z cannot contain more than two electrons (and this only if their spins are in opposite directions). The exclusion principle lays no restriction on the shape of the exclusion cell, only on its volume. The shapes are determined by the detailed mechanics of each particular case. The cell of volume h^3 is made up of the product of two factors, an ordinary and familiar spatial volume $\Delta x\Delta y\Delta z$, inside which the pair of electrons is supposed to be situated, and a momentum volume $\Delta p_x\Delta p_y\Delta p_z$ within which they also lie; meaning that the momentum arrow for that electron pair has its point inside the momentum cell in question so that its three momentum co-ordinates lie between p_x and $p_x + \Delta p_x$, p_y and $p_y + \Delta p_y$, p_z and $p_z + \Delta p_z$ respectively. (This somewhat over-simplified language of cartesian co-ordinates implies that the cells are rectangular boxes, but no such restriction exists—their shapes are here undefined. In reality x, y, z, p_x, p_y, and p_z should be regarded as generalized co-ordinates appropriate to the mechanics of the case.) The presence of the position vector of the electron pair inside the first cell and the momentum vector inside the second cell excludes all other electrons from having their positions and momenta so located. Since the product of the volumes of the two cells is a universal constant, h^3, this means, in rough language, that if electrons are very densely packed in space they must be spread wider apart in momentum and vice versa, since their number density in the phase space is a constant.

4. Origin of Optical and X-ray Spectra Contrasted.—All the characteristic spectral lines emitted when atoms give off electromagnetic radiation are due to transitions of atomic electrons between the different initial and final stable electronic states. (Certain very faint lines known as satellites are an exception to this statement. These however are accounted for by a similar but more complicated mechanism in atoms which have lost two or more electrons.) In the case of optical lines, an outer electron (one in the outermost shell) has been, by additional energy supplied from some external source, raised to a quantum-mechanically-permitted (but not ordinarily occupied) energy level of value sharply defined by the wave-mechanical requirements. (The atom is said to be "excited.") Its "fall" from this energy level W_1 to the normal one W_2 is then accompanied by emission of a photon of radiation whose energy $h\nu$ just accounts for the difference $W_1 - W_2$

$$W_1 - W_2 = h\nu \tag{11}$$

In the case of X-ray lines the atom is said to be excited when an electron in some inner shell is ejected completely from the atomic structure (by a supply from some external source of energy in amount equal to or greater than the energy of extraction). The atom is now left with a hole in its previously dense inner structure. The characteristic X-ray spectral line is then emitted when an electron from some shell outside the excited one falls into the hole or vacancy. Since it is the change in the total energy state of the entire atom which must be held accountable for the emission of the photon it turns out to be distinctly preferable to say that the hole in the structure has traveled upward to a new shell rather than to say that an electron from the new shell has fallen into the hole. (For clarity and brevity we shall use both descriptions in what follows as convenience dictates.) This process may occur in several steps before the hole reaches the outer surface. Eventually an electron from some external source will be picked up in the final vacancy and the atom will have returned to normal. In the process, characteristic spectral lines will have been emitted with definite frequencies determined by equations of the type of (11) for each of the discrete steps of readjustment.

[1]This statement is only roughly true. A new shell is quite frequently started at somewhat earlier Z than the completion of its predecessor. The entire rare earth series is formed by the successive addition of electrons in an $N_{vi\,vii}$ sheil, which process starts 21 atomic numbers later than the O shell outside it. Also with increasing Z, electrons are sometimes removed from outer shells and added to inner ones.



BY COURTESY OF JESSE W. M DUMOND

FIG. 6.— TYPICAL ARRANGEMENT OF THE HIGHER X-RAY ENERGY LEVELS OF AN ATOM

The vertical lines indicate the transitions or jumps between pairs of these levels which account for some of the stronger X-ray spectral lines as designated. Only K and L series lines are shown and by no means all of these. The magnitudes of the transitions are not shown to scale

Note that in the X-ray case the initial state of the atom, required for emission of a line, is one of ionization, creation of a hole. Now associated with this initial state there is a whole series of possible lines corresponding to electrons falling from different outer shells into that one vacancy. The most energetic of these lines (those of highest frequency) will be those that come from the remotest outer shells, those nearest the periphery of the atom. Such lines will approach in energy, hv, the energy of extraction of the electron removed when the hole was formed. The aggregate of all lines formed by such electron transitions from say the L, M, N, etc. shells into one ionized shell, say the K shell, is called a series, the K series. The initial state of the atom characterizes the X-ray series. In optical spectra on the contrary it is the final state of the atom which characterizes a series of lines. Note, however, that in both cases if we think in terms of the jump the electron executes when the line is emitted, then it is the final level on which the electron lands which characterizes the series designation.

5. X-Ray Energy-Level Diagrams and X-Ray Spectra.— As we have already indicated, the extraction energy is not quite identical for all electrons in the same shell, the energy levels of the shells being said to have a fine structure. For the detailed explanation of this the reader must consult more extended works. The accompanying diagram, fig. 6, shows three principal atomic energy levels corresponding to an atom which has lost one electron from its K, L, or M shell. Since more energy is required to ionize a K electron than an L or M electron the K level is plotted at the top. In such a diagram an electron falling from the L shell into the K shell appears to move upward but this is merely due to the convention used in plotting. It will be noted on this diagram that there is but one K level while the L levels are split into a triple fine structure and the M shell has five distinct sub-levels. It is the transitions of electrons as indicated by the lengths of the vertical lines which account for all of the frequencies of the characteristic spectral X-ray lines. (Except for certain very weak lines called satellites which are the result of multiply ionized atoms, about which space does not permit us to elaborate.) Not all possible transitions occur with equal probability and some are so improbable as to have earned the name forbidden. These transition probabilities control the relative intensities with which the various X-ray spectral lines are observed, for spectra must always come from a great multitude of excited atoms so that the probability of a radiative transition is statistically translated into the intensity of a line.

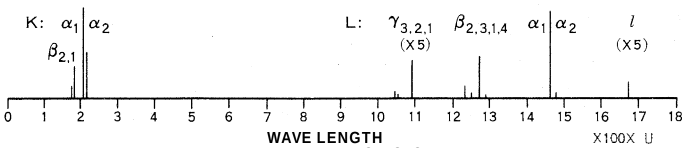
As a result of the spacing of the energy levels, large from K to L, relatively much less from L to M, relatively much less than the latter from M to N, etc.[1], the spectral lines of a given X-ray series form a rather compact group quite isolated from those of neighbouring series in the spectrum. As an example, we show in fig. 7 the K series and the L series lines of the spectrum of a tungsten target plotted against wave length, with the heights of the lines drawn to indicate roughly the relative intensities. If the value of hv for the shortest wave length or highest frequency line in each group is computed, it is found to correspond almost exactly (but not quite) to the extraction energy of the electron whose expulsion created the hole characterizing that series of lines. (Such extraction energies can be readily measured directly in a number of different ways, as we shall see.)

We owe our first insight into atomic structure and the complexity of spectra in general to the simplicity of X-ray spectra, paucity and compactness of lines in a series; absence of overlapping of series; etc., as well as to the fact that the frequencies of the K series, the one first studied by Moseley, are chiefly determined by the energy levels of the K shells, those nearest the nucleus, as we pass from atom to atom. The K electrons are in the full attractive field of the nucleus itself with minimum screening by negatively charged electrons of the full nuclear positive charge Ze. It is this screening effect which accounts for the factor $(Z-1)^2$ instead of Z^2 in Moseley's equation (3) above. After excitation by removal of one K electron, the electrons of the outer structure (L, M, etc., shells) find themselves in the field of a nuclear charge Ze screened by one K electron, hence effectively $(Z-1)e$.

IV. EXCITATION OF X-RAYS

Atoms can be excited to emit their characteristic X-rays (by expulsion of deep-lying electrons) in a number of ways as follows:

1. Electron Bombardment.— In this case the atom is ionized by collisions of fast electrons. (Of far greater total energy than the line spectrum from an X-ray tube, however, is the continuous spectrum generated directly by the impacts of the cathode electrons on the target, as explained below.) This is the method used in all X-ray tubes. As shown by experiments of W. Duane and F. L. Hunt and also of D. L. Webster, it is necessary that the colliding fast electrons have energy greater than the electron extraction energy W_e, the energy level of the series of X-ray lines to be excited. If V is the steady (D.C.) voltage applied in the tube to accelerate the electrons and e the electronic charge, then eV must equal or exceed W_e. The K series lines of silver, for example, just begin to make their appearance in the X-rays coming from



REDRAWN FROM RICHTMYER AND KENNARD, "INTRODUCTION TO MODERN PHYSICS" (MCGRAW-HILL BOOK CO.)

FIG. 7.— PLOT OF THE PRINCIPAL K AND L SERIES LINES OF TUNGSTEN AGAINST WAVE LENGTH

The relative intensities of the lines are indicated roughly by their heights save that the Lγ and l lines are so weak that they are here magnified fivefold. The same line designations have been used as in fig. 6. Note the compactness of the pattern lines of a given group (K or L) and the wide separation of groups

the electronically bombarded silver target when, as we increase the voltage, we reach a value of 25,600 v. although the L series lines of silver are already strongly in evidence. At the critical voltage, all the K series lines appear at once. It is such behaviour that so strongly confirms the picture we have given of the atomic X-ray emission process. This critical value, 25,600 v., is the extraction or ionization energy of silver K electrons expressed in electron volts. The electron volt is a convenient unit of energy much used by physicists. It is equal to the energy possessed by one electron which has fallen through a difference of potential of one volt and is equal to about 1.601×10^{-12} ergs. A quantum hv of radiation having this energy has a frequency of 242,000,000,000,000 cycles per second and a wave length $\lambda = 1.24 \times 10^{-4}$ cm. Energy, in quantum physics, can thus be expressed in ergs, volts, cycles per second, or wave length units. Convenient conversion relations from electron volts, V, to wave length A in centimetres

[1] The reason for this rapidly decreasing energy level spacing is implicit in Bohr's original formula for the individual permitted energy levels of his orbits (cf. Eq. 2). His permitted energy levels were given by

$$W_{nz} = \frac{2\pi^2 me^4}{h^2}\frac{Z^2}{n^2}$$

In an atom such as silver (Z=47), for example, the two K electrons are in a nuclear field of about 47 units, while the shielding of these places, the eight L electrons (also somewhat shielded by each other), in a field of somewhat less than 45 units. Also and more important, the quantum number $n=1$, applies to the K while $n=2$ applies to the L electrons. Similar reasoning applied to the M, N, etc., shells will convince the reader of the rapid decrease in energy-level spacing.

and frequency v in cycles per second are

$$\lambda = \frac{1.2398 \times 10^{-4}}{V}; \quad \nu = 2.4181 \times 10^{14} V \qquad (12, 13)$$

The original Crookes tube of fig. 5 used by Rontgen and the gas discharge tube of Sir Herbert Jackson. fig. 1, have been replaced by various forms of the pure electron discharge tube or hard vacuum tube invented by W. D. Coolidge of the American General Electric company in 1913, of which an early example is pictured in fig. 8. The electrically heated incandescent cathode

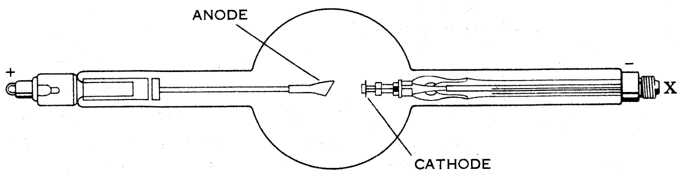


FIG. 8.— DIAGRAM OF THE STANDARD COOLIDGE X-RAY TUBE

Earlier tubes needed residual gas to sustain the electrical discharge but in the Coolidge tube the electrons forming the cathode rays are supplied by thermionic emission from an incandescent cathode

emits electrons by a process analogous to the boiling of vapour from a liquid. The target or anode may also be permitted to become incandescent, through the bombardment (this is not permissible however unless the tube is operated on a rectified supply so that the cathode is always negative); or if its substance is too easily melted. it may be kept cool by a supply of coolant circulating in its interior. Such a tube must be evacuated of gas in the space surrounding cathode and anode to such an attenuation that the chance of an electron in the bombarding stream colliding with and ionizing an atom of the gas in its path from cathode to anode is very low indeed. We say the mean-free-path for electron collisions must be much longer than the cathode-anode separation. Pressures as low as of the order of 10^{-6} (0.000,001) millimetre of mercury (or about 0.000,000,001 of an atmosphere) are required.

In another tube known as Metalix, developed at the Philips laboratories, Eindhoven, Neth., and pictured in fig. 9, the disposition of the metal anode and cathode together with a cylindrical metallic section in the envelope of the tube is such that X-rays can only emerge through a small window thus obviating the necessity for large complicated and expensive external protective shielding.

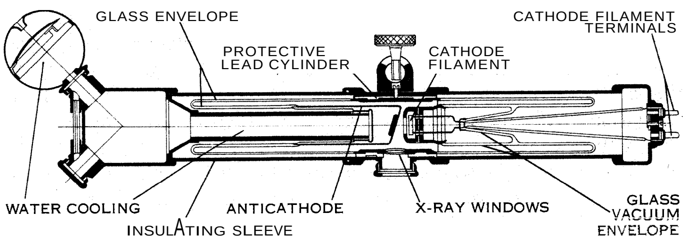


FIG. 9.— DIAGRAMOF THE METALIX X-RAY TUBE OF PHILIPS, SHOWING THE WATER-COOLED ANTICATHODE, THE TUBULAR METAL WAISTLINE WITH A THIN GLASS WINDOW AND THE OUTER PROTECTIVE LEAD JACKET

Since about 1945 the so-called shockproof X-ray tube has come into general use. In this the glass envelope of the tube itself is often completely immersed in oil contained in a compact, grounded metal envelope into which high-tension cables with grounded external sheaths conduct the electrical power. The arrangement is such that no high voltage is accessible anywhere on the exterior surface of the apparatus.

2. Fluorescent Excitation of Characteristic X-Rays.—The second method whereby atoms can be excited to emit their characteristic X-rays consists in using radiation to supply the energy needed to extract one of the deeper electrons. In order for this to take place the photons of the exciting radiation (like the electrons in the previous methodj must have energies, $h\nu$, equal to or greater than the work of extraction of the atomic electron whose removal accounts for the series of X-ray lines to be excited. Thus, in order to excite by fluorescence a sheet of silver to emit its K series lines when exposed to a beam of monochromatic X-rays. it is necessary that the frequency of the X-ray beam exceed 6.2×10^{18} cycles per second (or, what is equivalent, that its wave length be less than 0.48×10^{-8} cm). Both these figures are simply the quantum equivalents (computed from the formulas [12, 13]) of the extraction energy, 25,600 ev. for the K electrons of silver This is a striking example of the quantum or particle-like behaviour of X-radiation. Consider in detail how the event must take place:

A beam of X-rays from which has been selected a small bundle of monochromatic radiation of the required critical wave length either by reflection at a definite angle from a crystal surface or by diffraction from an artificial ruled grating or in any other way, falls on a sheet of silver No matter how much the intensity of this beam is attenuated. either by distance of transmission. or by absorption in matter before reaching the silver, its photons will always possess the property of being able to eject K electrons from the silver (the ejected K electrons can be observed by appropriate means) and of exciting the silver sheet to emit the silver K spectrum of lines (easily observable by means of an X-ray crystal spectrometer). Weakening the intensity of the beam does not reduce the energy of the photons, it merely diminishes their number.

Fluorescent excitation is being increasingly used for the production of characteristic X-rays. This method of chemical analysis was first applied with great success by G. Hevesy who, with D Coster, in 1923 discovered the ne element ($Z = 72$) hafnium by means of its characteristic X-rays.

Maurice de Broglie was the first to show that there is a class of photoelectrons ejected by X-rays of frequency v whose kinetic energy, W_{kin}, accurately satisfies the equation

$$W_{kin} = h\nu - h\nu_q \qquad (14)$$

wherein hv, is the characteristic energy of extraction of some level of the irradiated matter.

3. The Continuous **X-Ray** Spectrum.— X-ray tubes emit also a smoothly spread. continuous spectrum of X-rays upon which the lines are superposed. The lines are very narrow. though they do have a finite measured nidth in wave length or frequency units and a very definite structure or profile which has been carefully studied. The X-ray energy in a section of continuous spectrum the same width as a line is much smaller, even in the most intense regions, than that in the stronger spectral lines. Nevertheless the lines are so narrow and the gaps between them so large that the total energy in the continuous spectrum far outweighs that in the lines. The bulk of the X-ray output of the tube is therefore in its continuous spectrum. Because of this it is chiefly the continuous spectrum which does the work in medical diagnosis and therapy.

The continuous spectrum has a sharp upper frequency limit beyond which it is absent altogether and which constitutes its most striking feature. If the X-ray tube is excited with a steady (D.C.) voltage I' so that all electrons (of charge e) impinging on the target have the same energy eV at all times then this highest frequency emitted, ν_{max}, satisfies the equation

$$h\nu_{max} = eV \qquad (15)$$

wherein h is Planck's constant. This important law, first observed about 1915 by D. L. Webster working in Duane's laboratory is usually called the Duane-Hunt law. It furnishes one of the important methods of measuring the ratio h/e from which, knowing e from other sources. Planck's constant h can be computed. The law asserts that no X-ray photon can be emitted from the X-ray tube with energy $h\nu$ greater than that of the impinging electrons which excite the X-rays. Such processes may be likened in classical analogy to sudden stoppages of the cathode-ray electrons striking nearly head-on blows at the nuclei of the atoms of the target, accompanied with complete radiative loss of their energy.

The continuous spectrum frorn an X-ray tube is usually found to be partially polarized with its electric vector parallel to the direction of motion of the electrons impinging upon the target. The effect is more pronounced in thin targets and as one approaches the short wave-length limit of the spectrum.

At moderate electron voltages the direction of strongest emission is nearly at right angles to the direction of the impinging electrons but as we pass to higher voltages the maximum inclines toward the forward direction of the impinging electrons. At 24 000 v. the maximum emission is at about 70° to the forward direction of the cathode rays, at 38,000 v. it is at 64° while at 1,000,000 v. it is at about 25° only.

Targets of high atomic number are much more efficient emitters of the continuous X-ray spectrum, E. Wagner and H. Kuhlenkampff have shown that, plotted per unit frequency increment, the intensity in the continuous spectrum from a massive target falls off practically linearly with frequency down to the Duane-Hunt limit, with some steepening there. As a result of their studies as well as those of R. T. Beatty and others, the total X-ray energy output of an X-ray tube target divided by the cathode ray energy input (therefore the'efficiency ϵ of X-ray production) has been shown to be given by the approximate formula: $\epsilon = kZV$, wherein Z'is the atomic number of the target material, V the voltage and k a constant probably about 1.1×10^{-9} according to S. K. Allison. (Elaborate theoretical calculations in 1945 by P. Kirkpatrick and L. Wiedmann indicate $k = 1.4 \times 10^{-9}$. The formula obviously must fail long before $\epsilon = 100\%$.) Thus a tungsten target (Z = 74) bombarded at 100,000 v. would emit in all X-ray wave lengths about 0.8% of the electrical energy input. The other 99.2% of input energy is converted into heat.

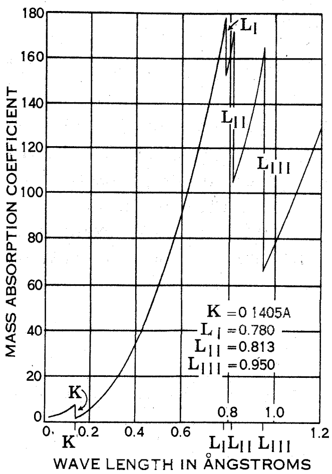
V. INTERACTIONS OF X-RAYS WITH MATTER

1. Photoelectric Absorption; the Effects Upon the Radiation.—When a pencil of X-rays passes through a material-absorbing screen its intensity is reduced as an exponential function of the path length in the screen according to the law

$$I_x = I_0 e^{-\tau x} \qquad (16)$$

Here I, is the intensity after passage through x centimetres of screen, I_0 the initial intensity and τ is called the total linear absorption coefficient per centimetre. It is clear that this law implies that each additional increment Δx of screen thickness removes the same fraction of intensity from the beam. This removal occurs partly by scattering of the X-rays into other directions than the forward one and partly by absorption of the X-rays and conversion into other forms of energy. Thus τ can be split into two components $\tau = \sigma + \mu$ where σ is the linear scattering coefficient and μ is the linear true absorption coefficient. We are at present only concerned with the true absorption coefficient μ. This differs widely for different materials. A more significant coefficient however is μ/ρ where p is the density (in grams per cubic centimetre) of the screen material. This is called its mass absorption coefficient. Of still more fundamental significance is the atomic absorption coefficient, $\mu_{At} = (\mu/\rho)(A/N)$ wherein A is the atomic weight of the absorbing material and N is Avogadro's number. The quantity μ_{At} is the fraction of X-rays removed from an X-ray beam one square centimetre in cross section by each atom placed therein. It may be regarded as a cross section, the equivalent stopping area of the atom for the X-rays in question.

When μ/ρ or μ_{At} for a given absorbing screen is plotted as a function of λ, the wave length of a monochromatic beam of X-rays whose absorption coefficient is under investigation, certain very abrupt discontinuities are observed at well-defined values of λ which depend on the material of the screen. Such a curve is shown in fig. 10 as an example for the mass absorption coefficient of a lead absorbing screen. The first, or K, discontinuity occurs at a wave length λ_K or frequency ν_K, for which the quantum energy (photon energy) of the radiation is just sufficient to eject K electrons from lead. There are three L discontinuities at wave lengths λ_L (or frequencies ν_L) such that the radiation just has the quantum energy to eject L electrons from the three different L levels of the lead atom. The sudden increase in absorption as the wave length is shortened in crossing one of these critical values, say the K, is caused by the fact that a new group of electrons in the lead atom (the K electrons), previously inactive, are now taking



REDRAWN FROM RICHTMYER AND KENNARD, INTRODUCTION TO MODERN PHYSICS, (MC GRAW HILL BOOK CO)

FIG 10.—MASS ABSORPTION COEFFICIENT CURVE OF LEAD IN THE WAVE LENGTH REGION OF THE K AND ALSO OF THE THREE L ABSORPTION DISCONTINUITIES

The sudden increase in absorption at each discontinuity as one passes toward shorter wave lengths λ or higher frequencies $\gamma (= c/\lambda)$ is due to the fact that the quantum energy of the radiation has become sufficient to eject a new class of electrons, previously taking no part in the absorption process

some extra energy from the beam (by being ejected from their atoms). Let us call the critical wave length values, λ_K, λ_L, etc.

In 1914 W. H. Bragg and S. E. Pierce showed that apart from the discontinuities, the coefficient μ/ρ approximately followed a law of the form

$$\frac{\mu}{\rho} = C\lambda^3 Z^3 \qquad (17)$$

Z being the atomic number of the absorber. The coefficient C assumes a new value at each discontinuity. If we consider the absorption per atom. C is replaced by a constant, A' and the exponent of Z becomes 4 (since A is approximately proportional to Z).

$$\mu_{At} = A' \lambda^3 Z^4 \qquad (18)$$

F. K. Richtmyer finds for the region $\lambda < \lambda_K$ that $A' = 2.25 \times 10^{-2}$ and for the region $\lambda_K < \lambda < \lambda_L$, $A' = 0.33 \times 10^{-2}$ when in both cases λ is in centimetres. B. Walter (1927) gives the following results which may be slightly more reliable than Richtmyer's: $\lambda < \lambda_K$, $\mu_{At} = 2.64 \times 10^{-2} Z^{3.94} \lambda^3$; $\lambda_K < \lambda < \lambda_L$, $\mu_{At} = 8.52 \times 10^{-4} Z^{4.30} \lambda^3$; where, again, λ is in centimetres in each case.

The absorption discontinuities taken together with the characteristic X-rays emitted by the absorber give a complete verification of the picture we have formed of the absorption process and of the structure of atoms. As we diminish the wave length incident on the absorber, for example, in the range $\lambda_K < \lambda < \lambda_L$, the L series of lines is strongly emitted by the absorber but the K series is absent. But as soon as the wave length of the incident beam becomes shorter than λ_K, the entire K series makes its appearance. All the K series lines are on the long wave length side of the K edge, etc., because, to use rough figurative language, no energy of transition of an electron from a higher to a lower atomic level can exceed the work required to raise an electron from the lower of the two levels completely out of the atomic structure in the act of ionization, the essential preparation for the former transition. All this furnishes highly satisfactory confirmation of the picture we have formed of the atomic processes of absorption of radiation quanta when these have sufficient energy to eject a given class of electrons, and the concomitant process of emission of characteristic lines from the absorbing atom after the hole has been created by ejecting one of these electrons. The absorption edges furnish one of the best ways of determining the atomic extraction energies or energy levels. All the prominent X-ray spectral lines can be accounted for, as to their frequencies (photon energies hv), as the difference between two of these levels. Thus for example the $K\alpha_1$ line satisfies the equation

$$h\nu_{K\alpha_1} = h\nu_K - h\nu_{L111} \qquad (19)$$

wherein ν_K and ν_{L111} are the frequencies of the K and the third L absorption discontinuities. Moseley diagrams for the critical absorption frequencies (plotted between $\sqrt{\nu_A}$ and Z) are even more convincing than for the emission lines.

2. Photoelectric Absorption; Effects Upon the Absorbing Atoms.—If we wish a rough classical analogue to the true fluorescent absorption process we must think of the electric,vector of the incident electromagnetic waves as acting simultaneously on two members of an electric dipole, the positive consisting of the heavy nucleus and all but one of its attendant electrons, the negative consisting of one electron only of the outer structure, setting the latter (the lighter member of this dipole) into forced vibrations of increasing amplitude until practically the entire quantum energy of the incident photon has been transferred to the electron and the latter is ejected from the atom, moving away as a free photoelectron with kinetic energy equal to the photon energy less the work of ejection just necessary to free it. The momentum given the photoelectron is balanced by an equal and opposite momentum given the heavy nucleus (and also the rest of its attendant electronic structure) which experiences a recoil like that of a gun when a bullet is fired. As might be expected from this picture, cloud chamber experiments with polarized radiation show that the ejected photoelectrons are most numerous in the direction of the electric vector of the radiation.

The X-ray ionization of gases and the effects of X-rays on living tissues have been shown to be due not to the direct action of the X-rays but to the photoelectrons which the X-rays eject from atoms of the gas or the tissue. These photoelectrons may, as we have explained, have energies (in volts) ranging practically all the way up to the energies of the electrons in the cathode ray stream of the X-ray tube where the radiation was generated. As the photoelectrons plow through a gas (or living tissue) they ionize many thousands of atoms in their paths. the average energy expended in ionizing an atom of air for example being only about 30 to 35 v. The process is made indubitably clear in the Wilson cloud chamber Of profound biological significance is the action of the photoelectrons in inducing mutations of the genes in living cells. It has been shown by M. Delbriick in such X-ray studies that the size of the molecular structure of a gene, the carrier throughout the ages of hereditary traits of amazing permanence, is of the order of that of a cube (or sphere) having only ten atoms in its linear dimensions!

3. The Scattering of **X-Rays.**—The tremendously significant work of Arthur Compton dating from his discovery in 1923 of modified scattering, followed by the work of a long list of other investigators, has established that there are two important ways in which X-rays are scattered (deflected from their original paths) by atoms. called respectively modified and unmodified scattering. It was in this field that the particlelike behaviour of the photons of radiation was first driven home with telling force. As in the photoelectric process, here again there are two experimental aspects —the effect on the radiation and the effect on the atoms which scatter it.

It is the electrons in the atomic structure which are responsible for scattering X-rays. In unmodified scattering, which occurs the more frequently (for radiation of specified quantum energy) the higher the binding energy of the scattering electrons, the radiation is not changed in wave length at all by the scattering process—it is merely deflected into a new direction. Such unmodified scattering accounts for all of the selective diffraction phenomena in crystals and on ruled gratings which result in the formation of spectral lines. Each atom of the periodic structure reradiates the incident radiation without change of wave length in definite phase relationship to the primary exciting radiation. Since the photons lose none of their quantum energy $h\nu$ in the process, no net work is done on the atom, no electrons are removed or disturbed. and the final state of the atom is exactly like the initial state. It is as though all the electrons had co-operated in the reradiating process. each absorbing and re-emitting its share of the total $h\nu$. (The electrons must not be extracted by the radiation, their final energy states must be the same as their initial energy states before scattering the radiation in order that the latter shall not be modified in frequency. There is a finite chance according to ideas first enunciated by A. Smekal that this can occur even if the quantum energy $h\nu$ exceeds the energy of extraction. One may perhaps think of the electron as momentarily ejected and then immediately falling back to its original state.) For certain wave lengths and atomic numbers the amount of radiation thus scattered per electron approximates the amount predicted by J. J. Thomson's classical formula

$$I'_\phi = \frac{I}{r^2}\frac{e^4}{m^2c^4}\frac{1+\cos^2\phi}{2} \qquad (20)$$

for the intensity I'_ϕ of X-rays scattered per free electron at an angle ϕ from the direction of the incident beam of intensity **I**, r being the distance from the scattering electron to the point of observation of I'_ϕ. The total scattering in all directions given by the above formula leads to a scattering coefficient per electron

$$\sigma_e = \frac{8\pi}{3}\frac{e^4}{m^2c^4} = 6.66 \times 10^{-25}\ \text{cm}^2. \qquad (21)$$

corresponding to an absorption cross section, that of a circle of radius 4.6×10^{-13} cm. When however the wave length of the radiation is long compared with the size of the atomic electron swarm there is a constructive interference of the radiation scattered by the individual electrons so that n of them instead of scattering n times the amount σ_e behave (in the limiting case of very long wave lengths) as though the charge e (raised to the fourth po er in the formula) were first multiplied by n so that ten electrons become equivalent to $10^4 = 10{,}000$ independently scattering electrons. The presence of m^2 in the denominator. however. reduces the ratio by the divisor $10^2 = 100$ so that the net effect of 10 electrons is 100-fold that of 1. All this is fairly reasonable according to classical concepts.

It has been possible, by study of the intensity of unmodified X-ray scattering as a function of scattering angle for gaseous atoms and also for atoms in crystal lattices, to learn a very great amount about the statistics of the spatial distribution of electrons around the atomic nuclei both in single atoms and in solid crystals, to reveal the sizes of the cloudlike electron shells and to map the regions of periodically varying electron density in crystals.

It is as the wave length becomes short, however, that our classical ideas of scattering break down completely and the scattering becomes very much lower than Thomson's formula predicts. The Compton effect here becomes pronounced.

4. The Compton Effect.—It had been observed by J. A. Gray (1920) that short wave-length radiation. after scattering from carbon and other low atomic number atoms, was somewhat more absorbable than the primary radiation. It is a simply demonstrable consequence of Maxwell's electromagnetic theory of radiation that when any quantity of radiant energy W is absorbed by a charged particle there will be exerted upon the latter an impulse (or quantity of momentum) in the direction of propagation, of magnitude Wlc where c is the velocity of light in *vacuo*. Thus a photon of energy $h\nu$ should carry with it the ability, if completely absorbed, to exert a momentum $h\nu/c$ on an electron (or any other charged particle). In 1923 Arthur Compton and, simultaneously. Peter Debye proposed the daring hypothesis that a photon of X-rays might be regarded as a small projectile able to hit one and only one electron in the scattering atom (actually their initial theory envisaged as a first approximation only a free electron). The idea was that the photon bouncing off the electron (in the direction of scattering that was being studied) would deliver a blow giving, at the expense of some of its energy, a recoil velocity and a recoil energy to the electron in accord with the familiar laws of conservation of energy and momentum applicable to larger colliding masses. The energy so lost by the photon, initially of energy $h\nu$,, would result in a new lowered frequency ν_θ corresponding to a lesser quantum energy, $h\nu_\theta$. Clearly the loss of energy should increase nith increasing angle of scattering θ. The accompanying fig. 11 shows the simple vector momentum diagram with the help of which, together with the conservation of energy, it was possible for Compton and Debye to compute that the modified photon should exhibit a shift toward longer wave lengths relative to the primary wave length and independent of the value of the latter given bv

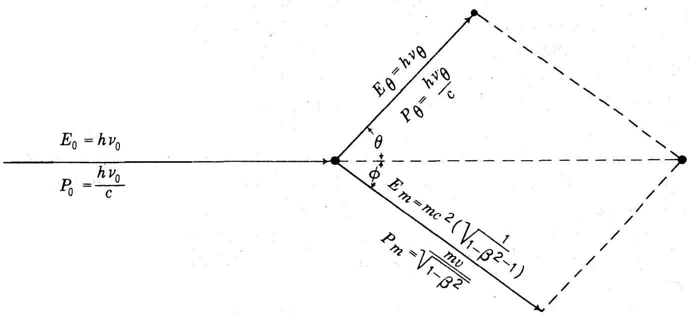
$$\lambda_\theta - \lambda_0 = (h/mc)(1-\cos\theta) = 0.0242 \times 10^{-8}(1-\cos\theta)\ \text{cm}. \qquad (22)$$

Compton outdid Debye in that he immediately and quantitatively demonstrated this shift in wave length in the laboratory together with its dependence on the scattering angle 19. The theory shows that the recoiling electron must have a forward velocity in an obvious well-specified direction and an energy E_r given by

$$E, = h\nu_0\,\frac{\xi(1-\cos\theta)}{1+\xi(1-\cos\theta)} \text{ wherein } \xi = \frac{h\nu_0}{mc^2} \qquad (23)$$

Immediately following Compton's prediction of their existence, these recoil electrons were discovered in the laboratory by C. Wilson and by W. Bothe. Compton and Alfred W. Simon (1925) showed with fair quantitative accuracy in the Wilson cloud chamber that both the scattered photon and the recoil electron obey the required laws in individual scattering processes and A. A. Bless has checked their energy accurately by the method of the magnetic spectrograph.

E. Schrodinger (1927) proposed an alternate theory of the



REDRAWN FROM RICHTMYER AND KENNARD, "INTRODUCTION TO MODERN PHYSICS," (MCGRAW-HILL BOOK CO.)

FIG. 11.— VECTOR DIAGRAM SHOWING THE CONSERVATION OF MOMENTUM IN ITS TRANSFER FROM PHOTON TO ELECTRON IN THE COMPTON EFFECT

P_m is the momentum received by the recoiling electron. P_0 and P_θ are the momenta of incident and scattered photons. θ is the scattering angle through which the photon is deviated. Formulas for the energies E_0, E_θ and E_m are also given. The fundamental law of conservation of momentum requires that the vector sum of P_θ and P_m after the collision, that is to say the dotted diagonal of the parallelogram, shall be equal in magnitude and direction to the initial momentum of the radiation P_0 before the collision

Compton effect based entirely on a wave picture in which the initially free recoiling electron must be replaced by its train of De Broglie waves, completely unlocalized in space, which act to reflect the X-radiation like the atomic layers in a crystal. The change in wave length. in this picture of the process, is to be ascribed to a Doppler effect caused by the velocity of recoil of the reflector. No basis for preference can be shown for either viewpoint, and we have here a striking example of the dual aspect of all nature. N. Bohr, after very painstaking study of the entire duality principle! resumed his work in what he called the two principles of complementarity and renunciation, *i.e.*, the wave and the particle concepts are complementary aspects of the same phenomena (like the two sides of a coin which cannot both be seen at once) and we must renounce further efforts to reject either one or to harmonize them.

5. Evidence for Motion of Atomic Electrons.—The scattering electron in the original Compton-Debye theory was assumed free and initially at rest. P. A. Ross proposed and G. E. M. Jauncey. J. W. ill. DuMond and H. Kirkpatrick have each analyzed the case where the electron possesses an initial velocity before the scattering process takes place. Thus not only does the photon deliver a blow upon the electron but the electron (like a baseball bat) may (1) either happen to hit back, thus decreasing somewhat the loss of photon energy; or (2) may recede as it receives the blow (as in bunting) so as to increase the loss of photon energy. Now there is no such thing as a supply of free stationary electrons in nature to use as a scattering agent. All the electrons in sufficient numbers for this purpose are in the atoms of solids, liquids or gases. In monatomic gases the electrons may be expected to be in motion (to have momenta) quite rigorously as the wave mechanics predicts for single atoms. In solids or liquids, on the other hand, the electronic momenta will not be quite the same as for free atoms because of the perturbing effect of neighbouring atoms. In the case of metallic solids, conductors of electricity. a theory of A. Sommerfeld proposes as a first approximation that about one electron per atom in the metal crystal lattice is substantially unattached to any particular atom and wanders about freely so that the totality of all such electrons forms a free electron gas in the interspaces of the lattice. The quantum theory (principle of exclusion in phase explained above) requires the electrons of this degenerate gas to be in a state of extremely rapid motion at velocities on the average substantially higher than they would have as outer electrons in a free atom. (They are crowded into less volume in the crystal lattice than in the free atom and hence they must occupy more momentum space.) These electron velocities required by Sommerfeld's theory and the corresponding electronic energies are enormously greater at terrestrial temperatures, or even at 0° Kelvin, than an equipartition of the ordinary thermal energy between the atoms and the electrons can alone account for.

These ideas would lead us to expect a considerable broadening of the Compton modified line as a statistical result of the individual shifted scattering processes from electrons rapidly moving in every conceivable direction, and exactly this was observed by DuMond and Kirkpatrick both with solid and with gaseous scatterers. The structure and width of the broadened modified line is in complete accord with the magnitude and distribution of electron velocities predicted not only for single atoms and molecules (helium and hydrogen gases as scatterers) but also for the free electron gas in a solid electrically conducting crystal. We thus have quantitative experimental verification of the high velocity free electron degenerate gas in a conductor predicted by Sommerfeld. at least as concerns the velocities and the approximate number of electrons which belong to the class. and a refutation of the older statistical idea that such free electrons should on the average possess only the same energy as that associated with the thermal vibration of the atoms of the crystal lattice. The breadth of the modified line in wave-length units should diminish with decreasing scattering angle and also with decreasing primary wave length in a definite way and DuMond and Kirkpatrick have shown experimentally that it does, thus confirming the validity of the entire picture. Two illustrations (see Pl. III, fig. 1, 2) are shown giving the spectra of (1) the K lines of molybdenum after scattering at three different angles from a block of graphite; and (2) the K lines of molybdenum, silver and tungsten respectively each after scattering from graphite at about the same angle. In these spectra the modified α line is very clear but the modified β line can also be seen with less intensity. The sharp unmodified α and β lines formed by the unmodified scattering process are also clearly visible. (The modified lines in the picture are designated α, and β_c while the c is omitted in the subscript for the unmodified lines.) These figures obviously not only illustrate the effect of the broadening of the Compton line by the electronic motions and the variations of the breadth with scattering angle and primary wave length; they also clearly illustrate the Compton shift itself, its variation with scattering angle and its independence of primary wave length, all in perfect accord with the theoretical picture of the process.

In modified scattering the light pressure may be thought of as the agent which ejects the electron from the atom with the energy of recoil. The fact that the electron is initially bound to the atomic nucleus, which therefore shares slightly in the momentum transfer. introduces a slight correction to the Compton shift (in wave length). This correction, computed by F. Bloch, was verified in very careful and ingenious work by Ross and Kirkpatrick.

If photons can be used as projectiles or probes to study the velocities of the electrons in matter, why not electrons? A. L. Hughes has done exactly this. Certain classes of electrons after scattering from gas atoms exhibit modifications of their energies and momenta (or De Broglie wave lengths if we prefer) which yield information as to the atomic electron velocity or momentum distributions in completely satisfactory accord with the X-ray results of DuMond and Kirkpatrick.

In further research work done about 1937–38, DuMond and Kirkpatrick, using gaseous helium and hydrogen as X-ray scattering agents, were able to obtain very accurate spectral profiles of the broadened, modified and scattered lines. These profiles were compared with calculated expectations based on the electron momentum distributions to be expected from quantum mechanical theory ior atomic helium and molecular hydrogen. The complete agreement between the theoretical and experimental profiles was excellent. These two atomic species were chosen for two reasons: (1) The simplicity of their electronic structures indicated them at the time as almost the only ones whose electronic momentum distributions could be calculated with the necessary reliability;

and (2) the perturbing effects of the proximity of neighbouring atoms on the calculated distributions for the case of a free atom are serious effects in the solid and liquid state, but are absent for the gaseous state. The broadening of the Compton line may be said to have established beyond doubt the dynamic (as opposed to static) character of the electronic structure of the atom. This is in good accord with quantum mechanics.

6. The Bohr-Heisenberg Uncertainty Principle.—From this evidence that both radiation and matter act like particles, combined with the equally good proof that they have the characteristics of waves, there flows a consequence of the deepest philosophical and physical significance. This consequence is that there is a definite and fundamental limit placed upon the precision of prediction of the future actions of any object or system as based upon observations made with any form of radiation or matter. Space is not available to give here the interesting chain of reasoning leading to this conclusion. (See UNCERTAINTY PRINCIPLE.) This principle asserts that no physical experiment of any present known type can be devised which will simultaneously measure the momentum p_x and the position q_x of a system to precisions of order Δp_x and Δq_x respectively greater than the limits prescribed by the inequality

$$\Delta p_x \Delta q_x > h. \tag{24}$$

A sufficient relaxation of precision in either factor, momentum or position, will permit any desired degree of precision in the other but the product of their uncertainties cannot be less than the constant, h. The role which x-ray research has played in bringing to light the Bohr-Heisenberg Uncertainty Principle is perhaps its most significant achievement. (J. W. M. D.)

VI. USE IN MEDICINE

The extraordinary value of Rontgen's discovery has been nowhere more in evidence than in medicine, and for a full discussion of the use of X-ray in medicine, *see* RADIOLOGY.

VII. MODERN INDUSTRIAL APPLICATIONS

The foundations of the industrial applications of X-rays, at least industrial radiography and uses dependent upon differential absorption in matter, were laid in the experiments of Rontgen in 1895, along with the beginnings of the medical and physical areas of a radiation science which later became so remarkably versatile and diversified. But in those early years there was no general acceptance and no recognition of the potentialities of the Rontgen rays, for their nature was still unknown. It remained for the discovery in 1912 by von Laue of diffraction by crystals, proving the electromagnetic nature of X-rays, identical with light except for much shorter wave lengths; of the Bragg law and the spectrometer by the famous father-son team of Sir William Henry and Sir William Lawrence Bragg in 1913; of the Coolidge X-ray tube in 1914; of powder diffraction and nondestructive X-ray analysis of solids by Hull in a U.S. industrial laboratory, simultaneously with Debye and Scherrer in Europe; and of rapidly improving equipment at the hands of electrical engineers and physicists even to this very day—all of these and many other advances—were needed to give the real impetus to a vision of a new applied industrial science.

The United States government in 1921 was among the first to recognize that ordnance should be tested by X-rays, and this work began at the Watertown arsenal under the leadership of H. H. Lester. His success with radiographic inspection led to the acceptance of nondestructive testing of welded pressure vessels, castings and fabricated units of all sizes by some progressive foundries and machine works. An X-ray research laboratory for the investigation of a wide range of industrial problems was established at the Massachusetts Institute of Technology in 1924. Thus began and gradually developed in academic laboratories, and one by one in the laboratories of industries, an industrial Rontgen science, concurrent and integrated with the development of the pure science of spectrometry and atomic structure, of the fundamental laws of absorption and scattering, of radiation physics, chemistry and biology, of the unique derivation of crystalline and molecular structures by the most advanced mathematical computations from X-ray diffraction patterns of single crystals.

X-ray instrumentation in modern testing and research laboratories is as appropriate and common as the older and wider range of optical apparatus. But in many respects we are still in the early stages of development, since only comparatively recently has electronics come to the aid of Rontgen science in the design and construction of ever more sensitive, powerful, automatic, quantitative X-ray apparatus. Now commercially produced are tubes to generate radiation at millions of volts to penetrate 20 or more inches of steel; extraordinarily efficient power plants of minimum size and weight for portability; detectors and quantitative intensity and dosage measuring devices far transcending the always indispensable photographic film and the ionization chambers—Geiger, proportional and scintillation counters. It is such instrumentation that meets the requirements of industry in the saving of time and manpower so that the original investment, which may be sizable, may be rationally and economically amortized; and that satisfies the demand for dependability and sensitivity to handle microquantities and trace analyses.

The industrial applications of X-rays comprise almost 12 categories. This versatility and wide scope are partly responsible for the increasing interest in laboratory and plant installations to meet specific needs of a given industry. Without attempting to describe in detail modern equipment, techniques or interpretations, which are covered in many papers, books and manufacturers' bulletins, a brief survey of actual accomplishments is presented in the following sections.

1. Characteristic Emission Spectrometry.—This technique, long known for qualitative and quantitative elementary analysis (now almost exclusively by fluorescent radiation), came into its own as a practical and useful analytical tool at about mid-20th century. X-ray spectrometry provides a method of rapid, nondestructive chemical analysis which in many instances parallels optical emission spectrography. In brief, a beam of intense primary X-rays from a permanently installed, sealed-off tube (such as the familiar Machlett AEG-50 tube with beryllium windows) is directed upon any specimen, gas, liquid, solution or solid. This primary radiation excites in the specimen secondary fluorescent X-rays whose wave lengths are characteristic for each chemical element. This radiation is spread out into a spectrum and analyzed by means of a crystal spectrometer in accordance with the Bragg law, $n\lambda = 2d \sin \theta$, where n is an integer, the order of the spectrum; λ is the wave length of a sharp emission line; d is the grating constant of the crystal analyzer; and θ is the angle of incidence of the collimated X-ray beam on the specific set of parallel planes in the crystal from which the beam is diffracted. The experimental measurement is actually that of 2θ, the angle of diffraction measured on the spectrum, which is registered as sharp lines (in series) on a photographic film, or as sharp peaks on a chart automatically recorded in modern installations for the response of Geiger, proportional or scintillation counters with attendant electronic circuits. The wave lengths of the characteristic lines in emission spectra of course have been accurately measured, and are tabulated in readily available handbooks and reference works, for almost all the chemical elements from hydrogen (element 1) to nobelium (102), or may readily be calculated from the relationship between wave length and atomic number discovered by Moseley in 1914. Thus qualitative analysis of the elementary composition of any specimen is directly possible, and can be extended to highly sensitive and accurate quantitative analysis from the evaluation and calibration of intensities of the spectrum lines.

Commercial equipment is available for point-by-point X-ray spectrometric analysis, that is, chemical analysis of very small individual areas such as the grains in aggregates which constitute the usual texture of metals and alloys. Extremely fine electron beams collimated by magnetic lenses, as in electron microscopes, generate primary characteristic rays of all the chemical elements in each minute area upon which the beam impinges, identification being made with a sensitive crystal spectrometer.

The chief disadvantage in X-ray emission spectrometry lies in the fact that elements of low atomic number generate long wave-length rays which are easily absorbed even by air. This difficulty is overcome in spectacular fashion by means of helium or vacuum tunnels through which beams pass, and with flowing proportional counters with extremely thin windows. The cement industry analyzes magnesium (12) in slags as routine procedure, and there is every hope of reaching down to carbon (6). The tremendous advantages of the simplicity of X-ray spectra in comparison with optical spectra, nondestruction of the specimen, multiple analyses simultaneously by dispersive and nondispersive methods, and the dependability of quantitative analyses, when carried out intelligently with and without internal standards, are now recognized. A list of industries using these methods, and of routine and research investigation on raw materials and finished products, would run to formidable length. The growing numbers of technical papers and books on this technique are indications of interest in analyses of alloys of every description, minerals and ores (especially those containing uranium, thorium and other atomic energy elements for which classical methods of analysis are very unsatisfactory and laborious), lead and bromine in ethyl fluid, sulfur and other elements in petroleum, elements such as iron in hazardous dusts, additives in lubricants, catalysts and catalyst poisoning, thickness of multilayer electrodeposits, metallic elements in foods and biological materials—to mention only a few. Truly the progress made since the earlier days of primary emission spectrograph~involving laborious pasting of specimens onto targets of demountable X-ray tubes, followed by evacuation to the requisite very low gas pressure, is clear indication of persistent effort and faith in the practical utility of this method.

2. Absorptiometry (Absorption Photometry).—The value in industrial testing and research of optical spectrophotometry from ultraviolet to infrared is accepted as a matter of course. The extension to the measurement of absorption of radiation in the spectrum below the ultraviolet in the X-ray range was logical and has been increasingly utilized for analyses of gases, liquids, solutions and solids with commercially produced equipment. This equipment consists of a source of monochromatic or polychromatic X-rays which may be made to pass through either a standard known material, such as a pure solvent, or an unknown dissolved in this solvent, for example, and then impinge upon a phosphor and multiplier phototube. Usually a calibrated wedge is interposed in one path until there is exact balance in the intensities of the radiation after passage through standard and unknown.

The analysis of gasoline for ethyl fluid and sulfur (providing a check on the spectrometric method) is common practice. One industrial laboratory ingeniously developed a method for sulfur analysis utilizing X-rays of constant quality emitted from manganese-by K-capture, a process in which an external electron in the atom is captured by the nucleus and, as the vacancy is filled from higher energy levels, X-rays are emitted. The percentage of bromine and the rate of vapour phase bromination of organic compounds is a routine procedure, as is the determination of the concentration of uranium salt solutions; glass composition, adsorption of gases andliquids on activated charcoal and other absorbents and catalysts, and flow from nozzles are but a few industrial examples. Automatic control of the thickness of rolled metals was made possible by multiplier phototubes. The porosity of many materials, such as storage battery plates and separators, is not only accurately measured by X-ray absorption, but controlled in manufacture, as is the packing of tobacco in cigarettes, filling of containers and other processes.

3. Industrial Radiography.—This special case of absorptiometry is the oldest and most familiar of all branches of applied X-ray science, parallel with medical diagnostic radiography. It dates from Rontgen's original photographs in 1895 of weights in a box and wood coated with lead paint. It is well to remember that radiography is the production of a shadow picture by passage of X-rays through, and differential absorption in, any object in close contact with a photographic film. The heavier the chemical element in a specimen the greater its absorbing power for X-rays. It follows that an internal flaw in a metal casting—blowhole, porosity, crack, inclusion of lighter elements—will disclose itself on a radiograph as a darkened area in comparison with the sound metal of given thickness; or like the bones in a diagnostic radiograph, denser portions will appear as lighter areas on the photographic negative. This method of inspection, therefore, not only assures safety in performance of any casting, but also the success of subsequent expensive machining operations; and of course the development, step by step, of the best foundry practice to assure soundness on a continuing production basis depends upon radiographic inspection as a guide.

Penetration and differential absorption of X-rays also depend upon the wave length of the X-ray beam (the shorter being the more penetrating), and the wave length in turn depends upon the voltage applied to the X-ray generator. Thus a minimum wave length of 10 Å (ångstrom unit = 10^{-8} cm.) is generated at 1,240 v., 1 Å at 12,400 v., 0.1 Å at 124,000 v., 0.01 Å at 1,240,000 v. and so on. In the last case the energy of the X-ray beam is expressed as 1.24 Mev (million electron volts). Herein lies the basis for the development of resonance transformers, Van de Graaff electrostatic generators and betatrons and other types of electron accelerators for the generation of X-rays with energies of millions or billions of electron volts and a penetrating power for detecting flaws in thicknesses of solid steel up to feet instead of inches or fractions. For example, it became routine procedure to test every inch of the automatic welds in the hulls of the U.S. atomic-powered submarines; to examine for soundness giant castings, forgings and welds for permanent engineering structures such as dams and pipe lines; to test the assembly of the smallest fabricated objects such as electron tubes; to study ballistics and armour penetration by shells in radiographs made in 0.000,001 sec. with X-ray beams of enormous intensity from surge generators; and to study motion by cineradiography, and every detail of internal motions and wearing in internal-combustion engines by stroboradiography. Radiography became one of the principal methods of nondestructive quality control for an almost endless variety of products including foods, fresh and packaged; gems; packages and baggage for customs inspection; coal; automobile tires; wire and cable insulation; boiler tubes; fitting of screw threads; and many other raw materials and finished articles. It is not surprising that rigid specifications of quality have been established based upon radiographic inspection by carefully prescribed techniques by many official agencies, so that the user or consumer is assured of satisfactory performance, especially where the safety of life and property is of vital significance.

In a field closely related to industrial radiography, art galleries and museums all over the world are equipped with X-ray laboratories for the examination of art objects and the establishment of authenticity of masterpieces. To cite a single example, even one of the most famous paintings in America, Thomas Gainsborough's "Blue Boy" in the Henry E. Huntington art gallery, San Marino, Calif., has not escaped X-ray scrutiny. When an area above the head appeared to have a peculiar light reflection, described by painters as a pentimento, radiographic examination, entirely without damage to the masterpiece, disclosed the figure of a man over which the "Blue Boy" had been painted. The pentimento corresponded with the white stock around the neck of this underlying figure on a canvas which had been cut down for the "Blue Boy." Differential absorption of the rays by the various mineral pigments makes possible this fascinating contribution of science to art. The positive identification of the pigments in crystalline form is an entirely different application of X-ray techniques discussed below under *Powder Diffraction Analysis*.

4. Industrial **Fluoroscopy**.—Radiographic images, in addition to photographic registration, may also appear on fluorescent screens as brilliantly luminescent shadow pictures. While applications in industry have been secondary to those in medical diagnosis, the use of fluoroscopy grew rapidly since following the introduction of electronic intensification of images, which resulted in greatly increased safety for the operators against overexposure. Safety considerations were a prohibitive factor in earlier attempts to use the fluoroscope for rapid continuous inspection of products and raw materials, but by utilizing electronic devices, the images formed by very weak beams of X-rays are intensified on television screens far removed from radiation exposure.

Processes of mixing, diffusion, precipitation and other reactions in chemical industries within opaque vessels are continuously observed and controlled. The viscosity of tooth pastes and cosmetic creams and other similar substances can be measured by fluoroscopic observation of the rate of fall of metal balls through the substance.

5. Microradiography and X-Ray Microscopy.—There has been gradual progress in the acceptance by industry of the potentialities of enlarged radiographic images of small specimens, to supplement the familiar optical photomicrography of surfaces and thin sections. The penetration of X-rays through a small specimen of finite thickness in close contact with a fine-grained photographic emulsion provides an image which may be enlarged by several hundred diameters until graininess in the film interferes with sharp definition.

The greatest usefulness of microradiography has been in depicting the phase structure of alloys, which may be resolved even for very complex alloys by using several different wave lengths for which absorption coefficients change in characteristic fashion. Wood, sawdust, laminated sheets with binders, fine-grained minerals, vulcanized rubber and plastics with fillers or unwanted foreign inclusions are a few of the industrial materials that may be tested successfully by this simple micromethod.

Inevitably commercial equipment was bound to be developed to provide a true point source of X-rays, resulting from the extremely fine collimation, by means of magnetic lenses, of the beam of electrons impinging on a target, thus providing an image without aberrations or loss of detail. This equipment also provides inherent enlargement of images by placing the photographic film at various distances from the specimen instead of in immediate contact as in the older microradiography. This, then, is a true X-ray microscope in which are enlarged images of alloy phases, textiles and fine-textured products of all kinds are directly recorded.

6. Chemical Changes Produced by X-Rays.—Radiation chemistry seemed to be one area well contained within a pure science, with immediate extensions to possible radiation dosimeters and correlations with biological changes. But it developed also an industrial process for modifying and improving by irradiation the properties of synthetic polymers produced by the millions of tons. Cross-linking of giant molecular chains occurs upon exposure to radiation, with a consequent decrease in solubility and increase in tensile strength together with modification of other properties. Electrical insulation may be irradiated on a production basis to improve mechanical and insulating properties. A latent image may be formed on a piece of polyethylene or polyvinyl sheet in a microradiographic exposure which is converted into a relief image by differential solubility in organic solvents depending on the degree of exposure. This relief image may be replicated by the various methods familiar in electron microscopy, so that the replica of the original specimen may be enlarged in the electron microscope up to 200,000 diameters, with no interference from graininess. Of course there are recognized definite signs of damage to materials by radiation, especially with very high energies from atomic piles. Atoms are driven from their normal positions in crystal lattices, thus creating vacancies and defects and abnormally high energies. By this means a crystal of graphite can be made into a storage battery of energy, and the energy may be recovered by heating so that misplaced carbon atoms return to their normal locations. But science is only at the threshold of detecting and utilizing radiation effects on chemical and physical properties to reach potentially valuable ends. There has been great industrial interest in at least five processes involving choices of irradiation by X-rays, y-rays from radioactive isotopes, and electron beams: sterilization of foods, chlorination of benzene, polymerization of monomers. cross-linking of polyethylene and cold vulcanization of rubber. The energies required per pound are known, and intensive investigations have been directed to determination of the minimum cost of irradiation as an industrial process.

7. Biological Changes Produced by X-Rays.—Here again the preponderant knowledge and application of a wide range of biological effects, generally damaging or unfavourable to living organisms, would seem to be limited to medical therapy and genetics. Since 1896 there have been attempts to sterilize food products on an industrial scale. The necessity for enormous doses, and therefore much time and expense, to kill spores, bacteria and viruses discouraged the development of continuous processes until the advent of X-ray and electron sources of very high intensities. Electron (β-ray) beams have been most successful because of their complete absorption in thin layers of materials. A 24-Mev electron accelerator has been used by the quartermaster corps of the U.S. army for food sterilization. Agriculturalists continue an intensive study to develop new species from genetic mutations induced by X-rays. At Michigan State university vine peas were converted into a more disease-resistant bush variety. In Sweden three field crops widely grown are the results of radiogenetics. The pharmaceutical industry has conducted intensive research on creating mutations in the molds which synthesize antibiotics.

8. Single-Crystal Structure Research.—The best evidence of the growth of industrial interest in X-ray techniques was the effortby the larger industrial research laboratories to employ crystallographers who were expert in the advanced stages of single-crystal analysis by X-ray diffraction, leading to the derivation of molecular configurations particularly of organic compounds. The Fourier synthesis of electron density contour maps with the aid of electronic computers was until recently a matter of academic research of the purest type. The door was opened most dramatically in the early stages of World War II by the necessity of knowing exactly the complex molecular configuration of penicillin, before steps could be taken to synthesize it on an industrial scale. The usual methods of organic and physical chemistry were not quite adequate for this urgent task. The three-dimensional analysis of this molecule by Dorothy Crowfoot Hodgkin and her associates at Oxford and elsewhere in England, together with contributions from the X-ray laboratory at the University of Illinois, giving an unequivocal answer, was one of the great discoveries which had positive industrial overtones. Other antibiotics, strychnine, sugars, amino acids and other pharmaceutical and biochemical agents followed as a result of industrially sponsored research. It was only natural that the General Electric company should turn to X-ray diffraction analysis and identification for synthetic diamonds and the new cubic form of boron nitride which showed promise of supplanting diamonds in industrial uses such as drilling.

The most significant single-crystal achievement in industry was the X-ray diffraction control of the cutting of quartz crystals into slabs for the control of oscillation frequencies for radio, radar and television. Special single-crystal diffraction apparatus, commercially produced, formed the essential foundations of this industry, which later was extended to the determination and control of orientations of crystals in rods of germanium and silicon in the process of manufacturing transistors.

9. Powder **Diffraction Analysis.**—Outstripping all other analytical techniques utilizing X-rays in industry, this method of analysis of solids became generally accepted as indispensable. Literally thousands of diffraction patterns of powders and aggregates, each one a characteristic "fingerprint" of a particular crystal structure of a particular chemical element or compound, have been registered daily on film or on charts in Geiger and proportional counter diffractometers, on every conceivable kind of natural and manufactured product exactly as it exists in a specimen. More than 100 known examples of industrial applications have been listed, roughly classified under mineralogical and geological, petroleum exploration and production, petroleum refining and catalysis, water purification for power-plant boilers and turbine deposits, rubber, storage batteries, dry cells, paints and pigments, cement and fertilizer manufacture, countless metallurgical applications, phosphors and electronic parts, organic, biochemical and pharmaceutical compounds, ceramics and refractories, welding, electroplating, corrosion-resistant coatings, internal-combustion engine deposits, public health hazards from industrial and mining dusts, agricultural products, soils and clays, asbestos, paper, wood, textiles, plastics. Among many industrial products and processes which have depended in large measure on X-ray studies may be mentioned magnetic tape for tape recorders, wax-polyethylene blends for paper coating and a wide variety of new chemicals.

So important in industrial testing and research is powder diffractometry that there is generous international support of the American Society for Testing Materials (A.S.T.M.) card index (originally the Hanawalt tables of the Dow Chemical company) for thousands of pure crystalline compounds of the characteristic spacings and intensities of lines in powder patterns. With punched cards it is possible rapidly to identify qualitatively any unknown sample whose constituents are represented in the index. Line shifts disclose solid solutions, or crystal lattice compressive or tensile strains. Quantitative analyses of crystalline species in a mixture depend upon evaluation of diffraction interference intensities with proper calibration from internal standards.

10. Texture From X-Ray Diffraction Patterns. — Many of the foregoing illustrations involve not only nondestructive chemical identification of solids and analysis of mixtures but also the important matter of textures, which are determinative factors in performance of materials. By texture is meant random or preferred orientation (fibring); degree of crystallinity and amorphous phases; grain sizes and shapes in microscopic and colloidal ranges; strain, distortion and imperfections in crystal lattices; and of course changes which may occur in any or all of these with various manufacturing procedures such as heat treatment. Among a large number of examples may be cited the correlation of carbon black primary particle size and shape with abrasion resistance in rubber tires, otherwise impossible even from electron microscope observations; the correlation of percentage of amorphous phase in mood pulps with densities and with tensile strength of paper sheets made from the pulps; the degradation of structure by fine grinding of graphite and the effect on lubricating qualities. Even low-angle scattering, developed in a highly theoretical approach to particle size measurement by Guinier, Debye and others, came to be used as a highly valuable tool in industrial specifications, in some instances supplementing the electron microscope.

11. Fibre Structure. — A special case of composition and texture investigations encompasses the vast range of natural and manufactured materials constituted of small crystal grains, or crystallites, oriented not at random but in preferred directions as the result of natural or artificial aligning forces. A fibre diffraction pattern is much richer in the information which it affords than that from grains at random, for in one, two or three directions the fibre pattern approximates a single crystal rotation pattern around particular axes. The wet strength of rayon fibres and of catgut surgical sutures was vastly improved simply by pulling cellulose and protein crystallites into better parallel alignment by stretching in plastic condition. Native rubber on stretching actually crystallizes into a fibre; this pattern was the criterion of final successful synthesis in the laboratory of native rubber at the end of 1955. It would be difficult to guess where the textile, rubber, starch and plastics industries would be without X-ray diffraction patterns to offer clues and signposts. (G. L. CK.)

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X-RAY TREATMENT: see RADIOLOGY.

XYLENE (XYLOL), the name given to certain hydrocarbons, the dimethylbenzenes, which occur in the light oil fraction of the coal-tar distillate. Three forms exist with the same formula, $C_6H_4(CH_3)_2$ (see ISOMERISM). Xylenes are also obtained during the aromatization of high-boiling-point petroleum fractions for conversion to motor fuel with the aid of catalysts such as chromium oxide or molybdenum oxide retained on aluminum and magnesium oxides. Xylene-rich fractions are used as charging stock for aviation fuel because of their high octane rating. Commercial xylene is a mixture of the three isomers, comprising 50% to 60% by volume of metaxylene, the remainder being made up by orthoxylene and paraxylene in about equal proportions. The mixture is a colourless, mobile, flammable liquid, with a density of 0.86, insoluble in water but miscible with many organic liquids. It dissolves many organic substances and is used in making lacquers and rubber cements. The three xylenes cannot be separated by fractional distillation because of the closeness of their boiling points (137° to 144° C.). The mixture may be separated by shaking with sulfuric acid, whereupon the ortho and meta compounds are sulfonated, the para compound remaining unattacked. The ortho and meta acids may then be separated by fractional crystallization of their salts, after which desulfonation is usually accomplished by treatment with superheated steam. Metaxylene is successively nitrated and reduced to m-xylidine (4-amino-1,3-xylene). From paraxylene a similar base, *p*-xylidine (2-amino-1,4-xylene), is prepared. Both xylidines are employed in dyemaking. Metaxylene is also used in making artificial or xylene musk which is trinitro-tertiary-butyl-m-xylene. The three xylenes are oxidized by nitric acid to the corresponding toluic acids. Further oxidation leads to ortho, meta (iso) and para (tere) phthalic acids. (See PHTHALIC ANHYDRIDE AND PHTHALIC ACIDS.) The wide acclaim and commercial success of polyester fibres (Dacron or Terylene) and film (Mylar) based on terephthalic acid gave the xylenes a new importance as chemical raw materials. In the late 1950s annual production of terephthalic acid approximated 90,000,000 lbs. in the U.S. alone.

(P. G. SR.)

XYLOPHONE, a musical instrument consisting, in its simplest form, of a series of wooden bars of varying size which when struck, usually with hammers or mallets held in the player's hands, produce a range of tones.

In Africa and southeast Asia the history of the xylophone dates to ancient times. One of its primitive forms was that of the leg xylophone in which the wooden bars are laid across the player's legs and struck with clubs. Later, the bars were laid across logs or over pits dug in the earth to provide a resonating chamber. The Bantu tribes attached a gourd to each bar to increase resonance and sound. This arrangement was a forerunner of the modern marimba in which the resonator is a cedar block or a metal tube. Eventually the bars were attached to a supporting frame either suspended from the neck or fixed as a table.

The earliest trace of the xylophone in Europe dates to 1525 (Holbein's *Dance of Death*), although it is mentioned in *Spiegel der Orgelmacher und Organisten* by Arnold Schlick in 1511. In 1836 Felix Mendelssohn heard a xylophone played by a Russian, J. Gusikov, which consisted of bars lying in a bed of straw. The first concert use of the xylophone was by Hans Christian Lumbye in *Traumbilder* and by Camille Saint-Saëns in Danse *Macabre* in which the hollow sound of the instrument effectively imitated the rattling of skeleton bones. Other composers of the late 19th century used the xylophone similarly to produce new and unusual tonal effects. In the 20th century it became popular among jazz musicians who accented speed and versatility in their use of it.

Descendants of the xylophone are the metallophones, or saron, of the Javanese in which bronze replaces wood as the resonating material; the modern vibraphone or vibraharp. In this latter instrument metal bars are used, each of which is equipped with a tubular resonating chamber and an electrically driven fan used to set in motion the column of air. Vibraphones are used principally in dance or jazz orchestras.

XYSTUS, Greek term for the covered portico of a gymnasium.

X Y Z CORRESPONDENCE, the letters which when made public in 1798 nearly involved France and the U.S. in war. By orders of the French Directory fully 1,000 U.S. vessels had been stopped on the high seas for examination. Pres. John Adams sent three commissioners, C. C. Pinckney, John Marshall and Elbridge Gerry, to France to negotiate a treaty which would do away with this annoyance.

The commissioners were met in France by three agents who demanded a large sum of money before the Directory would receive the commission and also notified the commission that France would expect a loan from the United States if satisfaction of any other kind was to be given. The commissioners upon rejecting these overtures were ordered out of France. Their report was published immediately in the United States and in it the French agents were labeled X, Y and Z, from which the correspondence took its name.

The United States increased its army and navy, and hostilities were actually begun when Talieyrand disavowed any connection with the agents and agreed to receive any minister the United States might send.

Y THE 25th letter of the modern alphabet dates only from Roman days in its present position. The Latin alphabet as adapted from the Chalcidic and Etruscan ended nith **X**. The two final letters **Y** and **Z** were introduced after the conquest of Greece for use in Greek words transliterated and borrowed. **Y** was the form taken by the letter *upsilon* in the Ionic alphabet, which by the time of the Roman conquest had become generally used in Greece.

The letter in the western alphabet was in the form **V** in which form it had passed into Latin nith the vocalic value of *u* and the consonantal value of modern English w. In the common post-classical Greek based upon Attic the letter **Y** had the value of French *u* or German *u*. This sound was unknown in the Latin language, and if pronounced in borrowed Greek words passed quickly into that of i

In Old English and Middle English the letter was frequently used in place of *i* (*e.g.*, in words such as cyng). In modern English its value is identical with that of *i* both long and short, its most frequent use being perhaps as final in the adverbial termination (*e.g.*, "nidely," "strongly") When initial it represents a palatal semivowel; e g , in "yacht." "yoke," "young." See also ALPHABET.
(B. F C A.; J. W. P.)

YABLONOI or YABLONOVY ("Apple Mountains"), known to the Mongols as Dynze-Daban, a range of the eastern part of Asiatic Russia. The range is really the eastern slope of a narrow north-northeast extension of the Malkan horst. which rises from eruptive rocks near Kiakhta. The Ingoda river flows along the foot of the range, the highest point being Mt. Kusotui (5,512 ft.), near the Mongolian frontier. The descent of the Yablonoi to the trough of the Ingoda is 800 to 1.000 ft and the slope is mainly rocky debris. nith scattered patches of forest. The scarp cuts across the Archaean rocks, which strike to the east-northeast; all the horsts and ridges lying to the east of the Yablonoi are thus cut through by the Ingoda-Shilka valley, their waters Aoning across the grain of the country in their course toward the Khingan range. The Yablonoi slope is part of the watershed between the Arctic-flowing and the Pacific-flowing streams and it also forms the boundary betneen the Siberian and the Daurian flora. The trans-Baikal railway crosses the range at 3.137 ft above sea level.

YACHT, a sail- or power-driven vessel. usually light and comparatively small, used for racing purposes or for pleasure exclusively. Boats propelled by paddles, oars or outboard motors are not considered as yachts. After the decade 1840–50, when steam began to replace sail in commercial vessels, this type of power, and later the internal-combustion engine, was increasingly used in pleasure vessels. Large power yachts were developed to a high degree and long-distance cruising became a favourite pastime of the rich. The earliest power yachts were paddle-wheel boats which in turn gave way to the completely submerged screw or propeller type of propulsion.

As in the case of naval and merchant vessels, auxiliaries carrying both sail and power were the yacht fashion for many years. By the second half of the 20th century many yachts were still auxiliaries, but the majority were exclusively power yachts using gasoline or diesel engines.

During the last decade of the 19th century there was a boom in the construction of large steam yachts. Conspicuous among these was the "Mayflower" (1897) of 2,690 tons, triple-expansion engines. twin screws. compartmented iron hull and manned by a crew of more than 150. The "Mayflower," purchased by the United States navy in 1898. mas the official yacht of the president of the United States until 1929 and saw active service during World War II.

As larger and more reliable internal-combustion engines were produced. good sized yachts began using them for power. The development of the diesel engine, using heavy oil for fuel, advanced during World War I, and in the decade that followed large power yacht building flourished and reached its climax in the "Orion" (1930), 3,097 tons. During that period the largest auxiliary yacht built mas the four-masted steel barque-rigged "Sea Cloud" (1931), 2,323 tons.

The building of large power yachts declined after 1932, and the trend thereafter was toward smaller, less expensive, class boats of uniform design. After World War II. many small naval vessels were sold to private owners for conversion to yachts. By mid-20th century yachting had become a widespread popular sport enjoyed by thousands of yachtsmen personally manning and keeping up their own small pleasure craft. (J. B. HN.)

YACHTING is considered here as the sport of racing and cruising in sailing craft.

UNITED STATES

Although sailing for pleasure was a popular diversion in the American colonies at an early time) the first boat known to be built exclusively for that purpose was the "Fancy," owned by Col. Lewis Morris of New York (1717). The next boat to be built as a yacht was the 22-ton sloop "Jefferson," built in 1801 for Capt. George Crowninshield, a wealthy shipmaster, of Salem, Mass. In 1815 Captain Crowninshield had the schooner "Cleopatra's Barge" built by Retire Becket and sailed her to the Mediterranean, where he cruised extensively. "Cleopatra's Barge" was 83 ft. long on the water line and 23-ft. beam. She was furnished with great luxury and was the first large U.S. yacht.

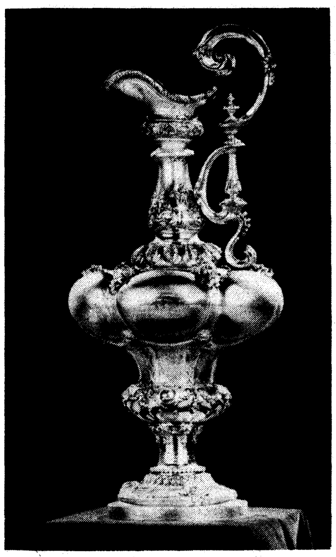
Living in Hoboken, N.J., on the banks of the Hudson river across from New York city, was the Stevens family, after whom Stevens Institute of Technology was named. John C. Stevens and his brother Edwin A. were the first prominent yachtsmen in the New York area. In 1809 they built the 20-ft. sailboat "Diver," in 1816 the 56-ft. "Trouble" and in 1820 the catamaran "Double Trouble." This is believed to be the first catamaran built in the U.S. In 1832 they built the 65-ft. schooner "Wave," in 1839 the 91-ft. waterline schooner "Onkahie" and in 1844 the 49-ft. waterline schooner "Gimcrack." The latter had the distinction of being the yacht aboard which was organized the New York Yacht club (N.Y.Y.C.), on June 30, 1844. A brother, Robert L. Stevens, in 1846 designed the 88-ft. waterline sloop "Maria," which incorporated certain features to be found in modern yachts, such as a hollow boom and crosscut sails. By this time there were a number of yachts racing on New York harbour, and the archives of the N.Y.Y.C. show that there were eight yachts enrolled in their fleet in 1844.

The yachts of that date tended to follow the models which had been developed for commercial purposes and most of them were schooner-rigged, following the lead of the fast and weatherly New York pilot schooners, although the "Maria" resembled more closely the Hudson river sloops which carried cargo between New York city and Albany at the headwaters of the Hudson river.

Beginnings of Organized **Yachting.**—Although the Knickerbocker Boat club of New York was founded in 1811, it was disbanded the following year and organized yachting can be regarded as dating from the founding of the N.Y.Y.C. in 1844. Some of the country's more important early yacht clubs and their dates of organization follow: Southern Yacht club. New Orleans. La. (1859); Detroit Yacht club (1865); Boston Yacht club (1866); San Francisco Yacht club (1869); Eastern Yacht club, Marblehead, Mass. (1870); Seawanhaka-Corinthian Yacht club, Oyster Bay, N.Y. (1871); Chicago Yacht club (1875); and Larchmont Yacht club (1880). Active yacht clubs in the United States in the late 1950s totaled approximately 800, many of which were located on fresh water, and the number was increasing yearly as the federal government expanded its program of building artificial lakes for irrigation and power purposes. The greatest concentration, however, was still in the New York area, where about 140 clubs are located.

The Yacht "America."—Probably the greatest single stimulant to the early development of American yachting was the victory of the schooner "America" in a 53-mi. race around the Isle of Wight against a large fleet of British yachts in 1851 (see *America's Cup,* below). Designed and built by George Steers of New Tork. the 100-ft., 170-ton schooner followed in general characteristics the pilot schooners for which Steers was famous. She was financed by a syndicate consisting of John C. Stevens, Edwin A. Stevens. George L. Schuyler. Col. James A. Hamilton, Hamilton Wilkes and J. K. B. Finlay. Her cost was $30.000. The "America" crossed the Atlantic on her own bottom, setting sail on June 21, 1851, from New Tork and arriving at Le Havre, France, a month later. In the Royal Yacht squadron race around the Isle of Wight she was captained by "Dick" Brown, a famous Sandy Hook pilot. After being owned by a succession of yachtsmen, she ended her active career in 1901 in a N.Y.Y.C. regatta, 50 years after her famous victory. After many vicissitudes she was restored by a group of patriotic citizens and presented to the C.S. Naval academy at Annapolis. Md., where she ended her days. She was finally broken up in 1946.

The America's Cup.—This 100-guinea cup was offered in 1851 by the Royal Yacht squadron for a 53-mi. race around the Isle of Wight, and was won by the visiting schooner "America.'! In 1857 the syndicate which had built "America" gave the cup (thereafter known as the "America's" cup) to the N.Y.Y.C. as a perpetual challenge trophy to be raced for by yachts of foreign countries. Between 1870 and 1937 U.S. yachts successfully defended the trophy against challengers, two of uhich were Canadian and five Irish.



WIDE WORLD

FIG 1.—THE AMERICA'S CUP

The original deed of gift imposed disadvantages on challenging yachts, but a mutual consent clause ironed out several difficulties and subsequent modifications of the original deed during the lifetime of the donors further improved the challengers' chances. Finally, on Dec. 18, 1956, at the request of the N.Y.Y.C. the New York state supreme court eliminated a clause requiring the challenger to sail on her own bottom to the scene of the contest. At the same time the permissible waterline length for a single-masted vessel was reduced from 65 to 44 ft. The effect of these changes was to permit a challenger of 12-m. size to be tuned up in her home water (an advantage hitherto enjoyed only by the defender) and shipped for final prerace trials. Cnder these conditions. a challenge from the Royal Yacht squadron nas accepted for a series of races in 1958, and the U.S.12-m. yacht "Columbia" successfully defended the trophy against the British challenger "Sceptre."

The America's cup races enjoyed the greatest public fame of all international yachting contests. As sporting events. however. they frequently proved less successful, becoming battles of wits and complicated legislation as much as sailing, and a source of discords that at times were inflated into minor international incidents. Among such were: the defending club's early refusal to permit the challenging yacht to race against only one defender; Lord Dunraven's allegations in 1895 that his "Valkyrie III" had been fouled by the U.S. yacht "Defender" and that the spectator fleet's crowding had endangered him; and in 1934 the club's contention that a protest could not be entertained because T. O. M. Sopwith's "Endeavour" had not "promptly" shown a protest flag. In the late 1890s ruffled feelings were smoothed by the genial tea magnate Sir Thomas Lipton, who was thereafter so much in the public eye with his "Shamrocks" and five challenges between 1899 and 1930 that the famous cup was often thought of erroneously as the Lipton cup. In 1937 Harold S. Vanderbilt's "Ranger" proved to be the fastest J-boat ever built and won four consecutive races from Sopwith's "Endeavour II" without untoward incident.

The contests exerted great influence in the matter of design. Initially, they brought together two opposed ideas: the beamy, shallow-draft, centreboard American type and the deep-keeled, plank-on-edge vessel of the British tradition. In 1855 the opposing types were well exemplified in the "Puritan" and the "Genesta"; but the four matches of the next decade witnessed a gradual merging of the two conceptions, until in 1895 the British challenger was actually the beamier of the two boats. Subsequently the enormous sums spent on cup yachts raised the science and art of design to a level of exceptional refinement.

Many causes can be found for the unvarying failure of the challengers. So long as defenders were lightly built the ocean voyage, and the strength it necessitated, further handicapped the challenger. But after 1920 rules governing the construction of the yachts ensured that challenger and defender alike should be of reasonable strength, and the most persistent cause of the challenger's failure was probably inferior organization and handling. The defenders created in the course of the years a new standard of syndicated ownership, organization and racing seamanship. Of the former, the administrative thoroughness of the three defenses conducted in 1930, 1934 and 1937 by Harold S. Vanderbilt are examples. Of the latter, an example is the contest of 1893 when in the last race the defender "Vigilant" daringly sent men aloft to shake a reef out of her enormous mainsail in a strong wind without for a moment allowing the sail to stop drawing.

TABLE *I.—America's Cup Race Results, 1851–1958*

Year	Winning Yacht	Onner	Challenger	Owner
1851	America	J. C. Stephens	—	
1870	Magic	F. Osgood	Cambria	J Ashbury
1871	Columbia Sappho	F Osgood W. P. Douglas	Livonia	J. Ashbury
1876	Madeleine	J. Dickerson	Countess of Dufferin	C Gifford
1881	Mischief	J. Busk	Atalanta	A. Cuthbert
1885	Puritan	J. Forbes	Genesta	Sir R. Sutton
1886	Mayflower	Gen. C. J. Paine	Galatea	Lieut W. Henn
1887	Volunteer	Gen. C. J. Paine	Thistle	J. Bell
1893	Vigilant	C. Iselin & syndicate	Valkyrie II	Lord Dunraven
1895	Defender	C. Iselin & syndicate	Valkyrie III	Lord Dunraven
1899	Columbia	C. Iselin & syndicate	Shamrock	Sir T. Lipton
1901	Columbia	J. P. Morgan	Shamrock II	Sir T. Lipton
1903	Reliance	C. Iselin & syndicate	Shamrock III	Sir T. Lipton
1920	Resolute	C. Vanderbilt & syndicate	Shamrock IV	Sir T. Lipton
1930	Enterprise	H. Vanderbilt & syndicate	Shamrock V	Sir T. Lipton
1934	Rainbow	H. Vanderbilt & syndicate	Endeavour	T. Sopwith
1937	Ranger	H. Vanderbilt	Endeavour II	T. Sopwith
1958	Columbia*	H. Sears & syndicate	Sceptre*	H. Goodson & syndicate

*12-metre yachts.

Development of Design.—Before 1870 yachts were usually turned out by local builders by rule of thumb. each builder having his favourite type. Usually the hulls were "modeled"; *i.e.,* a half model was whittled out by the builder prior to setting up the frames for the full-sized boat. The type most in favour along the Atlantic seaboard was a broad-of-beam, shoal-draft, centreboard craft with great initial stability, carrying a large spread of canvas with a relatively small amount of inside ballast. They were usually fast in smooth water but were not particularly good sea boats. An adaptation of the leeboards which had been used for centuries in Holland, the centreboard was housed in a "trunk" located on the centre line of the yacht and was lowered through a slot in the keel in order to give the boat sufficient lateral plane to work to windward. Even quite large yachts were built on this model. The sloop "Maria," 94 ft. over-all, 26-ft. 6-in. beam, had a draft of only 5 ft. 2 in. with her centreboard up.

At this time the so-called "cod's head and mackerel tail" form was in favour. That is, hulls were given a full bow and a long easy run, a type which had been in general use for naval and commercial vessels for centuries. It is generally believed that George

Steers, designer of the yacht "America," was the one who introduced the fine entry in designing his pilot schooners, the form which was also given to the "America." Steers's boats caused a revolution in yacht design, but it was not until 1870 that A Cary Smith laid down the lines of the cutter "Vindex" on paper—the first American yacht to be so designed.

A disaster in 1876 to the yacht "Mohawk" caused the advocates of beamy, shoal-draft centreboarders to take stock of type. This 140-ft. schooner capsized at anchor in a squall uith sails set and sheeted home, drowning her owner and several guests Thereafter Smith designed the so-called compromise sloop "Mischief." She was a 67-ft iron centreboarder, but had a slightly deeper hull than the old skimming dishes, and relied not only on beam but also on the placement of her ballast lower in the hull for stability. "Mischief" successfully defended the America's cup in 1881 against the Canadian challenger "Atalanta," also a centreboarder.

In that year the 46-ft. cutter "Madge," designed by George L. Watson and owned by James Coats, arrived in America from her native Scotland. During her first summer she won most of her races boat-for-boat against the best centreboarders. Her phenomenal success greatly influenced Edward Burgess whose compromise cutter "Puritan" defended the America's cup against the Watson-designed "Genesta" in 1885.

The success of "Puritan" made Burgess the most popular U S designer, and the Burgess hull soon became the accepted U S standard. He subsequently designed two more successful America's cup defenders, "Mayflower" and "Volunteer."

In 1891 Nathanael G. Herreshoff, of Bristol, R I.. turned out a yacht that was destined to again revolutionize yacht design. This yacht mas "Gloriana," in nhich "Mr. Nat" boldly cut away the yacht's forefoot so that her profile showed an easy sweep from the stem head to the bottom of the keel.

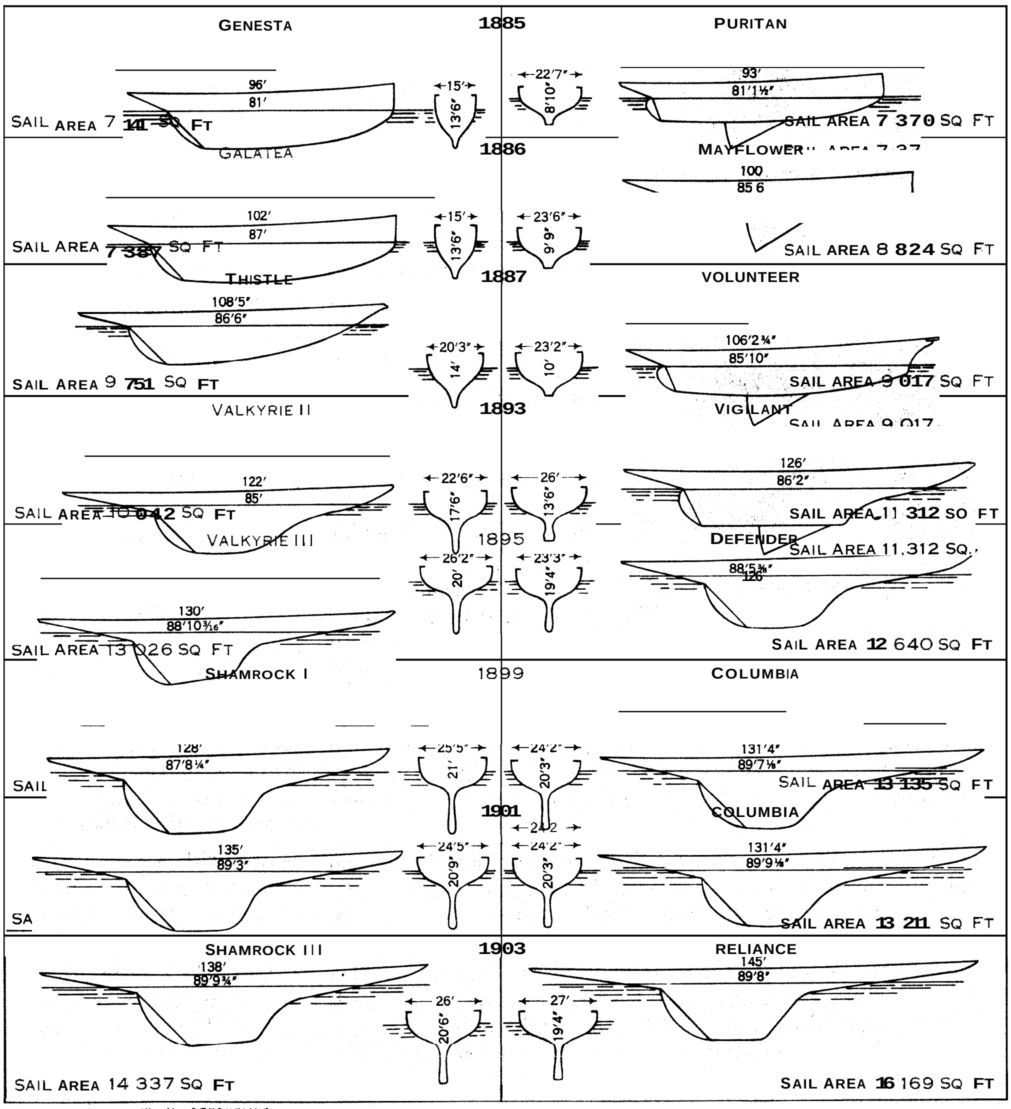
When the next challenge for the America's cup (1893) was received from the Royal Yacht squadron, Herreshoff designed the successful defender. the sloop "Vigilant" While a keelboat she also carried a centreboard nhich worked through a slot in the lead keel. After the "Vigilant," Herreshoff designed the successive defenders up to and including the 1920 contest, when "Resolute" successfully defended and Herreshoff was recognized as the foremost yacht designer in America. By 1930 nhen Sir Thomas Lipton made his last challenge with "Shamrock V," Herreshoff had retired and "Enterprise," the defender of that year, was designed by Ednard Burgess' son W. Starling Burgess.

The "Rainbow," defender in the 1934 race, nas also from his drafting board and in 1937 he collaborated with the young designer Olin Stephens in the design of "Ranger." During the long period from 1887 to 1937 the designers of the ten British challengers were George L. Watson, William Fife and Charles E. Nicholson.

Rig Development.—Probably no one factor has contributed more to the speed of yachts than the development of modern rigs. After 1920 the science of aerodynamics was applied by naval architects to the design of sail plans, resulting in a revolutionary change in yacht rigs. Tall, narrow sail plans with a long, efficient leading edge replaced the older gaff rig where the base was longer than the perpendicular.

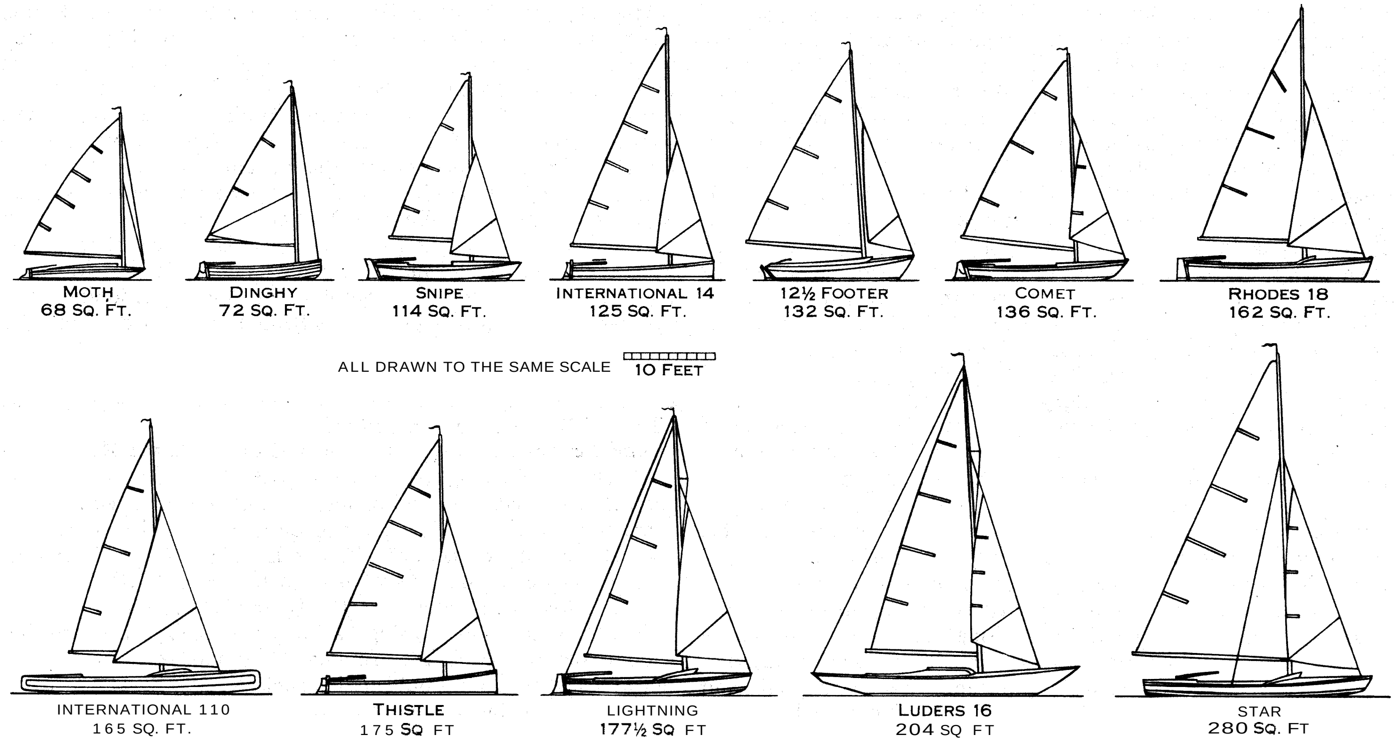
The new mainsails were triangular (called Marconi. Bermudian or jib-headed) and were set on tall masts with a ratio of hoist to foot (aspect ratio) of 2.1 or 24.1. In the case of the class J yachts (America's cup class), masts were as high as 165 ft. on a waterline length of 80 ft Large fore-triangles and overlapping head sails folloned as a natural consequence and tremendous jibs, overlapping the mainsail by as much as one-third the length of the main boom and cut flat so as to be used on the wind, came into use. These were called Genoa jibs because the first one used was on a yacht racing off Genoa, Italy. So efficient were the new rigs that yachts carrying from 25% to 40% less sail area than formerly had as much or more speed as with the old, larger sail spread The new rigs were also easier to handle and a smaller crew sufficed. while the elimination of the gaff and the topmast, with its fittings saved weight aloft.

Large. full spinnakers, cut much like a parachute, also replaced the old, smaller. flatter spinnakers and had much greater pulling power. As an example of the efficiency of the new rigs, the 1937 America's cup yacht "Ranger" carried only 7.500 sq ft. of sail, as



FROM A DRAWING BY W H DEFONTAINE

FIG 2 — EVOLUTION OF THE DESIGN OF THE INTERNATIONAL RACING YACHT 1885–1903 YACHTS WHICH WON THE AMERICA S CUP ARE SHOWN ON THE RIGHT



FROM A DRAWING BY W. H. DEFONTAINE; BY COURTESY OF RATSEY & LAPTHORN

FIG. 3.— SMALLER U S. SAILING BOATS

against the 16,000 sq.ft. of the "Reliance" (1903), yet her average speed around a course bettered that of the larger yacht.

Rating Rules.—Before 1905 the length-and-sail-area rule

$$\frac{\text{L.W.L.} + \sqrt{\text{S.A.}}}{2} = \text{rating}$$

was in use in the United States; in the formula L.W.L. is length at water line and S.A. is sail area. In the United States, however, the same tendency mas apparent as in England—to develop flat-bodied hulls with long overhangs and light displacement, producing an extreme skimming-dish type. This reached its extreme limit in the America's cup defender "Reliance" (1903), which had overhangs totaling 55 ft. 4 in. on a waterline length of 89 ft. 8 in. Following this match a conference of yachting organizations under the lead of the N.Y.Y.C. adopted (1905) a rule which, while retaining length and sail area as the chief factors, also used displacement in the formula and controlled overhangs, draft, freeboard, etc . by imposing penalties. This was called the Universal rule. It produced a more nholesome vessel and, while amended several times, it remained in use in the United States, and the America's cup matches after 1930 were sailed under it. The formula is 18% of the product of length times the square root of the sail area, divided by the cube root of displacement, equals the rating.

Smaller and One-Design Classes.—There was almost no yacht building during World War I but shortly thereafter there was a boom—particularly in the smaller classes. During that period the P class (31 rating). Q class (25 rating), R class (20 rating) and numerous one-design classes, all small by comparison with prewar yachts, came to the fore. This was partly attributable to the great increase in postwar costs but also because interest in yachting was spreading and many owners preferred sailing their own boats to employing professionals. In the late 1920s several international rule classes became popular, including the 6-, 8- and 12-m.. the "sixes" being most numerous. A number of international races were held in this popular class in which British, Scottish, Swedish, Italian and other yachtsmen participated.

Because theoretically identical yachts are supposed to be a better test of the relative abilities of their skippers to win races and also because they are more economical to build, the "one-design" idea was developed as far back as the 1890s. At that time Herreshoff turned out the Newport-30s and the 70-ft. class, the latter being large sloops.

The first popular one-design class, the Stars, developed from the 17-ft. Bug class, were promoted by George A. Corry and designed by William Gardner. In 1910 the design was modified, increasing the over-all length to 22 ft. 8½ in., and the larger boat was christened "Star." The Star Class Association of America was formed in 1915 and in 1923 the International Star Class Yacht Racing association replaced the original organization. By the second half of the 20th century the class was world-wide in scope and numbered more than 3,900 boats. Competition in the class is very keen. and international as well as national and regional contests are staged annually. There are hundreds of one-design classes For some of the most popular, see fig. 3 and Table II.

The Scow Type and Seawanhaka Cup.—On certain waters of Canada and on lakes and Barnegat bay in the United States where conditions are not suited to keelboats, the Universal rule is not applied, and in such localities the scow type has been highly developed These boats are extremely flat, draw only a few inches, have two bilge boards (instead of one centreboard), double rudders and are sailed without fixed ballast. On a reach they are exceedingly fast, reputedly reaching speeds of 20 m.p.h. Contests for the Seawanhaka cup, first held in 1895, did much toward the development of the scow type. The trophy was offered by the Seawanhaka-Corinthian Yacht club of Oyster Bay, N.Y., for international competition among small yachts. Thereafter there aas a long series of races for the prize, with fleets from the United States, Canada, Great Britain, Norway and other countries taking part.

TABLE 11.—Some Popular One-Design Classes

Class	Length over all	Designer
Penguin	11 ft. 6 in.	P. L. Rhodes
Blue Jay	13 ft	Sparkman & Stephens
Snipe	15 ft. 6 in.	W. F. Crosby
Comet	16 ft.	Lowndes Johnson
Bull Dog	16 ft.	N. G. Herreshoff
Thistle	17 ft.	Gordon K. Douglass
Lightning	19 ft.	Sparkman & Stephens
Star	22 ft. 8½ in.	Wm. Gardner (Sweisguth)
S class	27 ft. 6 in.	N. G. Herreshoff
Atlantic	30 ft.	Burgess & Morgan
Pa.ific Coast One-Design	32 ft.	G. W. Kettenburg, Jr.
International	33 ft. 2 in.	B. J. Aas (Norway)
New York Yacht Club 32-ft.	45 ft. 4 in.	Sparkman & Stephens

The North American Yacht Racing Union.—Regulations affecting yacht racing and measurement rules, up to about 1900, had been in the hands of individual yacht clubs or local yacht-racing associations composed of clubs in the same locality. There was thus lack of uniformity in different sections of the country. At the time of the agitation for a new measurement rule to supersede the length-and-sail-area rule. the N.Y.Y.C. called a conference of yachting organizations of the Atlantic coast and the Great Lakes to determine what was wanted and to bring about uniformity by persuading the other sections to adopt the Universal rule then being formulated. This was a step forward, but after the conference there still was no real governing body for yachting affairs in the United States. To remedy this situation, there was formed in 1925 a union of most of the local yacht-racing associations and a number of yacht clubs, the guiding spirits in the movement being Clifford D. Mallory and W. A. W. Stewart. This organization, called the North American Yacht Racing union (N.A.Y.R.U.), was the first permanent legislative and governing body of national scope in the United States, and through it both the racing and measurement rules were standardized and an appeals board for its members was formed. In 1927 delegates from this union met with delegates of the International Yacht Racing union in London to bring about closer international co-operation. Realizing the value to the sport of international racing, the union recognized (in addition to the Universal rule) the International rule used in European countries, with the result that several international classes such as the 6-m., 8-m. and 12-m. were built and became popular in the United States. International Yacht Racing association meetings have been held annually, with the N.X.T.R.C. frequently participating, to the benefit of the sport.

Ocean Racing.—The first transatlantic yacht race (Sandy Hook, N.J., to England) took place between three American schooners in Dec. 1866. Contestants were the "Henrietta," "Fleetwing" and "Vesta." The "Henrietta," James Gordon Bennett, Jr.. owner: won: her time, 13 days 21 hr. 45 min.

Two transatlantic match races (between "Cainbria" and "Dauntless" from Daunt Rock, Ire., to Sandy Hook in 1870. and between "Coronet" and "Dauntless" from Sandy Hook to the Lizard in 1887) were held before, in 1905, 11 yachts raced from Sandy Hook to the Lizard, a prominent headland in the English channel. The winner, "Atlantic,'! a three-masted schooner owned by Wilson Marshall, covered the 3,031 mi. in 12 days 4 hr. 1 min., establishing the record for all types of sailing vessels for the course and distance. Her best day's run of 341 mi. remained a record for yachts into the second half of the 20th century.

Again in 1928, under the ownership of Gerard B. Lambert. "Atlantic" made a try for transatlantic honours, but was defeated by the schooner "Elena," William B. Bell, owner, in a race to Santander, Spain. for the Ring of Spain's cup. In a concurrent race for the Queen's cup, which marked the debut of small craft in transatlantic racing, the 50-ft. schooner "Niña," owned by Paul Hammond and Elihu Root, Jr., won from three competitors—one of which. the schooner "Rofa," sank without loss of life. "Niña" cruised from Spain to England where, sailed by Sherman Hoyt with the owners not on board, she became the first U.S. yacht to win the Fastnet. Other transatlantic races for small craft were held later.

Rafael Posso, life commodore of the Havana Yacht club, promoted in 1951 a 4.200-mi. transatlantic race from Havana to San Sebastian, Spain. Sailed in June and July, the U.S. ketch "Malabar XIII," Kennon Jewett, owner, won from three competitors. In 1955 the race from Havana to San Sebastian was again held and was won by the Spanish yawl "Mare Nostrum," Enrique Urrutia, owner, from U.S., Cuban and Argentine entries. In the same year a transatlantic race was sponsored by the N.Y.Y.C. and the Royal Swedish Yacht club. It was sailed from Newport to Marstrand, Sweden: and was won by the 53-ft. yawl "Carina," designed by Philip L. Rhodes and owned and sailed by Richard S. Nye. She sailed 3,467 mi. in the good time of 20 days 9 hr. 17 min., averaging about 7 knots for the course. Another American, a Norwegian and four German yachts competed. Two years later the N.Y.Y.C. sponsored another transatlantic race, this time in partnership with the Royal Santander Yacht club and the Havana Yacht club. Again "Carina" was the winner, covering the 3.000 mi. between Newport and Santander. Spain. in a corrected time of 18 days 2 hr. 14 min. There were seven entries.

In 1960 the 47½-ft. yawl "Figaro," William T. Snaith, owner, won a 3,370-mi. race from Bermuda to the Skaw lightvessel in the Skagerrak, from a record transatlantic entry list of 17 yachts. The U.S., England, Sweden and Germany mere represented. The 72-ft. yawl "Escapade," Baldwin M. Baldwin. owner. a Californian entry. finished first in the fast time of 19 days 1 hr. 32 min.

In South America ocean racing made its debut in 1947 when the Argentine and the Rio de Janeiro yacht clubs collaborated in a 1,200-mi. race from Buenos Aires to Rio. It was sailed triannually in the 1950s, and included among its participants yachts from Argentina, Uruguay, Brazil, Great Britain, Germany, Portugal and the U.S. It was won in 1959 by the Argentine 38½-ft. yawl "Tango," Raul G. Decker. owner.

The Bermuda, Honolulu and Other Distance Races.—In 1906 Thomas Fleming Day. to demonstrate that small yachts if properly designed, built and handled, could go to sea with safety, promoted a race from New York to Bermuda in which there were three starters, the winner being "Tamerlane," a 38-ft. yawl. Later, races for power cruisers were also run to Bermuda and Havana. But after five years, interest in the Bermuda race died our.

In 1922 a group of cruising yachtsmen organized the Cruising Club of America (C.C.A.). Among this group were several who felt that ocean racing would be beneficial to the development of both yachts and yachtsmen. Accordingly, under the leadership of Herbert L. Stone: a committee was formed (not under C.C.A. auspices, however) to revive the race to Bermuda. Thus in 1923, after a lapse of 13 years. a race was run from New London: Conn., to Bermuda (660 nautical miles). There were 22 entries; the winner was "Malabar IV," designed, owned and skippered by John G. Alden. Subsequent races were run thereafter in even years by the C.C.A. (1924 race was under auspices of the New Rochelle Yacht club) except during World War II. The start of the 1932 race was shifted to Montauk Point. L.I. (distance 628 mi.), and the 1938 and subsequent races were started from Newport (635 mi.). A record of 71 hr. 35 min. 53 sec., established in 1932 by the cutter "Highland Light," under charter to her designer, Frank C. Paine, was finally broken in 1956 by Sven Salen's Swedish-owned yawl "Bolero" with a time of 70 hr. 11 min. 40 sec. Winner that year in the record-breaking corrected time of exactly 64 hr. was the keel-centreboard 38½-ft. yawl "Finisterre," Carleton Mitchell, owner. He won again with the same boat in 1958 and in 1960—an unparalleled achievement. All Bermuda race finishes were handled by the Royal Bermuda Yacht club.

As a result of the interest in this race architects commenced to design to the measurement rule then in use, which was a simple one. It soon became apparent that, to equalize the chances of divergent types and promote sound design, a more restrictive measurement rule was required. Accordingly, in 1940 Wells Lippincott drew up a scientific rule, called the cruising-club rule. The basic rule—which fills a small book and is far too technical to be given here—has been modified from time to time as experience dictated, and is the basis for measurement rules for nearly all important long-distance races in the United States. Under it such events as the Chicago-Mackinac, the Port Huron-Mackinac and the Rochester races are held in the Great Lakes. Established annual ocean races include the St. Petersburg. Fla.-Havana, Cuba, the Miami-Nassau, and the Newport Harbor, Calif.-Ensenada, Mex., races. In May 1960. the 125-mi. Ensenada race brought a record number of 356 yachts to the starting line. A 1,400-mi, race from San Diego, Calif., to Acapulco. Mex., was sailed in 1953 and 1954, becoming a biennial in 1956. A biennial previously sailed from Newport, R.I., or New London, Conn., to Annapolis, Md., was reversed in 1957 and sailed to Nemport.

The 2,225-mi. race from San Pedro, Calif., to Diamond Head, Oahu, Hawaii (formerly sailed also from the California harbours of Santa Barbara, Balboa, Santa Monica and San Francisco) ranks with the Bermuda race in age, importance and total number of races sailed. First held in 1906 and repeated at irregular intervals, it was in 1928 embraced by the newly organized Transpacific Yacht club and in 1939 was made a biennial to alternate with the Bermuda race. There being no limitation on over-all length (the largest yacht to sail the course having been the 161-ft. schooner "Goodwill") and the course being predominantly down wind, the race is notable for the good speeds sustained. Thus in 1949 the 98-ft. schooner "Morning Star," Richard S. Rheem, owner, covered the distance in 10 days 10 hr. 13 min., and in 1955 when rerigged as a ketch reduced her previous time to 9 days 15 hr. 5 min. for an average speed of 9.69 knots for 2,225 mi.

Noteworthy also in the Honolulu race is the required use of the radio for morning position reports and the daily dissemination by an accompanying coast guard cutter (or other vessel) of current meteorological data gathered from weather ships and other reliable sources. For the history of sail and other vessels: *see* SHIP.

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(W. H. DE F.; A. F. LO.)

GREAT BRITAIN

From their royal introduction into Britain at the Restoration until the coronation of Victoria, racing and pleasure sailing mere esoteric pastimes rather than national sports; and though there was a Cork Harbour Water club in 1720 (now the Royal Cork Yacht club) and a Cumberland fleet in 1775 (of which the Royal Thames Yacht club is the descendant), yachting of the kind that this article covers did not appear until the three decades following the establishment of the Yacht club (now the Royal Yacht squadron) at Cowes, Isle of Wight. in 1812. The sport was encouraged by the royal and official patronage naturally extended to it in a seafaring nation. During these decades there was energetic founding of yacht clubs at points on the coast where the local conditions suggested the pleasures of sailing; and a national institution was born.

Early English Yachts.—Among the earliest English yachts of uhich there is any record were the "Pearl." 95 tons, built in 1820 at Wyvenhoe, Essex, and the "Arrow," 84 tons. built in 1822, which for 58 years was one of the most successful cutters afloat: while one of the largest, the "Alarm." was built by Inman of Lymington, Hampshire, in 1830 for Joseph Weld, from the lines of a famous smuggler captured off the Isle of Wight. Some yachtsmen at this time preferred still bigger vessels and owned square-top-sail schooners and craft resembling the contemporary naval brigs Of such vessels were the "Waterwitch," built at Cones in 1832, while Lord Yarborough's second "Falcon" was a full rig ship of 351 tons, pierced for ten guns a side and nith a crew under naval discipline It was a quaint, buccaneering phase of yachting.

The working craft of Great Britain and Europe in the last days of sail, and the yachts nhich evolved from them, embodied in their shape one of the earliest theories of naval architecture—the fish form—according to which it mas assumed that the shape of a fish was a natural guide to the ideal form of ship. Hence originated the wide. bluff bows of the early yachts, with their greatest breadth at about one-third of their length from forward, and long "streamline" after bodies. A change of type was foreshadowed many years before it became general. J Scott Russell, in the mid-19th century, was advancing his wave-line theory which was not, as it happens, a hydrodynamically valid argument. But by emphasizing the importance of finer lines forward it helped to discredit the excessively bluff bows affected by the boatbuilders. Two yachts, the "Mosquito," 50 tons, and the "Volante," 59 tons, embodied the new shape but had no great influence. It was the "America," sailing across from the United States in 1851 and winning a cup offered by the Royal Yacht squadron in that year, which decisively tipped the scales against the older tradition (see *United States,* above). This was not wholly logical, for her success was as much due to her sails and her handling as to her hull shape; but thereafter the form of yachts changed, and bluff bows with an angle of entrance of about 30° were replaced by hollow bows with an angle of less than 20°.

There now appeared yacht designers of high technical ability and rare artistic gifts, such as G. L. Watson, W. Fife and, later, C. E. Nicholson, who established yacht design as a distinct branch of naval architecture. The evidence of contemporary scientific researches in ship design was applied to the shaping of yachts and led. after 1874, to a second fundamental change in design—the reduction of wetted surface. The "Jullanar" of 1874 originated the trend. that reached maturity in the "Britannia" of 1892. of combining the minimum of wetted surface with the maximum of sailing length in a hull of moderate displacement. Incidental to this evolution was a return toward the fuller bows of the pre-"America" period, but in yachts of a very different type.

Organization and Rules.—The Yacht Racing association (Y.R.A.) was founded in 1875 with the object of providing a set of rules governing regatta sailing, and by 1881 most of the important clubs were members of the association. The prince of Wales (afterward Edward VII) was its president. He was also commodore of the Royal Thames Yacht club and of the Royal Yacht squadron, and during these years the influence of the Y.R.A. was established. The sailing rules, governing the handling of yachts, were codified in 1875. The collision in 1894 between the "Satanita" and the "Valkyrie" at the start of a race on the Clyde river, Scotland, led to a lawsuit passing through three courts, the house of lords finally upholding the legality of these rules, which differed materially from the Merchant Shipping act. They were adopted internationally in Europe (1907) and the United States (1929); but after World War II the United States introduced a new code, and complete international uniformity remained to be achieved after mid-20th century.

The Y.R.A. rules governing yacht measurement were initially less successful. The influence exerted on design by rules of measurement used to assess speed potentiality was not yet recognized and a series of tonnage rules, the precise implication of whose mathematics the rulemakers failed to appreciate, put such a crushing penalty on beam that there appeared a new type of craft having no parallel in history. They were of extreme depth and narrowness—a trend in design made possible by the use of the external ballast keel—and in 1887 the vice-president of the Institution of Naval Architects said that it was ". . . lamentable . . . to find that the Yacht Racing association had encouraged . . . the worst type of vessel it is possible to conceive."

The association. however, had in 1887 introduced a new system of measurement. the length-and-sail-area rule of Dixon Kemp. It was as dangerous mathematically as those it superseded, but the fact that it encouraged an opposed though equally vicious type of vessel and had as its natural conclusion yachts shaped like saucers, allowed design to pass, in its swing from extreme to extreme. through a period of yachts producing the one classical form in the shifting art of yacht design. The "Thistle" appeared in 1887. the "Petronilla" in 1888. Lord Dunraven's first "Valkyrie" in 1889, the "Ivernia" in 1890, all improvements on the old, misshapen boats. Then in 1892, in an unprecedented burst of new construction, came the "Valkyrie II," a challenger for the America's cup. the "Britannia," a near sister to this yacht, built for the prince of Wales, the "Calluna" and the "Satanita." By the end of 1893 nine first-class new cutters had appeared and were stimulating interest in all classes. There had never previously been such activity in the yacht yards.

The Linear and International Rating **Rules.**—By 1895 yachts were becoming skimming dishes with little internal space and unreasonably light scantlings. The swing from one extreme type to another under the influence of measurement formulas reflected the inadequacy of the rules in the face of clever naval architecture and growing scientific knowledge open to designers. There was need for a new system of measurement which, without offensively curbing the freedom of designers in their pursuit of speed—the essence of their art—exercized a tighter control over the shape of yachts. The First and Second Linear rules (1896 and 1901) devised by R. E. Froude, a naval architect and nephew of the historian, were more complex formulations than those hitherto used for measurement and were intended to encourage reasonably full-bodied yachts with good accommodation for their size and well-proportioned hulls according with the idealized conception of a yacht as a vessel combining speed, beauty and comfort.

In 1906, on the initiative of B. Heckstall-Smith, conferences of European yachtsmen led to the production of an international rating rule. similar in form but significantly modified in detail compared with the Second Linear rule. The International Yacht Racing union was also founded. Eleven racing classes were built to the First International rule, ranging in size between the 5-m. and a class for yachts exceeding 23-m.. one of which was the kaiser's "Meteor IV." The sailing of small boats was by the beginning of the 20th century one of the strongest branches of yachting, and the popular small rater classes produced by Dixon Kemp's length-and-sail-area rule found their success repeated in the 6-m. of the new international rule. 328 of which were built between 1907 and 1914.

With the resumption of racing after World War I the Second International rule was formulated. It was similar in structure to the first. but with sail area more heavily penalized and excessive fullness of body discouraged The object of the alterations was to produce yachts that combined speed habitability and beauty but which had lighter hulls capable of being driven under smaller sail areas and manned by fener hands.

The rule was in tno parts, the second being a slightly modified form of the first and applicable to yachts above 12-m in rating. This latter came into force in 1928 and produced three magnificent big cutters, "Astra," "Cambria" and "Candida"; then in 1931 the American Universal rule was adopted for yachts rating above $14\frac{1}{2}$-m. It was to this rule that the last three challengers for the America's cup were built. In 1933 the Third International rule was produced: it was fundamentally similar to the second, which had proved extremely successful. Essentially rating consisted as in the First International rule, of the sum of the length and the square root of the sail area modified by factors controlling the shape of the overhangs and the fullness of the body, the latter control being augmented by a displacement limitation based on waterline length. The Second and Third International rules produced in the 12-, 8- and 6-m. classes the finest inshore racing yachts in the history of the sport. The hulls were of beautiful, moderate and seaworthy proportions—if we overlook the undue narrowness which appeared in the later 6-m boats—and the rules were successful in restraining sail area. Within each class the years produced a slight increase in the hull size and reduction in the proportion of rated sail area to length.

The major change in yacht design after 1925 was the almost universal replacement of the traditional gaff rig by the Bermudian or Bermuda rig (*q.v.*). The change, foreshadowed in the "Nyria" in 1912, nas inspired by the nen knowledge of aerodynamics and encouraged by the international rule's heavy penalty on sail area (see *United States: Rig Development,* above).

International Racing.—Although public interest in international yachting was confined to the few America's cup contests (see above), the highest competition in design and sailing during the 1920s and 1930s was in the international 6-m. class. The British-American cup team races were inaugurated in 1921 and sailed annually between 1921 and 1924. Three out of four British victories gave the cup outright to Britain. Thereafter the races became biennial and fell into three series. two of which were won outright by the United States while the first three races for the fourth cup nere non by the United States in the 1950s. This is a story of an initial British superiority in design and sailing followed by an unvaried inferiority. A similar pattern of events appeared in the Seananhaka trophy races contested betneen two 6-m.—except in 1929 and 1931 when the 8-m. were used. In the Scandinavian Gold cup honours have been shared by Great Britain, Sweden, the United States and Norway.

Cruising.—Though many people have made voyages in small craft since Samuel Pepys found in it "great content," the powerful body of amateur seamen in existence by 1930 was a product of the previous 50 years. The Cruising club was founded in 1880 and granted the prefix "Royal" in 1902. It gained a unique position in the world of yachting by the publication of charts especially prepared for use in small craft and the award of challenge cups for cruises in which excellent seamanship, navigation and pilotage. and the collection of information on the lesser-known coasts and harbours, were distinctive features. The Cruising association was formed in 1908 nith the principal objects of providing a central reference library, organizing local representatives and boatmen in as many ports as practicable and issuing handbooks of sailing directions. The work of these organizations and others, such as the Little Ship club, with its publications and lectures. the Clyde Cruising club and the Irish Cruising club, bred a race of amateur seamen with a breadth of knowledge hitherto unknown.

The favoured cruising grounds were widespread, extending to the Baltic, the Spanish coast and the Scilly Isles. The south coast of England, particularly from the Solent to the west country, raised a thick population of cruising yachts. The rivers and creeks intersecting the islands of Essex, the sandbanks and swatchways of the Thames river and the richly wooded coast of Suffolk were near enough to the centres of population to become the most popular cruising waters. The Clyde river and west coast of Scotland, where among the islands of Islay, Jura. Bute and Kintyre overnhelming hillsides drop to the waters of firth and loch, have been claimed to be the loveliest cruising ground knonn to yachting. By 1935 the coast of Brittany from the Tréguier river to the Morbihan *département* had become as frequented by British cruising yachts as the waters nearer home were in the late 19th century.

The need for seaworthiness in cruising yachts led to the favouring of craft that were converted from, or modeled on the lines of, various types of working boat—notably the pilot cutters. trawlers, Falmouth quay punts, Morecambe bay prawners and Itchen ferry boats. These had the further advantage of being cheap for their size. The meticulous studies by Claud Worth of seamanship and cruising yachts led to a refinement in design that was seen in his own yachts "Tern III" of 1913, "Tern IV" of 1923 and "Bittern" of 1936; and his influence was furthered by such amateur designers as Albert Strange and T. Harrison Butler. whose work closed the gap left by professional designers whose main interest nas in larger racing craft.

Racing is a forcing house of design and when the current racing craft were of good type they favourably influenced the design of cruisers Thus, during the period 1925–35, the benefits of the short underwater profile and the outside ballast keel with the minimum of internal ballast. moderate length of overhang and Bermudian rig—features once strongly deprecated in seagoing yachts—were adopted and proved offshore as a result of their testing in the international rating classes.

This process was hastened by the growth of ocean racing. The hard driving of boats on offshore courses, with the need for maintaining speed day and night. often in bad conditions, was a harder test of boats than even long cruises; it also led to a greater concentration of professional designing talent on seagoing yachts than hitherto.

Ocean Racing.—The Royal Ocean Racing club (R O R.C.) was founded by E. G. Martin. Weston Martyr and others as the Ocean Racing club in 1925 nith the principal objects of encouraging long-distance yacht racing and the building and navigation of sailing vessels in nhich speed and seaworthiness were combined. In the same year a race was sailed from Ryde. Isle of Wight around the Fastnet rock (off the southnest coast of Ireland), and back to Plymouth. Devon. A race around the Fastnet was held annually betneen 1925 and 1931 and thenceforward every other year in alternation with the American Bermuda race. In 1928 an

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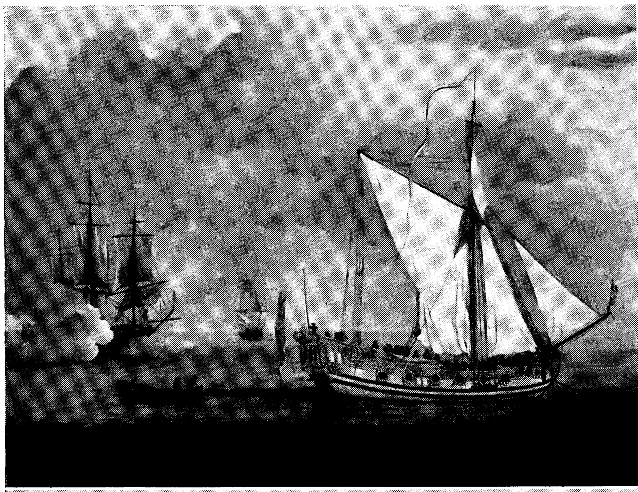

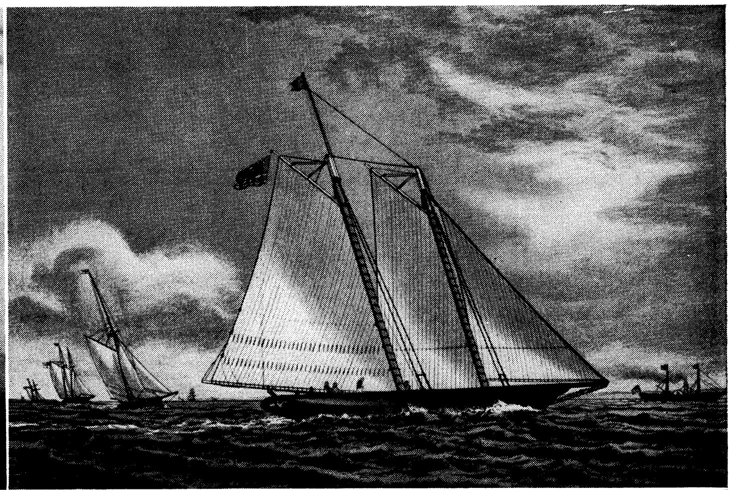

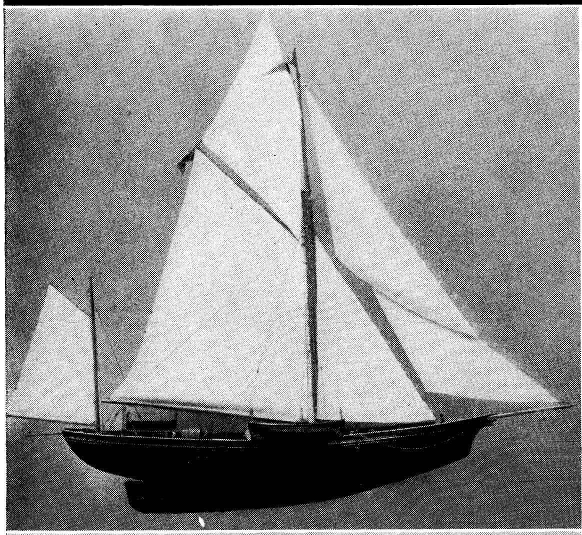

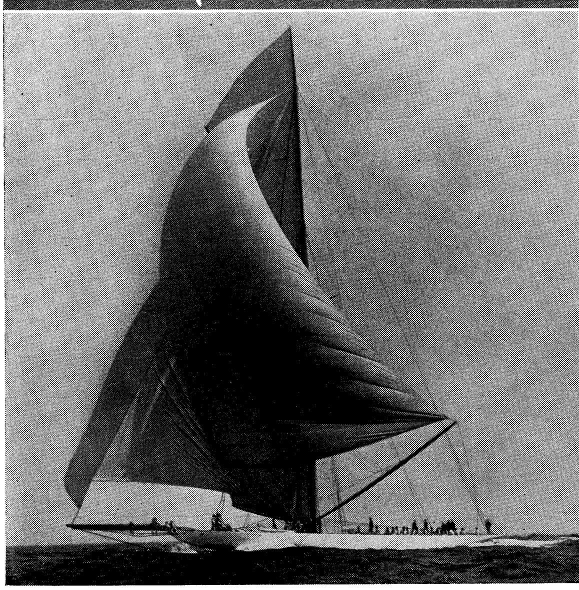

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EARLY BRITISH AND U.S. YACHTS

Top left: Painting by W. van de Velde of a 17th-century British armoured yacht, the "Portsmouth"
Top right: "America," 1851, a painting by John O'Hara Cosgrave II
Centre left: Model of the British yawl "Jullanar," 1875
Centre right: "Gloriana," 1891, designed by N. G. Herreshoff
Bottom left: "Reliance," U.S. entry in the America's cup race of 1903
Bottom right: "Atlantic," winner of the transoceanic race of 1905 from Sandy Hook, N. J., to Lizard Pt., Eng.

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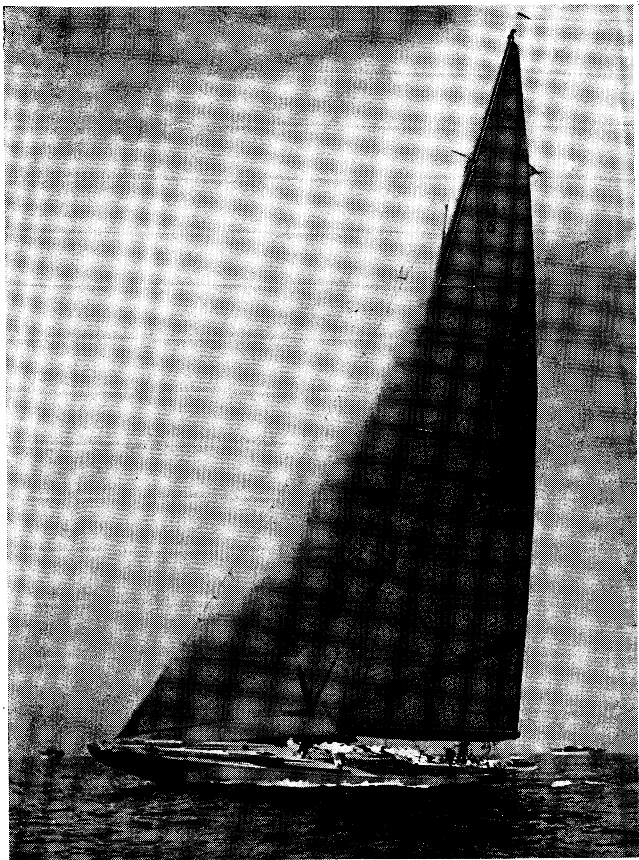

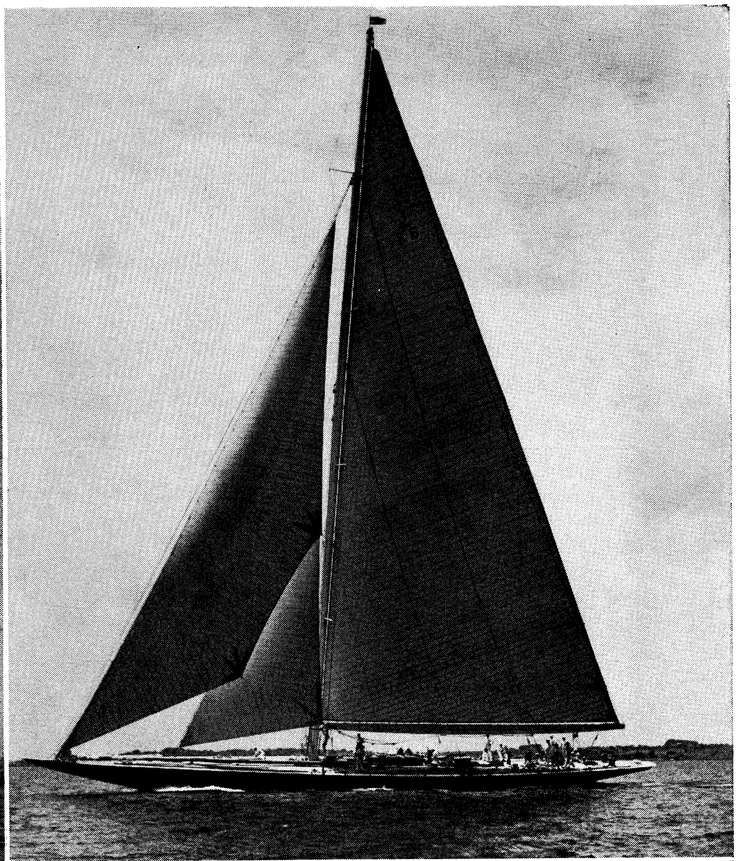

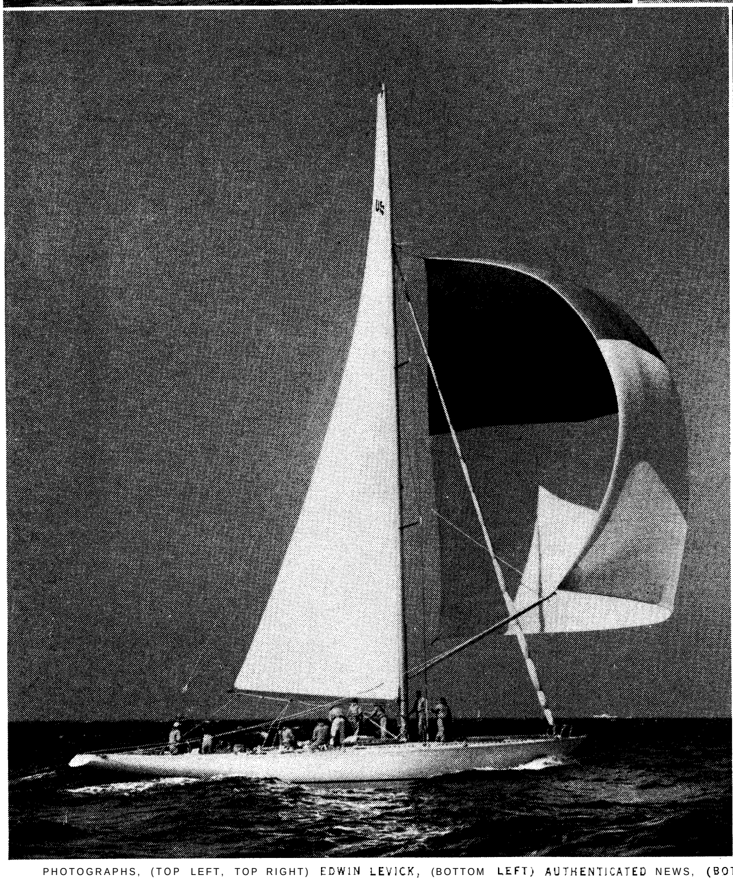

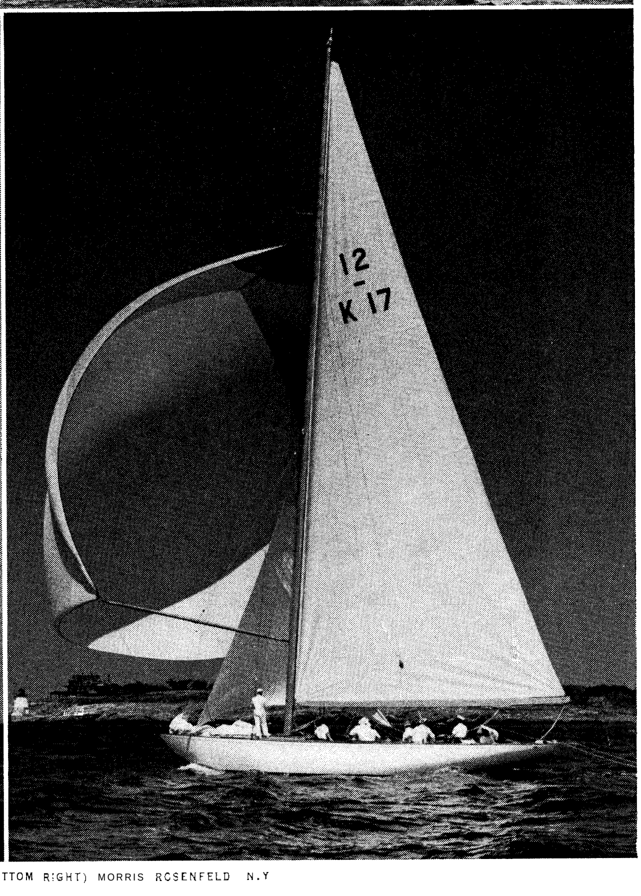

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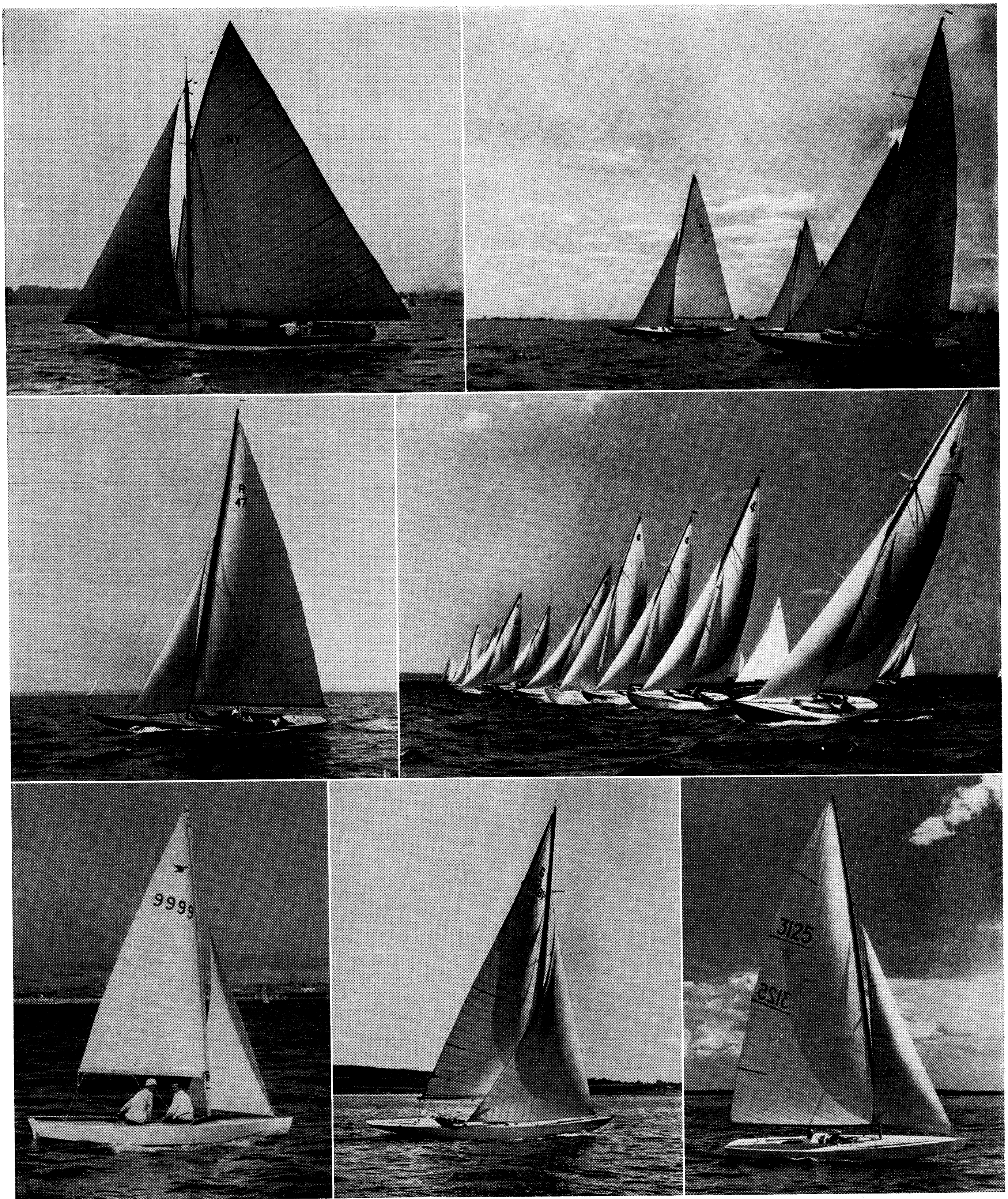
AMERICA'S CUP YACHTS

Top: H. S. Vanderbilt's "Ranger" (left), which in Aug. 1937, won four consecutive races of 30 mi. each on the Atlantic off Newport, R.I., from T. O. M. Sopwith's "Endeavour II" (right)
Bottom: Twelve-metre yachts of the 1958 renewal: "Columbia" (left), owned by a syndicate headed by Commodore Henry Sears, U.S., which defeated the British challenger "Sceptre" (right), owned by a syndicate headed by Hugh Goodson, in four straight races off Newport in September



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U.S. YACHTS

Top left: New York Yacht club 30-ft. class
Top right: Q-class boats in a regatta
Centre left: Class *R* sloop
Centre right: Start *of a* regatta of International one-design class
Bottom left: Snipe, *a* national champion owned by T. Frost
Bottom centre: "Goose," a champion international six-metre-class boat of the 1950s
Bottom right: "Shannon," champion *of* the popular Star class

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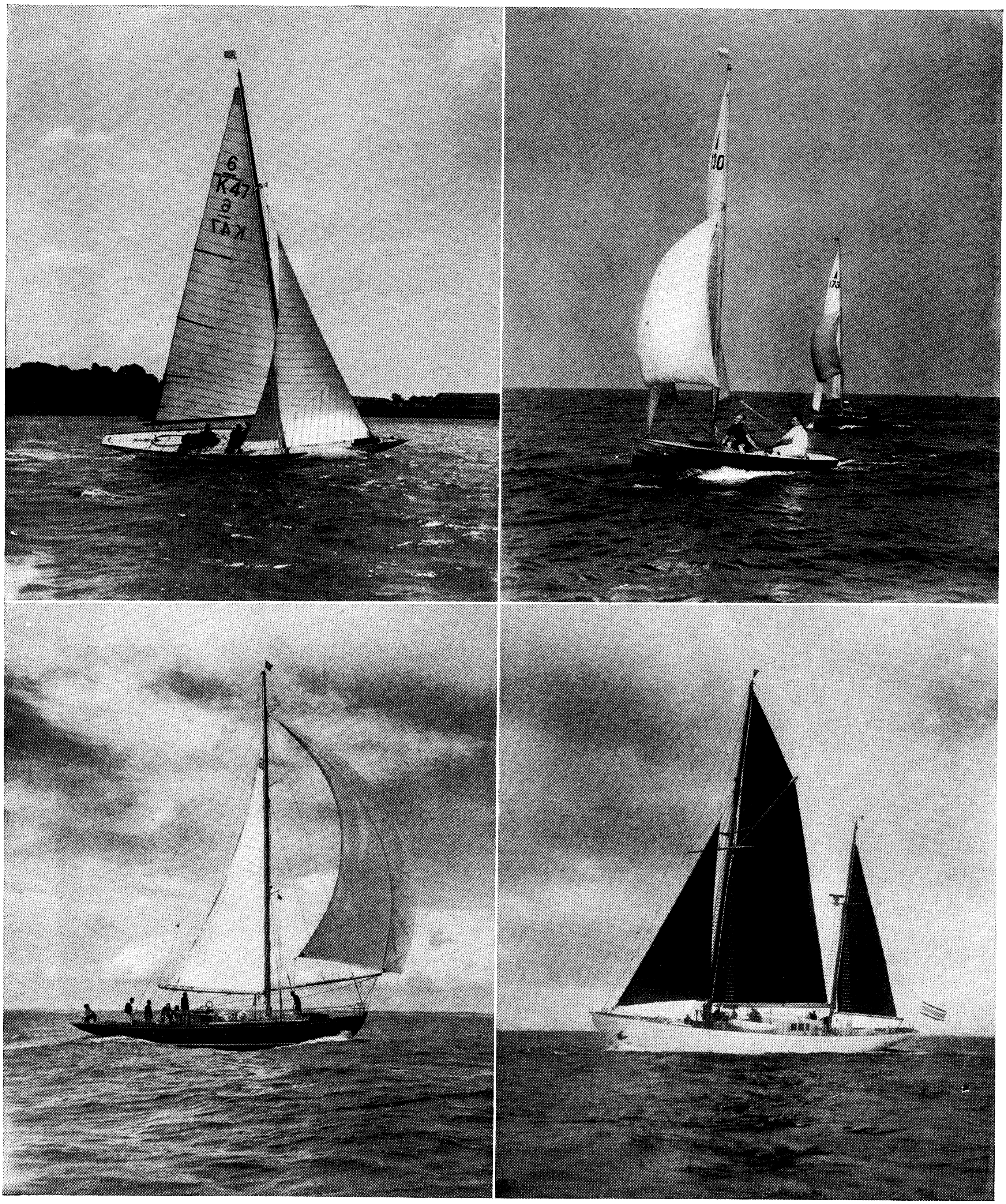

PHOTOGRAPHS. BEKEN & SON (COWES, I.O W.)

MODERN CRUISING AND RACING YACHTS

Top left: **"Catherine," six-metre class**
Top right: "Turnturtle" **and "Tinker," Merlin Rocket class**
Bottom left: **"Jocasta," ocean racing yacht**
Bottom right: **124-ton ketch "Aries," with auxiliary engine**

English channel race was inaugurated with a 251-mi. course from Cowes. around the Royal Sovereign light vessel and Cherbourg breakwater, and back to Cowes. This was held annually thereafter, with the exception of the World War II years, the Le Havre light vessel being substituted for the Cherbourg breakwater in 1930 (distance. 225 mi.). In 1929 a first race was sailed to Santander, Spain. and in 1930 the Cowes-Dinard (France) race originated thereafter becoming an annual event. In 1931, apart from the Fastnet. Channel. Dinard and the North sea Maas and Haak races. there mas a transatlantic race. "Maitenes II" was the one British boat to figure in the prize list. The years 1932 and 1933 were unsuccessful, honever, with small entries for all the races, and it would at that time have been difficult to augur the predominant position in yachting that ocean racing was shortly to assume.

Offshore racing is organized on a handicap basis with time allowance derived from rating. In 1933 a formula devised by Malden Heckstall-Smith was devised to approximate the immersed bulk of the boat by means of simple internal measurements capable of being made with the yacht afloat; for it was considered essential to the purpose of the rule that it should be possible to measure rating without access to scale drawings or the necessity of slipping a boat. Apart from the basic formula the rule comprised clauses by which bonuses or penalties in rating were derived in accordance mith the characteristics of yachts' rigs and constructions. In the second half of the 20th century the formula was still unchanged, but a process of trial and error during the years had produced modifications in the measurements and allowances.

A growing interest in offshore racing after 1933 shoxed that the R.O.R.C. and its rule was to become the most vital force molding yacht design. The early British ocean racers were drawn from the first-class cruising yachts of their day. "Jolie Brise," winner of the Fastnet in 1925. 1929 and 1930, was a converted Havre pilot boat; "Tally Ho," winner in 1927. was a refinement of a Falmouth quay punt; "Saladin," which won a place in three out of the first five Fastnet races. was a Bristol channel pilot cutter; "Flame," the only British yacht to gain a place in 1933, was a fast cruiser with the impress of the 19th century strong on her. The decade 1929–39 saw the development of a new type of seagoing yacht nhich profoundly influenced the design of the cruising yacht and which, in the years following World War II, was destined to replace the international classes of inshore racing yacht as the principal repository of designing talent and popular interest.

The offshore racing yacht evolved during these years mas the derivative of the international rule craft. whose fundamental seaworthiness was proved in offshore racing. Encouraging the development were such American yachts as "Dorade," winner of the Fastnet in 1931 and 1933, and "Stormy Weather," winner in 1935; but as early as the second Fastnet race in 1926 a precursor of the new type appeared in the Fife-designed "Hallowe'en," nhich nas of the genre of the international rule 12-m. but suitably modified for offshore sailing. The "Maid of Malham" and "Ortac" of 1936 epitomized the new type of seagoing racing yacht in which the speed of the international rule boats was blended with the robustness of the earlier cruisers to produce a new and exceptionally versatile type of yacht. Yet in 1947 in the first post-World War II Fastnet, the "Myth of Malham," a high-sided, straight-sheered light-displacement sloop which defied the tenets of both beauty and convention, won from her conservative competitors. Duplicating her performance in a hard chance in 1949, "Myth" was laid aside for some years, but was still able and fast enough to win in her class in 1957.

The Royal Yachting Association and Lloyd's Register.—In April 1948 it was arranged that Lloyd's Register of Shipping, in consultation with the Y.R.A., should prepare revised scantling tables for the constructional requirements of yachts classified by Lloyd's. These were to be based on the principle of a general reduction in the society's requirements, which experience had indicated to be excessive. As a result the 1929 rules were replaced in 1950 for yachts of all but the largest sizes by revised rules, and experience in the following years led to further modifications in these and brought them up to date with modern practices in construction.

Immediately after World War II the need for a national representative body for yachting, competent to deal with the trade, with port, harbour and other authorities. and with the government, became evident. The Y.R.A., which was financially supported by the yacht clubs, was a basis for such an organization and steps were taken to broaden its activities. A general purposes committee was founded to deal nith yachting matters as a whole. These included such diverse questions as that of a projected purchase tax on yachts, the municipal rating of yachts' moorings, the siting of oil refineries and bombing ranges in unspoiled coastal areas and the pollution of coastal and estuary water. To express the enlarged functions of the association, which now took more time than its purely racing activities. its name was changed early in 1952 to that of the Yachting association. Later in the same year the prefix "Royal" was granted.

The International Yacht Racing Union.—The Third International rule was replaced in 1950 by the Cruiser-Racer rule, framed to produce more economical yachts of greater versatility and of a less purely racing character than the prewar 8- and 12-m. classes. This rule nas different in form from the previous international rules, but like them retained as the basis of rating the length and sail area, with minimum displacement limitations based on length The other factors in the rule consisted of credits or penalties derived from the standard of a basic hull form of good but not necessarily ideal proportions.

The principle was accepted that the rating rule used to govern small racing craft without accommodation should be separate and of a different type from that employed for the bigger vessels. To replace the prewar 6-m. class a rule devised by Malden Heckstall-Smith. already well tested in model yachting. was adopted. The formula produces a linear variation betneen length, sail area and displacement, and approximately 3 in. of length costs 7 sq.ft. of sail area. and 64 lb. of displacement earns about 2 sq.ft. of sail area The limits of variation in these elements is specified by the rule and nithin these the designer has to select the balance of length, displacement and sail area best suited to the racing conditions. A typical 5 5-m has an over-all length of about 33 ft. and on the water line of 22.5 ft. They are smaller, lighter boats than the 6-m. that they replaced and are more economical to build and race. But nhile the 5.5-m. gained a footing and the importance as a result of their selection as one of the classes for the Olympic games yachting in 1952 and 1956, the older 6-m.. though expensive, retained adherents and continued to be the class in which the British-American cup and Seawanhaka trophy were contested.

The trend of yachting after World War II was epitomized in the progress of the Dragon class of small racer which nas given official international status by the International Yacht Racing union (I Y.R U) in 1949. having already achieved a certain international popularity. Designed by the Norwegian naval architect Johan Anker as inexpensive cruiser-racers in 1929, Dragons appeared in Great Britain by 1935 and after World War II they became a premier racing class. International status expedited their transformation from cheap cruiser-racers into a pure racing yacht of the first class, expensive for their size but capable of replacing

TABLE III.—*Winners of the Fastnet Cup*

Year	Yacht	Owner	Nation
1925	Jolie Brise	Lt. Cdr. E. G. Martin	Great Britain
1926	Ilex	Royal Engineer Yacht Club	Great Britain
1927	Tally Ho	Lord Stalbridge	Great Britain
1928	Niña	Paul Hammond	United States
1929	Jolie Brise	Robert Somerset	Great Britain
1930	Jolie Brise	Robert Somerset	Great Britain
1931	Dorade	Roderick Stephens	United States
1933	Dorade	Roderick and Olin Stephens	United States
1935	Stormy Weather	P. Le Boutillier	United States
1937	Zeearend	C. Bruynzeel	Netherlands
1939	Bloodhound	Isaac Bell	Great Britain
1947	Myth of Malham	J. Illingworth	Great Britain
1949	Myth of Malham	J. Illingworth	Great Britain
1951	Yeoman	O. A. Aisher	Great Britain
1953	Favona	Sir Michael Newton	Great Britain
1955	Carina	R. S. Nye	United States
1957	Carina	R. S. Nye	United States
1959	Anitra	Sven Hansen	Sweden

the older, larger racing craft whose price had become exorbitant.

Later History. — The principal features of yachting after World War II were a downward trend in the size of yachts accompanied by an upward trend in their numbers; the almost complete elimination of professional hands concurrent with the attainment of a high level of ability by amateurs; a wave of enthusiasm for ocean voyaging in small craft; and the formation of many new clubs. The period was characterized by a growing strength, supported by ever-spreading roots, of yachting as an institution and this may be attributed at least partially to the knowledge of the sea gained by many men during the war. The late 1940s were a period of yachting development comparable with the 1840s.

Before 1914 a 40-tonner was considered a small yacht; by 1938 a 20-tonner might have been classed as small in the major yachting centres, though nowhere else; by 1955 a 20-tonner found herself among the larger yachts anywhere. The pure racing yachts of large size, such as the international 12-m., were replaced by smaller. more versatile craft represented internationally in the cruiser-racer classes, but found in much greater numbers in the unclassed cruiser-racers which were primarily cruising homes afloat, yet with good sailing ability. The popularity of this type of yacht--a type evolved from the experience gained between the wars by the R.0.R.C.--encouraged the growth of handicap racing over regatta courses, or ones slightly longer, and this form of racing — one of the oldest known to the sport — reached a popularity shown most vividly in races around the Isle of Wight.

The offshore racing over longer courses, which by 1938 had become so firmly established, gained in strength, the entries for the races of the R.O.R.C. increasing and also the number of events organized in the course of a season. these ranging from transatlantic races to the annual Cowes-Dinard race and including the biennial Fastnet race. The chief development in design was the appearance of the light-displacement yacht with high freeboard, short overhanging length and containing good accommodation. None of these characteristics was new to yacht design but the combinations were original. The appearance of the type was initially due to a flaw in the R.O.R.C. rating rule, whose depth measurement, when this was associated with considerable height of freeboard, allowed a light-displacement, easily driven hull to gain the benefits in rating that were intended to accrue to heavier, slower craft. This type of yacht was latent in preuar design and appeared explicitly in the "Myth of Malham" of 1947. The rating rule was modified to prevent this type of vessel gaining undue advantage under handicap. but the type persisted on its architectural merits and proved its seaworthiness. The combination of light displacement, high freeboard (attained possibly with the help of a convex curve in the sheerline) and short overhangs made possible a small yacht of economical type which was also seaworthy and provided serviceable accommodation.

The most impressive support gained by yachting appeared with dinghy sailing, which became a powerful interest between the wars and continued to appeal to some of the most expert helmsmen in the world, nhich did not prevent its remaining an accessible sport at a modest expense. By the second half of the 20th century the racing of small craft, which was already popular in the Solent of the 1890s, had spread over all practicablesailing waters in Great Britain.

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(D. H. C. P.-B.; A. F. Lo.)

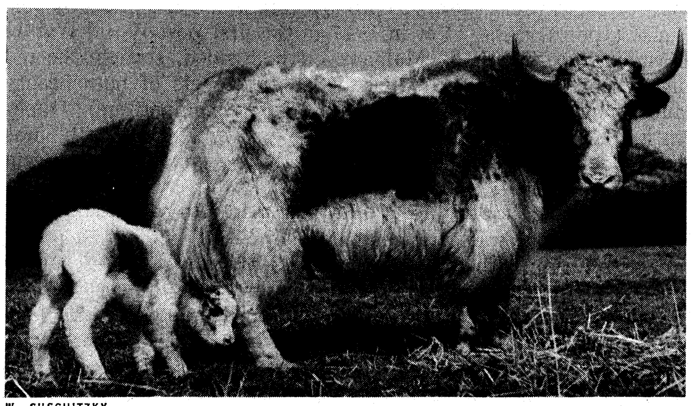
YAHATA (Yawata), the second largest city of Fukuoka prefecture and one of Japan's most important industrial centres. Pop. (1955) 286.241. Located on the southern shore of shallow Dokai bay, Yahata was a fishing port but grew spectacularly after 1897, when work began on large steelmaking facilities. With the Yahata (formerly Imperial) Iron and Steel works as its nucleus, Yahata became Asia's largest concentration of heavy industry, 60% of the city's labour force having industrial employment. Plentiful supplies of coal and limestone are available in ndrthern Kyushu, and iron ore is imported for use in industry. Representative heavy products are iron and steel materials. heavy chemicals, fertilizer, coke, glass and cement, many of which serve as raw materials for industry throughout Japan. Large factories and smaller satellite plants, which mostly exist strictly on subcontracts, are restricted by hills to a narrow bayside strip of reclaimed land. Shortages of level land and industrial water are serious handicaps to further expansion. Yahata is joined with neighbouring Wakamatsu, Tobata. Kokura and Moji in a single northern Kyushu transportation and industrial belt. (J. D. Ee.)

YAHGAN, an Indian tribe. almost extinct in modern times, occupying the south coast of Tierra del Fuego and the adjacent islands southward to Cape Horn. Hence they are the southernmost people in the world. That they lived in the same region for many centuries is attested by great middens covering their camping. places. Yahgan life before the European settlement was extremely simple. In spite of the cold climate their chief garment was a single seal or other skin, which they wore on the windward shoulder. Their houses were usually small domed affairs of saplings covered with bark and grass or sealskins. Their canoes, peculiar for their raised pointed ends and a fireplace amidships. were constructed of the bark from a beech tree. Their manufactures included baskets of several weaves, harpoons, spears, shell necklaces and simple tools. Their diet embraced shellfish, seal, whale, various birds, a few berries and several kinds of fungi.

The Yahgan had no organized tribal life or recognized leaders. Each family, often including several wives, was a law unto itself, wandering at will and rarely camping in one place for more than a few days. At times, groups of relatives would assemble to perform elaborate initiation ceremonies for both the boys and the girls. (S. K. L.)

YAHYA KEMAL BEYATLI (1884–1958), Turkish poet, whose work is distinguished by a high degree of technical perfection, was born at Üsküb, Dec. 7, 1884. Educated in Paris (1903–12), he was successively professor at Istanbul university, member of parliament and diplomat. His works consist of a few poems in classical prosody: nostalgic evocations of past Ottoman glories, the beauties of old Istanbul and the Bosporus, love songs and meditations on death and eternity. The poems were published in periodicals and in the newspaper *Hirriyet*. A master of form, he conceived of poetry as a sharply wrought miniature, technically faultless, with a fastidiously precise vocabulary, colourful imagery. musical and onomatopeic effects. His cult of verbal virtuosity derived from French Parnassian poetry, particularly that of J. M. de Heredia. He died in Istanbul, Nov. 2, 1958. (F. I.)

YAK, the wild (and domesticated) ox of the Tibetan plateau; a species allied to the bison group. The yak. *Bos grunniens,* is one of the largest of oxen, characterized by the growth of long shaggy hair on the flanks and underparts of the body and the well-known bushy tail. The mild species is black in colour. Domestic yaks are often black and white, and small-sized breeds exist. The magnificent half-tamed animals kept by the natives of the elevated Rupsu plateau, south of the Indus, afford the only means of transport by this route between Ladak and India. But even these are



W. SUSCHITZKY

DOMESTICATED YAK (BOS GRUNNIENS) WITH YOUNG inferior to the mild yak, which stands nearly six feet at the shoulder and is confined to the arid plateau of Tibet.

YAKIMA, a city of south central Washington, U.S., on the Yakima river 115 mi. S.E. of Seattle; the seat of Yakima county. Incorporated as North Yakima in 1886 (the name is from the Yakima Indians), it dropped the prefix in 1918. It has a council-manager forrn of government, in effect since 1959. The area was a sagebrush desert suitable only for grazing until the late 1870s, when. the advent of extensive irrigation began its transformation into a rich agricultural and fruit-raising area, producing especially apples, pears and cherries. Livestock and dairy products, cereals, sugar beets, potatoes and hops are also important. The city has extensive fruit drying, packing and cold storage facilities and a number of plants processing frozen and canned fruits and vegetables, juices and wine. Fruit sizers and sprayers and other farm machines are manufactured there and the city has several nurseries.

Yakima formerly had a large transient population during the harvesting season and various governmental and social, problems were associated with it. The harvest workers were greatly reduced in number as mechanization of agriculture increased. A community-financed hotel, an art association, an art gallery, a museum and a library are among the facilities of the city. For comparative population figures *see* table in WASHINGTON: *Population.* (H. J. DE.)

YAKOVLEV, ALEKSANDR SERGEEVICH (1906–), Soviet army officer and distinguished Russian aircraft designer. was born in 1906. He graduated from the Air Force Engineering academy in 1931 and immediately began to design aircraft. He specialized in the design of military aircraft. both piston- and jet-engined, mostly of the fighter type, though he also designed training and passenger airplanes earlier in his career. Just before the beginning of World War II, he designed the Yak-1 fighter. which was largely used in that war as also were his Yak-3 and Yak-9. His first jet fighter, the Yak-15. was designed in 1935. followed by the Yak-17 and Yak-23. His successful twin-engined "flying wagon" helicopter (the Yak-23'1 held several world records. A member of the Communist party of the Soviet Union from 1938. Col. Gen. Yakovlev served from 1940 to 1948 as a deputy people's commissar (later minister) of the aircraft industry. He was awarded the Stalin prize six times and the order of Lenin seven times. (D. CR.)

YAKUP KADRI KARAOSMANOGLU (1888–), Turkish novelist, noted for his vigorous studies of modern Turkish life. Born in Cairo and educated at a French school there, and in Izmir (Smyrna), he wrote of his early years in *Anamin Kitabi* (193'7). He moved to Istanbul in 1908 and became connected with the *Fecr-i-Ati* ("Dawn of the Future") literary school, attracting attention as a stylist by his outstanding prose poems. A journalist during the War of Liberation, he became a member of parliament. and later a diplomat. His novels are powerful studies of Turkish society since its reform. *Kiralik Konak* (1922) is a story of the period immediately before World War I. *Nur Baba* (1922; German trans., *Flamme und Falter,* 1917) tells of the decaying atmosphere of the Bektashi religious order; *Hüküm Gecesi* (1927) describes the party struggles after the introduction of the 1908 constitution; *Sodom ve Gomore* (1928; French trans., *Leila fille de Gomorrhe,* 1934) is about life in occupied Istanbul after World War I; *Yaban* (1932; German trans., *Fremdling,* 1939), the most famous and controversial of his novels, deals with the problem of the gap between the Turkish peasant and the intellectual. His other novels include *Bir Sürgün* (1938) and *Panorama I and II* (1954). His somewhat hesitant style has a strange charm and compelling power.

See O. Spies, *Die türkische Prosaliteratur der Gegenwart* (1943); E. Saussey, *Prosateurs turcs contemporains* (1935). (F. I.)

YAKUT, a major native people of Siberia, now completely Russianized culturally. They numbered 236.000 in 1959. Three hundred years ago they inhabited a limited area on the middle Lena river but instead of dwindling like other Siberian tribes they have undergone great expansion and in the 1960s formed the main population of the entire Lena basin and adjacent areas, now organized into the Yakut A.S.S.R. Racially they resemble the so-called Central Asiatic type of Mongoloid (*e.g.,* Buriats). Their language is related to the Turkish family. The Yakut are apparently a fusion of migrants from the Lake Baikal region with the aborigines of the Lena — probably mostly Tungus. The latter have contributed much to their culture. Many aspects of Yakut life. beliefs and folklore. however. point to a southern ancestry related to the Turkish tribes of the steppe and Altai mountains.

Despite the arctic climate the Yakut have clung stubbornly to a cattle economy. though the livestock must be sheltered and fed a large part of the year. Dairy products occupy a prominent place in the diet. Fishing in rivers and lakes ranks next in importance. Nowadays the southern Yakut have turned to farming under Russian influence; the most northerly adopted reindeer breeding from the Tungus. In the 17th century the Yakut were divided into 80 independent tribes, subdivided into clans.

The winter settlements were of earth-covered log huts; in summer the livestock were moved to distant pastures, the herders living in conical tents of poles and birchbark, while wild hay was gathered around the settlement and stored for winter. Travel was on horseback. with loads packed on oxen. The Yakut were the only potters among the historic Siberian tribes; they were also ironworkers. Great supernatural power was attributed to blacksmiths, exceeding that of shamans (*see* SHAMANISM), since their art was considered a divine gift. The old Yakut religion was characterized by a complex pantheon and dualistic concepts (good beings *v.* evil ones). Shamans were of two kinds: black shamans dealt with evil spirits and were equipped with a special drum and costume decorated with symbolic metal appendages typical of much of Siberia; white shamans dealt with benevolent beings and had no special equipment. Religious attitudes toward horses culminated in the famous kumiss (fermented mare's milk) festivals: one in spring for good deities, one in fall accompanied by blood sacrifices of livestock for evil gods. At these times libations of kumiss were offered from special goblets to various deities.

Although cattle have come to predominate in the economy. the cultural emphasis on horses in many situations and the religious role of kumiss indicates that the ancient Yakut were a horse-breeding people. Their poetical folklore is also reminiscent of the Turkish steppe tribes.

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YAKUT, an Autonomous Soviet Socialist Republic, U.S.S.R., formed in 1922, stretching from the Krasnoyarsk *kray* on the west to the Khabarovsk *kray* on the east, and from the Arctic ocean to about latitude 54° N. It covers 1,188,339 sq.mi. and is therefore almost equal in size to European Russia, but its total population in 1959 was roughly 489,000. The region, the least explored in the U.S.S.R., has a tragic history of disaster overtaking many scientists whose efforts to investigate this inhospitable region have provided what information is available. A geological expedition sent out to the Aldan watershed by the soviet government in 1926 nearly perished of starvation and records that the price of salt was 4 g. of gold for 400 g. of salt and that meat cost 30 to 40 g. of gold per kilogram.

Physical Features. — Much of Yakut is occupied by the basin of the Lena (*q.v.*). The Lena forms the eastern marginal river to that ancient block along the edge of which the Yenisei (*q.v.*) flows in the west. It flows in a true valley of erosion of very great age and is not confined by mountains except near its mouth, where the Khara-ulakh range, a spur of the folded mountains of the Verkhoyansk arc, rises on its right bank and deflects its course, while subsidiary fold lines affect the lower courses of the Olenek and the Anabar to the west.

To the north lies a broad tundra belt sloping to the Arctic, from which rise four domes of basic eruptive rock.

Climate. — The soils of the republic are not favourable to cultivation; a broad belt south of the Arctic consists of dry, clayey, stony tundra soil, merging southward into forest tundra soil and then into the ash-coloured alkali forest soils of the south, while there are belts of silty bog soils on the mountains. Along the banks of the Lena and Olekma are strips and patches of fertile alluvial soils. The climate is severe and extreme, and Verkhoyansk (67° 50′ N., 133° 50′ E.) has the greatest annual range of temperature in the world; its average January temperature is −58° F., absolute minimum −94° F., average July temperature 60° F., absolute maximum 93" F. The fact that this cold pole lies so far east shows that the Atlantic has much more moderating influence than the Pacific, the latter being shut off by mountains and also having strong prevailing offshore winds. The change of temperature between the seasons is sudden and there is a drop of 40° F. between October and November.

At Yakutsk in latitude 62° 1' N., winter is still extremely long and severe. The average January temperature is −46° F, and the river is frozen from Nov. 12 to June 10 in most years.

Occupations.—The Skoptsi, an exiled religious sect. settled in Yakut in the 1860s and introduced agriculture in the neighbourhood of Olekminsk and Yakutsk. The clean. well-built Skoptsi villages were a striking contrast to the dirty Yakutsk settlements.

Grain crops include barley, spring rye and wheat. Potatoes, turnips and cabbages thrive. Cultivation slowly spread in the alluvial patches of the Lena and Aldan, though the disturbed post-1917 conditions temporarily checked progress.

Meadowland is important. Cattle and horse breeding proved successful as far north as Yakutsk; both horses and cattle are short. long-haired and very hardy. The milk yield is small, but of good quality.

North of this agricultural region is the region of the nomad reindeer breeders, relying entirely on their herds, while in some regions there is no reindeer breeding and the natives rely on fish.

Ivory. — An important product is mammoth ivory. The mammoth (*Mammuthus primigenius*) existed in comparatively recent times in great numbers in the polar region of Siberia and carcasses, with flesh, skin. fur and congealed blood in the veins have been found in the region. Mammoth ivory is mentioned by Pliny and its existence was known to the Russians in 1582.

Mines. — Gold proved to be one of the main products of the republic. It has been known to the Russians since the mid-19th century, when it was worked in the Olekma mines, later abandoned. The Aldan mines were reopened in 1923. The gold there could be easily worked, being on or near the surface, but there were great difficulties of transport and the miners were often unable to procure the necessities of life.

In 1914 a fresh source at Kyukhinsk was discovered.

Iron ore, worked in an entirely primitive way, has been smelted by the Yakuts to make hunting knives. They were capable smiths long before the coming of the Russians. Coal of recent origin and poor quality extends over a belt of 1.200 mi. N. and S. of Yakutsk.

There is an area of curative mud on the Lena river with a high percentage of iron and aluminum. Sulphur springs exist in many places, especially near Parsheva, and jasper and carneol are found below Zhigansk, uhere there is iron, coal and platinum.

Sources of spars, amber, graphite, gypsum, crystal and emerald are also reported.

Population. — The Yakuts are a Turkic branch of the Ural-Altaic stock and their language closely resembles that of the Turks. A Yakut grammar by Boethlingk was published in 1851. They are thick set, brachycephalic, with dark eyes and hair, narrow foreheads, broad noses and long narrow eyes.

The Yakuts form a majority of the population. The Russians settled mainly in the Aldan mining region and in Yakutsk. There are also Chinese and Koreans in the mining district. About half the population of the republic lives in or near Yakutsk. In former times *brodyagi* or escaped convicts were a great terror in the district and there was much intermixture with Russian exiles, convicts and traders.

The Tungus are another branch of the Ural-Altaic group, as are the Lamuts.

The Yukaghir are a Palaeo-Siberian tribe, mainly found in modern times between the Kolyma and Indigirka rivers and occupied in hunting and fishing. They are very short, with yellow or brown complexion. dark eyes and hair and scanty beards. They were quickly reduced in number, especially after the advance westward of the Chukchee lessened the number of wild reindeer. The latter tribe spread westward from the Khabarovsk territory (see FAR EASTERN AREA).

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YAKUTSK, a town of the Yakut Autonornous Soviet Socialist Republic, Russian Soviet Federated Socialist Republic, U.S.S.R., 2 mi. from the Lena, there 9 to 11 mi. wide, on its left bank. in 62° 5' N., 129° 4' E. Pop. (1959) 74,000. The alluvial soil is frozen all year, but thaws to a depth of three or four feet in summer. when the streets become quagmires. Many mud huts exist. though some houses and the schools, churches and official buildings were built of brick; some wooden houses were built on high platforms as a protection against the June floods. when the ice breaks on the river. which remains open till November.

Winter sledge tracks radiate from the town to the sea of Okhotsk, Vilyuisk, the Kolyma and to Irkutsk (1.165 mi.). The town suffered from a lack of good roads, but air communication lessened its isolation. Between the town and the Aldan are meadowlands with sandy subsoil and scattered clumps of birch, willow and spruce. The fort was founded in 1632. and the town became a centre for trade in furs, mammoth ivory, reindeer hides and cattle. Education in the vernacular was encouraged.

YALA, the southernmost province of Thailand. Area 1,821 sq.mi.; pop. 11960) 131.839. It borders Malaya on the south and southwest, and a majority of the population is Malay by ethnic descent and Moslem in religion. The major industries, tin mining and rubber cultivation, were developed by Chinese immigrants and are still dominated by their descendants.

Yala town, the capital, is 646 mi. from Bangkok on the branch railroad running from Ban Hat Yai to eastern Malaya. Betong, with a population largely of Chinese descent, lies 81 mi. to the south on the road connecting Yala with Penang. (G. W. SK.)

YALE, CAROLINE ARDELIA (1848–1933), U.S. educator, collateral descendant of Elihu Yale. was born at Charlotte, Vt., on Sept. 29, 1848. She attended the academy at Williston, Vt., which her father had helped to found, studied for two years at Mt. Holyoke college, South Hadley, Mass., and taught briefly in academies at Williston and Brandon, Vt.

In 186; the Clarke Institution for Deaf Mutes, which in 1896 became the Clarke School for the Deaf, was established at Northampton, Mass. Its principal. Harriet Burbank Rogers, rejecting the finger alphabet method of teaching deaf children, introduced the German oral method by which children were taught to speak and to read lips. Caroline Yale was invited to join the teaching staff of the Clarke institution in 1870. She visited the school for a trial month and remained for 63 years. In 1873 she became associate principal and, in 1886, principal. She collaborated with Alexander Graham Bell, inventor of the telephone, in experimental use of the phonetic system devised by his father. Under her direction. the school added athletic and manual training, and in 1889 normal classes were opened to train teachers for the deaf. Resigning as principal in 1922, Miss Yale stayed on as director of the normal department and principal emeritus until her death in 1933. She was director of the American Association to Promote Teaching of Speech to the Deaf and author of Years *of* Building; Memories *of* a Pioneer *in a* Special Field *of* *Education* (1931).

(E. F. WR.)

YALE, LINUS (1821–1868), **U.S.** inventor, designer of the compact cylinder pin-tumbler lock that bears his name, was born in Salisbury. N.Y., on April 4, 1821. He started to be a portrait painter but became interested in locks after his father, who was also an inventor, began to make bank locks in Newport, N.Y., about 1840.

Linus' first independent achievement was the "Yale Infallible Bank Lock" in 1851. Subsequently, he produced more intricate locking mechanisms for bank use and operated his own factory in Shelburne Falls. Mass.

His most important achievement was the cylinder lock. It was well suited for use where a small but secure lock was desired and it was operated by a flat key that could easily be carried on the person. He received patents for this lock on Jan. 29, 1861, and June 27, 1865. When the success of the Yale lock required him to expand his business he consulted William Sellers. a machine-tool manufacturer in Philadelphia, and through him met John H. Towne. Yale and Towne formed the Yale Lock Manufacturing company at Stamford, Conn.. in Oct. 1868. When Yale died in New York city on Dec. 25, 1868. Towne carried on the business, which eventually became the Yale and Towne Manufacturing company. (J. B. RA.)

YALE UNIVERSITY, the third oldest institution of higher education in the United States, situated at New Haven, Conn. In 1700 the needs of New England in the way of higher education were supplied by Harvard college. at Cambridge. Massachusetts Bay Colony was naturally the chief patron of Harvard, but Connecticut bore its full share in support of the enterprise. The two commonwealths, however. diverged to some extent in their theological and political development and there arose the desire for a separate college in Connecticut. The first distinct traces of this scheme appear in the early summer of 1701, in the neighbourhood of New Haven. The Rev. James Pierpont (Harvard, 1681), minister of the New Haven church, was the chief promoter.

The general court of the Colony met at New Haven in Oct. 1701, and a charter was granted "for the founding, suitably endowing and ordering a Collegiate School within his Majesty's Colony of Connecticut." The founders chose the Rev. Abraham Pierson of their number as rector of the Collegiate school and it was at his parsonage in Killingworth that the first scholar sought admission in March 1702. The school continued at Killingnorth, with the annual commencements at Saybrook, until the death of Rector Pierson on March j, 1707. From 1707 to 1716, although the commencement exercises nere held annually at Saybrook, the students resided in the several towns where their tutors were established. It was not until a gift of nearly 1 coo volumes of great value was secured by Jeremiah Dummer, the agent for Connecticut at London, that a building for the school became necessary. After much argument it nas decided to establish the institution at New Haven. A cargo of gifts for the Collegiate school, from Elihu Yale. former governor of Ft. St. George, Madras. India. and a native of Boston, including, besides books, East India goods which were sold in Boston for £562 12s., led the trustees to use the name Yale college at the first commencement (1718) in the completed college building.

Pres. Thomas Clap secured the passage in 1745 of a new charter which legalized the narne Yale college and established its corporate form, in general providing a more explicit and liberal statement of powers and privileges conferred in 1701 and 1723. The organization of a college church in 1757 provoked much criticism and revived the struggle to bring the college under the control of the legislature.

In 1792 the governor and lieutenant governor of the state and six senior state senators were made ex *officio* members of the corporation. In 1872 the six senators were replaced by six graduates, chosen by the alumni. The act authorizing the name Yale university was passed in 188;.

The curriculum of the college changed little before the administration of Timothy Dwight the Elder (1795–1817), who expanded the usefulness of the college by the organization of professional schools. Benjamin Silliman, Sr. (1779–1864), was appointed to the first chair in chemistry, mineralogy and geology in the United States in 1802. In 1810 a medical department was established, and the theological and law departments were organized in 1822 and 1824.

Under the administration of Theodore Dwight Woolsey (1846–71) graduate courses were organized in 1846 and the graduate school (under the title department of philosophy and the arts) was established the following year. The degree of doctor of philosophy was first conferred in the United States by Yale in 1861. In 1847 courses in applied chemistry were offered and in 1852 instruction in engineering. Two years later these courses were distinguished as a separate section with the title Yale scientific school, which was later changed to Sheffield scientific school in appreciation of the assistance of Joseph E. Sheffield of New Haven, who endowed the school. From 1863 to 1892 this school was also the state college of agriculture and applied arts. The school of fine arts, established through the generosity of Augustus R. Street, was opened to students in 1869, the first of its kind to come within the scope of any university. The elective system of instruction in Yale college was substituted for the fixed curriculum in 1876.

During the presidency (1886–99) of Timothy Dwight, grandson of the former President Dwight, the institution more than doubled in resources, faculty and student enrolment. The school of music was established in 1894, and its resources were augmented through the patronage of Joseph Battell, Albert Arnold Sprague and his daughter Mrs. Elizabeth Sprague Coolidge.

An outstanding feature of the administration of Arthur Twining Hadley (1899–1921) was the development of the university idea co-ordinating the various schools and departments. The school of forestry, the oldest forest school in continuous operation in the United States, was founded in 1900 as the result of the gifts of James W. Pinchot and his family.

Under Pres. James Rowland Angell (1921–37) the university expanded rapidly. A school of nursing was established in 1923 by a gift from the Rockefeller foundation; in 1924 endowment was provided by Edward S. Harkness for a department of drama and a university theatre; the Institute of Human Relations was organized in 1929; and in 1932 the school of engineering, which had been a division of the Sheffield scientific school. was re-established in a separate school. In 1937 President Angell resigned and was succeeded by Charles Seymour.

Yale trained almost 22,000 men for service in the armed forces during World War II. In 1943 the Institute of Far Eastern Languages was established and in the following year the Labor and Management centre. Alfred Griswold became president of Yale in July 1950.

Residential Colleges.—The establishment in 1933 of residential colleges, designed to regain for undergraduates in a large university the educational and social advantages inherent in small groups of students, was an important modern development at Yale. This was made possible by gifts from a Yale graduate, Edward S. Harkness. A number of colleges were established, each providing accommodations for undergraduates during the last three years of the course. The master of each college lives in a house attached to the college quadrangle. He is assisted in the work and life of the college by a group of faculty members who are fellows of the college and have their studies and. if unmarried. their living quarters in the quadrangle. The master and fellows assist in guiding the undergraduate in his choice of courses, in his supplementary reading, and in general preparation for the examinations at the end of senior year.

Administration and Organization.— The board of trustees, called the Tale corporation, consists of the president of the university, the governor and lieutenant governor of Connecticut, ten fellows known as the successors or' the original trustees and six graduates elected for six-year terms.

Four divisions—liberal arts. sciences, arts and engineering—were established. Except in the cases of certain professional schools. the university faculties. organized in separate departments, were further organized in these four broad groups. In 1920 the freshman year school was established to prepare students for admission to Yale college and the school of engineering, the undergraduate schools. The graduate schools of the university include the Sheffield scientific school, reorganized in 1945 as a graduate school; the school of medicine; divinity school; law school; school of the fine arts; school of music; school of forestry; school of nursing; and graduate school.

Curriculum. — After completing preparatory freshman year work, students may enter, as noted above, the upper undergraduate schools — Yale college and the school of engineering. Yale college offers bachelor of science and bachelor of arts degrees and the school of engineering, which established programs of study in chemical, civil, electrical and mechanical engineering and metallurgy, the bachelor of engineering degree and the bachelor of science degree in industrial administration.

Advanced degrees came under the jurisdiction of the graduate school, but the administration of various advanced professional degrees was assumed by the professional schools.

The Sheffield scientific school offers graduate study in the sciences and mathematics, students registering jointly in this school and the graduate school. In addition to preparation for the practice of medicine the school oi medicine offers courses leading to degrees in public health. The school of the fine arts offers professional courses in architecture, drama, painting and sculpture, in which lectures are combined with technical practice. The school of music admits those who intend to become musicians by profession or to enter the field of musical criticism and literature of music. The curriculum of the school of nursing is open to women graduates of approved colleges and leads to the degree of master of nursing. Properly qualified women are admitted to all schools except the undergraduate schools and the school of forestry.

Libraries. — The University libraries had acquired more than 4,215,841 volumes by the early 1950s. Besides gifts of the early years of the college, particular mention should be made of the Aldis collection of American belles-lettres, the Elizabethan Club library of Shakespeare quartos and folios; the Henry R. Wagner collection of British and Irish economic and historical tracts, the William S. Mason collection of Benjamin Franklin and the Ezra Stiles manuscript diaries and itineraries. Other important collections are the Penniman library of education, the William A. Speck collection of Goetheana, the Albert S. Wheeler Roman law library, the Lowell Mason music library, the Frederick S. Dickson collection of Fielding's works, the Scandinavian library of Count Riant, the Curtius and Seymour libraries of classical literature, the Robert von Mohl library of political science! the Edward M. House collection of historical papers and the J. Sumner Smith Russian library. Among its rare volumes the library has a copy of the Gutenberg 42-line Bible.

Special Collections. — The collections of the Gallery of Fine Arts include the Jarves collection of Italian primitives (13th to 17th centuries); the Trumbull collection of paintings and miniatures; the Rebecca Darlington Stoddard collection of Greek vases; objects discovered at Gerasa and Dura-Europos; the Mabel Brady Garvan collection of American arts and crafts; and the Achelis, Herr and Callender collections of prints. The collections of the Peabody museum (1866) embrace the major fields of natural history.

Publications. — The Yale University press was founded in 1908 for the publication of works having permanent interest and value. From 1926 the Yale University press published the *Yale Review* (1892), a national quarterly owned by the university. The publications which are under the direction of students are the *Yale Law Journal;* the *Yale Daily News* (1878), the oldest daily; the *Yale Record,* a humorous monthly; and the *Yale Scientific Magazine.*

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YALTA CONFERENCE, also known as the Crimea or Argonaut conference, was held Feb. 4 through Feb. 11, 1945. Pres. Franklin D. Roosevelt and Prime Minister Winston Churchill conferred with Marshal Joseph Stalin in the Crimea, near Yalta on the Black sea coast.

Though the Allies were in sight of victory, a number of military questions needed discussion. The Russians, about to launch their final offensive against Germany, requested concerted Anglo-U.S. advances in Italy and on the western front, so that Germany could not transfer forces to the east. It was agreed that the supreme Allied commander in the west, Gen. Dwight D. Eisenhower, should communicate with Soviet authorities in order to achieve closer co-ordination of effort. With regard to Asia, Stalin confirmed his earlier promise to declare war on Japan shortly after the defeat of Germany, but he deferred consideration of specific projects for co-operation with the United States and Britain.

Germany. — Because of the imminence of victory, postwar issues occupied a large part of the conference agenda. Most pressing was the question of a policy for Germany. It had already been agreed that the defeated state should be divided into occupation zones—the Russian to run 200 mi. W. of Berlin; the British to include the northwest; and the U.S. the remainder, south of the Saar and the Palatinate. These arrangements were confirmed at Yalta and, in addition, a portion of the U.S. zone was set aside to be occupied by France. There remained the question of. common occupation policies. The president and prime minister had already drawn back from the "Morgenthau plan," the program for pastoralization of Germany which they had initialed at Quebec in Sept. 1944; but no clear substitute had been developed by them, and the Soviet marshal had none to suggest. All the conferees could do, therefore, was to accept the principle that the Allies had no duty except to provide the Germans with a minimum level of subsistence and to include in their final agreement the general declaration: "We are determined to . . . eliminate or control all German industry that could be used for military production." They also agreed in general terms that major war criminals should be tried, and on this authority their foreign ministers and a special conference of jurists subsequently devised the international military tribunal that sat at Niirnberg. The conference also agreed to set up a commission in Moscow to determine what reparations Germany should make to the Allies.

WIDE WORLD PHOTOS INC

PRIME MINISTER WINSTON CHURCHILL. PRES FRANKLIN D. ROOSEVELT AND MARSHAL JOSEPH STALIN (LEFT TO RIGHT) AS THEY APPEARED AT LIVADIA PALACE. YALTA. CRIMEA, U S S.R., FOR THE THREE-POWER CONFERENCE. FEB 4 THROUGH FEB. 11, 1945

Other Defeated and Liberated States. — The conference also had to deal with problems in the Balkan area. As a result of prior agreements, Allied control commissions were in being or in formation for all defeated or liberated countries. In Rumania and Bulgaria, however, British and U.S. commissioners complained that Soviet chairmen ignored them and that Communist regimes were rapidly being installed. When Stalin discounted these reports, the president and prime minister were not in a position to dispute with him. They did, however, secure his acceptance of a Declaration on Liberated Europe, which reaffirmed "the right of all peoples to choose the form of government under which they will live" and called for "interim governmental authorities broadly representative of all democratic elements in the population and . . . the earliest possible establishment through free elections of governments responsive to the will of the people." The conference agreed that action should be taken by Britain, The United States and Russia in conference, not unilaterally. The conference also recommended that a new government be formed in Yugoslavia on the basis of an agreement between Marshal Tito and Ivan Subasitch.

Poland.—One problem that could neither be postponed nor disguised was that of Poland. Throughout the war, the British and U.S. governments had maintained relations with a Polish government in exile; resident in London. Despite strong urgings to the contrary from his allies, Stalin had broken with this government and recognized instead a Polish committee of national liberation. which claimed Lublin as its seat. Since the western Allies would not abandon the London government and the U.S.S.R. would not abandon the Lublin committee, they could only agree that the two groups of Poles should confer and try to concert some provisional regime. The Lublin committee was to be, as Stalin later put it, "the nucleus—that is to say. the principal part—of a new reorganized Government of National Unity," but, as seeming assurance that the committee would not simply take over the Polish state, the conferees also pledged "free and unfettered elections as soon as possible on the basis of universal suffrage and secret ballot. In these elections all democratic and anti-Nazi parties shall have the right to take part and to put forward candidates." The question of Poland's future frontiers was also discussed, but decision was postponed.

The United Nations Charter.—In addition to immediate military and political problems, the conferees discussed the United Nations organization charter that had recently been drafted at Dumbarton Oaks. A compromise formula to govern voting in the Security council (subsequently ch. v, art. 27, of the charter) was found acceptable by the conferees, and the Russians withdrew their claim that all 16 Soviet republics should have membership in the general assembly. The president and prime minister consented in return to support the candidacy of two, the Ukraine and Belorussia, in addition to that of the C.S.S.R. itself.

The Far East.—During the conference, agreements were also reached about eastern Asia. A secret protocol stipulated that in return for Russia's entering the war against Japan within "two or three months" after the surrender of Germany, the independence of Outer Mongolia should be recognized and Russia should regain what had been lost through the Russo-Japanese War of 1904–05: southern Sakhalin and adjacent islands, the lease of Port Arthur as a naval base. the right to use an internationalized port at Dairen and a share in control over the Chinese Eastern and South Manchuria railroads. In Dairen and in the joint Russo-Chinese corporation that was to manage the railroads, the "preeminent interests of the Soviet Union" were to be "safeguarded." In addition, the Kuril Islands were to be ceded to Russia by Japan, and Russia was to sign a pact of friendship and alliance with China. Somewhat ambiguously, it was provided that the agreement should require the concurrence of Generalissimo Chiang Kai-shek of China but that the terms would be "unquestionably fulfilled."

The conference protocols, most of which were kept secret for military reasons, were finally published in 1946. Almost at once, they drew criticism in the United States from friends of Nationalist China, Poland and Germany. This criticism swelled as charges were added that the president had been ill and hence incompetent at the time of the conference, that he had been influenced by alleged pro-Soviet groups in the department of state, and that the far eastern protocol had been indirectly responsible for the Communist triumph in China in 1949. Though testimony by participants and investigations by historians showed these charges to be largely unfounded, Yalta remained a lively partisan symbol. The Republican party platform in 1952 called for repudiation of "all commitments contained in secret understandings such as those of Yalta which aid Communist enslavements." President Eisenhower proposed in 1953 a congressional resolution against any "interpretations or applications" of such agreements, "which have been perverted to bring about the subjugation of free peoples," but partisans on both sides of the senate blocked action. In 1954 the state department published all minutes and records of the conference, and the public debate gradually ebbed.

See Herbert Feis, ***Churchill, Roosevelt, Stalin:*** *the War* ***They*** *Waged and the Peace They Sought* (1957); John L. Snell (ed.), *The Meaning of Yalta: Big Three Diplomacy and the New Balance of Power* (1956). (E. R. M.)

YALU (Chinese YA-LU CHIANG; Korean AMNOK-KANG) a river that forms the northwestern boundary of Korea with Manchuria, and a sharp dividing line between Chinese and Korean culture. From a mountainous source in Chiang-pai shan (Korean Paek-tu san), the river winds through deeply entrenched channels. It widens out on a large flood plain near the Yellow sea, 491 mi. from its origin. Located near its mouth and connected by railroad and highway bridges are Sinuiju, Korea, and Antung. Manchuria. During Japanese control (1910–45), hydroelectric power potential was exploited by the construction of dams on some tributaries and of a large dam across the river at Sup'ung capable of generating power at an installed capacity of 640,000 kw.

When in the fall of 1950 advances of UN forces threatened this important resource. Chinese Communist forces entered the Korean war. Some large industries based on timber and power resources that had been developed near the mouth of the river were destroyed by air raids during the Korean war. (S. McC.)

YAM, a term usually applied to plants of the genus *Dioscorea* (family Dioscoreaceae), including several tropical species cultivated for food. These are plants with thick tubers (generally a development of the base of the stem), from which protrude long, slender, annual, climbing stems bearing alternate or opposite, entire or lobed leaves and unisexual flowers in long clusters. The flowers are generally small and individually inconspicuous, though collectively showy. Each consists of a greenish, bell-shaped or flat perianth of six pieces, enclosing six or fewer stamens in the male flowers and surmounting a three-celled, three-winged ovary in the female flowers. The ovary ripens into a membranous capsule, bursting by three valves to liberate numerous flattish or globose seeds. The species are natives of the warmer regions of both hemispheres, The plant grows freely in deep sandy soil, moderately enriched.

Most of the yams contain an acrid principle, which is dissipated in cooking. D. *sativa* and *D. alata* are the edible species most widely diffused in tropical and subtropical countries. The tubers of *D. alata* sometimes weigh 100 lb. D. *esculenta,* grown on the subcontinent of India, in southern Vietnam and the South Sea islands, is one of the best foods. D. *batatas,* the Chinese yam or cinnamon vine, is cultivated for ornament in the U.S. and Britain. The only indigenous European species is D. *pyrenaica,* a native of the Pyrenees, a remarkable instance of a species growing at a long distance from all its congeners. In North America there is a single native species, *D. villosa*, called wild yam root or colic root. This is found from Rhode Island to Ontario and Minnesota and southward to Florida and Texas, hut is of no economic value.

True yams are botanically distinct from the sweet potato (*q.v.*), *Ipomoea batatas,* but "moist-fleshed" varieties of sweet potato are often called yams in the U.S. D. *bulbifera,* the air potato yam,. is one of the few true yams cultivated for food in the U.S.

YAMAGATA ARITOMO, PRINCE (1838–1922), Japanese leader of the Meiji period and builder of the modern Japanese army, was born into the family of a foot soldier in the fief of Chōshū. Swept into the currents of loyalism and radicalism that followed the coming of Perry and Townsend Harris, he emerged from the Meiji Restoration as a leader of the semimodern militia of Chōshū, the *Kiheitai*. In 1869, after the Tokugawa shogunate was overthrown, Yamagata visited Europe. He returned impressed by the merits of Prussian military organization and alarmed by the rising tide of liberalism in the west. Yamagata took a leading part in planning the conscription system introduced in 1873, and he was primarily responsible for the introduction of the Prussian general staff system in 1878. He was determined to prevent civilian control of military policies, and achieved this by seeing that the army and navy were responsible only to the emperor, by keeping the high command beyond the reach or influence of civilian leaders, by stressing a code of loyalty for servicemen and by a requirement of 1900 that service ministers had to be named from the active list of generals and admirals. Yamagata also did much to organize Japan's modern bureaucracy. As home minister in the 1880s he set up the central police system and perfected central controls over local government. In 1501 his civil service laws put key posts beyond the reach of party-controlled cabinets. Yamagata served as prime minister in 1890 and 1898–1900. He was for a time commander of the 1st army in Korea during the Chino-Japanese War of 1894–95, and he was chief of staff during the Russo-Japanese War of 1904–05. Named a prince in 1907, Yamagata was the most honoured and respected member of the *genrō,* particularly after the death of Prince It6 in 1909. In addition to an important advisory role in foreign affairs, he virtually controlled the selection of prime ministers until his death in 1922. (M. B. J.)

YAMAGATA, the name of a Japanese prefecture (ken) of northern Honshu and of its capital city. The area of the prefecture is 3,600 sq.mi. Pop. (1960) 1,320,664. Essentially agricultural, Yamagata is noted for its rice production (third largest in Japan), sericulture and fruit orchards. Forestry and mining in the mountainous interior and fishing along the Sea of Japan coast are important locally. Some petroleum, natural gas and lignite deposits are worked. Among its cities Yamagata and Yonezawa dominate the interior while Tsuruoka and Sakata are industrial centres of the coastal district. Sakata is the main port.

Yamagata, pop. (1960) 188,597, is the largest city. Located in an interior mountain basin, it developed as the castle town of the Mizuno clan. It is the commercial centre for the basin's rice, silk and fruit. Metal casting is a thriving traditional industry that is carried out in small workshops and produces varied consumer goods. The city has a main branch of Yamagata university. (J. D. Ee.)

YAMAGUCHI, the name of a prefecture (ken) in western Japan and of its capital city. The prefecture, Yamaguchi-ken, has an area of 2,345 sq.mi. and a population of 1,602.207 (1960). Since the greater part of the land area is composed of plateaus and hills, there are no extensive plains. The Akiyoshi caves on Nagato mountain present a typical karst formation and are famous tourist attractions. Rice fields are mostly of the two-crop type. Surrounded on three sides by sea, Yamaguchi has a large deep-sea fishery catch, exceeded only by Hokkaido and Nagasaki prefectures. Anthracite coal from Ōmine and limestone and marble from Akiyoshi are important mining products.

Yamaguchi-shi, the capital, is located in the central part of the prefecture. Pop. (1960) 87,695. Dating from the 14th century, when the town was planned after Kyōto, it prospered as a castle town as well as a cultural and commercial centre under the Ōuchi feudal lords. There are many institutions and objects of historical interest. (R. B. H.)

YAMANASHI, inland prefecture (ken) in central Japan, with an area of 1.723 sq.mi. and a population of 782,062 (1960). The prefecture presents an attractive topography and a complicated geologic structure. Agriculture is the basic industry. Mulberry fields and orchards are extensive. The so-called Kōshū grapes are of ancient origin. Other fruits grown are peaches, apples and cherries. The factories are small scale, textiles being the most important, followed by the processing of foodstuffs. Yamanashi-ken is located within a convenient distance from Toyko, and is favoured with many scenic attractions. Week-end tourists provide important income. Kofu, pop. (1960) 160,963, is the prefectural capital. (R. B. H.)

YAMASHITA, TOMOYUKI (1885–1946), Japanese army officer, whose brilliant campaign in the Malay peninsula during World War II earned him the nickname "Tiger of Malaya," was born Nov. 8. 1885, in Kochi prefecture. A graduate of the Military academy and Military Staff college, he also studied in Europe. He spent much of his career in the war ministry, served in China and for five months in 1940 held the important position of inspector general of military aviation

When Japan entered World War II. Yamashita commanded the forces attacking the great British naval base of Singapore He led his forces down the peninsula, striking by sea again and again at the defenders' rear, until he entered Singapore and, on Feb 15, 1942, forced its surrender. He was promoted to full general in 1943 and in Sept. 1944 was put in command of Japanese troops in the Philippines, arriving in Manila barely a week before the United States reinvasion of the islands. Yamashita's forces were weakened and scattered: and he was driven into the mountains of northern Luzon, where he managed to hold out until the end of the war. He was convicted by a U.S. military court of violation of the laws of war, condemned to death and hanged near Manila on Feb. 23, 1946. (S. L. Fk.)

YAMATO, the ancient name for the peninsula on the Japanese island of Honshu. In its northern section is the former Japanese capital. Nara. It is generally accepted that the tribe or "clan" of early Yamato. in Bronze Age times, was successful in establishing political domination over the islands in the south, the Ainu being still dominant in the north. It is said that the imperial line came from the Yamato people of prehistoric Japan. To the Japanese, Yamato has always been a symbol of political unity and national consciousness. *Yarnato damashii* refers to the national "soul." the spirit of bravery characterizing the warrior ethic of the Japanese. (R. F. Sr.)

YAMBOL, a town of Bulgaria, on the Tunja river, 49 mi. W. of Burgas by rail, and an important corn-growing centre. Pop. (1956) 42,333. In the town are the remains of old fortifications, and the ruins of a fine mosque. Yambol is first mentioned in the 11th century, when it was known by the Byzantines as Hyampolis.

YAMETHIN, a town and district in the Mandalay division of Burma. The town has a station on the railway 275 mi. N. of Rangoon on the main line to Mandalay. It is an important centre of trade with the Shan states. The district lies between the Shan states and the Meiktila, Magwe and Toungoo districts and comprises the Sittang valley in the centre, the Pegu Yomas on the west and the forested Shan hills on the east. Area, 4,196 sq.mi.; pop. (1941) 463,189, showing an increase of 72,369 in the decade. The staple crop is rice, which is irrigated from tanks and canals. Millets and oilseeds are grown in the north, where drought has more than once caused distress. Besides the chief town, Pyinmana and Pyawbwe, both also on the railway, carry on an active trade with the Shan states. Pyinmana has a forest school, and from Pyinmana a branch railway now crosses the forested Pegu Yomas to the Magwe district.

YANCEY, WILLIAM LOWNDES (1814–1863), **U.S.** political leader, son of Benjamin Cudworth Yancey, lawyer of South Carolina, was born in Warren county, Ga., on Aug. 10, 1814. He attended Williams college, Williamstown, Mass.. for one year, studied law at Greenville, S.C.. and was admitted to the bar. He was elected in 1841 to the state house of representatives, became state senator in 1843 and in 1844 was elected to the national house of representatives to fill a vacancy. being re-elected in 1845. In 1846 he resigned his seat, and devoted himself to the resistance of the antislavery movement. In 1848 he secured the adoption by the state Democratic convention of the so-called "Alabama platform," declaring that it was the duty of congress not only to allow slavery in all the territories but to protect it, that a territorial legislature could not exclude it, and that the Democratic party should not support for president or vice-president a candidate not openly opposed to the exclusion of slavery from the territories. When the Democratic convention in Baltimore refused to incorporate his ideas into the platform. Yancey with one colleague left the convention. He opposed the Compromise of 1850. and went so far as openly to advocate secession. In 1858 he advocated the appointment of committees of safety, the formation of a league of united southerners and the repeal of the laws making the African slave-trade piracy.

He attended the Charleston convention of the Democratic party in April 1860. and again demanded the adoption of his ideas. Defeated, he again left the hall, followed by the delegates of Alabama, Mississippi, Louisiana, South Carolina, Florida, Texas and two of the three delegates from Delaware. On the next day the Georgia and a majority of the Arkansas delegation withdrew.

In the Baltimore convention of the seceders he advocated the nomination of John C. Breckinridge. and made a tour of the country on his behalf. When the south seceded, he delivered the address of welcome to Jefferson Davis on his arrival at Montgomery, but declined a place in President Davis' cabinet. On March 31, 1861, he sailed for Europe as the head of a commission sent to secure recognition of the Confederate government, but returned in 1862 to take a seat in the Confederate senate. Because of his failing health, he left Richmond early in 1863, and on July 27 died at his home near Montgomery.

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YANG, CHEN NING (1922–). Chinese theoretical physicist, together with Tsung Dao Lee (*q.v*), received the Nobel prize in physics in 1957 for the discovery of violations of the principle of parity (the principle of space reflection symmetry). This principle had previously been considered generally valid, but Lee and Yang demonstrated that for certain processes it had not, in fact, been established, and pointed out specific experiments to test the principle. These experiments then proved the violation of the parity principle, and rapidly led to substantial advances in the physics of elementary particles.

Yang was born Sept. 22, 1922, in Hofei, Anhwei province, and was educated at the National Southwest Associated university, Kunming. and The University of Chicago (Ph.D., 1948), studying under Enrico Fermi. He was an instructor in physics at The University of Chicago (1948–49), a member of the Institute for Advanced Study. Princeton, N J. (1949–55). and, from 1955, a full professor there. Yang's other contributions in physics are chiefly in the fields of statistical mechanics and symmetry principles. (JK. S.)

YANGCHOW (formerly (CHIANG-TU or KIANGTU), a city of Kiangsu province, China, on the Grand canal north of the Yangtze river, about 35 mi. N.E. of Nanking. The Chinese Communists returned to the use of the old name in 1949, applying Chiang-tu to a suburb. The site of the city is very old, and was the location of a southern capital of the Sui dynasty in the 5th century. Yangchow was a foreign trade seaport by the 9th century, with a colony of foreign merchants. It reached its commercial peak during Mongol times, so that it was logical that Marco Polo be appointed an official and stationed there (c. 1282–85). Sacked by the Japanese in the late 16th century, Yangchow never regained its importance. particularly as the Grand canal silted up during the late 18th and 19th centuries. It is a cultural and trade centre (salt and rice), rather than industrial. Pop. (1953) 180,000. (J. E. SR)

YANGTZE (CH'ANG CHIANG), the longest river of China and its principal waterway. The commonest Chinese name for the whole river is Ch'ang Chiang. though Ta Chiang is often used, these meaning "long river" and "great river." There are many local names. Yangtze. meaning "river of the Yang village," a British early 19th-century name, being that of a portion near the mouth; Chin Sha Chiang ("river of golden sand") is used in the Tibetan border area, and Dre Che is the Tibetan name. The Yangtze traverses central China roughly from east to west floning past the cities of Chungking, Wu-han and Nanking (qq v) to the East China sea near Shanghai (q v.), thus linking the interior with the Pacific maritime routes. Its course passes through China's chief economic regions (among the most densely populated in the world)—the Lower Yangtze plain comprising Anhwei and Kiangsu (qq v.) provinces, and the Middle Yangtze plain including Hupeh, Hunan and Kiangsi (*qq.v.*)

The length of the Yangtze is 3,602 mi., and its drainage basin covers about 756.498 sq.mi., most of nhich lies within and below the Szechwan (*q.v.*) basin of west China. The river rises in the Tibetan highlands on the southern flanks of the Kunlun mountains in several headstreams including the Murui Ussu and Ulan Muren at an elevation close to 17,000 ft. It flows southeastward for about 1.200 mi., and drops almost 15,000 ft. Some 600 mi. of its course in the Tibetan border zone involves great bends through deep gorges across the southeastward trend of the border ranges Its chief Tibetan tributary, the Ya-lung, here comes in from the north. The Yangtze emerges into the Szechwan basin at P'ingshan, having dropped another 1.000 ft., and flows at about 950 ft. elevation at the head of navigation 1.630 mi. from the sea. Within the Szechnan basin the fall of the river is more gradual. The Min Chiang enters from the north at I-pin (Sui-fu). 30 mi. below P'ingshan. Between I-pin and Chungking the T'o Chiang joins from the north and the Hung Chiang comes in from northeastern Kweichow. At Chungking the Chia-ling Chiang enters as a major northern tributary. The elevation of the river at Chungking is 650 ft., and the shift between winter low level and summer flood peak often is over 100 ft Between Chungking and I-ch'ang the only major tributary is the Wu Chiang, entering from northeastern Kweichow.

Through the western Szechwan basin the Yangtze flows between fairly low banks. but east of Chungking it becomes entrenched. The Szechnan-Hupeh mountain border is strongly folded and faulted. and stands nell above the level of the Szechwan basin. Just below Wan-hsien the river turns eastward and plunges into the spectacular Yangtze gorges. For about 200 mi. these are a succession of narrow, steep-sided to vertical-walled, canyons broken by short reaches where tributaries have cut deep side canyons. In several places hard rock ledges in the river bed cause rapids, and other rapids are caused by landslides from the canyon walls. In summer flood the river often rises 200 ft., during which time the rapids cause little hazard for shipping, though the swift current can be troublesome. During winter low water the reaches are quiet, but the rapids are beset with violent whirlpools and narrow swift races in which the water velocity may exceed 13 m p h. A tow path runs through the gorges on the left bank, often cut out of solid rock, by which large gangs of men, known as "trackers," pull native craft over the rapids, using half-mile long bamboo ropes. Modern ships require powerful engines to cope with the treacherous river. It is within this section that hydroelectric sites present superabundant power potentials, but cost of development would be tremendous.

The Yangtze emerges from the gorges at I-ch'ang, at 131 ft. elevation, 1 000 mi from the sea. For the next 400 mi. the river drops about 90 ft.. nith Wu-han, 600 mi. from the sea. standing at 40 ft. elevation. In this section the river meanders. and its bed is well above the lake level of Tung-t'ing Hu which gathers the drainage of the Hunan rivers to join the Yangtze. from the south, slightly west of Wu-han Historically this section long has presented major diking problems; nhen the main river is in flood it often breaks through into the lake, which serves to detain the flood waters. The Chinese Communists in 1953 diked off a 356 sq.mi. sector of the lake basin as a flood reservoir.

From the northwest the long Han Shui enters the Yangtze at Hankow where flood level stands 55 ft. above low water, and well above the city. There, completed in 1957. is the only bridge across the Yangtze, a 3,762-ft. double-decked road and rail bridge.

Below Wu-han the river gradient is slight, and the channel crosses structural lines of old mountain blocks, as it winds its course between major hill bastions. From the south the last major tributary stream system. of nhich the Kan Chiang is the chief river. gathers behind P'o-yang (*q.v*) in Kiangsi. to enter the Yangtze at Chiu-chiang (Kiukiang). Below Wu-hu is the estuarial-delta portion of the river, nith tidal effects reaching that city. Here begins a broad and flat, but watery, flood plain-delta which merges on the north with the southern north China plain Shanghai, the natural outlet for the huge Yangtze basin, situated on a tidal flat, is linked to the river by the Whangpoo (Huang-p'u Chiang). It is estimated that the Yangtze is building its delta outward at the rate of more than a mile per century.

Belon I-ch'ang much of the river is diked, the Han and the Kan also being partly diked, so that the total length of main dikes exceeds 2.000 mi. In the Hupeh plain sector the main dikes now exceed 50 ft. in height. There are nearly 7.000 sq.mi. of lake surface in the Yangtze system below I-ch'ang, providing flood reservoir space. Low water normally occurs from December to March throughout the whole river system. Flood season in the Kan river basin in Kiangsi normally is in late May, that of the Hunan tributaries is in early June, the Han river flood peak is mid-to-late June, and for the Szechwan basin the peak period normally is in early July. When heavy rains flood only one major sector of the

Yangtze system at a time. there seldom is serious flooding throughout, but in those years in which the whole basin receives torrential rains at the same time, disaster results. In 1931 about 34.000 sq.mi. in the Yangtze and the Huai Ho (*q.v.*) were inundated, and in 1954 the worst flood in known history hit the same region. The mean volume of water discharged into the sea is estimated at about 700,000 cu.ft. per second, but the 1931 peak flood was close to 3,000,000 cu.ft per second, well over the safe level for the dikes of that year. The annual sediment discharge is close to 1,000,000,000 tons per year, with heavy flood seasons exceeding that figure.

The Yangtze river system forms one of the world's best commercial highways and to the Chinese has always been important as a means of intercommunication. Marco Polo. who visited central China in the 13th century, was impressed by the volume of river traffic. In summer, ships up to 10.000 tons can reach Hankow, 4,000-ton ships can make I-ch'ang. and powerful 1,000-ton ships can navigate to Chungking. About 2,000 mi. of tributary courses are open to steam launches in summer. About 25.000 mi. of main river and tributary channels can be navigated by native junks and rafts during summer periods. The long flow period of the Yangtze is notable, so that much of the system is navigable for almost eight months of the year.

In the past the Yangtze valley as a political term indicated the sphere of influence or development assigned to Great Britain by international agreement. Subsequently more than 1.000 mi. of the river were held by the Japanese during the Chinese-Japanese War (1937–45). The Yangtze was the scene in 1949 of a famous naval exploit: in April the British frigate H.M S. "Amethyst" was attacked and detained by Chinese Communist artillery for nearly three months while proceeding to Nanking on a humanitarian mission on behalf of the foreign community. Unable to obtain a safe-conduct guarantee, the warship navigated downstream for 140 mi., at times under heavy fire, and arrived at the mouth with only a few hours of fuel remaining. (J. E. Sr.)

YANKEE, a word of uncertain origin (perhaps from Dutch Janke, Little John), applied in the 18th century to New Englanders, first by British soldiers as a contemptuous nickname, then as merely descriptive, finally as a respectable designation, still acceptable in New England. Yankee was the given name of a Negro slave offered for sale in Carolina in 1725. Toward the close of the 18th century, Britons began to use Yankee for all United States citizens and continued to do so until well into the 20th century. This usage was encouraged in World War I, when, in the United States as well as in Europe, members of the U.S. armed forces were often called Yanks. During and after the Civil War, southerners spoke of northerners as Yankees. (A. McQ.)

YAO (of Africa), a Bantu-Negroid people inhabiting the region between the Rovuma and Lugenda rivers in Mozambique, who spread into Tanganyika and Nyasaland after 1850. Their culture is similar to that of the Makonde and Makua-Lomwe peoples. They have matrilineal clans, matrilocal marriage, annual initiation ceremonies for boys and girls. They had a form of ancestor worship but are now mainly Moslems. They were slave traders until subdued by the British in 1896.

Bibliography.—J. C. Mitchell, "Modern Political Organization Among the Yao of Southern Nyasaland," *African Studies*, vol viii (1949), "The Yao of Southern Nyasaland," *Seven Tribes of British Central Africa*, ed by E. Colson and M. Gluckman (1951), H. S. Stannus, "The Wa Yao of Nyasaland," *Harvard African Studies*, iii (1922). (M. M Ds.)

YAO (of China), a mountain-dwelling Mon-Khmer ethnic group in south China that once roamed much of the hill lands south of the Yangtze river and east of Szechwan and still are found in small groups in many southern provinces Traditionally, they have led a semimigratory life of shifting cultivation, clearing and fertilizing the mountain slopes for cultivation by burning the forest and brush. Tribal organization has been poorly developed, although a strong patrilineal clan society existed. Features of the traditional culture included sexual freedom before marriage and marriage by free choice of the partners after a child is born. A type of shamanism also was practised together with the ancestral cult of the dog-god P'an-hu, a legendary dog that delivered the head of an enemy to a monarch and was awarded a princess for a wife. The Yao claim descendance from this union.

Conflicting theories variously speak of the Yao as a branch of the Miao in western Szechwan, or as having evolved in southeast China independently of the Miao and speaking a paleo-Austronesian language modified by T'ai. Miao and Chinese contacts. The Tao now are largely concentrated in Kwangtung and Kwangsi provinces. Some groups of Yao have migrated into northwest Vietnam and Laos. The Shê people of Chekiang and Fukien provinces are considered related to the Yao, as are the Li tribes of Hainan Island. All of these groups combined may number between 600.000 and 1,000,000 people.

At intervals during the centuries of the extension of Han Chinese settlement into the south China hills, oppression of the Yao or the taking of Yao land by the Chinese have brought fierce and large-scale uprisings. It is recorded that during the great Yao rebellions of the 16th century in Kwangsi, several hundred thousand Chinese troops were required to subdue them. Since then, only sporadic small-scale revolts have occurred.

After 1953 the five hill areas in which the Yao predominated were organized by the Communist regime into five so-called "autonomous districts." Two of these lie in the Nan Ling range between Hunan and Kwangsi, one lies in northwest Kwangtung, one in central Kwangsi and one in southwest Kwangsi.

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YAP, the largest island in an archipelago of that name, is the headquarters of a district of the U.S. Trust Territory of the Pacific Islands in the western Carolines. The district includes 16 coral atolls to the east and southeast. The other main islands of the archipelago are Tomil, Map and Rumung; the coral atolls nearest to the archipelago are Ulithi, Fais and Ngulu.

The archipelago has an area of approximately 39 sq.mi. and a population of 3.176 (1958 est.), only one-fifth of what it was early in the 20th century. The Yapese, of Malay origin, have distinct racial and linguistic characteristics that distinguish them from other peoples of the Carolines. The total population of Yap district is 5,459 (1958 est.).

The mean monthly temperature of Yap is 81.6° F., and the average annual rainfall, 122 in. Tropical hurricanes are frequent from June through December. The soils, mostly lateritic, are derived from ancient volcanic and sedimentary rocks much weathered by the high temperatures and heavy rainfall of the tropics. Yap Island has a series of hills, the highest Mt. Tabiwo1.570 ft., that divide the east coast from the west.

The natives of the archipelago have a surplus of Polynesian chestnuts, bananas, coconuts and taro that they send to some of the coral atolls. They also raise yams, sweet potatoes, pepper, cloves and tobacco. Livestock include cattle, swine and poultry. The district also produces copra and there is some fishing. Yap Island has small amounts of phosphate and bauxite. Men and women share the agricultural labour, women cutting grass for fertilizer and weeding gardens, and men clearing stumps, cutting brush and doing other heavy work. Women's taro lands. separate from those of the men, are tended entirely by the women themselves. Women make their own skirts — the only garments they wear — of various grasses, leaves and long fibres of the hibiscus plant; men wear cotton loincloths. In a caste system that has economic significance, the three highest ranking villages in the archipelago of Yap are Gatchapar. Teeb and Balabat. Ninety per cent of the native houses of the district are constructed of wood, bamboo and thatch; the remainder have roofs of corrugated iron.

The Tapese experienced three foreign governments before the trusteeship administration was established in 1947: Spanish (nominally to 1399). German (before World War I) (1899–1919) and Japanese (1920–47). To facilitate their government, the Germans divided the islands into ten administrative districts that remained after German rule. Each district is headed by an elected magistrate. Together the magistrates form a counci! to advise the district administrator who is appointed by the high ccmmissioner of the trust territory. Administrative problems arise from the conservative nature of the natives, who resent education for their children or any action that makes for change in their traditional social order. Ceremonial dancing plays an important part in their culture. Native systems of land tenure and of rights to use and enjoy the products of land are complicated as they are on most islands in Micronesia. In the second half of the 20th century there were 21 public elementary schools, 1 private (mission) elementary school and 1 public secondary school in Yap district with more than 6jo students. About half the deaths in the islands are due to tuberculosis. Infant mortality is 11%.

See J. W. Coulter, *The Pacific Dependencies of the United States* (1957). (J. W. Cr.)

YAPOCK: *see* WATER-OPOSSUM.

YAʿQUBI (AHMAD IBN ABI YAʻQUB IBN JAʻFAR IBN WAHB IBN WADIH) (9th century). Arab historian and geographer. was a great-grandson of Wadih, the freedman of the caliph Mansur. Until 873 he lived in Armenia and Khurasan; and later he traveled in India. Egypt and the Maghrib, where he died in 891. His history is divided into two parts. In the first he gives a comprehensive account of the pre-Mohammedan and non-Mohammedan peoples, especially of their religion and literature. For the time of the patriarchs his source is now seen to be the Syriac work published by C. Bezold as *Dze Schatzhöhle.* In his account of India he is the first to give an account of the stories of Kalila and Dimna, and of Sindibad (Sinbad). When treating of Greece he gives many extracts from the philosophers (*cf.* M. Klamroth in the *Zeitschrift der deutschen morgenländischen Gesellschaft,* vol. xl and xli). The second part contains Mohammedan history up to 872, and is neither extreme nor unfair, although he inherited Shi'ite leanings from his great-grandfather.

Edition by T. Houtsma, 2 vol. (1883). Yaʻqubi's geography, the *Kitāb ul-Buldān,* contains a full account of the larger cities and much topographical and political information (ed. by M. de Goeje, 1892; French trans. by G. Wiet, 1937). (G. W. T.)

YAQUT (YAKUT; YAQUT IBN 'ABDALLAH AR-RUMI) (1179–1229), Arab geographer and biographer, was born in Greece of Greek parentage but in his boyhood became the slave of a merchant of Hamah (Hamath), who trained him for commercial traveling and sent him two or three times to Kish on the Persian gulf. After his master's death he became a bookseller, and he traveled in Persia, Syria. Egypt and visited Merv, Balkh, Mosul and Aleppo. About 1222 he settled in Mosul and worked on his geography, the first draft of which was ready in 1224. After a journey to Alexandria in 1227 he went to Aleppo, where he died in 1229. In his large geography, the *Muʻjam ul-Buldān* (ed. by F. Wüstenfeld, 6 vol., 1866–73), the places mentioned in the literature or the stories of the Arabs are given in alphabetical order, with the correct vocalization of the names, an indication whether they are Arabic or foreign and their locality. A sketch of their history and of their monuments follows.

The parts of this work relating to Persia have been translated by C. A. C. Barbier de Meynard under the title *Dictionnaire géographique, historique et littéraire de la Perse* (1861). Yaqut wrote a dictionary of geographical homonyms, the *Mushtarik,* ed. by F. Wüstenfeld (1846). Yaqut also wrote an important dictionary of learned men, the *Muʻjam ul-Udabāʻ;* it has been edited by D. S. Margoliouth, *Irshād al Arib ilā Marifat al Adīb* (1908–26).

YARACUY is one of the northern states of Venezuela; area 2,741 sq.mi.; pop. (1950) 132,436. Its climate is tropical, the rainy season extending from June to December. Within the state is the fertile, productive and important Yaracuy valley, which separates the great Andine spur on the west from the coastal area on the east. The valley is important for its agriculture, producing bananas, cacao, corn, cotton, rice, sugar cane, tobacco and yuca and, at the higher elevations, coffee. Several minerals are to be found in the state—coal, copper, iron pyrites, lead and platinum. San Felipe is the capital. The excellent Pan-American highway traverses the heart of the state, connecting San Felipe with the neighbouring cities of Puerto Cabello to the east and Barquisimeto to the west. (L. WE.)

YARKAND (Chinese SO-CH'E) is the largest town in one of the two chief oases of the Tarim basin in the Sinkiang Uigur Autonomous Region, 38° 25' N. and 77° 16' E., 3,900 ft. above sea level. The oasis lies along several rivers of the southwest part of the Tarim basin and, as these streams come from the glaciers of the high Pamirs, they are strong and give a good water supply. The Kashgar oasis lies to the northwest and the Khotan oasis (across a desert belt) to the southeast. In the Yarkand oasis irrigation is highly developed and the soil at the foot of the mountains is largely fertile loess, on which wheat, barley, rice, beans and oil plants are grown. while there are also many fruit orchards. Among the mountains there is good pasture and large herds of camels, yaks, goats, sheep and cattle are kept. Cotton and silk (mulberry) are cultivated to some extent.

Marco Polo visited Yarkand between 1271 and 1275 and Goes went there in 1603. Schlagintweit passed through Yarkand a few days before he was killed at Kashgar in 1857.

The town is surrounded by a great earth wall with towers of Chinese type and has mosques and madrasas (colleges) of great fame, though less well known than those of Bukhara and Samarkand. The city is a centre of caravan trade along routes from Cadakh, Khotan, Kansu and trans-Caspian regions, as well as India and the U.S.S.R. generally. Horses, cotton, skins and leather and leather goods, carpets, silk, etc., are dealt in. and carpets as well as woven stuffs in silk, cotton and wool are made. Pop. (1953) 80,000.

YARKAND, a headstream of the Tarim river in Sinkiang Uigur Autonomous Region, China. The Yarkand. which is 600 mi. long, rises in the Karakorum pass of the Karakorum range of northern Kashmir. In its upper course it forms part of the undefined border between Kashmir and Sinkiang, as it cuts a deeply incised valley through the mountain ranges of the Kunlun system. Upon emerging from the Kunlun gorges, the Yarkand loses the characteristics of a raging mountain torrent and spreads out in many branches over an alluvial fan to irrigate the Yarkand oasis. The oasis, one of the largest in Sinkiang, contains the towns of Yarkand (So-ch'e) and Tse-p'u (Posgam). Upon leaving the Yarkand oasis, the river flows north past Mai-kai-t'i (Merket-Bazar) and then northeast around the eastern margins of the Takla Makan desert. South of the Aksu oasis it joins the Kashgar, Aksu and Khotan rivers to form the Tarim. Unlike the other headstreams of the Tarim, the Yarkand carries water all year round and is regarded as the main source stream of the Tarim. The Yarkand derives most of its water from melting snou and glaciers in the Karakorum and Kunlun systems. Its volume is therefore greatest in the summer and lowest in the winter. Most of its water is used for irrigation or is absorbed by desert sands. (T. SD.)

YARMOUTH, a historic little port on the northwest shore of the Isle of Wight, Eng. Pop. (1951) 953. A ferry service to Lymington brings summer visitors. The town hall (rebuilt 1763) contains charters of 1135, 1280, 1335, 1440, 1465 and 1560. Yarmouth castle was built in 1537 after the town had suffered many attacks and been burned twice (1377 and 1524).

YARMOUTH (GREAT YARMOUTH), a municipal, county and parliamentary borough and seaport in Norfolk, Eng., 20 mi. E. of Norwich by road. Pop. (1951) 51,105. Area j.8 sq.mi. It is situated where Breydon water (the combined waters of the Yare, Waveney and Bure) makes to enter the North sea but is turned southward for about 3 mi. by the sandy spit on which the town is built. The estuary of the rivers forms the harbour which can accommodate ships up to 300 ft. in length. Yarmouth is a popular seaside resort and a centre for boating on the Norfolk Broads.

Yarmouth is one of the largest herring-fishery ports in the world; the trade used to be carried on at an annual fair between Michaelmas and Martinmas. Industries include electrical and marine engineering, foodstuff processing, brewing and the manufacture of textiles, shoes, boxes and pulp. There is a big open-air market and the Easter fair is of ancient origin. When the Romans built Gariannonum (Burgh castle, now 4 mi. W. of Yarmouth) it stood close to the seashore, but the discovery of a cemetery of 7th-century date or earlier shows that the sandbank on which Yarmouth (Gernemutha Magna) now stands was habitable by then. By the 14th century the sandbank had extended south for about 8 mi but later it was cut through several times for purposes of navigation. The present entrance to the harbour was made by Joost Jansen, a Dutch engineer, in 1567, and affords a depth at the bar of 12 ft. at low water. Fishermen were attracted to Yarmouth from the Cinque Ports and at the time of the Conquest there was a settlement of 70 burgesses which Henry I placed under the rule of a reeve. The charter of King John (1208), which gave his burgesses of Yarmouth general liberties according to the customs of Oxford, a guild merchant and weekly hustings, was amplified by several later charters asserting the rights of the borough. In 1552 Elizabeth I granted a charter of admiralty jurisdiction, afterward confirmed and extended by James I. In 1668 Charles II incorporated Little Yarmouth by a charter which, with one brief exception, remained in force till 1703, when Anne replaced the two bailiffs by a mayor. The council now comprises 12 aldermen and 36 councillors. Yarmouth returned two members to parliament from 1300 to 1868 and one after 1885.

Old Yarmouth, built along the eastern bank of the Yare and enclosed within flint-faced walls in 1260, has extended beyond its ancient walls to the seashore. Unique features of the town are the very narrow streets called "rows," with their small houses, leading down to the river. The town suffered greatly from air raids during World War II and damage from gales and floods in Jan.–Feb. 1953. The parish church of St. Nicholas, built of flint ornamented with limestone, was founded in 1101 by Herbert Losinga and was completely gutted in 1941. It was the largest Anglican parish church in England.

YARN. The derivation of this word from *"garn,"* a word common to the Scandinavian languages, meaning "guts," is interesting since today "cat-gut," which may be the drawn-out "guts" of the silk-worm, is a well-known commodity; and the same "guts" spun by the silk-worm itself into a fine filament are the basis of the best silk yarn produced. The silk-worm, however, in its "spinning" simply thins-out the silk fluid to a double microscopic strand some 500 to 1,000 yards long, several of which are combined by mechanical means to form a yarn; while the human spinner usually combines a number of much shorter fibres or filaments, also by mechanical means, into a continuous strand often much longer than the 1,000 yards filament of the silk-worm; and this also is spoken of as a yarn.

Materials. — The materials from which yarns are constructed or spun markedly influence the processes of production. In the case of the best silk yarn the worm itself does what is termed the spinning and the later running-together of several of the long silk filaments is not spoken of as spinning but as "throwing." In the case of a typical short fibre — say the cotton fibre ½″–2″ long — the spinning process is the binding together of many thousands of cotton fibres into a fine regular, continuous thread — usually spoken of as "yarn." Two or more of these threads or single yarns may be combined together by "twisting" to produce a thicker. stronger yarn.

Of the true long fibres there are only two types, the natural silk reeled from the cultivated silk-cocoon and the synthetic fibres such as nylon.

Of the short fibres there are many classes. The longest are the waste silks just mentioned; then come the animal fibres including hairs and wools up to 18" long, short wools down to, say, 2" long and broken-up wool fibres (variously termed shoddy, mungo, extract, flocks, etc., according to their source and manner of breaking up from the virgin wool clothes, knitted garments, etc.) which (it is popularly said) can be spun into yarn if they possess two ends; next come the "stem-fibres" such as flax (producing linen yarn), hemp, jute and china-grass which may vary in length from several inches down to fractions of an inch; lastly come the cotton fibres and cotton wastes often under one inch in length along with which should perhaps be ranked the mineral fibre asbestos, which may be spun into a yarn from which fireproof cloths are woven.

Structures. — Yarn structures may be considered from two points of view. In the first case particular fibres lend themselves only to particular "fibre combinations." Thus long silk filaments can only be "thrown" together with or without "twist." But the twisting of silk filaments is an art in itself. Thus several filaments may be reeled together from separate cocoons and these given a suitable "combining-twist" to produce what is known as singles; then several of these singles may be thrown together with little twist to produce almost a "paralleled-fibre" thread termed "tram," the most lustrous yarn known, or with much twist to produce a strong, fairly lustrous yarn termed "organzine" which is employed as "warp." On the other hand one inch cotton fibres after being drawn into a fairly fine "paralleled sliver" termed a "roving" can only be spun out into a fine thread by means of "supporting twist" which no doubt binds the fibres more or less concentrically in the thread or yarn: this is said to be the true form of spinning — draft (that is, drawing-out thinner) against twist.

Fancy Twists. — These naturally group themselves into three classes, viz., structural twists; colour twists; and structural-and-colour twists. Of the first class the two most important are the knop yarn — in which knops are formed at any required intervals on an otherwise level thread by holding one thread tightly and allowing the second thread to run in slackly to form knops of the required size, after which equal delivery of the two threads for the required length is followed again by the varied delivery to form the knop; and the curl yarn — in which a knop yam is first formed and then this two-fold yarn twisted, in the opposite direction, with a third thread, this opening out the knops into loops which may be produced at more or less regular intervals or "spaced," *i.e.,* a length of the thread without loops and then a series of loops, which in turn are followed by a length of the thread without loops. Of fancy colour twists the simplest is the corkscrew twist which is formed by first twisting, say, a dark and a light thread in the normal manner and then twisting this two-fold yarn in the reverse direction, with a third dark thread, this producing the special appearance which gives its name to the yarn.

Other Fancy Yarns. — Fancy yarns of an effective character may also be produced with simple modification in the normal carding and spinning processes. Thus "knicker yarns" are produced by throwing little bits of highly coloured material into the last cylinders of the card so that instead of being broken up by carding they are carried forward as "knickers" into the spun thread. "Random yarns" are produced by feeding the card with alternate stripes of dark and light material and taking the condensed slivers off with a zig-zag or moving-laterally doffer which takes sections of the lengths of its slivers from first one and then the other stripes. "Marl yarns" are produced by running two differently coloured slivers together on the roving frame just prior to the worsted spinning process, so that the colours are "regularly irregularly" mixed together.

If on the other hand a very level mixture effect is required dark and light coloured tops are mixed together in the worsted drawing processes, or, better still, the "tops" are printed the required colours in bands and then passed through the worsted drawing processes this producing the extraordinary level mixture effect termed a "melange." Of the simple twofold yarns the best known is the "granderelle" in which a dark and light thread — usually of similar material, but not necessarily so — are finely twisted together as perfectly as possible. Another twofold twist termed a "spiral yarn" is formed by two single threads twisted in opposite directions being combined with twofold twist which necessarily shortens one of the threads by adding twist and markedly lengthens the other by taking out twist. Thus the slack thread "spirals" round the tight thread.

Yarn Effects and Special Properties. — The effects which may be produced by suitable selection of materials and yarn structure may be grouped into three classes, viz., light-reflective effects; form effects, and colour effects. Light reflection from the surface of a woven fabric depends upon the material or materials employed, upon the fibre arrangement in the thread, upon the thread interlacings and upon such modifications as may be introduced in the finishing processes. Thus some wools are lustrous — the Wensleydale wool, for example — and some are opaque and dull — the Down wools. Ordinary cotton is dull, mercerized cotton is lustrous. A lightly twisted net silk yarn ("tram") is the most lustrous yarn known, while a specially hard twisted net silk yarn (crepe) is the dullest yarn produced. Tram silk yarn interlaced on the "satin" principle produces the most lustrous fabric and crepe silk yarn interlaced on the "crepe" principle produces the dullest fabric known.

Merino wool spun on the woolen principle when woven into a normal fabric gives a dull surface but if the fibres are "raised" from the surface and laid parallel in the "finishing" processes then a brighter fabric may result than that produced from a merino wool spun on the worsted principle in which the fibres are laid parallel in the thread structure only.

The "form" effects will have been appreciated from the descriptions already given of knop, curl, spiral, etc., yarns. These yarns specially coloured as already described offer the designer the opportunity of producing a never-ending array of novel fabrics. Should specially white fabrics be required a "bleached" yarn is employed but it is more usual to bleach the material in the fabric state. Should a yarn which may be spun white but later — either in the yarn or cloth state — dyed two distinct colours be sought for, cotton may be blended with wool in the carding or in the drawing processes, or strands of wool and of cotton may be twisted together and dyed distinctive colours later.

Yarn Counting and Numbering. — The numbering or counts of yarns—30s, 40s, 80s, etc.—may be explained best by the counting of woolen yarns. The basic weight is the "wartern" of 6 lb., the "quartern" of the old 24-lb. stone. This appears to have been a convenient weight for the spinners to take away to their homes for hand or jenny spinning. If this weight was spun in 1.536 yd.—that is each dram spun out to 1 yd.—it was termed one skeins. If one dram was spun to 2 yd., it was termed 2 skeins; if to 20 yd., it was 20 skeins. Later it was found more convenient to deal with the unit weight of one pound, so that it has come to be usual to reckon the woolen skein as 256 yd. and the number of skeins to which a pound of this material is drawn out as the counts, spoken of as skeins in the woolen districts. Thus if one pound is drawn out to 5,120 yd. (256 × 20) the yarn is a 20 skeins. Unfortunately the woolen industry was spread over the whole of the known world before the unifying mechanical era dawned with the result that not only each country but each manufacturing district has adopted its own system of woolen yarn counting. Thus 200-, 300-, 420-yd. skeins are to be found and there is a still further complication in the United States where in one case the length is fixed and the count or skeins is given by the number of times the unit weight (the grain) is contained in this unit length. This method is that natural to the net silk industry in which the drams per 1,000 yd. or the deniers (or $\frac{1}{2}$ decigram) per 450 m. gives the count spoken of as the deniers.

The cotton-spinning industry which started from England adopted from the first a hank (or skein) of 840 yd. and the hanks per pound as the count and this has obtained world-wide acceptance. The worsted industry, apparently an offshoot of the cotton industry, taking a yard instead of a $1\frac{1}{2}$-yd. reel, has adopted a hank of 560 yd. and the hanks per pound give the count. The kilogram and the kilometre (or gram and metre) are the universal bases for everything excepting thrown silk and synthetic yarns for which a base length of 500 m. is used and the weight of this in decigrams give the deniers or count.

The yards to which one pound of material may be spun naturally vary with the fineness and nature of the material. Thus cotton has been spun on a commercial basis to 588,000 yd. per pound, linen to 180,000 pd., worsted yarn to 56,000 yd. and woolen yarn to 15,000 yd.; while net silk yarns, if required, may even be thrown finer than the finest cotton.

Sometimes to obtain a fine, straight-fibred thread, wool is spun or twisted with cotton and later the cotton is "carbonized" by acid treatment. The reverse process may also be employed. Special note should be made that in twisting threads together the count number of the yarn will be lessened in proportion to the added weight of the thread or threads. Thus two threads of a 40s count twofolded give a 20s count — written 2/40s. There is, however, an exception to this in spun-silk yarn in which a 2/40s yarn (often written 40/2) is a 40s but twofold; *i.e.*, two threads of 80s are twisted together giving a folded yarn with 40 hanks (each 840 yd.) to the pound. The twisting of varied count numbers is really simple but mystifying to the uninitiated. Thus a 10s count twisted with a 40s count does not give an intermediate count number (say 25s) but naturally a thicker count than 10s and consequently a lower count number, viz.. 8s count; and this is true in whatever denomination the count may be stated — cotton, linen, woolen, worsted, etc. (A. F. B.)

YAROSLAVL, an oblast of the Russian Soviet Federated Socialist Republic, surrounded by those of Kalinin, Vologda, Gorky (Nizhegorod), Ivanovo and Moscow. Area 14,286 sq.mi. Pop. (1956 est.) 1,371,000 (urban 757,000).

Thick deposits of boulder clay, remains of the bottom moraine of the icecap of the Glacial period, cover the Jurassic clays, and patches of Triassic variegated marls outcrop in some places, while Upper Carboniferous limestones crop out only in the northwest and toward the east. Coniferous forest, with firs predominating, occupies 39% of the region, and marshes are extensive, especially between the Sheksna and Mologa. and in the Rostov district. Dwarf birch, the arctic raspberry (*Rubus* arcticus) and *Linnaea borealis* are widespread.

The climate is severe, the rivers being frozen 118 to 183 days per annum, average January temperature 6.5° F., average July 61.5° F. The prevailing southwest and west winds make the rainfall heavier than in central Russia.

Of the land free from forest and marsh, only 25% is under plow culture, with rye, oats and flax. Potatoes, barley, grass, vegetables, chicory and herbs are grown, the latter especially in the Rostov district. Meadow and grassland prevail and the region has a flourishing dairy industry, with exports of butter and cheese. Bog iron ores, copper sulfate and pottery clay are obtained and there are salt and mineral springs.

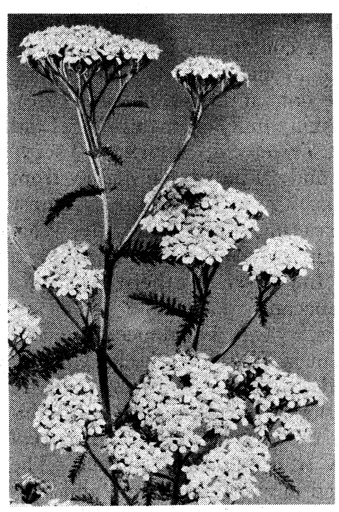
The principal river is the Volga, which is connected with the Neva by the Mariinsk and Tikhvinsk canals through its tributaries the Sheksna and the Mologa. The Kotorost, flowing from Lake Nero to the Volga, is navigable in spring, and the Kostroma, flowing along the northeastern boundary, is a channel for the export of timber and peat fuel. Of the rivers, 39% are available for navigation. Yaroslavl and Rybinsk (*q.v.*) are the chief towns

YAROSLAVL. the chief town of the above oblast on the right bank of the Volga, at its confluence with the Kotorost, in 57° 38' N.. 39° 50′ E. Pop. (1956 est.), 374,000.

It is a productive centre with textile factories, and tobacco, leather and lacquer industries. Founded in 1026–36, it was the chief town of the principality from 1218 to 1417, when it was annexed by Moscow. The Uspenskiy cathedral was begun in 1215 and rebuilt 1646–48, and there are remains of 15th- and 17th-century monasteries.

YARROW, river and parish of Selkirkshire, Scot. Yarrow water, after issuing from St. Mary's loch, flows for $14\frac{1}{2}$ mi. in a northeasterly direction through Ettrick forest to join Ettrick water 2 mi. below Selkirk. The stream and vale are famous in poetry and song.

Population of the parish was 402 in 1951.



ROCHE

YARROW (ACHILLEA MILLEFOLIUM) FLOWERS

YARROW (*Achillea millefolium*), a plant of the family Compositae, also called milfoil, native or naturalized throughout the northern hemisphere. It has white or, rarely, rose-red flowers, borne in flat-topped clusters, and very finely divided leaves. Legend ascribes the discovery of its healing virtues to Achilles, in whose honour it was named. The leaves were in ancient times in great repute for use in the treatment of wounds.

In lawns yarrow sometimes makes a solid turf, being more resistant to drought than most lawn grasses. The closely allied *A. ptarmica,* the sneezewort or sneezewort yarrow?so named because of the use of the root for snuff, native to Europe and northern Asia and found in the British Isles. is naturalized in eastern North America.

YATES, RICHARD (1818–1873), U.S. political leader. born at Warsaw, Ky., Jan. 18, 1818. He graduated at the Illinois college at Jacksonville in 1838. was admitted to the bar and entered politics as a Whig. From 1842 to 1845 and again in 1849 he served in the state house of representatives. He was a representative in congress in 1851–55, but. having become a Republican, was defeated for a third term. From 1861 to 186j he was governor of Illinois, and was successful in enlisting troops and in checking the strong pro-Southern sentiment in the state. He was a member of the United States senate in 1865–71, and was prominent in Reconstruction legislation. He died at St. Louis, Mo., on Nov. 2j, 1873.

His son Richard (b. 1860) was governor of Illinois from 1901 to 1905.

YAUCO, a town near the southwestern coast of Puerto Rico. Pop. (1960) 9,024. The town is located on the highway which connects the cities of Ponce and Mayagüez. Ten miles east at Guayanilla is one of the large oil refineries of Puerto Rico. Ten miles west of Yauco is the port of Guanica where one of the largest sugar-cane factories on the island is located. This port was the first landing place of the U.S. troops commanded by Gen. Nelson A. Miles on July 25, 1898, during the Spanish-American War. In the mountains to the north of Yauco is the island's largest coffee-producing centre. (T. G. Ms.)

YAUPON (*Ilex* vomitoria), a holly shrub of the southern United States. also known as cassina. It grows up to 15 ft. high and bears scarlet berries. A tea brewed from the leaves contains from 1% to 2% caffeine and acts as an emetic.

See HOLLY.

YAVOROV, PEYO KRACHOLOV (1877–1914), Bulgarian poet and dramatist, the founder of the Symbolist movement in Bulgarian poetry, was born at Chirpan, May 6, 1877. Passionately interested in the Macedonian question, he took part in the preparation of the ill-fated Ilinden uprising (Aug. 1903), edited revolutionary papers and crossed twice into Macedonia with partisan bands. He committed suicide at Sofia, Jan. 20. 1914.

Until 1900 he wrote mainly poetry of a social-political character, inspired by compassion for the peasantry, the struggles of the Macedonians and the suffering of the Armenian exiles. Disillusionment with radicalism led him then to abandon realism for introspection and Symbolism. Besides several collections oi poems—*Stihotvorenia* (1901); *Bessanitsi* (1907); Podir *Senkite na Oblatsite* (1910)—his works include the plays *V Polite na Vitosha* (1911) and Kogato Gram *Udari* (1912); a biography of the hlacedonian leader Gotse Delchev; and a book of reminiscences of his fighting days. Naidushki *Kopnenia.* (L. BY.)

YAWS (FRAMBOESIA, PIAN) is a contagious disease with an initial cutaneous papule at the site of inoculation. followed by multiple cauliflower eruptions of the skin: and later, in some cases, by mutilating destruction of the skin. mucous membranes and bones. The agent is a spirochaete, Treponema *pertenue,* discovered by Aldo Castellani in 1905, and is indistinguishable from T. *pallidum,* which causes syphilis. Yaws is confined almost exclusively to the warm moist tropics, including Africa, the West Indies, central and northern South America, Burma, Malaya, Siam. Indochina, the Philippines, Indonesia, northern Australia and the southwest and south Pacific ocean.

Epidemiology.— Unlike syphilis, yaws is innocently contracted. The spirochaetes are present in the serous discharge from the centre of the cracked elevated crust of the lesion and are transferred on direct contact to the abraded skin of an uninfected person. Moreover, filth flies which feed on open sores may transmit the infection mechanically from person to person. The disease is most frequently contracted in early childhood. and considerable immunity to subsequent infection is acquired. In contrast with syphilis yaws is more strictly rural. principally in primitive peoples. Some syphilologists contend that yaws is merely a tropical rural form of syphilis, but epidemiologically and clinically the two diseases are different. Yaws is not congenital and the peculiar characteristic of notched teeth and other signs of congenital syphilis are lacking. Moreover, yaws is usually milder and rarely involves the aorta or central nervous system. The primary yaws sore is characterized by a wartlike thickening of the epidermis. which becomes fibrous, cracks open, bleeds easily and allows the discharge of a serous fluid.

Usually the yaws sores are relatively painless unless they develop in calloused regions, such as the palms of the hands while grasping objects, the soles of the feet while walking and the buttocks while sitting down. They may cause severe itching. The period from inoculation until the "mother yaw," or yaws, appears is three to four weeks. A month or more later, when the first lesion may have disappeared except for a scar, multiple eruptions of the same type characteristically develop, often at mucocutaneous junctions, as around the mouth, nose and anus, or on the perineal skin, neck, arms, legs and buttocks. These lesions, whether initial or secondary, are yellowish red and are somewhat like a raspberry (hence the name "framboesia"). Later the disease may subside, leaving only superficial scarring, but in some instances there may be deforming tertiary yaws, involving the nose (eroding type, "gangosa"; bulbous type, "goundou"), long bones ("boomerang leg" of Australia) and rarely the spleen, brain and great blood vessels.

The primary and secondary lesions, especially in endemic areas, are not readily confused with other eruptive diseases. but at times those on the face must be differentiated from mucocutaneous leishmaniasis and American blastomycosis. The Wassermann and Kahn reactions are usually positive. With early recognition and specific treatment the prognosis is excellent. Arsenicals, particularly mapharsen, are specific against yaws, while some physicians employ bismuth as an adjuvant. Penicillin is rapidly effective in killing the causal agent and in healing the yaws. Prevention consists in isolation and prompt treatment of cases to reduce exposure, and in personal and group hygiene. All abrasions and sores of the skin and mucous membranes should be treated with appropriate antiseptics and covered with clean dressings. and all clothing in contact with yaws lesions should be sterilized to prevent its serving as a vehicle for disseminating the disease.

See G. C. Shattuck, *Diseases of the* Tropics (1951). (E. C. F.)

YAZDEGERD ("made by God." Izdegerdes), the name of three Sassanid kings of Persia. (1) YAZDEGEKD I. son of Shapur III. 399–421, called "the sinner" by the Persians. was a highly intelligent ruler, who tried to emancipate himself from the dominion of the magnates and the Magian priests. He punished the nobles severely when they attempted oppression: he stopped the persecution of the Christians and granted them their own organization. With the Roman empire he lived in peace and friendship, and is therefore as much praised by the Byzantine authors (Procop., Pers., i. 2; Agath., iv, 26) as he is blamed by the Persians. After a reign of 20 years he appears to have been murdered in Khurasan. (2) YAZDEGERD II was the son of Bahram V Gor, 438–457. He persecuted the Christians and Jews, and had a short war with Rome in 441. He tried to extend his kingdom in the east and fought against the Kushans and Kidarites (or Huns). (3) YAZDEGERD III, a grandson of Chosroes II, who had been murdered by his son Kavadh II in 628, was raised to the throne in 632 after a series of internal conflicts. He was a mere child and never really ruled; in his first year the Arabic invasion began, and in 637 the battle of Kadisiya decided the fate of the empire. Ctesiphon was occupied by the Arabs, and the king fled into Media. Yazdegerd fled from one district to another, till at last he was murdered at Merv in 651. The Parsees, who use the old Persian calendar, continue to count the years from his accession (era of Yazdegerd, beginning June 16, A.D. 632). (ED. M.)

YEARBOOK, a term applied to annual summaries either of events throughout the world during the previous year or of general or local progress in some one department of administration, art, science or industry. Examples are the Britannica Book of *the Year, the Statesman's* Year-Book, *Annual* Register, Whitaker's *Almanack,* the World Almanac, Information Please Almanac, biographical records such as the various *Who's Who*, genealogical records such as those of Debrett and Burke and the continental *Almanach de Gotha,* a scientific and scholastic publication of the type of the *Index Generalis,* and the innumerable specialized economic and industrial publications. The English legal *Year Books,* described by Pollock as "our glory. for no other country has anything like them," are reports of cases covering the period 1292 to 1534, written in provincial French. Abridgments of these *Year Books* were made by Sir Anthony Fitzherbert in 1516 and by Sir Robert Brooke in 1568. The first systematic printer of them was Richard Pynson, from 1510; the principal publisher, from 1553, was Richard Tottell. In 1863 A. J. Horwood was commissioned by the then master of the rolls to edit the unpublished *Year Books* of Edward I. This Rolls Series was continued by L. O. Pike and supplemented by Maitland and others working for the Selden society.

The most convenient brief discussions of the *Year Books* are in *Holdsworth's History of English Law,* vol. ii, pp. 444–462 (1903–09), and W. C. Bolland's *The Year Books* (1921).

YEAST. The botanist and microbiologist apply the term yeast to a group of plants, many of which exhibit a marked ability to change sugar into alcohol and carbon dioxide. The characteristics of the group, which includes hundreds of species, are quite restricted. To the layman, untrained in botany, the term yeast suggests the cakes of pressed yeast available in almost every hamlet. The ability of certain yeasts to form carbon dioxide from sugar has caused some of them to be used for leavening bread. For centuries, other species have been used in the making of wine, alcohol, beer, etc. *(See* also FERMENTATION; FCNGI.)

Yeasts probably have as early origin as the bacteria. Grüss examined some fossil remains of Devonian plants and obtained striking evidence of the existence of budding fungi in this early age. This same investigator on examination of the sediment from a beer jar in a Theban tomb of the 11th dynasty (2000 B.C.) isolated a yeast which was named *Saccharomyces winlocki.* Examination of "beer bread" found among the offerings in other tombs also yielded the same yeast. It is now known that yeasts are widely distributed in nature and that those species concerned in fermentation pass the winter in the soil. They are disseminated by bees, dust and other agents in the spring.

The use of yeast in such fermentations as that of bread has made it convenient to have a constant supply of fresh active yeast, While in former days the by-product of certain fermentation industries was used, pressed (or compressed) yeast is now available to those who desire it. To this end the organism is grown in suitable media and the crop harvested when a sufficient crop of cells has appeared. The medium, according to an older method, consists of wort prepared from grains mashed in water. The mash prepared from grains is inoculated with lactic acid bacteria to "sour" it; the acid prevents putrefaction and also serves as food for the yeasts. The clear wort is passed into fermenters where it receives the seed yeast. The temperature is kept constant and rapid growth takes place. The yeast cells are then separated from the fluid in which they have grown by filter presses. They are mixed with starch and pressed into large cakes. These are sent to distributing centres, where they are cut and wrapped in the small size package commonly used in the home. In more recent times, yeast has been cultivated in mineral salt-sugar solutions instead of the wort described above. The cells are also incorporated in corn meal which is pressed into cakes.

Besides the application of yeasts in fermentology, they have been widely heralded as therapeutic agents. Their application to the cure of disease goes back to very early times. Many of the statements on the use of yeasts in this manner rest upon uncontrolled experiments, if indeed they may be called experiments. We are told that the monks used yeast for curing plague and that Hippocrates advised its use in leucorrhea. (F. W. TA.)

YEATS, WILLIAM BUTLER (1865–1939), Irish poet, dramatist and critic, one of the greatest poets of the 20th century, was born at Sandymount, a suburb of Dublin, on June 13, 1865. His father, J. B. Yeats, was a painter of some distinction, whose friendship with Henry Irving, and with the later members of the Pre-Raphaelite school of painters, was to be of importance in his son's work. His mother was of the Pollexfen family of County Sligo; through both parents he claimed kinship with various Anglo-Irish Protestant families who are mentioned in his work.

Soon after his birth 'I-eats's parents moved to London, and he went to school in Hammersmith, but much of his boyhood, and his school holidays, were spent in Sligo, where he stayed with his grandparents. This county, its scenery, folklore and supernatural legend, colours much of his work, providing many and complex emotions, and certain symbols, which are afterward recollected in varying degrees of tranquillity or emotion. A second, and equally important, influence of place was to come later when, after enjoying for long periods the hospitality of Lady Gregory at Coole in Galway, he bought a ruined Norman castle in that neighbourhood, Thoor Ballylee—the Tower which becomes a dominant symbol in much of his latest and best work.

For a short time he studied painting, and retained throughout his life a passionate love and understanding of that art. But while he was still young, his father (always a profound influence upon him) introduced him to two prominent literary figures! Edward Dowden and John Todhunter, of Trinity college, Dublin; and through Dowden's encouragement some of Yeats's earliest poetry was published. But, having returned to Dublin in 1881, his parents again moved to London in 1887, and Yeats became engaged as a professional writer. An early work, *John Sherman and Dhoya* (1891), contains certain biographical elements; but his first success came with *The Wanderings of Oisin* (1889), which the critics compared favourably with Tennyson's "The Voyage of Maeldune." He quickly became involved in the literary life of London of the 1890s: as a founder of the Rhymers' club, a friend of William Morris and W. E. Henley, Lionel Johnson and Arthur Symons. The story of those years is told in *The Tragic Generation,* which, together with *Reveries Over Childhood and Youth,* form part of *Autobiographies* (1926). In 1892 his first play, *The Countess Cathleen,* was published, having for its heroine the beautiful Maud Gonne, who had been attracted to his friendship by the earlier *Oisin,* and who remained a constant source of inspiration (often under the symbol of Helen of Troy) for the remainder of his life.

During this decade other important influences can be seen at work upon the poet's mind. In collaboration with E. J. Ellis he edited *The Poetic Works of William Blake* (1893); and this led him to the study of Blake's thought and its sources in Swedenborg, Boehme and the Neoplatonists. Esoteric reading was widened by his membership in The Order of the Golden Dawn, the Theosophical society and by his friendship with Madame Blavatsky. He knew and admired the work of Aubrey Beardsley and Oscar Wilde (the latter's *Salome* is of some importance as a later influence). Out of the current of the time he drew some knowledge of French literature: Mallarmé, Baudelaire and, above all, Balzac; his friendship with the Indian Purohit Swami led him to Indian theology, and long afterward he was to assist with a translation of the Upanishads. Fruits of this esoteric reading appear in *The Secret Rose, The Tables of the Law* and *The Adoration of the Magi* (all 1897) which, together with *Per Arnica Silentia Lunae* (1918), are important documents for the study of his thought. An earlier volume of essays, *The Celtic Twilight* (1893), indicates another line of development, toward Irish nationalism; he became the first president of the Irish Literary society. In 1897 a series of fortunate meetings, and the financial support of Annie Elizabeth Horniman, resulted in the evolution of the Irish Literary theatre, which gave its first performance (with English actors) in Dublin in 1899. To the end of his life Yeats remained a director of the theatre; in the crucial period 1899–1907—the Abbey theatre was founded in 1904—he managed its affairs, found and encouraged its playwrights (notably J. M. Synge) and contributed many of his own plays. This "time of drudgery" was astonishingly prolific. There is much dramatic criticism, both general and in relation to the ideals of the Irish theatre; essays of major importance on Blake, Shelley, Morris, Spenser (he had made a selection of the poems of Spenser in 1906); essays on Shakespeare, symbolism, painting. This prose has not been collected and edited; much of it is available in *Ideas of Good and Evil* (1903), *The Cutting of an Agate* (1912), *Plays and Controversies* (1923), *Dramatis Per-*

sonae (1936) and in *Essays* (1924). Among the plays which became part of the Abbey theatre's repertoire are *The Land of Heart's Desire* (1894), *The Shadowy Waters* (1900), *Cathleen ni Houlihan* (1902), *The Hour Glass* (1903), *On Baile's Strand* (1905), *The King's Threshold* (1904) and *Deirdre* (1907). Of poetry there is a succession of work, from *The Wind Among the Reeds* (1899) to the collected editions of 1906 and 1908 onward; much of their contents undergoing extensive revision, then and afterward, before their final appearance in the posthumous *Collected Poems* (1949).

The years 1909–14 may be said to mark a decisive change in Teats's life and art. For the previous decade there had been a slow discarding of Pre-Raphaelite rhythms and colours and of certain Celtic and esoteric influences; now the remaking of himself and his style became more definite. Many reasons may be suggested: the quarrel over the production of Synge's *The Playboy of the Western World;* the death of Synge; a loosening of the ties with the Abbey; bitterness over his involvement in Irish politics, as in the affairs of the Municipal gallery and the Lane pictures; his friendship with Ezra Pound, and a new range of study. particularly of metaphysical poetry under the stimulus of Sir Herbert Grierson's edition of *Donne*. All these are reflected in *Poems Written in Discouragement* (1913) and in *Responsibilities* (1914); a tightening and hardening of the verse, a more sparse and pregnant imagery, and perhaps a hatred of "man, woman and event." But now events "came upon him like waves." providing an almost unlimited mass of poetic subject matter. The Easter rising of 1916, later to be refracted with a mythologema and aligned with the legend of Cuchulain, was perceived at first as an emblem of triumphant nationalism ("Easter 1916," "The Rose Tree"); thereafter (with characteristic ambivalence) as that which was to destroy the Anglo-Irish civilization in which he had found an ideal of aristocracy. World War I left little direct mark upon his writing, save for three major poems celebrating the death of Maj. Robert Gregory. Of these the most famous is "An Irish Airman Foresees His Death," the mood of which is denied by a later poem, "Reprisals" (not in *Collected Poems),* which is the outcome of the "war" between the English and the Irish Republican army during 1918–21. In 1917 he published *Tlze W'ild Swans at Coole,* married. lived for a lime at Thoor Ballylee, moved to Oxford and began to read vigorously and widely. From then onward he reached the height of his achievement, a renewal of inspiration and a perfecting of technique that is without parallel in the history of English poetry. *The Tower* was published in 1928, *The Winding Stair* in the United States in 1929. Both use, as dominant subjects and symbols, the Irish rising and civil war, his own Norman tower. the Byzantine empire and its mosaics; Plato, Plotinus and Porphyry; his interest in the philosophy of G. E. Moore and contemporary psychical research. The scaffolding of his "philosophy" or "system" is contained in the prose work, *A Vision* (1925, revised extensively in 1937); it contains, often in deliberately veiled statement, a theory of history and of the human soul and personality which. whatever disagreement it may provoke. is indispensable to the serious student of his work. In 1936 he edited, with a long prefabory essay. *The Oxford Book of Modern Verse,* a selection which was sufficiently unorthodox (since it reflected to a certain degree his own tastes and friendships) to arouse hostile criticism. At the same time he wrote a number of important plays; the Nō theatre, to which Pound had introduced him, provided a framework drama designed for a small audience of initiates; stylized, intimate, capable of using to the full the resources of mask, mime. dance and song, and of conveying—in contrast to the public theatre—his own recondite symbolism. So we have *Four Plays for Dancers* (1921), *Calvary* (1930) and *The Resurrection* (1931); in more normal technique. *The Cat and the Moon* (1924), *The Words Upon the Window Pane* (published 1934); the translation of Sophocles' *Oedipus Rex* (1928). These were followed in 1934 by two versions of *A Full Moon in March,* together with some important poems related both to the Irish political scene and to his renewed interest in Indian philosophy, as evidenced by his part translation of *The Ten Principal Upanishads* (1937).

In 1922 Yeats was elected a senator of the Irish Free State. and became (as he to some extent remained) the "sixty-year old smiling public man." In 1923 he was awarded the Nobel prize for literature) which he celebrated in the essay "The Bounty of Sweden." Thenceforward may be traced an increasing disillusionment with the Irish scene. Lady Gregory. who had been for nearly 40 years his friend, patron and co-worker, died in 1932; Coole park. where so much of his poetry was written. became desolate. An increasing preoccupation (like that of his master Swift) with the problem of the One and the Many culminated at the last in the pamphlet called *On the Boiler* (1939) of which the setting is Sligo quay. In *Last Poems* (1939) many previous themes are gathered up, rehandled, with an immense technical range; using (in particular) ballad rhythms and dialogue structure. with an undiminished energy. as he approached his 70th year; and culminating in *Under Ben Bulben* and his own Epitaph. Of drama there are the complex and many leveled play *The Herne's Egg* (rejected. typically, by the Dublin stage for religious reasons); the mysterious *Deatlz of Cuchulain;* and the brief but important *Purgatory,* which T. S. Eliot has recognized as among the most important contributions to the verse drama of the 20th century. It is noteworthy that one of the *Last* Poems—"Cuchulain Comforted"—was dictated a few hours before his death, which took place at Roquebrune in the south of France on Jan. 28. 1939. The body lay in a cemetery there during World War II. until (in accordance with his wishes) it was brought back for burial in the churchyard at Drumcliff. near Sligo, under the shadow of Ben Bulben.

Had Teats ceased to write at the age of 40, it is probable that we should value him as a minor poet, writing in the dying Pre-Raphaelite tradition that had drawn for a time renewed beauty and poignancy from the Celtic revival. There is no precedent in literary history for a poet who produces his greatest work between the ages of jo and 7j. The work of this period takes its core of being from his long and dedicated apprenticeship to poetry, so that, finally "words obey my call"; from his experiments in a wide range of forms of poetry, drama, prose; from the consolidation of his own spiritual growth and physical experience. into the framework of his own mythology. This last. from which arises the distilled symbolism of his great period. is not always easy to understand; nor did Yeats intend its full meaning to be apparent except to those who had followed his thought and who were conscious of the tradition in which he worked. His own cyclic view of history suggested a recurrence and convergence of images, so that they become multiple and enriched; and this progressive enrichment (which involves the consideration of his work as a unity) may be traced throughout his life. Among such dominant images are Leda and the Swan. Helen and the burning of Troy; the Tower in its many forms; Byzantium and its mosaics; sun and moon; the burning house; cave, thorn tree and well; eagle, heron, sea gull, hawk; blind man, lame man and beggar; unicorn and phoenix; horses, hound and boar. Yet, though traditional, these images are continually certified, validated, by their alignment with his own experience, and it is this that gives them their peculiar vital quality. In the verse they are often shaped into a strong and proud rhetoric. that "high breeding" of style. or into the many poetic tones of which he was master. All are informed by the two qualities which he valued and retained in old age, "passion"—"cold passion —and "joy."

Bibliography.—The bibliography of Yeats is vast and complicated, and is best studied through Allan Wade's *A Bibliography of the Writings of W. B. Yeats* (London, 1951; New York, 1952). Since his poems (and on occasions his plays) were often meticulously and repeatedly revised between the date of their first appearance and their progress through successive editions—and these revisions are an index to the growth of his mind—reierence should be made to the *Variorum Edition* of the poems, ed. by P. Allt and R. K. Alspach (New York, 1957; London, 1958). Various collections of *Letters* are indispensable; notably Allan Wade's edition of the *Letters* (London, Toronto, 1954), *Letters on Poetry to Dorothy Wellesley* (Oxford, New York, 1940), J. B. Seats's *Letters to His Son,* ed. by J. M. Hone (London, 1944; Sew York, 1946). The amount of critical literature is considerable, and is increasing yearly; *see* the *Cantbridge Bibliography of English Literature;* J. M. Hone, *W. B. Yeats, 1865–1939* (London, 1942; New York, 1943); L. MacNeice, *The Poetry of W. B. Yeats* (London, New York, 1941); Graham Hough, *The Last Romantics* (London, 1949; New York,

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YELLOWBIRD, a name applied in the United States to the American goldfinch (Astragalinus tristis) and to the yellow warbler (Dendroica petechia). See GOLDFINCH, WARBLER.

YELLOW FEVER is an acute infectious disease of tropical and subtropical regions that is capable of devastating invasions of the temperate zones. The disease is caused by one of the smaller viruses (*q.v.*), which is also infective to all species of monkeys and to certain species of galagos, opossums and rodents. The virus is transmitted among susceptible hosts by any of several species of mosquitoes.

History and Distribution. — There is considerable uncertainty concerning the origin of yellow fever. Although West Africa has been regarded as the home of the virus, there is no account of an outbreak suggesting yellow fever along the west coast of Africa until well over a century after the Columbian voyages. On the other hand, the early Spanish explorers to the new world reported a highly fatal epidemic disease characterized by bloody vomiting. That the disease had long been known in Central America and the coastal regions of the adjacent South American continent is suggested by the Maya chronicles, which speak of an outbreak of bloody vomiting (xekik) that ravaged Yucatan in 1484. Similar outbreaks (matlazahuatl) in southern Mexico appear to have wiped out coastal settlements in pre-Columbian times.

For more than 200 years yellow fever was one of the great plagues of the world. The tropical and subtropical regions of America were subjected to devastating epidemics, while serious outbreaks occurred as far north as Boston and as far away from the endemic centres as Spain, France, England and Italy. During this period, appalling epidemics swept repeatedly over the West Indies, Central America and the southern United States, decimating populations, paralyzing industry and trade and holding the people of these regions in a state of perpetual dread.

Philadelphia suffered 20 epidemics, New York city 15, Boston 8 and Baltimore 7. The last outbreak in the United States occurred in 1905, when New Orleans was invaded as were other ports of the south.

There are known to be two substantially different patterns of transmission of the virus. They are: (1) urban or classical yellow fever, in which the transmission is from man to man by the *Aëdes* aegypti mosquito; and (2) jungle yellow fever, in which man may become involved incidentally in a forest cycle in which the mammalian host is usually a monkey and the transmitting mosquito may be one of a number of forest-living species. Until well into the 20th century, urban yellow fever was the only cycle known. Carlos Finlay of Havana, Cuba, in 1881 advanced the thesis that the infectious agent was transmitted by the mosquito now known as Aedes aegypti (then called *Stegomyia* fasciata). Proof of this was established in 1900 by the Yellow Fever commission of the U.S. army under Maj. Walter Reed (*q.v.*) by experiments using human volunteers including the members of the commission. In 1932 unquestionable yellow fever in the absence of Aedes aegypti was encountered in Espirito Santo, Braz.

It was then recognized that a similar situation had long existed in various parts of Colombia. Studies in both Brazil and Colombia demonstrated the second type of cycle in the tropical forest involving animals and forest mosquitoes and not requiring the presence of man.

With the discovery of the jungle habitat of the virus, it became apparent that it was constantly present over a huge area of South America, which could be described roughly as the drainage areas of the great rivers Magdalena, Orinoco and Amazon, and extending up the eastern slopes of the Andes mountains to about 1,500 m. of elevation and as far south as Bolivia.

Later it was found that the virus was established in the forests of tropical Africa save in regions at high altitude. Again, the river systems delineate most of the endemic region: the Volta, Niger, Cross, Congo and Zambezi rivers and the upper portion of the Nile.

Because of the effective campaigns for the eradication of *Aëdes* aegypti throughout South and Central America, only sporadic cases infected in the forest have been encountered in Latin America since 1934. In Africa, however, a case of jungle origin rarely is recognized because of the vast preponderance of Aedes aegypti transmissions in the villages.

An important exception is the Republic of the Congo, where suppression of Aedes aegypti and an effective diagnostic system (viscerotomy) have permitted the identification of many cases of true jungle yellow fever.

Urban outbreaks have not been seen along the east coast of Africa. and the disease is unknown in India and the countries of the far east.

The Virus. — The yellow fever virus multiplies in the living cells of certain species of animals and mosquitoes. Extraordinarily large concentrations of virus may occur in the blood of some mammalian hosts. Not only may the virus multiply in the intact animal or insect, but it generally grows excellently in embryonic cells in tissue culture.

While Walter Reed had shown that yellow fever mas caused by a virus, experimental work awaited a susceptible animal. The West African Yellow Fever commission found that the rhesus monkey from India would become fatally ill from the West African yellow fever virus. Later the white mouse was also shown to be susceptible, permitting the development of practical methods for demonstrating immunity.

Clinical Features. — After the bite of the infecting mosquito, there is an incubation period of several days while virus is multiplying within the body. The onset of symptoms is characteristically abrupt, with headache, severe backache, rapidly rising fever, nausea and vomiting. In severe cases there is hemorrhage into the mucous membranes, so that vomiting of dark, altered blood is one of the classical manifestations. Because the virus injures and destroys liver cells, jaundice is common, and is reflected in the name of the disease.

The course of the disease is rapid. Convalescence is prolonged, but recovery, when it occurs, is remarkably complete and accompanied by a lifelong immunity. Mortality varies greatly, depending upon the strain of virus and to some extent upon race.

There is no specific treatment for yellow fever. Good nursing and supportive care are important in maintaining comfort and reducing mortality.

Epidemiology. — Free yellow fever virus may be found circulating in the blood stream during the first four to six days of the illness. The mosquito vector must feed during this period if it is to receive an infective dose. Thereafter, about 12 days must pass before the virus has multiplied in the mosquito so that the salivary glands of the insect have become infective. Henceforward, it will discharge a small amount of virus through its proboscis each time it takes a new blood meal. If the animal or man that is bitten is susceptible, a new case of yellow fever virus infection results and the cycle begins again.

Classical or urban yellow fever involves only man and Aedes aegypti. Concentrations of population, a house-loving mosquito vector and the introduction of the virus furnish the necessary conditions for an epidemic. In the tropical forest. similarly, the spread and maintenance of the virus is dependent upon the density of susceptible animals and the efficiency of the transmitting mosquitoes.

Migration of the virus may occur through travel of either the infected animal or man or the virus-carrying mosquitoes. The direct flight of mosquitoes is generally limited, but winds may carry them long distances. Mosquitoes, like man, may also enjoy the facilities of the airplane. In nature, speeds are more moderate. For example. in the Central American outbreak that began in 1948, the progression northward as shown by both human and monkey infections was at an average speed of 13 mi. per month.

In South America, the chief vector mosquito in the forest belongs to the genus *Haemagogus*. The species most frequently implicated in the Amazon and Orinoco watersheds is H. *spegazzinii* *falco.* From the central portion of Colombia northward the genus is complex, and more than the one species may participate in the transmission. There are a few other forest mosquitoes in tropical America that under certain conditions appear to be able to spread the virus of yellow fever.

The forest mosquito of tropical Africa that fills the role of *Haemagogus* in tropical America is *Aedes africanus.* Like its American counterpart, it breeds in tree holes and exhibits a marked preference for the forest canopy. Unlike *Haemagogus,* which bites only by day, *A. africanus* becomes active at dusk and may bite through the night. These biological differences are of the greatest importance; the forest infections of man are acquired during daylight where *Haemagogus* is the vector, but, because there is little human contact with the forest after dark in tropical Africa, transmission of yellow fever to man by *Aedes africanus* must be rare.

Another mosquito, *Aedes simpsoni,* has been found to predominate in carrying the virus from monkeys to. man. especially in the eastern portion of equatorial Africa.

In South and Central America, some of the monkey species. but especially the howlers *(Alouattaj,* exhibit high mortality. Generally, the other susceptible animals show a similar ease of infection with the virus but do not become appreciably ill. The African monkeys generally behave as the *Cebus* of South America in that they may be readily infected and circulate virus adequate to infect mosquitoes without showing signs of illness. A notable exception is the bush baby *(Galago),* some of uhich show high fatality with yellow fever virus infections.

As a generality, all the mammals that are susceptible to the virus produce antibodies and, if they survive the acute disease. are thereafter immune for life. The monkey behaviour thus has many parallels with the human case, and careful study of the blood antibodies of animals may serve to reconstruct the past history of a forest region with respect to the passage of yellow fever virus through the area.

Prevention.—Yellow fever is an outstanding example of a completely preventable disease. Originally, the control of *Aëdes aegypti* mosquitoes was the only preventive procedure available. The success of the campaign against these mosquitoes made possible the Panama canal Later it appeared more economical to eradicate the mosquito than merely to control it. and all of South and Central America and Mexico have been freed from this dangerous mosquito.

Live virus vaccines, capable of producing active immunity without clinical illness, are the second great preventive measure. French workers hdve used an attenuated neurotropic virus in mouse brain for the successful immunization of millions of persons, especially in Africa. In the United States, workers of the Rockefeller foundation produced the 17-D vaccine strain by prolonged cultivation of the Asibi strain in embryonic chick tissues. The vaccine made from growing the 17-D virus in chick embryos has been employed for the immunization of millions oi people all over the world.

Eradication of the *Aedes aegypti* mosquito gives effective protection to the populace of cities. Where people must travel or live in regions where the forest cycle of the virus is maintained. then individual immunization is necessary. In jungle yellow fever areas, human cases will continue as long as there remain unimmunized persons, for there is no known practical way of eliminating the virus of yellow fever from the vast tropical forests of South America and Africa.

See also references under "Yellow Fever" in the Index volume

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YELLOW POPLAR: *see* TULIP TREE.

YELLOW RIVER: *see* HWANG-HO.

YELLOWROOT, a small North American shrub (*Xanthorhiza simplirissima)* of the crowfoot family (Ranunculaceae, *q.v.*), found in woods from western New York to Kentucky and Florida. It has smooth stems, one to two feet high, with yellow wood, long yellow roots. parsleylike leaves and small purplish flowers in slender drooping clusters. It is sparingly planted for ornament. Yellowroot is also applied to the goldenseal *(Hydrastis canadensis)* and goldthread *(Coptis trifolia).*

YELLOW SEA (HUANG HAI), a large inlet of the Pacific ocean (area about 180.000 sq.mi.) lying between Korea and China. The Strait of Chihli between the Liaotung and Shantung peninsulas links the Yellow sea on the northwest with the Gulf of Chihli (Po Hai) and the Gulf of Liaotung. To the south the Yellow sea merges with the East China sea along a goo-mi. line between the southwestern tip of Korea and the coast of Kiangsu province south of the Shantung peninsula. The Yellow sea is shallow with a maximum depth of about 250 ft., lying entirely above the continental shelf.

Although some warm, saline water from the Japanese (Kuroshio) current enters the Yellow sea. water temperature and salinity are highly variable and strongly influenced by an inflow of fresh, silt-laden water from major rivers. Of these: the Yellow river (Huang Ho). flowing into the Gulf of Chihli. is the most important. One of the most heavily silt-laden of the world's major rivers, the Yellow discharges an estimated 15,000,000,000 cu.yd. of sediment per year, hence the name for both river and sea. The Huai river reaches the Yellow sea south of the Shantung peninsula, a course also followed by the Yellow river at various periods during the past and most recently during the years 1938–47. To tht north other important rivers are the Pai, the Liao and the Yalu in China and the Taedong and Han in Korea.

None of these rivers is important for water transport, and port development is handicapped along much of the shore line by silting and the substantial tidal fluctuations. However, the areas adjacent to the Yellow sea are densely populated and agriculturally productive. Mineral and manufacturing industries were being rapidly expanded in the second half of the 20th century, especially in north and northeast China. with a consequent potential for substantial import-export traffic through the Yellow sea. Ports such as Tsingtao. Chefoo, Tientsin, Hulutao, Port Arthur, Dairen and Inchon are signiiicant for both coastal and overseas commerce.

Although statistics are lacking, fishing is of undoubted importance in view of the population pressure in the adjacent areas and the abundance of fish in the waters above the continental shelf. Fishing villages dot the hilly, indented coasts of the Shantung and Liaotung peninsulas. Also Korea is an important fishing nation, with its major concentrations of population in the area facing the Yellow Sea. (T. R. S.)

YELLOW SPRINGS, a village of Ohio, U.S., is located in Greene county 9 mi. S. of Springfield, 9 mi. N. of Nenia and 18 mi. E. of Dayton, in the Dayton metropolitan area. The village. which was incorporated in 1856, was named after a local spring originally the site of a resort and health spa during the period 1820–80. Antioch college, a private, nonsectarian, coeducational. liberal arts institution was founded there in 1852 with Horace Mann (*q.v.*) as its first president. Over the years, the college became known for its high academic standards. its pioneering leadership in the field of education, its alternating work-study program and the affiliated research organizations of the Charles F. Kettering foundation and Fels Research institute for the study of human development. The teaching and research faculty numbers about 125 and over 1.200 students are enrolled representing 44 states and 13 foreign countries.

The local industries are diverse, producing aluminurn castings. molded rubber products, electronic equipment. stained glass. granite surface plates. bronze art casting and most of the nation's bookplates. The national headquarters of the American Humanist association as well as Community Service Inc. are located there. (J. F. LY.)

YELLOWSTONE NATIONAL PARK, oldest and best known of the United States national parks, uas established by congress March 1, 1872, as the first extensive land area set aside and preserved by any government for the benefit and enjoyment of the people for all time to come.

The park includes 2,221,773 ac.. including 8 566 ac. of nonfederal land, and is surrounded by national forests — the Gallatin on the north, Shoshone on the east; Teton and Targhee to the south and the Targhee and Gallatin on the west. The park is bordered on the east and south by Wyoming, on the west by Idaho and Montana and on the north by Montana.

Volcanic plateaus. with an average elevation of 8,000 ft.. compose most of the park. High rugged mountains flank and protrude into it on the northwest, north and east. The peaks along the northwest are the Gallatin range. with the 10,992-ft. crest of Electric peak being the park's second highest. The majestic Absaroka range forms an unbroken barrier along the eastern side, and many of its rugged peaks and canyon-grooved mountain masses lie within the park. Eagle peak, elevation 11,360 ft., the park's highest point, is in the southern section of this range. The Snow mountains stretch their snow-capped summits across the north — just beyond the park. The Teton range. one of the most spectacular features of the northern Rockies, looms high upon the park's southern horizon, and its northern foothills approach the park.

Tellowstone has unusual geologic phenomena. Outstanding among these are fossil forests, eroded basaltic lava flows, Obsidian cliff—a, black glass mountain — spectacular deep valleys. unique landslides. vast bisected plateaus and odd erosional forms.

Yellowstone's 10,000 hot springs find surface expression as steam vents; fumaroles. colourful hot pools, mud caldrons. paint pots! hot springs and terraces, hot rivers and geysers. Of its 200 geysers, many erupt to heights in excess of 100 ft. Outstanding thermal zones are: the Upper, Midway, Lower. Norris. Rest Thumb, Heart lake and Shoshone lake geyser basins, the Mud Volcano area and the Mammoth Hot Spring terraces.

Old Faithful geyser. with its graceful and beautiful column of hot water and steam vapour. was named by Gen. Henry D. Washburn in 1870. Its average eruption interval is 64.j minutes — intervals vary from 33 to 93 minutes. Eruptions'last 2½ to j minutes — 10,000 to 12,000 gal. of water are discharged. Eruption heights average 150 ft. Although eclipsed in size by other geysers, Old Faithful remains the most popular.

Hot pools of great magnitude provide brilliant splashes of colour on the white sinter plains of the geyser basins. Their names suggest their gemlike beauty — Turquoise. Emerald. Jewel, Sapphire, Beryl, Grand Prismatic, Opal and others equally expressive.

Hundreds of miles of clear streams flow from the park's mountains and plateaus. Large rivers are the Yellowstone, Snake, Madison. Lamar. Falls. Bechler. Firehole. Gallatin, Gardner and Gibbon. A pattern of creeks, tributary to these rivers, spreads to the crests of the mountain ranges. Beautiful waterfalls occur along the stream courses. Lakes and ponds dot the forested plateaus. Yellowstone lake's maximum depth is 320 ft.. surface 139 sq.mi., length 20 mi.. width 14 mi., shore line 110 mi. and mean surface elevation 7,731 it. Unexcelled as a place of beauty, it is a sapphire in a jade green forest surrounded by snow-capped mountains. Other large park lakes of unusual beauty are Shoshone, Lewis, Heart and Grebe.

The Grand Canyon of the Yellowstone, sculptured from decomposed rhyolite lava rock, is a colourful gorge 19 mi. long. Its greatest depth is 1,540 ft., and its widest point 3,500 ft. It is a remarkable display of the work of water, wind, weathering and other erosive forces. The brilliant multicoloured walls of red, pink, yellow. buff. lavender. white and a thousand combinations of these colours are its crowning glory. The rugged pinnacles, ridges, spires, sinuous river. white cascades and emerald green waters enhance its spectacular character. Two majestic waterfalls grace it with their beauty — the Upper falls drops 109 ft., the Lower falls 319 ft.

The park's verdant plant covering varies from microscopic algae in hot-spring runoffs to forest trees. The park is 90% forested, and 90% of this is lodgepole pine. The park's eight evergreen species are: lodgepole pine, Engelmann's spruce, Douglas fir. subalpine fir, limber pine, nhitebark pine, Rocky mountain juniper and mountain common juniper. Cottonnoods grow along streams and aspen stands occur in many sections. Intermontane meadows abound, and vqst alpine tundra areas occur above timber line. In season, wild flowers splash the landscape nith colour. Colourful flowers include geraniums, lupines, phacelias, sunflowers, balsamroot, fringed gentians, cinquefoils, pedicularis and many more. Dainty, rare and less conspicuous plants bloom in secretive woodland environments. Small lakes harbour aquatic plants — their surfaces covered with bright yellow wokas blossoms.

The park fauna, typifying the native animals of the Rocky mountain region, runs the gamut from microorganisms to American bison. Large mammals — elk, mule deer, moose, bighorn, antelope, bison, black bear and grizzly bear — and coyotes are common. Wolves, fisher! cougar, white-tailed deer and wolverines are extinct or rare transients. Smaller mammals, otter. mink, badger, weasel. marten, beaver. skunk. marmot and many small rodents are commonly seen. The bird list includes 237 species as permanent residents and seasonal migrants. Waterfowl are especially abundant on the lakes and streams. Reptiles and amphibians are not abundant. The park waters are stocked with a variety of fishes,, and the native black-spotted trout is eagerly sought by fishermen.

John Colter in 1808 first described the Yellowstone country. Daniel T. Potts, July 8, 1827, wrote a vivid description of West Thumb geyser basin. James Bridger, Joseph Meek, Osborne Russell and other trappers told of the canyon, lake and geysers. Warren Angus Ferris prepared a comprehensive map of the countryside in 1836. In 1859 an official government party, commanded by Capt. W. F. Raynolds, failed to reach the fabled area. The well-planned expedition of 1870, led by General Washburn and Lieut. Gustavus C. Doane, explored the area and forcefully promoted the establishment of Yellowstone National park.

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YELLOWSTONE RIVER, U.S., most productive tributary of the Missouri river. is an interstate stream draining southeast Montana, north central Wyoming and a small, northwest area of North Dakota. The river and all its principal tributaries — Clarks Fork. Bighorn, Tongue and Powder rivers — originate in and receive most of their water from the Absaroka, Wind River and Bighorn mountains. Rising on the slopes of Younts peak in Wyoming, the river enters Yellowstone National park and feeds into Yellowstone lake via the southeast arm. Below the lake it plunges 422 ft. in two spectacular waterfalls and enters one of the most magnificent of all river gorges, the Grand Canyon of the Yellowstone. Leaving the park at Gardiner, Mont., the river turns north to Livingston, thence northeast past Billings, Miles City and Glendive. crosses the Montana state line and joins the Missouri near Buford, N.D. The river system is used primarily for irrigation. Its lower reaches are generally silt laden but its headwaters are clear, snow-fed streams, originating in heavily forested, mountainous areas with abundant recreational, fishing and hunting resources.

The Yellowstone was unexplored until 1806 when Lieut. William Clark sailed down the river on his return journey from the Pacific. Manuel Lisa. Indian trader, accompanied by John Colter, established the first trading post on the Yellowstone at the mouth of the Bighorn river in 1807. In connection with this endeavour, Colter visited the Indian tribes south of the river, which, in turn, led to his becoming the first white man to see the geysers of Yellowstone park. (G. V. Sk.)

YELLOWTHROAT, the name given to a species. with several subspecies, of North American birds of the passerine family Mniotiltidae, the American wood warblers. The best known is the Maryland yellowthroat (*Geothlypis trichas*) which ranges over the greater part of the United States and southern Canada.

About five inches long. this bird is olive green above. yellow below. with black forehead and cheeks in the male. Its subspecies the tule yellowthroat (G. t. *scirpicola)* is resident in southern California.

The western yellowthroat (G. *t. occidentalis*) is found in southeastern California and southwestern Arizona.

YELLOWWOOD, AMERICAN (Cladrastis *lutea*), a handsome North American tree of the family Leguminosae, called also yellow locust. gopherwood and virgilia. Though somewhat rare in the wild state! being found only locally in rich soils, chiefly along mountain streams. from North Carolina to Missouri, it is widely cultivated for ornament. The tree has a short trunk branching into a graceful crown, sometimes rising 50 ft., with smooth bark, pinnate leaves and fragrant, pealike white flowers, 1 in. long, borne in loose drooping clusters, 10 in. to 20 in. long, blossoming in June. The hard strong wood yields a yellow dye.

YEMEN (YAMAN), a kingdom in the southwestern coastal region of the Arabian peninsula, bounded northwest and northeast by Saudi Arabia, southeast by Aden and southwest by the Red sea. Area 75,290 sq.mi.; population (1953) about 4,500,000. The capital is Sana (*q.v.;* pop. about 50,000).

Ptolemy and the ancient geographers in general include the whole peninsula under the name of Arabia Felix (eudaimon), in which sense they translate the Arabic *Yaman,* literally "right hand," for all Arabia south of the Gulf of Aqaba was to the right from their standpoint of Alexandria; the Moslem geographers, however, viewing it from Mecca, confine the term to the regions south of Hejaz, including Asir, Hadhramaut, Oman and part of southern Nejd.

Yemen occupies the uptilted edge of a block of ancient land forming Arabia. This edge is known as the Jibal or highlands of Yemen (average height 9,000 ft., highest measured point 12.336 ft.). The principal town of the Jibal is Ta'iz (pop. about 12,000), formerly a large city, in the centre of a comparatively fertile district and at the junction of several trade routes. About 30 mi. farther north are the small towns of Ibb (6,700 ft.) and Jibla, about 5 mi. apart, typical hill towns with their high stone-built houses and paved streets. Manakha produces the best coffee in Yemen. Still farther north, in the mountain mass between the Wadi Maur and Wadi Laja, the strongholds of Dhafir, Afar, Haja and Kaukaban have long been known for their independence. The last-named was once a city of 20,000 inhabitants and the capital of a small principality which preserved its independence during the earlier Turkish occupation between 1536 and 1630. The lowland strip of Yemen, from 20 to 30 mi. wide, is known as the Tihama and is hot and generally sterile. There are oases, however, near the foot of the mountains, fertilized and irrigated by hill streams and supporting many large villages and towns. The most important of these are Zaidiya, Bait al Faqih and Zabid in the western Tihama, the latter a town of 20,000 inhabitants. Hodeida (*q.v.*) is the only port of commercial importance. while Mokha is the old centre of the coffee trade. Beyond the crest of the Jibal stretches the third natural region of Yemen — the great desert. As it lies entirely to the east of the high crest, it has a smaller rainfall than the Jibal. Its general character is that of a steppe increasing in aridity toward the east where it merges in the desert, but broken in places by rocky ranges. some of which rise 2,000 ft. above the general level and which in the Hamdan district north of Sana show evidence of volcanic action. 'This desert is intersected by several wadi systems, of which the principal are: in the north those uniting to form the Wadi Najran; in the centre the Wadi Kharid and Shibwan running to the Jauf; and in the south the Wadi Bana and its affluents draining to the Gulf of Aden. The plateau has a gradual fall from the watershed near Yarim. 8,500 ft. above sea level, to less than 4,000 ft. at the edge of the desert.

The northern part nearly down to the latitude of Sana is the territory of the Hashid and Baqil tribes. which never submitted to the Turks. Sada is an important town on the old pilgrim road 120 mi. S. of Sana, Khaiwan and Khamr. To the northeast, bordering on the desert. lies the district of Najran, now in Saudi Arabia, a mountainous country with several fertile valleys including the Wadi Najran, Badr and Habuna. all probably draining northeast to the Rub' al Khali. Farther south is the oasis of Jauf, a hollow or depression, as its name signifies, containing many villages. It was the focus of the old Minaean and Sabaean kingdoms, known to the ancients through their control of the frankincense trade of south Arabia. Ma'in, identified by Halévy as the seat of the former, is on a hilltop surrounded by walls still well preserved. Marib, the Sabaean capital, had a great dam to whose breaking between A.D. 542 and 570 tradition ascribes the final decay of Yemen. The city was abandoned. probably because oi the deterioration of the country through desiccation, which forced the settled population farther westward, where Sana became the centre of the later Himyaritic kingdom. The Arhab district drained by the Wadi Kharid and Shibwan between Sana and the Jauf is covered with Himyaritic ruins. showing that the land formerly supported a large settled population. Throughout Yemen is found the *mijal*—a cemented well for the storing of water. These wells have associations with Persian influence in the 6th century A.D. South of the territory described above are Amran and Shibam on the road leading north from the capital Sana; Dhamar (the seat of an ancient university) and Yarim are on the road leading south to Aden; and two days' journey to the east is Rada'.

The inhabitants of Yemen are settled and for the most part occupied in agriculture and trade. The people may be considered under four groups: (1) the Saiyids or Xshraf. descendants of the Prophet. forming a religious aristocracy; (2) the Qabail or tribesmen, belonging to the Qahtanic or original south Arabian stock, who form the bulk of the population; (3) the trading class; and (4) a mixed group mostly of African descent. A Jewish minority of 50,000 emigrated to Israel in 1949.

The kingdom of the Yemen, founded by a revolt against the Ottoman empire led by the imam Yahya ibn Mohammed ibn Yahya Hamid ud-Din in 1904. achieved its full independence in 1918. In 1933 it lost its northern province Asir to Saudi Arabia.

The imam Yahya, inurdered in Feb. 1938. was succeeded by his eldest son. Xhrned ibn Yahya ibn Mohammed Hamid ed-Din. The government is patriarchal. An Anglo-Yemeni agreement of 1951 established diplomatic relations between Great Britain and Yemen. However, throughout the mid-1950s there were clashes on the frontier between Yemen and the West Aden protectorate which the Yemeni government claimed as part of its territory. In 1955 a G.S. company secured the first oil and mineral concession ever granted by Yemen. In the same year Yemen established diplomatic relations with the C.S.S.R.. and a trade agreement was later concluded between the two countries. During 1957 arms were imported in some quantity from the Soviet Union and Czechoslovakia.

The federation of Yemen with the United Arab Republic (formed March 8, 1958. and known as the United Arab States) was dissolved in Dec. 1961. See also ARABIA.

See Hugh Scott, *In the High Yemen,* 2nd ed. (1947); A. Faroughy, *Introducing Yemen* (1947); G. E. Heyworth-Dunne, *Al-Yemen. Social, Political and Economic Survey* (1052); Current history and statistics are summarized annually in *Britannica Hook of the Year.*

(P. K. H.; X.)

YEN, the monetary unit of the Japanese empire, is divided into 100 sen and 1,000 rin.. Under the Gold Standard law of 1897 the yen has a theoretical gold content of 750 mg. of fine gold. but Japan's gold reserves are valued under the Gold Reserve Revaluation law of 1937 on the basis of a gold content of 290 mg. per yen. The obligation of the Bank of Japan to convert its notes into gold was suspended by the Gold embargo of Dec. 13. 1931, and repealed by the Law of the Bank of Japan of 1942. From 1936 on, the extension of Japanese domination to parts of China and southeast Asia brought under the control of the Bank of Japan (*q.v.*) the various currencies of the "Greater East Asia Co-prosperity Sphere." and resulted in the formation of a "yen monetary bloc." At the time of its largest expansion, in 1944, the yen bloc included the currencies of Manchoukuo, Mongolia, northern China, central and southern China, Indochina. Malay, Thailand. Burma, the Philippines and the East Indies. The Japanese authorities followed a policy of bringing about a uniform value (1:1) between the various local currencies and the yen through strict control of all movements of funds and goods between countries of the yen bloc.

After World War II the Bank of Japan was reorganized. the responsibility for setting money policies being assumed by a new policy board, comprised of the president oi the bank and representatives of various financial interests. In Jan. 1950 a new 1,000-yen bank note was introduced. The official value of the yen in 1957 was 360 to the U.S. dollar. (F. M. T.; X.)

YENISEI, a river of central Siberia, U.S.S.R., is one of the largest in the world. with a length of 2.538 mi. Its drainage area is 1,003,485 sq.mi. The Yenisei is formed by the union of the Bolshoi Yenisei, or Bii-Rhem, and the Maly Yenisei, or Ka-Khem. These two headstreams rise in the Tuva Autonomous Soviet Socialist Republic and flow westward through tectonic basins to meet at Kyzyl. Thereafter the Yenisei flows west past Shagonar and turns sharply north to cut through the western Sayan mountains in a narrow gorge, in places less than 100 yd. wide. In this stretch are many rapids. notably those of Bolshoi Porog. The river emerges from the western Sayans into another broad, tectonic basin. that of Minusinsk in Krasnoyarsk *krai.* There the Yenisei receives its first large tributaries, the Abakan on the left and the Tuba on the right. and becomes nearly 1.000 yd. broad and braided. As the Yenisei cuts across the northern end of the eastern Sayans, it is once more confined in a single bed, between high granite banks. On this section, immediately above Krasnoyarsk, the construction of a huge barrage and hydroelectric station was begun in 1956. The station was planned to have a capacity of 4.000.000 kw. and the reservoir to hold 105,000,000,000 cu.yd.

At Krasnoyarsk, the largest town on the Yenisei, the river is crossed by the Trans-Siberian railway and transshipment is important.

Below Krasnoyarsk the river follows a north-by-west course to its estuary, along the western edge of the Central Siberian plateau. which rises steeply from the right bank. This long. relatively straight course is joined by the largest tributaries. the Angara. Podkamennaya Tunguska and Nizhnyaya Tunguska. The Yenisei gradually widens from 1.500 yd. to 3 mi. At Osinovo, at the northern end of the Yenisei ridge. rock outcrops narrow the river and cause rapids. which impede navigation. Below Dudinka, the Yenisei turns west and north into a series of distributaries which enter the long, narrow Yenisei gulf of the Kara sea. The gulf represents the drowned lower valley of the Yenisei.

The outstanding feature of the basin of the Yenisei is its extreme asymmetry. Apart from the Abakan in the upper course! there are no left-bank tributaries of any size and in many places the Ob basin extends to within 50 mi. of the Yenisei itself and at one point to within 6 mi. On the right bank the tributaries are large and drain Lake Baikal. much of Transbaikalia and the greater part of the Central Siberian plateau. The Yenisei carries the largest volume of water of any river in the C.S.S.R., with an average annual discharge of 614,477 cu.ft. per second. As with most Russian rivers there is a very marked spring maximum, with more than half the annual flow. The maximum recorded flow at Dudinka was 4.661.547 cu.ft. per second and the minimum 88,287. Freeze-up on the Yenisei begins in early October in the lower course and mid-October in the upper, but because of the volume of warmer water which it brings from the south it freezes later than its tributaries. Ice cover is established by the end of October in the north and in early November in the upper reaches. Some rapids do not freeze at all. The ice breakup begins in early May on the upper river, but not until a month later in the lower reaches. This delay causes huge and impressive ice jams, which may do extensive damage to riverside installations and cause widespread flooding.

Since 1952, when the Bolshoi Porog was made passable, the Yenisei has been navigable during the ice-free months for its entire length to Kyzyl. Below Teniseisk the river is the only line of communication other than winter trails. A length of railway connects the Yenisei at Dudinka to the mining region of Norilsk. The chief ireight is timber, rafted to Igarka on the lower course. Igarka is a major sawmilling centre and second only to Archangel as a timber-exporting port of the U.S.S.R. For the most part the Yenisei basin is very thinly peopled tundra or taiga, but in the steppes around Krasnoyarsk and Minusinsk population density is much greater and economic activity, especially mining and agriculture, is well developed.

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YEOMAN, a term meaning, first, a class of holders of land and second. a retainer, guard, attendant or subordinate official. The word appears in M E as *ʒeman, ʒoman* and *yeman;* it does not appear in O E. It is generally accepted that the first part is the same word as the German *Gau,* district, province, and probably occurs in O E. as *gēa* in *Súðri-géa,* Surrey; i *e.,* southern district. and other place names. Yeoman thus meant a countryman, a man of the district, and it is this sense which has survived in the special use of the word for a class of landholders.

The extent of the class covered by the word "yeoman" in England has never been very exactly defined. One of the earliest pictures of a yeoman is that given by Chaucer in the Prologue to the *Canterbury Tales.* Here, represented as a forester, he follows the esquire as a retainer or dependant. The yeomen of later ages, however, are practically all occupied in cultivating the land, although, doubtless from its younger sons. the class furnished retainers for the great lords, men-at-arms and archers for the wars. and tradesmen for the towns. Medley *(Eng. Const. Hist.)* describes the yeomen of the 15th century as representing on the whole "the small freeholders of the feudal manor." Holinshed, in his *Chronicle,* following Sir T. Smyth *(De republica Anglorum),* and W. Harrison *(Description of England),* describes them as having free land worth £6 annually, and in times past 40*s*., and as not entitled to bear arms. They formed the intermediate class between the gentry and the labourers and artisans.

YEOMANRY, the name given to the volunteer mounted troops which, together with the militia (*q.v.*), supplemented the armed forces of Great Britain in times of national emergency. These bands of cavalry were first formed as the result of the Jacobite rising of 1745: the duke of Montagu and other local magnates hastened to raise volunteer mounted troops, such as the Northampton association and the royal regiment of hunters enrolled by the landowners of Yorkshire. The landed gentry were the officers of the force; the tenant farmers served in the ranks; and all provided their own mounts. This constituted the organization envisaged by the Militia acts of 1757 and 1763 and adopted in 1794. The Provisional Cavalry act rendered every owner of ten horses, either personally or in a group, responsible for furnishing one trooper; but this was later amended to clear the way for voluntary enlistment, sweetened by generous bounties. The threat of a French invasion in 1803 greatly stimulated recruiting, both for the county yeomanry and the urban light horse volunteers, and the opportunity was therefore taken to abolish the limitations on the place of service within Great Britain. Despite the diminished threat of invasion, the yeomanry remained under arms, subsequently supporting the civil power in such disturbances as the Peterloo tumult of 1819 and the Chartist riots.

From 1849 to the outbreak of the South African War in 1899, houever, the yeomanry declined in strength and enthusiasm (save for a brief period during the French war scare of 1852), the total of the force shrinking from 44,000 to 10.000. The call for mounted troops, capable of shock action with the sword and missile action with the rifle, to take the field against the Boers, met with an instant response from the yeomanry. In all, more than 34,000 volunteered and were accepted for service. for whom the standing yeomanry organization furnished the cadres and training. Yeomanry hill, near Nooitgedacht on the Megaliesburg range, commemorates one of the corps' more notable exploits during the war.

In 1901, William Brodrick, as secretary for war, remodeled the yeomanry on the basis of four squadrons to a regiment, legislating for a total force of 35,000. In 1907, with Richard Haldane's reorganization of the volunteers, the yeomanry became an integral part of the new territorial force.

With the outbreak of World War I in 1914, 53 regiments of yeomanry mobilized, four regiments being brigaded with the regulars of the cavalry corps. The first to see action were the Oxfordshire hussars, who accompanied the Royal Naval division in the brief holding action during the siege of Antwerp. The trench warfare in France and Flanders and in Gallipoli, however, temporarily ruled out the use of mounted troops, so that the Scottish horse and Lovat's scouts served as infantry against the Turks on the peninsula of Gallipoli It was not until Gen. Sir Edmund Allenby revitalized the campaign in Palestine that the yeomanry could be employed in the work for which they had trained, and 14 regiments, including some survivors from Gallipoli, were distributed over the divisions making up the desert mounted corps. Following the third battle of Gaza the yeomanry, without any support from the regular cavalry, scored heavily in the actions of Huj and El Mughaiyir with classic attacks in the best tradition of open warfare. In Nov. 1917 the yeomanry led the assault against the Turkish centre at Kauwaka and assisted in the capture of the enemy railhead at Sharia. Opportunities for mounted action, however, were infrequent, and by early 1917 a complete infantry division, the 74th. had been improvised out of 18 yeomanry regiments, many of which had already had experience of ground combat. It was first engaged as a division at the second battle of Gaza and later participated in the capture of Jerusalem. In the spring of 1918 it mas transferred to the western front, where eight yeomanry formations had been grouped into machine gun units.

With the postwar reduction in the regular cavalry, the greater portion of the yeomanry was mechanized, 8 regiments being converted to armoured car companies and 25 transformed into artillery units. It was therefore in these and several other capacities that the yeomanry, which had ceased to be of a uniform character, served throughout World War II, winning particularly warm cominendation for its versatile work in the western desert. With universal mechanization and the threat of tactical atomic weapons, the traditional functions of the yeomanry became irrelevant to modern warfare, although every effort was made to maintain the localized, close-knit family relationship and traditions. (*See* also TERRITORIAL ARMY.) (R. C. H.)

YEOMEN OF THE GUARD, originally "Yeomen of the Guard of (the body of) our Lord the King"—"Valecti garde (corporis) *domini* Regis"—the title maintained with but a slight variation since their institution in 1485, of a permanent military corps in attendance on the sovereign of England, as part of the royal household, whose duties, now purely ceremonial, were originally those of the sovereign's personal bodyguard. They are the oldest existing body of the kind. The first warrants to individual "Yeoman of the Guard" date from Sept. 16, 1485, immediately after the victory of Henry VII. at Bosworth (Aug. 22).

The first official recorded appearance of the king's bodyguard of the Yeomen of the Guard was at the coronation of its founder Henry VII. at Westminster Abbey on Oct. 31, 1485, when it numbered 50 members. That number was rapidly increased, for there is an authentic roll of 126 attending the king's funeral in 1509. Henry VIII. raised the strength of the Guard to 600 when he took it to visit Francis I. of France at the Field of Cloth of Gold (*q.v.*). In Queen Elizabeth's reign it numbered 200. The corps was originally officered by a captain (a post long associated with that of vice-chamberlain), an ensign (or standard-bearer), a clerk of the cheque (or chequer roll, his duty being to keep the roll of every one connected with the household), besides petty officers, captains, sergeants or ushers. In 1669 Charles II. reorganized the Guard and gave it a fixed establishment of 100 yeomen, officered by a captain, a lieutenant, an ensign, a clerk of the cheque and four corporals, which is the present organization and strength. The captaincy is now a ministerial appointment filled by a nobleman of distinction under the lord chamberlain, and the old rank of "corporals" has been changed to "exon," a title derived from "exempt," *i.e.,* exempted from regular regimental duty for employment on the staff. Formerly officers on the active list were given these appointments in addition to their own.

The original duties of the Guard were of the most comprehensive nature. They were the king's personal attendants day and night at home and abroad. They were responsible for his safety not only on journeys and on the battlefield, but also within the precincts of the palace itself. In Tudor times the Yeomen of the Guard alone were entrusted with the elaborate formality of making the king's bed. Another of their duties still retained is the searching of the vaults of the houses of parliament at the opening of each session, dating from the "Gunpowder plot," in 1605, when the Yeomen of the Guard seized Guy Fawkes and his fellow-traitors and conveyed them to the Tower.

The dress worn by the Yeomen of the Guard is in its most striking characteristics the same as it was in Tudor times. It has consisted from the first of a royal red tunic with purple facings and stripes and gold lace ornaments. Sometimes the sleeves have been fuller and the skirts longer. Red knee-breeches and red stockings (white in Georgian period only), flat hat, and black shoes with red, white, and blue rosettes are worn. Queen Elizabeth added the ruff. The Stuarts replaced the ruff and round hats with fancy lace and plumed hats. Queen Anne discarded both the ruff and the lace. The Georges reintroduced the ruff, and it has ever since been part of the permanent dress. Up to 1830 the officers of the Guard wore the same Tudor dress as the non-commissioned officers and men, but under William IV. the officers were given the dress of a field officer of the Peninsular period. The weapons of the Guard are a steel gilt halberd with a tassel of red and gold and an ornamental sword.

The real fighting days of the Guard ended with the Tudor period, but it was only with the final appearance of an English King in battle (Dettingen 1743) that the Guard's function of attending a sovereign on the battlefield ceased. For a brief period during the Georgian era the Guard lost to a certain extent its distinctive military character and a custom crept in of filling vacancies with civilians, who bought their places for considerable sums, the appointments being of great value. William IV. put a stop to the practice, the last civilian retired in 1848, and the Guard regained its original military character. Every officer (except the captain), non-commissioned officer and yeoman must have served in the Home or Indian army or Royal Marines. They are selected for distinguished conduct in the field, and their pay is looked upon as a pension.

The nickname "Beef-eaters," which is sometimes associated with the Yeomen of the Guard, had its origin in 1669, when Count Cosimo, grand duke of Tuscany, was in England, and, writing of the size and stature of this magnificent Guard, said, "They are great. eaters of beef, of which a very large ration is given them daily at the court, and they might be called 'Beef-eaters.' "

In 1509, Henry VIII., envying the magnificence of the bodyguard of Francis I. of France, decided to have a noble guard of his own, which he accordingly instituted and called "The Gentlemen Speers." It was composed of young nobles gorgeously attired. In 1539 the guard was reorganized and called "Gentlemen Pensioners." That title it retained till William IV.'s reign, when the corps regained its military character and received their present designation, "The Honourable Corps of Gentlemen-at-Arms."

See *The History of the King's Body Guard of the Yeomen of the Guard, by* Colonel Sir Reginald Hennell, D.S.O., Lieutenant of the Yeomen of the Guard (1904).

YEOTMAL, a town and district in Bombay state. India. The town, 85 mi. S.W. of Nagpur, stands on an elevated plain at about 1,400 ft. The population in 1951 was 35,980. It was formerly the headquarters of the Wun district but in 1905 the new district of Yeotmal was established, the old Wun district being renamed, with additions from the district of Basim. Cotton ginning and pressing are the main industries. The town is also the chief trading centre of the district, being connected by a road, 29 mi. long, with Dhamangaon on the Central railway, while a narrow-gauge line connects it through Darhwa and Karinja with Murtizapur on the main line.

YEOTMAL DISTRICT has an area of 5,246 sq.mi. Yeotmal is a large cotton-producing district, but its upland is less fertile than the average of this region. The greater part of the district is drained by the Penganga river, which joins the Wardha in the southeast corner. There are large forest reserves in the south and southeast in which game abounds. There is a considerable aboriginal element of Gonds and Kalams in the wilder portions. The (1961) population was 1,097,973. There is coal at Pisgaon in Wun *taluka* near the Wardha river. The climate in the uplands is cool and the rainfall (41 in.) plentiful.

YEOVIL, a market town and municipal borough (1854) in the Yeovil parliamentary division of Somerset, Eng., 26 mi. E.S.E. of Taunton by road, standing by the river Yeo and near the Dorset border. Pop. (1061) 24,552. Area 3.5 sq.mi. A road centre in the middle of a large agricultural area, Yeovil also has industries including the long-established gloving and leather dressing trades; processed food. and light engineering, especially the making of aircraft such as helicopters. The parish church dates from c. 1380 and is known as the "lantern of the west."

YERBA BUENA (*Micromeria* chamissonis). a pleasantly aromatic North American herb of the mint family (Labiatae, *q.v.*), found in woods from British Columbia to southern California. It is a slender perennial. with trailing stems six inches to two feet in length, roundish, short-stalked leaves, one-half to one inch broad. and delicate, two-lipped, white flowers, borne on hairlike stalks usually singly in the leaf axils.

YERBA MANSA (*Anemopsis californica*), a North American herb of the lizard's-tail family (Saururaceae), found in wet saline places from western Texas to central California and southward to Mexico. It is a perennial with upright stems, six inches to two feet high. springing from aromatic, creeping rootstalks, and astringent, slightly spicy foliage. The flowers are borne in terminal spikes, ½ to 1½ in. long, surrounded at the base by a circle of conspicuous white bracts; the fruit is a capsule, splitting open from the top. The Spanish settlers in California used the plant medicinally.

YERBA MATÉ: see MATÉ.

YERBA SANTA (*Eriodictyon californicum*), a North American balsamic shrub of the waterleaf family (Hydrophyllaceae), native to dry slopes and mountain ridges from south central California to southern Oregon. It grows from two to eight feet high. bearing narrowly lanceolate leaves. which are very glutinous-resinous above and densely white-woolly below. and bluish or white flowers in loose clusters. The Indians and early Spanish settlers made extensive medicinal use of the bitter-aromatic leaves; the Indians also chewed and smoked them.

YEREVAN (formerly EREVAN, ERIVAN), the capital of the Armenian Soviet Socialist Republic, U.S.S.R., is located on the Razdan (or Zanga) river: a tributary of the Aras, 14 mi. from the Turkish frontier and 110 mi. S. of Tbilisi. Pop. (1959) 509,340. The twin peaks of Mt. Ararat across the frontier and Mt. Aragats and Xzhdaak to the northwest and northeast form a striking setting to the city. which has an attractive appearance with its tree-lined streets and squares. In addition to its administrative function Yerevan is an important industrial centre. Its chemical industry manufactures synthetic rubber and plastics; engineering products include electric machinery (such as mobile generators) and lamps, cables. compressors, turbines and machine tools. Clocks, textiles and clothing, shoes, wines and foodstuffs are also produced. Power for the city comes from the "cascade" of hydroelectric plants on the Razdan, one of which is located at Yerevan. The city is also the cultural centre of the republic, with an academy of sciences founded in 1943, a state university founded in 1920, a music conservatory and pedagogic, agricultural. medical, veterinary and polytechnic institutes. There are theatres of Armenian opera and ballet. of Armenian drama and of Russian drama, and the Armenian state museum. The Matenadaran archives hold a rich collection of ancient Armenian manuscripts, such as the Lazarus Gospel of 887 and fragments of even earlier date. Among notable buildings is the 16th-century Turkish fortress: now in ruins. which dominates the city. Many of the modern government buildings, designed by the Armenian architect Tamanyan and his pupils, have adapted traditional Armenian features. Yerevan is joined by a branch railway to the line which runs northward to Leninakan and Tbilisi and southward to Nakhichevan and into Iran. There are motor roads to Tbilisi. Leninakan and Baku, to Dzhulfa on the Iranian border and into Turkey.

Yerevan is one of the oldest towns of the Soviet Union, archaeological evidence indicating that the fortress of Yerbuni stood there in the 8th century B.C. From the 6th century B.C. it formed part of the Armenian kingdom. As it was a main focus of caravan routes across Transcaucasia and the centre of the fertile plain of Ararat: its history has been one of constant siege and storm in the struggle for possession of the area by the Romans, Parthians, Arabs, Mongols, Turks, Persians, Georgians and Russians. In 1582 it fell to the Turks. in 1604 to the Persians and in 1827 to the Russians under Gen. I. F. Paskevich. In 1920 it became capital of the Armenian S.S.R. and grew rapidly. (R. A. F.)

YERKES, ROBERT MEARNS (1876–1956), U.S. psychobiologist, authority on the great apes and especially on the chimpanzee, was born in Breadysville. Bucks county, Pa., on May 26, 1876. After graduation from Ursinus college he took a Ph.D. degree at Harvard. remaining on the faculty there until the U.S. entered World War I in 1917. At Harvard he established the Laboratory of Comparative (Animal) Psychology. During the war he was in charge of the psychological testing of 1,726,000 men who entered the U.S. army. From 1924 until his death he was associated with Yale.

In 1930 Yerkes established at Orange Park, Fla., the Yale Laboratories of Primate Biology (in 1942 renamed in his honour the Yerkes laboratories). a unique centre for the study of the neural and physiological basis of behaviour. He assisted in establishing the National Research council in Washington. D.C.. and gave important service to a number of scientific societies and academies. Among his published books and papers, the most significant perhaps are *The Great* Apes: a *Study* of *Anthropoid* Life, with Ada W. Yerkes (1929), and *Chimpanzees: a* Laboratory Colony (1943). He died Feb. 3, 1956, in New Haven, Conn. (L. CAR.)

YERSIN, ALEXANDRE ÉMILE JOHN (1863–1943), Swiss bacteriologist, was born at Aubonne on Sept. 22, 1863, and studied at Lausanne, Marburg and Paris. He was associated with Pierre Roux (*q.v.*) in his researches on the diphtheria serum at the Pasteur institute. With Roux he made fundamental studies in which they discovered the existence of diphtheria toxin (1889–90), and continued his researches in China and French Indochina. The plague bacillus was discovered by him in Hong Kong in 1894, S. Kitasato (*q.v.*) simultaneously making the same discovery. In 1895 Yersin prepared a serum to combat the disease. Under Chinese government auspices he founded a branch of the Pasteur institute at Canton. Yersin also established a similar institution at Nha Trang, Annam, of which he became director. He was awarded the Grand Prix Leconte by the Paris Académie des Sciences in 1927. He died in French Indochina, March 2, 1943.

YERWA-MAIDUGURI (commonly MAIDUGURI), capital of Bornu province, Northern Region, Nigeria, lies on the banks of the seasonal river Alo in savanna country about 1,160 ft. above sea level and about 70 mi. S.W. of Lake Chad. Pop. (1953) 56,740; (1959) 60,000. Founded in 1907 as a British military station, Maiduguri grew rapidly and replaced the old Bornu capital, Kanem. It is spacious and modern in plan, but with architecture typical of the Kanuri and the Shuwa Arabs who make up most of the population. The palace of the shehu of Bornu (completed 1954), in Moslem style, dominates the town and its modern trading establishments. There are a general hospital, schools, a training centre for women teachers, a government craft school and the offices of the Native authority (1958).

Astride the historic pilgrim route from Senegal to Mecca, Maiduguri is linked by road eastward to Fort Lamy; southward to Yola and the Southern Cameroons; and westward to Kano (373 mi.), Kaduna (573 mi.) and Lagos (1,043 mi.). The airport, 5½ mi. W., is used by internal services. Yerwa, derived from the Arabic expression of grateful pleasure, refers to the fertility of the region. The town is the principal market for Bornu; the peanut (groundnut) crop is exported by road, but merchants of the Northern Region assemble annually to buy the corn crop. The principal industry is the preparation of skins of crocodiles from Lake Chad for the typical leatherwork of northern Nigeria. In centuries-old fashion Shuwa Arabs ride their oxen to the town's Monday market. The old kingdom of Bornu (*q.v.*) once stretched to the Nile, and al-Azhar Moslem university at Cairo has, since the 15th century, had a college for Bornu students. whose religious learning and probity are recognized. The *shehu* of Bornu and the emir of Dikwa (now part of Bornu province) are direct descendants of Sheik al-Amin al-Kanemi who, in the 19th century, rallied the Kanuri to resist Fulani expansion. (W. H. I.)

YEVPATORIYA, a town of the Crimean oblast of the Ukrainian Soviet Socialist Republic. U.S.S.R., stands on the west coast of the Crimea at the head of Kalamitski gulf. Pop. (1959)

57,000. It was founded in the 1st century B.C. and named Eupatoria after Mithradates VI Eupator (*see* MITHRADATES). Yevpatoriya came in turn under the kingdom of Bosporus (*q.v.*), the Venetians, the Genoese and the Tatars of the Crimean khanate, who themselves owed suzerainty to Turkey. It passed to Russia with the annexation of the Crimea in 1783. The allied armies landed nearby during the Crimean War. The town is renowned for the finest beaches of the Crimea and is a popular resort. There are many sanatoriums, especially for children. Salt is obtained from nearby Lake Sasyk and limestone is quarried locally. Weaving and furniture making are carried on. Yevpatoriya is a fishing centre and port for coastwise traffic. A railway links it with the main line to Sevastopol. (R. A. F.)

YEW, an attractive evergreen tree of the genus *Taxus,* of the Taxaceae family. The fruiting structure is a solitary seed set in a red, fleshy cup (aril) one-fourth to one-half inch deep in contrast to the woody cone occurring in the Pinaceae family (pines and spruces). The aril is edible but insipid, and the seeds and foliage are poisonous if eaten. The poisonous alkaloid of the foliage, mentioned by such ancient writers as Caesar, Livy and Virgil, may be injurious and sometimes fatal to horses and cattle. There are seven species and many named varieties of yew irregularly distributed in the northern hemisphere. All are evergreen, two always shrubby, but the others, *T. baccata, T. brevifolia, T. floridana, T. cuspidata* and *T. chinensis,* are regularly trees or have arborescent forms. The branches are erect or spreading, and closely covered with flattened, linear leaves one-fourth to one inch long, attached in spirals but because of a twist at their bases appearing two-ranked. The yews are dioecious, *i.e.,* have separate male and female plants, the former bearing globose staminate catkins and the latter the carpellate structures. Each inflorescence is borne in the axil of a leaf, and consists of several thin scales. In the carpellate structure the scales surround the cup or aril, which at first is thin and green but becomes thick and red when ripe. Each aril normally contains a single seed, but two may occur in a cup.

JOHN MARKHAM

ENGLISH YEW (TAXUS BACCATA) BRANCH WITH CARPELLATE FLOWERS

Yew lumber has been used for cabinetwork, implements requiring strength and durability, and particularly for making the English longbow. The demand was greater than the supply! so little yew wood is available. Trees of the Pacific yew, T. *brevifolia,* native from southern Alaska to the central Coast ranges in California and eastward to Montana, was cut so intensively for bow staves that by 1940 few trees over four to six inches in diameter were left standing.

The most widely distributed yew is the English yew (*T. baccata*), which occurs wild in Great Britain, extends eastward across Eurasia to Amur and the Himalayas and south into Africa. Fossils indicate that yews were once more abundant and more widely distributed than they have been in historical times.

The best known yews native in North America are the American yew or ground hemlock (*T. canadensis*), which is a spreading shrub under five feet tall in the forests from Newfoundland to Manitoba, Iowa and Virginia; and the western yew (2'. *brevifolia*). Yew wood is hard, fine grained, and heavy, with white or creamy sapwood and amber to brown heartwood. It was used by the Indians to make bows and by the white settlers for tool handles, small containers, furniture and other household articles.

Yew shrubs and trees are popular ornamental evergreens and several varieties of the European and Japanese yews are used as single specimens, for planting in small groups, and set closely to form dense hedges. The columnar form of the European yew, called "Irish yew," is particularly esteemed where upright, slender growth is desired. Yew trees grow slowly but are long-lived and only moderately susceptible to attacks by pests.

Yew trees long have been associated with religious rites and cemeteries.

See also GYMNOSPERMS; TAXACEAE.

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YEZD (YAZD), a former province (*ostan*) of Iran, included in the *ostan* of Isfahan. Much silk is produced in this district, but not sufficient for the requirements of the looms of Yezd, and quantities are imported from Gilan. Other products are opium, madder, almonds and grain, of which last, however, only one-third of the supply required for local consumption is grown, the surplus requirements being brought from the adjacent *ostan* of Khurasan. The eastern part of the former province bordering on the Dasht-i-Lut (desert) is much exposed to moving sands.

Yezd, the chief town of the former province, is at 31° 54′ N. and 54° 22′ E. at an elevation of 4,390 ft., 162 mi. S.E. of Isfahan and 192 mi. N.W. of Kerman; pop. (1956) 66,484. When the Arabs invaded Persia, many of the Zoroastrians fled toward Yezd and Kerman where they remained. The highest and lowest temperatures are respectively 106° F. in July and 20° in December. Commercially, Yezd occupies an important central position in Iran, whence a number of routes radiate: to Isfahan to Meshed on the N.E. via Tabas and the desert and to Kerman on the west and Zahidan on the S.E. connecting with the Indian railhead. There is also an important direct caravan track to Bandar Abbas.

Since Sassanian times Yezd has been famous for beautiful silk textiles, rivalled in later periods only by Kashan and Isfahan. It is still the most productive centre of silk weaving, with approximately 8,000 weavers. Besides part of the imposing city wall, built in the 12th and 14th centuries, the most interesting mediaeval fortifications surviving in Iran, there are many important mosques and mausolea, dating from the Duwaz dah Imam (1035). The Masjid-i-Jami (cathedral or Friday mosque) is distinguished by the highest minarets in Iran, mosaic fai'ence, a superb mihrab dated 1375, and two oratories, Gothic in appearance, with deep transverse vaults. Some of the other mosques and mausolea are decorated with extremely delicate and rich stucco relief or are polychromed with tones of pale blue, rose and yellow. The sky line is picturesque, with minarets and many tall towers devised to bring moving air down to the many small chambers which are a necessary refuge from the intense heat of summer.

See G. N. Curzon, *Persia and the Persian Question* (1892); E. G. Browne, *A Year amongst the Persians* (1893 and 1926); *Survey of Persian Art* (1938), for the monuments especially vol. iv, Pls. 273, 4; 438, 449 and vol. ii *passim.* Textiles, vol. iii, pp. 1995–2220 *passim,* and vol. vi, Pls. 1032–1106 *passim.* (P. Z. C.; X.)

YEZIDIS, a religious sect, numbering about 50,000 persons, dwelling chiefly in the neighbourhood of Mosul. Their own name for themselves is Dasni, but they are called by their neighbours Yezidi; the origin of both names is uncertain, but the latter is probably derived from the Persian *Yazdān,* God. Their religion was probably originally an offshoot of Mazdaism, but it has absorbed elements from Christianity and Islam, for they regard Christ as an angel in human form and recognize Mohammed as a prophet with Abraham and the other prophets, and practise circumcision and baptism. They regard the devil as the creative agent of the Supreme God, and seek to propitiate him as the author of evil: they avoid mentioning his name and represent him by the peacock. Their sacred books have been translated by F. Nau, *Recueil de textes et de documents sur les Yézidis* (1918).

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YEZO: *see* HOKKAIDO; JAPAN.

YGGDRASIL, in Scandinavian mythology the mystical ash tree which symbolizes existence: binds together earth, heaven and hell and is the tree of life, knowledge, fate, time and space. Its three roots go down into the realms (1) of death, where, in the well Hvergelmer, the dragon Nidhug (Niðhöggr) and his brood are ever gnawing it; (2) of the giants; and (3) of the gods, Asgard.

Its stem upholds the earth, its branches overshadow the world and reach up beyond the heavens. Honeydew falls from the tree. and on its topmost bough sits an eagle. G. Vigfusson and York Powell saw in Yggdrasil not a primitive Norse idea, but one due to early contact with Christianity.

YI, a term used by the Chinese to designate what they formerly called the Lolo (*q.v.*), or Wu-man ethnic group of Austroasiatic origin numbering several millions, inhabiting the mountains of southwest China and speaking a Tibeto-Burman language. Their traditional culture include a primitive hoe-type agriculture, goat. yak and sheep herding and hunting. Relics of a possible matriarchal system appear in the significant status of women in their traditional society. Sorcery and belief in animism are prevalent. The dead are cremated. In the pre-Communist society, a caste system divided the Yi into two groups. The Blackbone Yi were the ruling group representing the descendants of people that appear to have originated in northwest China. The far more numerous Whitebone Yi were derived from people including many Chinese ohce subjugated or enslaved by the Blackbones. The fiercely independent Blackbones often harassed Chinese 'settlers entering their domain. The Whitebones, especially, have spread over the highlands of Yünnan and Kweichow, whereas the heartland of the Blackbones lies in the Great and Lesser Liang mcuntains southwest of the Ssu-ch'uan basin. The latter were constituted the Liang-Shan Yi Autonomous district by the Communist regime in 1953 when eight other so-called autonomous districts for Yi tribes were organized. (H. J. Ws.)

YIDDISH LANGUAGE AND LITERATURE. The origins of Tiddish, the Jewish idiom whose name is related to the modern German *Jüdisch,* can be traced as far back as the 10th century. At that time Jews from France and northern Italy began to settle in considerable numbers in western Germany, mainly in the Rhineland, superimposing the language of their new environment. Middle High German, on their Romance dialects saturated with Semitic elements. both Hebrew and Aramaic. Henceforth. the evolution of the Yiddish language. rendered in Hebrew characters. followed the fortunes of the people. From the 14th century onward. the bulk of the Yiddish-speaking and Yiddish-writing Jews were. through migration, transplanted to Poland and adjacent countries, the domain of Slavonic languages. The ties between Yiddish and German were thus loosened and the vernacular of the isolated Jewish enclave gained the freedom of independent development. In the process of this uninterrupted consolidation (from the 15th to the 18th century). the vocabulary and the grammar of Yiddish absorbed and assimilated a great many Slavonic elements which could not, however. impair the specific character of a language so intimately connected with the singular. essentially religious. Jewish way of life.

From the beginning of the 19th century, as a result of the migration of eastern European Jews to all parts of the globe, Yiddish became the *lingua franca* of world Jewry. On the eve of World War II. more than half of the 16.000.000 Jews of the world spoke or at least understood Yiddish. As in the past. the Yiddish-speaking Jews continued to enrich their ianguage by absorbing and assimilating new elements in the lands of their resettlement. Along with the older dialects of the Yiddish language. *e.g.,* the Polish, Lithuanian. or White Russian, there appeared the Anglo-American and the Spanish varieties.

The expansion of Yiddish came to an abrupt end with the destruction of millions of Yiddish-speaking Jews during World War II. A further setback was caused by compulsory assimilation in the U.S.S.R. In addition, the rise of Hebreiv in the wake of the re-establishment of the state of Israel put Yiddish on the defensive. Nevertheless, concentrated efforts in many parts of the world seemed to secure a new lease of life for the almost thousand-years-old language. The Yiddish Scientific institute in New York. known as YIVO, published in 1950 a *Thesaurus of the Yiddish Language* and in addition a *Great Dictionary* was being prepared Apart frorn this. out of the 20 volumes of the *General Encyclopaedia in Yiddish,* 9 had appeared by 1953.

LITERATURE

Earlier **Stages.**—While except in the strictly religious sphere colloquial Yiddish met with practically no rivals within Jewish life. Yiddish literature. ever since it emerged in the 13th century, had to assert itself against the authority of a mighty literary tradition. This tradition was rooted in the Hebrew Bible, the Aramaic Talmud and in the vast post-Talmudic Rabbinical literature inspired by the ancient sources and written in mediaeval Hebrew. Under such conditions, the literature in Yiddish was bound to remain a marginal phenomenon for a long period. The narrow field which the new literature was allowed to cultivate was restricted to themes of 3 secular character and to the popularization of the traditional values among the lesser educated, especially the women. Notwithstanding the unfavourable conditions, a great variety of literary forms—from the heroic epic to fables and fairy tales, and from Bible translations and paraphrases to elaborate guides of moral and ritual behaviour—steadily gained new ground through the medium of Yiddish. Some of these creations like the bulky Bible commentary for women *Tzeenah u'Reenah* ("Go forth, o ye daughters of Zion, and behold!" Song of Songs, 3. 11). compiled in the 16th century. still retain their appeal. The singular devotion of the Jewish woman to Yiddish literature accounts for the description of Yiddish itself as the "mother's tongue," in contrast to Hebrew. the tongue of the learned father.

Period of Crisis.—With the spreading of "enlightenment" in the 18th century (in Hebrew *Haskalah*) from west to east. Yiddish and its literature came under heavy attack. The exponents of Haskalah, the *Maskilim,* looked down on Yiddish as on illegitimate slang and preached its replacement by Hebrew or the language of the country concerned. However. to secure the people's support for the envisaged reform they had to use the people's tongue. and so inadvertently helped build the bridge from traditional to modern Yiddish literature.

The satirical stories, novels, comedies and pamphlets of Israel Axenield (1787–1866), I. M. Dick (1807–1893), I. B. Levinsohn (1788–1860) and others, which exposed the dark side of contemporary Jewish life and tried to discredit the outgrowths of the new *Hasidism* (*i.e.,* pietism), made the Jewish reader familiar with the main forms of modern prose and became the fountainhead of a broad secular streain in Yiddish literature.

The Classics.—By the middle of the 19th century, especially in Russia, where literature had become a paramount factor of political and social progress, the stage was set for the unfolding of outstanding artistic talent by means of the Yiddish word. In close succession there appeared on the scene Mendele Mocher Seforim, pseudonym of S. J. Abramowitsch (1836–1917), I. L. Peretz (1852–1915) and Sholem Aleichem, pseudonym of Solomon Rabinowitz (1859–1916) who together set the standard of both artistic expression and the author's duty to serve the cause of the people.

The oldest of the three is known to posterity as the grandfather of modern Yiddish literature. His novels, such as *Fichke the Lame, The Mare,* etc.. revealed the tragic discrepancy between the intrinsic moral quality of the average man and woman and the humiliating conditions of their social life. Peretz and Sholem Aleichem went a step farther in the same direction. Influenced by modern romanticism Peretz succeeded in vindicating. in a long series of masterly short stories. *e.g., Perhaps Even Higher,* as well as in symbolic drama (*The Golden Chain,* etc.), the mysticism and otherworldliness of the plain Jewish believer, thus bridging the gulf between the broad mass of the adherents of Hasidic pietism and the westernized Jewish intelligentsia. Sholem Aleichem transforined the humour inseparable from Yiddish speech into a subtle artistic instrument and lightened the darkest corners of Jewish life with his bright benevolent smile. The heroes of his stories and novels—Menachem Mendl, the Jack-of-all-trades constantly pursued by ill-luck, and Sheyne-Sheyndl, his quarrelsome-loving wife, or the entirely ignorant and yet miraculously wise dairyman, Tobias (*Tevye der Milchiker*)—were adopted by the people as kith and kin and became the ancestors of a large family of literary types.

New Developments.— Along with the classics, a group of gifted authors, including I. J. Linetski (1839–1915), J. Dinesohn (1856–1919) and M. Spector (1858–1925), maintained the flow of literary production. The future of Yiddish was further safeguarded by the division, after the 1880s, of its mainstream into two branches, the European and American, which, however, remained intertwined through close contacts.

The new conditions of life of the Yiddish-speaking immigrants in the United States found thcir characteristic reflection in poetry inspired by the ideals of social justice and human liberty by such worker-poets as Morris Vinchevsky (1856–1933), Morris Rosenfeld (1862–1923) and David Edelstadt (1866–1892). These beginnings later influenced many Yiddish poets both in the United States and Europe, *e.g.*, David Einhorn (1886–), and laid the ioundation of a Yiddish school of lyric expression. The Yiddish press which sprang up in the United States at the turn of the 19th century soon outstripped its European forerunners and gave Yiddish writers ample opportunity of bringing their writings, in prose and verse, to the notice of a rapidly growing public. An array of brilliant essayists and journalists, such as A. Cahan (1860–1951), C. Zhitlowsky (1865–1943), A. Liesin (1872–1938) etc., vied successfully with their colleagues in Europe. In 1953, the *Jewish Press of thr World* recorded 801 periodicals of which 117, including 12 dailies, were in Yiddish.

At the same time. marked progress was made in the United States by the Yiddish theatre, mainly thanks to the dramatists S. Libin (1872–1955), L. Kobrin (1872–1946) and J. Gordin (1853–1909), who were later joined by D. Pinski (1872–1959), P. Hirschbein (1880–1948) and H. Leivick (1888–), the great lyrical poet and seeker after universal truth.

The 20th Century.— Meanwhile the impulse given to Yiddish literature by the classics brought iorth in thcir own native land a new generation of authors excelling in every literary genre. In the first quarter of the century the total number of Yiddish writers rose over the thousand mark. The union between Hebrew and Yiddish literature, personified by the classics, proved beneficial to both, while the translation of masterpieces from the major literatures taught the Yiddish writer to see his own world in a universalistic perspective. He was greatly helped also by the emergence of a literary critique guided by the highest standards of aesthetic evaluation, set up by Baal Machshoves (1873–1924), S. Niger (1883–1955) and others.

Against this background Sholem Asch (1880–1957) built up his life's work which began with the idealization of the typical Jewish homestead in Poland and reached its peak in the historical novel *Moses* (1951). To the same category oi prose belongs the novcl, *In the Polish Forests* (1921), of J. Opatoshu (1887–1954). Their fellow-countryman, M. Boraisha, created *The Wayfarer,* a novel in verse, original in the music of its alternating rhythms and abounding in the wisdom of ages. All three reached maturity in the United States, where new roots were struck also by A. Reisen (1876–1953), the "Yiddish Heine" from Russia, and by A. Leyelles, pseudonym of A. Glanz (1880–), whose poetry was shaped by half-a-dozen European literatures. The outstanding versatility of the secular Yiddish writers explains the fact that no trend in modern literature, from simple naturalism to the most extravagant expressionism, remained uurepresented in Yiddish literature. However, despite this differentiation of taste and attitude, the Yiddish writers, with the exception of some in the Soviet Union. were always united in the beliei that they cultivated a literary tradition ultimately rooted in the Hebrew Bible.

Parallel with the development of Yiddish *belles-lettres* an ever-growing number of original works on philology, history, economics, etc., appeared in Yiddish. Particularly noteworthy was the new "Churban" literature dealing with the catastrophe of 1933–45.

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YIEWSLEY AND WEST DRAYTON, an urban district in the Uxbridge parliamentary division of Middlesex, Eng., 14 mi. W. of Charing Cross by road. Pop. (1961) 23.968. Area 8.2 sq.mi. The area was largely agricultural until the beginning of the 20th century, but was significantly placed on many lines of communication with London. The Bath road and the Grand Union canal pass through the district, and the former Great Western railway line to the west, passing through West Drayton, was opened in 1838. But the most important development in communications was the opening in 1946 at Heathrow of London airport. Agriculture is still carried on, but there are several engineering firms and factories making colour film, coach bodies and wax polish. A colonnaded Iron Age temple was discovered when the airport was being constructed.

YLANG-YLANG (*Cananga odorata*), a medium-sized tree of the custard-apple family (Annonaceae, *q.v.*), found in southern India. Java and the Philippines and planted in warm regions for its exceedingly fragrant flowers, which yield the widely prized perfume of the Pacific islands, known as ylang-ylang among the Malays. The tree has somewhat drooping branches; large, ovate, sharp-pointed leaves; numerous greenish or yellowish flowers, about two inches long, and oblong, greenish fruits about one inch long. It has been sparingly cultivated in southern Florida.

YODEL, a peculiar kind of singing consisting of alternations of high falsetto notes with ordinary chest tones. It is practised by the Swiss and Tirolese in the singing of their native melodies.

YOGA, originally one of the six system5 of Indian philosophy (*q v*) The classical form of Yoga, based on the text ascribed to Patanjali, became knonn in the middle ages as Raja Yoga. or "royal Yoga"; other forms of Toga also developed, which might be followed together with or independently of the classical Yoga Among these the practices of Hatha Yoga, or "the Yoga of force," have become famous throughout the world, and the term Toga is often used to denote them. Hatha Yoga seems to be a late development in Hinduism, and the earliest texts on the subject date from little before the Muslim invasion. It is closely connected with Tantrism, though many of its practitioners are not Tantrists.

Hatha Yoga is based on a fantastic physiological theory. teaching the existence of a dormant divine potency, called *kundalini,* "the serpent power." at the base of the spine. A vein, known as *sushumna,* runs through the backbone. linking the *kundalini,* by way of six psychic centres (called *chakras*, or "wheels") with the supremecentre of psychic power, at the top of the skull, called *sahasrara,* and described as a lotus with a thousand petals. The aim of the Yogi. according to this system. should be to raise the feminine *kundalini* through the vein *sushumna* from one chukra to another until at last it unites with the masculine *sahasrara,* when full salvation is achieved. This requires an intense development of the will. so that all the automatic processes of the body are brought fully under the control of the mind. and the Yogi can control the rhythm of his heart beats at will, live for days without food and water, and survive for an appreciable length of time even without breathing. Despite exaggerated claims there is ample evidence that some Yogis have achieved an almost superhuman control over their bodies. Yogic practices, in their less extreme forms, are believed to be conducive to health, clarity of intellect and long life; many Indians and some westerners perform Yoga exercises without any specially religious purpose.

See M. Eliade, *Yoga, Immortality and Freedom* (1958). (A. L. BA.)

YOGURT (YOGHURT, YOHOURT, etc.) is a dairy product resulting from the biochemical changes in milk produced by the yogurt bacteria *Lactobacillus bulgaricus, Streptococcus lactis, Thermobacterium yoghurti* (Orla-Jensen) and certain types of yeasts. Unfortunately these bacteria cannot be permanently implanted in the intestinal tract of man. They ferment lactose (milk sugar) to lactic acid. and break down casein, lactalbumin and globulin (milk proteins) to peptones and amino acids. With the exception of the tubercle and anthrax bacilli, all the pathogenic bacteria and *Endameba histolytica* are killed in yogurt within 24 hours. The bactericidal factor is diffusable, filtrable, relatively thermostable and is inactivated with alkalis.

Yogurt is prepared by inoculating milk which is previously boiled and cooled to body temperature either with a laboratory culture of yogurt bacteria or yogurt from a previous batch. It is then incubated at 110 to 112° F. for three to four hours or overnight at room temperature. It should then be kept in a refrigerator.

Yogurt is rich in vitamin B complex. Although an important article in diet, there is no proof that yogurt cures any disease or prevents intestinal intoxication. (H. T. A. S.)

YOKKAICHI, a commercial city on the northwest shore of Ise bay in Mie prefecture, south Honshu, in central Japan. Pop. (1960) 195,974. Yokkaichi was originally a small farming and fishing village. It developed into a market town about the middle of the 11th century. During the Tokugawa period it was an important post town on the Takaido highway. By 1897 it was the 6th largest port of Japan. By mid-20th century Tokkaichi was largely supported by its production of cotton textiles, vegetable oil, chemicals, tea and banko ware (a kind of porcelain). (R. B. H.)

YOKOHAMA, the capital of Kanagawa prefecture on the island of Honshu, Japan. It is an international seaport on the west shore of Tokyo bay. It stands on a plain shut in by hills. one of which, toward the southeast, terminates in a promontory called Hommoku-misaki, or Treaty point. The city is traversed by a network of canals. The cold in winter is severe because of north winds, while the heat is great in summer, though tempered by southwest sea breezes. The rainfall is about 70 in, annually. Pop. (1960) 1,375,710. Area 157.9 sq.mi.

In 1859, when the neighbouring town of Kanagawa was opened to foreigners under the treaty with the United States, Yokohama was an insignificant fishing village *(see* JAPAN: *History)* The Japanese government shortly afterward chose the latter place as the foreign settlement. This settlement, uhich developed under the administration of foreign residents enjoying extraterritorial rights until 1899. formed the nucleus of a flourishing city. prospering with the gronth of Japan's foreign trade and shipping. The harbour is commodious. It is somewhat exposed, but enclosed by two substantial breaknaters. The city was almost obliterated by an earthquake in 1923 when 80% of its houses were destroyed and thousands of its inhabitants were killed, mostly by fire. It nas rebuilt under a comprehensive government plan, and the docks and waterfront area, formerly known as the Bund, were much improved. Little remained of the old settlement.

Yokohama depended for its growth upon foreign trade and shipping, particularly the silk trade. The decline of silk in Japan's exports, together with a rapid gronth of manufactures and foreign trade ın other centres, notably Kobe, Nagoya, Osaka and Tokyo, tended to diminish the relative importance of Yokohama, and the city showed sıgns of depression before World War II.

The greater part of the city was destroyed in World War II. Yokohama was slow in recovering but during the late 1950s was rehabilitated. In 1954 Yokohama's exports were only 19% of the total exports of Japan while Kōbe's were 41.7% of the national total. Each port accounted for about 24% of Japan's imports. The United States was the destination for most of Yokohama's exports and the source of most of its imports. (R. B. H.)

YOKOSUKA, a seaport on the west shore of Tokyo bay, Japan, in Kanagawa prefecture. Pop. (1960) 287,309. The port is sheltered by hills and affords anchorage. The site was occupied by a small fishing village until 1865, when the shogun's government established a shipyard there. In 1884 it was made a first-class naval station by the Japanese government. After World War II it became a base for the U.S. navy and a station for the Japanese National Safety agency. The city has been reborn as one of Japan's important trade and fishing ports In the eastern part of the city are two fine harbours, Yokosuka and Nagaura. The latter is a base for ships engaged in whaling operations in the antarctic. Shipbuilding accounts for 49% of the city's employees. Yokosuka is also a residential district for commuters to the Tokyo-Yokohama area. (R. B. H.)

YOKUTS, a linguistic stock of Californian Indians, speaking Yokuts (a Penutian language), who inhabited the San Joaquin valley and adjacent foothills. Formerly about 18,000 in number and organized as individual tribes, *e.g.,* the Wükchamni and Tachi, each had its own dialect, territory, hereditary chief, and major village with grass-thatched or mat-covered dwellings and a men s sweat house. Game and fish were taken with arrows, throwing sticks, traps, nets and harpoons; acorn flour and seeds provided starchy foods. Women made coiled and twined baskets for cooking, serving, storage and ceremonious gifts; some also made crude, plain pottery. Men wore buckskin breechcloths, women buckskin or fibre aprons; both sexes used rabbit fur mantles. Water transportation was on huge tule rafts. Shell disk beads had monetary value. Shamans controlled sickness, the weather, bears and rattlesnakes through supernatural power, and religious dreams were induced by decoctions of wild tobacco or Jimson weed. Hundreds of Yokuts congregated to weep, dance and feast at annual mourning ceremonies.

See A. L. Kroeber, *Handbook* of *the Indians of California,* ch. 32–35, Bureau of American Ethnology bulletin 78 (1925); A. H. Gaytnn, Yokuts *and Western Mono Ethnography,* Anthrop. Rec. Univ. Calif., vol. 10 (1945). (A. H. GA.)

YOM KIPPUR: *see* JEWISH HOLIDAYS.

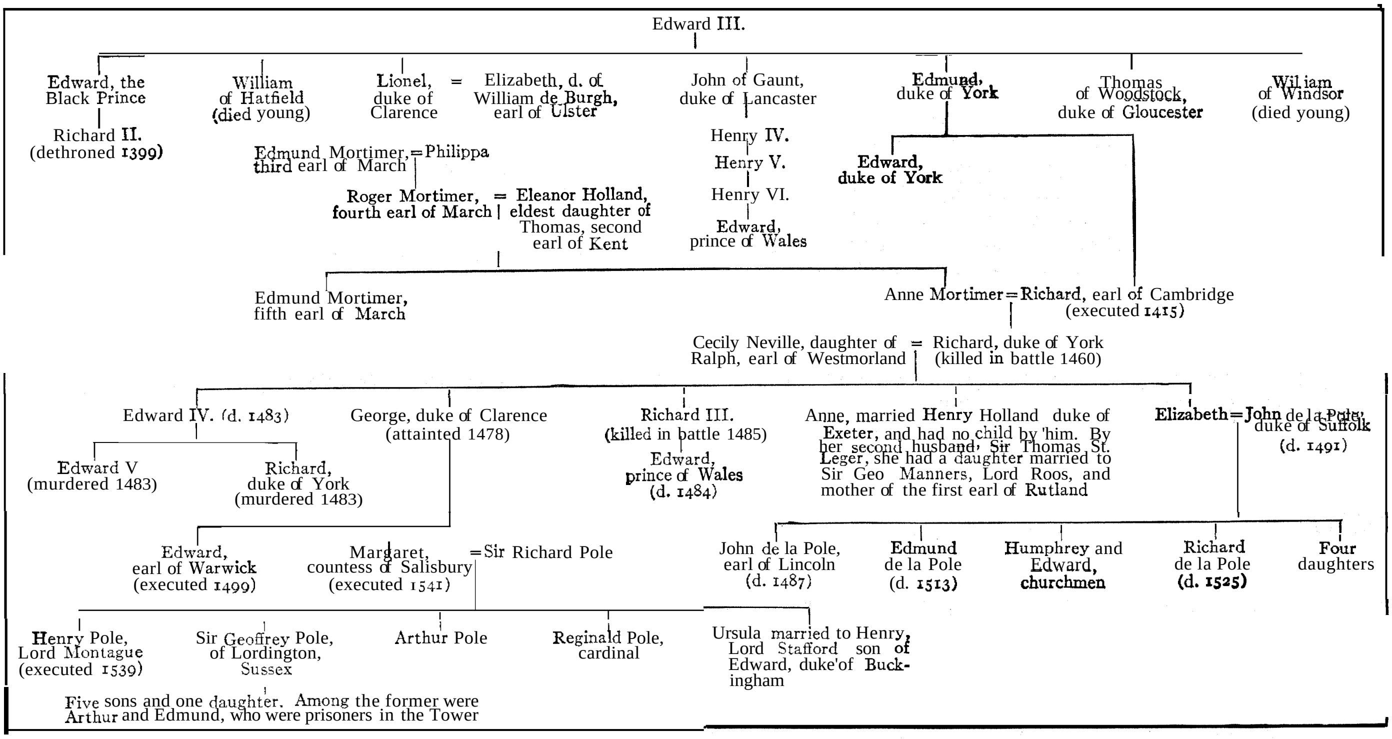
YONGE, CHARLOTTE MARY (1823–1901), English novelist and writer on religious and educational subjects, was born Aug. 11, 1823, at Otterbourne, Hants. She was one of the most prolific writers of the Victorian era. Her first success was attained with *The Heir of Redclyffe* (1853). *The Daisy Chain* (1856, reprinted 1911) continued the success. Other popular books include *Heartsease* (1854), *Dynevor Terrace* (1857), *The Young Stepmother* (1861), *The Trial* (1864) and *The Clever Woman of the Family* (1865). She wrote over 120 volumes, including novels, tales, school manuals and biographies, and was for more than 30 years editor of the *Monthly Packet.* She died at Otterbourne on March 24, 1901.

YONKERS, a city of Westchester county, N.Y., U.S., 15 mi. from Grand Central terminal in New York city, is located on the east shore of the Hudson river directly north of the borough of the Bronx, New Tork city. It is known as the "Terrace City" because of its many hills. Pop. (1960) 190,634. (For comparative population figures *see* table in NEW YORK: *Population.*)

Nappeckamack, the capital village of the Manhattes Indians, a Mohican tribe, stood upon the site of the present Philipse Manor hall in Yonkers. In 1639 the Dutch West India company acquired the area in the Keskeskeck purchase and in 1646 included it as part of a grant made to Adriaen van der Donck, the first lawyer in the colony. In 1652 this grant was enlarged to a patroonship known as Colendonck—the only one made within present Westchester county—extending irom Spuyten Duyvil creek to the northern part of Yonkers and from the Hudson to the Bronx rivers. Cultured, educated and a courageous foe of Gov. Peter Stuyvesant's administrative tyranny, Van der Donck was widely known as the young gentleman, or "jonkheer" in Dutch, from which the name of the city evolved. In a series of purchases between 1672 and 1692, Frederick Philipse, a prominent and wealthy merchant, speculator and officeholder, acquired the estate and the land beyond, northward to the Croton river. In 1682 he commenced the construction of his famed home, a gem of colonial architecture, which was eievated to the status of a manor hall when Philipse received a royal charter on June 12, 1693, combining his lands into the Manor of Philipsburgh. The manor was confiscated by the state in 1779 because the founder's great-grandson espoused the Tory cause during the American Revolution, and it was broken up and sold in 1786 under a writ of attainder. The manor house was sold to Yonkers in 1868 and was used as a village and city hall successively until it was acquired by the state in 1908. It is now maintained as a historic shrine and is open to the public. Although no major military action took place there during the American Revolution, Washington's army at one time occupied Yonkers. There was much skirmishing, raiding by Hessians and harassment of the area by irregulars and outlaws of both sides..

Yonkers was incorporated as a village in 1855 and chartered as a city in 1872. In 1874 the southern portion of old Yonkers was annexed to what was later to become the borough of the Bronx in New York city. Yonkers has more than 250 major industries. Chief products include elevators, escalators and hoisting machinery, aerosoi valves. sirups and sugars, copper wire and cables, chemicals, machines and tools, dairy products and paper products. The city has a council-manager form of government, in effect since 1940. (M. D. HH.)

GENEALOGICAL TABLE OF THE HOUSE OF YORK



YONNE, a department of central France, formed partly from the province of Champagne proper (with its dependencies, Sénonais and Tonnerroisj, partly from Burgundy proper (with its dependencies, the county of Auxerre and Avallonnais) and partly from Gâtinais (Orleanais and Île-de-France). It is bounded by Aube on the northeast. Côte-d'Or on the southeast, Nièvre on the south. Loiret on the west and Seine-et-Marne on the northwest. Pop. (1946) 266.014. Area 2,881 sq.mi. The highest elevation (2,000 ft.) is in the granitic highlands of Morvan. The department belongs to the basin of the Seine. except a small district in the southwest (Puisaye), which belongs to that of the Loire. The Yonne river flows through it from south to north-northwest. receiving on the right bank the Cure, the Serein and the Armançon, which water the southeast of the department. Farther north it is joined by the Vanne.

The department is served chiefly by the P.L.M. railway. The canal of Burgundy. which follows the valley of the Armançon, has a length of 57 mi. in the department, that of Nivernais. following the valley of the Yonne, a length of 33 mi. The department constitutes the archiepiscopal diocese of Sens, has its court of appeal in Paris, its educational centre at Dijon and belongs to the district of the VIII army corps. It is divided into 3 arrondissements (3; cantons. 48j communesj, of which the capitals are Auxerre, also capital of the department. Avallon and Sens; these with Chablis. Vézelay (*qq.v.*) and St. Florentin are its chief towns. Pontigny has a Cistercian abbey, where Thomas a Becket spent two years of his exile. with a 12th-century church. Druyes has a 12th-century château. Villeneuve-sur-Tonne has a mediaeval keep and gateways and a church of the 13th and 16th centuries. The Renaissance châteaux of Fleurigny, Xncy-le-France. Tanlay and the château of St. Fargeau, of the 13th century, rebuilt by Mademoiselle de Montpensier under Louis XIV, are all noteworthy. At St. Moré there are remains of the Roman road from Lyons to Gallia Belgica and of a Roman fortified post. There are many megalithic monuments in the department.

YORCK VON WARTENBURG, HANS DAVID LUDWIG, COUNT (1759–1830), Prussian general field marshal, was of English ancestry. He entered the Prussian army in 1772, but in 1779 was cashiered for disobedience. Entering the Dutch service. he took part in the operations of 1783–84 in the East Indies as captain. Returning to Prussia in 1785 he was. on the death of Frederick the Great, reinstated in his old service, and in 1794 took part in the operations in Poland. Five years afterwards Yorck began to make a name as commander of a light infantry regiment, being one of the first to give prominence to the training of skirmishers. In 1805 he was appointed to an infantry brigade, and in the Jena campaign played a successful part as a rearguard commander, especially at Altenzaun. He was taken prisoner, severely wounded, at Liibeck. In the reorganization of the Prussian army after the peace of Tilsit, Yorck took a leading part. At first major-general commanding the West Prussian brigade, afterwards inspector-general of light infantry, he was finally appointed second in command to General Grawert, the leader of the auxiliary corps which Prussia was compelled to send to the Russian War of 1812, succeeding to the command on Grawert's retirement. He conducted the advance on Riga with great skill; but his conviction that the French army was doomed led him at last, to neutralize the Prussian army by the Convention of Tauroggen (Dec. 30). The step was intensely popular, and although it was officially proposed to court-martial Yorck, he was absolved when the Treaty of Kalisch ranged Prussia with the Allies. During 1813–14 Yorck led his veterans with success at Bautzen, Katzbach, Wartenburg (Oct. 4) and Leipzig (Oct. 18). In France, he distinguished himself at Montmirail and Laon. The storm of Paris was his last fight. In 1821 he was created general field-marshal. He had been made Count Yorck von Wartenburg in 1814. He died at his estate of Klein-Ols, the gift of the king, on Oct. 4, 1830.

See Seydlitz, *Tagebuch des Preussischen Armee Korps 1812* **(1823)**; Droysen, *Leben des G. F. M. Grafen Yorck von Wartenburg* **(1851)**.

YORK (HOUSE OF), a royal line in England, founded by Richard, duke of York (*q.v.*), who claimed the crown in opposition to Henry VI. His claim was, perhaps rightly, barred by prescription, the house of Lancaster having then occupied the throne for three generations; it was really owing to the misgovernment of Margaret of Anjou that it was advanced at all. The duke was descended from Lionel, the third son of Edward III., while the house of Lancaster came of John of Gaunt, the fourth son. The claim was derived (*see* the Table) through females; but this could not reasonably have been objected to after Edward III.'s claim to the crown of France; and the duke's claim was probably supported by the fact that he was descended from Edward III. both through his father and through his mother. (See Table.) The earldom of Ulster, the old inheritance of the De Burghs, had descended to him from Lionel;

the earldom of March came from the Mortimers, and the dukedom of York and the earldom of Cambridge from his paternal ancestry. Moreover, his own marriage with Cecily Neville, though she was but the youngest daughter of Ralph, 1st earl of Westmorland, allied him to a powerful family in the north of England, to whose support both he and his son were indebted.

The reasons why the claims of the line of Clarence had been so long forborne are not difficult to explain. Roger Mortimer, 4th earl of March, was designated by Richard II. as his successor; but he died the year before Richard was dethroned, and his son Edmund, the 5th earl, was a child at Henry IV.'s usurpation. Henry took care to secure his person; but the claims of the family troubled the whole of his own and the beginning of his son's reign. It was an uncle of this Edmund who took part with Owen Glendower and the Percies; and for advocating the cause of Edmund Archbishop Scrope was put to death. And it was to put the crown on Edmund's head that his brother-in-law Richard, earl of Cambridge, conspired against Henry V. soon after his accession. The plot was detected, being revealed, it is said, by the earl of March himself, who does not appear to have given it any encouragement; the earl of Cambridge was beheaded.

The popularity gained by Henry V. in his French campaigns secured the weak title of the house of Lancaster against further attack for forty years.

Richard, duke of York, seems to have taken warning by his father's fate; but, after seeking for many years to correct by other means the weakness of Henry VI.'s government, he first took up arms against the ill advisers who were his own personal enemies, and at length claimed the crown in parliament as his right. The Lords, or such of them as did not purposely stay away from the House, admitted that his claim was unimpeachable, but suggested as a compromise that Henry should retain the crown for life, and the duke and his heirs succeed after his death. This was accepted by the duke, and an act to that effect received Henry's own assent. But the act was repudiated by Margaret of Anjou and her followers, and the duke was slain at Wakefield fighting against them. In little more than two months, however, his son was proclaimed king at London by the title of Edward IV., and the bloody victory of Towton immediately after drove his enemies into exile and paved the way for his coronation.

After his recovery of the throne in 1471 he had little more to fear from the rivalry of the house of Lancaster. But the seeds of distrust had already been sown among the members of his own family, and in 1478 his brother Clarence was put to death—secretly, indeed, within the Tower, but still by his authority and that of parliament—as a traitor. In 1483 Edward himself died; and his eldest son, Edward V., after a nominal reign of two months and a half, was put aside by his uncle, the duke of Gloucester, who became Richard III. and then caused him and his brother Richard, duke of York, to be murdered.

But in little more than two years Richard was slain at Bosworth by the earl of Richmond, who, being proclaimed king as Henry VII., shortly afterwards fulfilled his pledge to marry the eldest daughter of Edward IV. and so unite the houses of York and Lancaster.

Here the dynastic history of the house of York ends. But a host of debatable questions and pretexts for rebellion remained. The legitimacy of Edward IV.'s children had been denied by Richard III. and, though the act was denounced as scandalous, the slander might still be reasserted. The duke of Clarence had left two children and the attainder of their father could not be a greater bar to the crown than the attainder of Henry VII. himself. Seeing this, Henry had kept Edward, earl of Warwick, a prisoner in the Tower of London. Yet a rebellion was raised in his behalf by means of Lambert Simnel, who was defeated and taken prisoner at the battle of Stoke in 1487. The earl of Warwick lived for 12 years later in confinement, and was ultimately put to death in 1499.

His sister Margaret married Sir Richard Pole (or Poole), and could give no trouble, so that Henry VIII. treated her with kindness. He made her countess of Salisbury. reversed her brother's attainder, created her eldest son, Henry, Lord Montague, and had one of her younger sons, Reginald, carefully educated. *(See* POLE, REGINALD and POLE, FAMILY.)

YORK, EDMUND OF LANGLEY, DUKE OF (1341–1402), fifth son of Edward III., was born at King's Langley in Hertfordshire on June 5, 1341. He accompanied his father on a campaign in France in 1359, was created earl of Cambridge in 1362, and took part in expeditions to France and Spain. After marrying Isabella (d. 1393), daughter of Peter the Cruel, king of Castile, he was appointed one of the English lieutenants in Brittany, whither he led an army in 1375. A second campaign in Brittany was followed in 1381 by an expedition under his leadership to aid Ferdinand, king of Portugal, against John I., king of Castile; but Edmund shortly returned to England as Ferdinand had concluded an independent peace with John. Accompanying Richard II. on his march into Scotland, he was created duke of York in Aug. 1385, and subsequently on three occasions acted as regent of England.

York held a parliament in 1395, and he was again serving as regent when Henry of Lancaster landed in England in 1399. After a feeble attempt to defend the interests of the absent king, York joined the victorious invader; but soon retired from public life.

York died at King's Langley on Aug. 1, 1402.

YORK, EDWARD PLANTAGENET, DUKE OF (c. 1373–1415), elder son of the preceding (Edmund of Langley), was created earl of Rutland in 1390. Being a friend of his cousin, Richard II, he became admiral of the fleet, constable of the tower of London and warden of the Cinque Ports. He accompanied the king to Ireland in 1394 and was made earl of Cork; arranged Richard's marriage with Isabella, daughter of Charles VI of France; and was one of the king's helpers in the proceedings against the "lords appellant" in 1397. He became constable of England and obtained the lands in Holderness previously belonging to Thomas of Woodstock, duke of Gloucester, together with other estates and the title of duke of Aumerle or Albemarle. He deserted Richard in 1399, and in Henry IV's first parliament he was denounced as the murderer of Gloucester. He was reduced to his former rank as earl of Rutland, and deprived of his recent acquisitions of land. It is uncertain what share Rutland had in the conspiracy against Henry IV in Jan. 1400, but he was probably not seriously involved. He served as royal lieutenant in Aquitaine and in Wales and became duke of York on his father's death in 1402. He was concerned in the scheme, concocted in 1405 by his sister Constance, for seizing the young earl of March and his brother Roger Mortimer and carrying them into Wales, and he was imprisoned in Pevensey castle. Released a few months later, he was restored to the privy council and regained his estates. York led one division of the English army at Agincourt, where, on Oct. 25, 1415, he was killed by "much hete and thronggid." He was buried in Fotheringhay church.

YORK, RICHARD, DUKE OF (1411–1460), was born on Sept. 21, 1411, the son of Richard, earl of Cambridge. He became duke of York in 1415, and inherited the great possessions of the Mortimer family on the death of his maternal uncle, Edmund, earl of March, in 1425. He had been kindly treated by Henry V and his name appears at the head of the knights made by Henry VI at Leicester on May 19, 1426. York served in France (1430–31), and in 1432 he obtained livery of his lands and later went over to Ireland to take possession of his estates there. In Jan. 1436 he was appointed lieutenant general of France and Normandy. Me showed vigour and capacity. and recovered Fecamp and other places in Normandy. Dissatisfied with the support given him by the English government, York applied to be recalled in 1437, and returned home in the autumn. From this time he attached himself to Humphrey of Gloucester's party, in opposition to the government under Cardinal Beaufort. Marriage with Cecily, sister of the earl of Salisbury, allied York with his most powerful supporters, the rising family of the Nevilles.

On July 2, 1440, York was again appointed to the French command. His previous experience made him stipulate for full powers and a sufficient revenue. He did not go to Rouen until June 1441 During his second governorship York maintained the English position in Normandy. Distrusted by the court circle, he was recalled when his term of office expired in 1445.

The death of Humphrey of Gloucester in 1447 made York the first prince of the blood. Suffolk, now Henry's chief minister, found a convenient banishment for a dangerous rival by appointing York lieutenant of Ireland for ten years (Sept. 29. 1447). Tork, however, put off his departure for nearly two years.

During his absence Jack Cade's rebellion occurred. In Sept. 1450 York landed in Wales, came to London with an armed retinue and forced himself into the king's presence. He declared that he desired only justice and good government. In March 1452 York's first bid for power proved a failure; he came once more in arms to London, and endeavoured to obtain Somerset's dismissal. On a promise that his rival would be held in custody he disbanded his men and. thus outwitted, found himself virtually a prisoner. However, a nominal agreement was concluded, and York obtained the king's pardon. The situation was changed by the king's illness in Aug. 1453; York secured his recognition as protector on March 27, 1454. But the birth of a prince of Wales, in Oct. 1453, had removed York's chances of peaceful succession to the throne, and at the end of 1454 the king's sudden recovery brought the protectorate to an end.

The restoration of Somerset's ascendancy over the king made York and his friends take up arms, but, even when the two armies met at St. Albans. York endeavoured to treat for settlement. The issue was decided by the defeat and death of Somerset on May 22, 1455. Tork used his success with moderation. He became constable of England, and his friends obtained office. In Oct. 1455 a return of the king's illness made Pork again, for a brief space, protector. Henry recovered in Feb. 1456 and at Coventry, in October. the Yorkist ministers were dismissed. York mould not again accept honourable banishment to Ireland. Still there was no open breach and on March 25, 1458, a ceremony of reconciliation was held at St. Paul's. In Sept. 1459 both parties were once more in arms but York protested that he acted only in self-defense. The desertion of his best soldiers at Ludlow on Oct. 12. when the king advanced in person, left him helpless. With a few followers he escaped to Ireland, where his position as lord lieutenant was confirmed by an Irish parliament, and he ruled in full defiance of the English government. In June 1460 the earl of Warwick invaded England from Calais, and on July 10 their victory at Northampton gave the Torkists control of the king. York landed in England on Sept. 8, and marched on London. On reaching Westminster, he took up his residence in the royal palace, and formally asserted his claim to the throne in parliament. A compromise was arranged; Henry was to retain the crown for life. but Richard was to succeed him. On Nov. 8 he was accordingly proclaimed heir apparent. Early in December Richard went north with a small force. On Dec. 30 he was hemmed in by a Lancastrian army at Wakefield. Declaring that he had never kept castle in the face of the enemy, Richard rashly offered battle, and was defeated and slain. His enemies had his head cut off, and set it up on the walls of York adorned with a paper crown.

Richard of York was not a great statesman, but he was no mere pretender to a throne. He had ability and a genuine love of justice and might have made a good king. His widow, Cecily. survived until 1495; they had three daughters and four sons who survived infancy. Edmund, earl of Rutland, his second son, was killed at Wakefield. The other three were Edward IV, George duke of Clarence and Richard III.

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YORK, a city, county and parliamentary borough, seat of the archbishop of York. the county town of Torkshire and a county in itself, 194 mi. N.N.W. of London by road and 202 mi. S.E. of Edinburgh by the coast road. Pop. (1951) 105,371. Area 10 sq.mi. Lying in the vale of York at the junction of the rivers Ouse and Foss, with natural ways through the higher land to east and west, it is a big communications centre.

The Romans, realizing its strategic importance, built the military fortress of Eburacum (c. A.D. 71–74) for the 9th legion, with a *colonia* on the west bank of the Ouse. Of this fortress there remain the Multangular tower at the western corner, and the eastern corner tower. which was uncovered by excavation in 1925–27. The emperor Hadrian visited Uork; Severus and Constantius Chlorus died there; and Constantine the Great was proclaimed emperor in the city. The Roman occupation ended *c.* A.D. 400 and little more is known of York's history until 62j when Paulinus became the first archbishop. Edwin, king of Northumbria. was baptized there and founded the first minster in 627. About this date York became the northern ecclesiastical capital and by the 8th century had become famous throughout the Christian world as a centre of learning under Xlcuin.

In 867 the Danes captured the city and retained it as the capital of Northumbria. The name York, from the Danish Torvick, and some of the street names date from this period. Later the city was subjugated by the West Saxon kings after a long struggle. In 1066 it was captured by Tostig, aided by Harold Hardraade, king of Norway. Harold of England defeated them at Stamford bridge, a few miles from York. and was in the city when the Normans invaded. Under the Conqueror York suffered severely. It was the key position in the subduing of the rebellious north, and two castles were built for the purpose. A section of the city was demolished and land flooded to increase the defenses. Much of what was done may be learned from the Domesday survey.

In the medieval period York achieved great prosperity. Its merchants traded from the Baltic down to the French coast and the city became an important inland port. Wool was the chief commodity, York becoming a staple town. It was well fortified with walls, and the cathedral and many religious houses were built, notably the Benedictine abbey of St. Mary and St. Leonard's hospital. There were about 40 parish churches. as well as friaries, monasteries and other foundations. Craft guilds flourished and annually presented at the festival of Corpus Christi the still-surviving cycle of 48 mystery plays. The city's wealth and traditions established it as the northern capital.

Cnder the Tudors York remained ecclesiastically and politically important although economically it declined. largely because of keener competition with London merchants in overseas trade. the increased sizes of ships, which meant that fewer seagoing vessels reached the city, and constant demands for defense against the Scots and French. Matters were made worse by the dissolution of the monasteries after which the citizens had to provide for the sick, aged and poor who had previously been the care of the religious houses. During the Great Rebellion York was besieged and captured in 1644. Earlier Charles's northern headquarters, it was a royalist stronghold. It was not harshly treated. however. by the parliamentarians, largely through the good offices of Lord Fairfax, himself a Porkshireman. By the end of the century the wool trade had moved entirely to the West Riding and the city's population declined. But its geographical location saved York because of its importance for coaching routes, and during the 18th century it became a place of fashionable resort. Country gentry built houses there and a new prosperity came to the city. The 19th century saw the rise of commercial Tork. chiefly because of George Hudson, the "railway king," whose activities developed it as a railway centre. The consequent influx of workers and their families brought cheap labour, which benefited the new industries then coming into being.

The government of the city was laid down in its charters. The earliest extant is one of Henry II confirming one of Henry I. In this the citizens are granted a merchant guild and free customs. In 1189 Richard I granted exemption from tolls throughout the kingdom. In 1212 John granted the city to the citizens at a fee-farm rent of £160 annually. In 1396 Richard II made the city a county of itself, free of the Ridings, with power to appoint two sheriffs. Henry VI in 1449 confirmed the previous charters which were later all confirmed by Charles II in 1663, and James II in 168j. Parliaments and councils were held in York in the 13th and 14th centuries, and from 1482 to 1641 the city was the headquarters of the Council of the North. After the Pilgrimage of Grace failed, Henry VIII extended the council's powers. Between 1660 and 1664 abortive attempts were made to revive the council.

The Cathedral. — Dedicated to St. Peter and commonly called the "Minster," the cathedral was a secular foundation. It is cruciform in shape and occupies the site of the church founded by Edwin and destroyed at the Conquest. Between 1070 and 1154 another church was built, remains of which can be seen in the crypt of the present building. which took from the 13th to the 15th centuries to build. The transepts are 13th century, the "Five Sisters" window in the north transept being completed about 12jj. The nave and chapter house were built in the late 13th and early 14th centuries. The west, front was finished in 1338 The central tower, west towers and choir screen are ijth century. Two great fires have damaged the building. The first, in 1829, caused by Jonathan Martin, destroyed the choir woodwork. and the second, in 1840. damaged the southwest tower. The stained glass. much of it 14th century, was replaced after World War II, having been removed for safety in 1939.

Some of the parish churches also possess old glass. notably All Saints', North street, and St. Michael's: Spurriergate.

The City. — The walls surrounding the city are $2\frac{1}{2}$ mi. in circuit and date from the 14th century. They are pierced by four great gates or "bars" — Micklegate. Bootham, Monk and Walmgate, the latter still retaining its barbican. During the 18th century the walls fell into decay and proposals were made to demolish the bars. Some prominent citizens campaigned against the scheme and the walls were restored by public subscription. Prominent in the struggle was William Etty, the painter, who, like John Flaxman, the sculptor. was a York man.

Of some of the city's historical buildings, Clifford's tower (13th century) is quatrefoil in shape and stands on the artificial mound where the Conqueror built a castle which. in 1190. witnessed a massacre of York Jews; in 1684 an explosion destroyed the roof. The Merchant Adventurers' hall (1387) is still the home of the Merchant Adventurers' company; originally the Mercers' company it received its present style by royal charter in 1580. The guildhall (1446–48) was destroyed in an air raid in April 1942, as was the medieval church of St. Martin-le-Grand, Coney street. St. Anthony's hall (1446–53), formerly the hall of the minor guilds of the city. was the bluecoat boys' school from 170j to 1947. Now restored, it houses the Borthwick Institute of Historical Research, which was opened in 19j3. The Merchant Taylors' hall (late 14th-century and now restored) has been continuously the headquarters of the Merchant Taylors' company. St. William's college (1453), originally a college for chantry priests, has since its restoration at the beginning of the 20th century been the meeting place of the northern convocation. The Treasurer's house (National trust property) was the house of the treasurer of York minster until the office ceased at the Dissolution; the building passed into secular hands and was later divided into two parts, the other portion being known as Gray's court. The King's manor, the house of the abbot of St. Mary's until the Dissolution, later became the official residence of the president of the Council of the North. Since 1837 it has been the Yorkshire School for the Blind. The Assembly rooms were built in 1736 from designs by the earl of Burlington. The Mansion house (1725–26), the official residence of the lord mayor, contains the valuable collection of civic regalia and plate.

York contains rich material for students of history, its archive collections being particularly important. The city, merchant guiids, dean and chapter and College of Vicars Choral of York minster possess large accumulations. Archbishop Cyril Garbett (1875–1955) made available to students the vast series of diocesan records. which is housed at the Borthwick Institute of Historical Research.

The city also possesses several fine museums. The Yorkshire Philosophical society's museum includes, besides antiquities and natural history specimens, a fine Roman museum and a museum of medieval sculpture. Much of this latter comes from St. Mary's abbey, the ruins of which stand in the society's grounds. The society is the parent of the British Association for the Advancement of Science. The world-famous Castle museum, opened in 1938. contains the Kirk collection of bygones and is housed in the old female prison, built in 1780 by the York architect, John Carr. Its most striking feature is an old cobbled "street" with "shops" representing various trades. In the adjacent debtors' prison is the Military museum, as well as exhibits illustrating different crafts. The castle area in which these buildings stand, together with assize courts, although within the city boundary, has always been crown property and outside the city's jurisdiction. The Railway museum contains both small exhibits and rolling stock, including, among several famous locomotives. the "City of Truro," the first in England (in 1904) to travel at more than 100 m.p.h.

Although York retains much of architectural and historical interest it is also a thriving modern city. Chief of its many industries are the manufacture of cocoa and confectionery, and the railway with its passenger and freight car shops. Other industries include printing; scientific instrument. button and glass and furniture making: and the manufacture of hydraulic pumping.machinery. as well as many branches of light engineering. Sugar refining, brewing and the manufacture of artificial fertilizers are also carried on, The river provides a cheap means of transporting materials to and from the city. The first all-electric signaling system in the world was installed at York railway station. The increase in population had necessitated extensive building outside the old city with several boundary extensions. Some idea of this increase is gained from the following figures: 1801, 16,000; 1901, 77,793; 1951, 105.371. Inside the city boundary, areas of common land called "strays" serve as "lungs" for York. On one of these is the Knavesmire with its famous racecourse.

The city is an important centre for the marketing of agricultural produce and cattle. It is the headquarters of the northern command.

From 129j to 1918, when the number was reduced to one, two members were returned to parliament. From about 1450 to 1835 the area to the southwest of the city, known as the "Ainsty," was under the city's jurisdiction; its administration then passed to the West Riding. With the growth of the three county administrative areas York's position has declined as a civil capital but it has now become an important centre for tourists. The medieval hospital of St.. Leonard catered for the wayfarer, and the city council in 1951 restored and converted the 13th-century ruins into an information centre for travelers.

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YORK, a town (township) of York county, Maine, U.S., 40 mi. S.W. of Portland, comprised of York village, Uork Beach, York Harbor and Cape Neddick. It was settled in 1624 on a site called Agamenticus by Capt. John Smith,' who had explored the area in 1614. The community became the first English city on the American, continent when Sir Ferdinando Gorges (*q.v.*) endowed it with a city charter and government under the name of Georgeana in 1641. The Massachusetts Bay company took over the Gorges property in 1652, revoked the city charter and changed the name to York, after the English town.

The community was almost wiped out Feb. 2, 1692, in a raid by 150 Abenaki Indians; 80 residents were killed and 100 kidnapped in the worst massacre of its kind in New England. York was the shiretown of the province from 1716 to 1735 and of the county from 1760 to 1832, when the courts were moved to Alfred. With snug harbours, sandy beaches and rocky shores, the town is an attraction for photographers and artists. Its year-round population oi about 3,000 is multiplied several times during the vacation season. (A. K. GL.)

YORK, a city of southeastern Pennsylvania, U.S., 90 mi. W. of Philadelphia and 28 mi. S.S.E. of Harrisburg; the seat of York county. Pop. (1960) city 54,504, a decrease of 9.1% since 1950; standard metropolitan statistical area (York county) 238,336, an increase of 14.9%. (For comparative population figures for the city see table in PENNSYLVANIA: Population.)

York was the first permanent settlement in Pennsylvania west of the Susquehanna. It was laid out in 1741 in the centre of Springettsbury manor, a tract of 64,000 ac. granted to Springett Penn (a grandson of William Penn) in 1722, and was named for the English city. The first settlers were chiefly Germans from the Rhenish Palatinate (Lutherans, Reformed, Mennonites and Moravians), with some English Quakers and Scotch-Irish. The village was on the Monocacy road, the main route to the south and the southwest, and soon grew rapidly. When York county was established in 1749 the village of York was made the county seat, and by 1754 it had 210 houses and 1,000 inhabitants. In 1777, when the British approached Philadelphia, the Continental Congress left the city, and after holding one day's session in Lancaster, crossed the Susquehanna to York and made it the national capital from Sept. 30, 1777, to June 27, 1778.

In the old county courthouse (built 1754–56 and torn down in 1849) the congress passed the Articles of Confederation, received the news of Burgoyne's surrender, issued the first national Thanksgiving proclamation, received word from Franklin in Paris that France would aid with money, ships and men, received Von Steuben and Lafayette and commissioned them as major generals. It was in York that the Conway cabal, an attempt led by the Irish adventurer Thomas Conway to deprive George Washington of the command of the American army, was frustrated by Lafayette. There $1,500,000 in silver, lent by France, was brought in Sept. 1778, and there Benjamin Franklin's printing press, moved from Philadelphia, issued $10,000,000 of Continental money. During the Civil War Confederate troops entered the town on June 28, 1863, and a small Federal force retreated before them.

York is the commercial centre of a rich agricultural region and also has many large and diversified manufacturing industries. The city's area is closely built up and there are populous industrial districts just outside the corporate limits in several directions. Manufactures include refrigerating and air-conditioning equipment, hydraulic turbines, farm equipment, building materials, wall and roofing paper, tire chains and bakers' machinery.

York was incorporated as a borough in 1787 and as a city in 1887. Points of interest include the Quaker meetinghouse, erected in 1765; several old burying grounds; the building used by Gen. Anthony Wayne for his headquarters while recruiting his brigade for the march on Yorktown; and, in Farquhar park, a model of the provincial courthouse in which the Continental Congress held its sessions. (R. E. AT.)

YORK AND ALBANY, FREDERICK, DUKE OF (1763–1827), second son of George III, who as commander in chief of the British army introduced much-needed administrative reforms, was born in London on Aug. 16, 1763.

In Feb. 1764, through his father's influence as elector of Hanover, he was elected to the wealthy bishopric of Osnabriick, and retained that position until 1803. Entering the army in 1780, he received his military education in Hanover (1781–87) and was promoted to lieutenant general in 1784. A few weeks later he was created duke of York and Albany, and took his seat in the house of lords on his return home. In 1791 he married Princess Frederica (b. 1767), daughter of Frederick William II of Prussia, but the marriage was childless and not happy; a separation took place, and she died on Aug. 6, 1820.

In 1793 the king appointed the duke of York to command the English army sent to Flanders to co-operate with the Austrians. His personal bravery could not compensate for his inexperience and although his incompetence as a commander has been exaggerated, he must be held at least partly responsible for the defeats of 1794–95. In 1795 he was made a field marshal, and in 1798 commander in chief. His expedition to Holland in 1799 was even less successful, and he never again commanded in the field. He had to resign in 1809, being implicated in the scandals associated with his mistress, Mrs. Mary Anne Clarke (*q.v.*), but the house of commons acquitted him by 278 votes to 196 of having received bribes in return for military promotions. In May 1811 the prince regent replaced him at the head of the army.

Like his father, the duke owed much of his popularity to his hostility to the Catholic claims. His speech on that subject in 182j to the house of lords was printed on blue satin in letters of gold. During his last years he tried to organize an anti-Catholic party distinct from the ministerial. and in Nov. 1816 he tried unsuccessfully to induce his brother to dismiss George Canning, the leading advocate of Catholic emancipation. The duke's death on Jan. j, 1827, was a great blow to the opponents of Catholic relief, for the new heir presumptive, his brother the duke of Clarence, was at heart favourable to that cause. The long-continued irregularities of the duke of York's private life did nothing to diminish his popularity; indeed, it was suggested that in these failings "there was nothing that was un-English, nothing that was unprincely." He was an excellent commander in chief, applying himself with energy and devotion to the task of improving the welfare of the soldiers and eliminating administrative abuses.

See A. H. Burne, *The* Noble *Dube* of York (London, 1949); R. Fulford, *The* Royal Dukes (London, Sew York, 1949). (A. AL.)

YORKE, CHARLES (1722–1770), English jurist and politician, second son of Philip Yorke, Lord Chancellor Hardwicke, was born in London on Dec. 30, 1722, and educated at Corpus Christi college, Cambridge. In 1745 he published a treatise on the law of forfeiture for high treason and the next year was called to the bar.

In 1747 he gained a sinecure appointment in the court of chancery and entered politics as member for Reigate. In 1751 he became counsel to the East India company. His first political office was that of solicitor general under William Pitt (1756–61). He served as attorney general under John Stuart Bute (1762–63) and in the Wilkes cases condemned the principle of general warrants but maintained that parliamentary privilege did not extend to cases of libel.

As attorney general under the Rockingham administration Yorke maintained, in the dispute with the American colonies, that the Stamp act should be repealed but a Declaratory act should be simultaneously passed. He drew up the constitution for Quebec, which was later largely embodied in the Quebec act of 1774. He resigned office in 1767 and pledged himself not to accept office under the duke of Grafton. But when Grafton. in 1;70, invited him to accept the coveted office of lord chancellor, he at last yielded to the king's entreaties. Then, immediately overwhelmed with remorse, he fled to his own house and died there three days later, on Jan. 20, 1770. His last act was to refuse his official sanction to the patent raising himself to the peerage as Baron Morden. (D. TN.)

YORKSHIRE, the largest county of England, nearly spanning the country in its northeastern part. Bounded eastward by the North sea and southward by the Humber estuary with parts of Lincolnshire, Nottinghamshire, Derbyshire and Cheshire, on the west it is divided from Lancashire and Westmorland by a serpentine line drawn through and over the Pennine chain, approaching at one point within 8 mi. of the western shore. Northward the boundary against County Durham is the Tees. The total area (geographical county) is 6,100.6 sq.mi., distributed between the East (1,172.5), North (2,127.8) and West (2,790.3) Ridings and the City of York (10 sq.mi.)

Physical Features. — The county's geography is dominated by its western mountain wall: 95 mi. of the Pennine chain, which, boldly carved in the Ice Ages, presents rounded moorland crests, such as Mickle Fell, Whernside. Ingleborough, Buckden Pike and Penyghent, their flanks falling into the characteristic western dales, large scree slopes which have become hill meadows and broad alluvial floors traversed by rivers now relatively small (see PENNINES). Such are Upper Teesdale, Swaledale. Wensleydale, Nidderdale, Wharfedale and Ribblesdale, all north of Airedale ("the Aire gap"), the only low-level pass through the Yorkshire Pennines and a point where the geological exposures alter. The northern massif is of Carboniferous Limestone and Yoredale Beds, capped by Millstone Grit. South of the Aire, the prominent rock is the Millstone Grit, which has been arched upward approximately along the county boundary and has the Coal Measures preserved along either flank. The uplands again are bleak grouse moors. Under the eastern slopes of the Pennines, the county is traversed from north to south by a belt of Magnesian Limestone which produces a rich soil with luxuriant vegetation.

The remainder of Torkshire is a great tract of lower ground. North and south runs the broad central plain, parts of which are called the Vale of Mowbray and Vale of York; eastward to the sea extend Lower Teesdale, the Vale of Pickering and, in the south, the flats of the Ouse-Trent-Humber complex. Between these depressions, the northern hill mass is the tilted tableland of Jurassic limestones. rising nearly to 1,500 ft., now called the North Yorkshire Moors National park, but known for centuries as Blackamoor or Blakeymoor. Its majestic northwestern scarp dominates Cleveland (Cliffland) and the neoindustrial area of "Tees-side" or Lower Teesdale; while. apart from the Esk. which flows east to the sea at Whitby, all its major streams trend south into the Yale of Pickering and so by Derwent and Ouse into the Humber. The valleys of Eskdale. Ryedale, Farndale. Newtondale. etc.. sheltered and wooded. present much lovely scenery. South of Pickering vale rise the chalk Yorkshire wolds, similarly scarped to the northwest and dipping southeasterly. so that beyond Flamborough head the sea cliffs end and the chalk disappears under the flat, drift-covered promontory of Holderness which is subject to severe, and constant erosion by the sea.

Of coastal holiday resorts the principal are. from north to south, Redcar. Saltburn. Whitby, Robin Hood's Bay. Scarborough, Filey, Bridlington. Hornsea and Withernsea. Harrogate. with its mineral springs, is the chiei inland health resort.

Minerals. — Coal has long been the principal product and the Yorkshire Coal Measures are worked chiefly in the southwestern part of the county. Associated with the Upper Coal Measures are important nodular iron ores. Brick. pottery and fire clay are also found. besides gannister and oil shale. Farther north, some Pennine foothills are closely pocked with the shallow pits of the old-time coal miners. who likewise worked westward at Ingleborough and eastward in the Estuarine Lias of Cleveland. Lead ore (usually galena in calcite) was widely worked in the western dales irom, perhaps, pre-Roman times until the Nevada boom in silver-lead. Many of the limestones and sandstones provide excellent building material, though the most famous architectural quarries are in the Magnesian Limestone, while from the Lower Coal Measures come the smooth-faced Yorkshire paving and roofing flags. In the east. jet and Rimmeridge shale were worked from pre-historic times. Along the northeastern coast the production of alum prospered in the 17th and 18th centuries and deep deposits of potassium salts await development.

Archaeology. — From the Mesolithic period, Tardenoisian flints occur along the Pennines. notably near Huddersfield. while finds of stray Maglemose harpoons from Holderness were followed in 1949–51 by the excavation of a classic site, Star Carr, Seamer, near Scarborough, at the seaward end of the Vale of Pickering; a winter camp of hunter-fisher folk earlier than the best Maglemose sites on the continent and dated by radioactive carbon (C^{14}) technique about jooo B.C. For all periods between the Neolithic and Early Iron Age B—as also for the Anglo-Saxon — evidence lies thickest on the chalk wolds. East of Bridlington have been found concentrations of fine flint implements with long and round barrows, including many of the Beaker folk. Notable Megalithic monuments elsewhere are the 20-ft. standing stones called the Devil's Arrows at Boroughbridge. A great ceremonial centre is marked by three large earthen circles at Thornbrough. Cup-and-ring-marked stones near Ilkley could belong to the Middle Bronze Age, like some of the numerous running earthworks. Arras and Hessleskew farms near Market Weighton are famous for their chariot burials of chieftains of the immediately pre-Roman Iron Age and it is significant that among other deposits of this class! one was found in 1844 at Stanwick. where in 1951–52 Sir R. E. Mortimer Wheeler identified an 8 jo-ac. complex of earthworks as the last stronghold of the Brigantian king, Venutius, who revolted against the Romans in A.D. 69.

History. — Before the tide of Roman occupation rolled over it between A.D. 70 and 80. a part of the present East Riding was held by the Parisi. All the rest of modern Yorkshire belonged to the Brigantes. most numerous of the British tribes, according to Tacitus. Of Roman towns the principal and strategic centre was Eburacum (York, *q.v.*), garrisoned first by the hapless 9th legion Hispana and from A.D. 122 until the final withdrawal by the 6th Victrix. On the western fringe of the Ouse basin one great road ran from south to north by Bawtry, Doncaster, Castleford and Tadcaster to Isurium Brigantum (Aldborough by Boroughbridge) and so, under the modern Great North road to Cataractonium (Catterick Bridge) and the fork at Scotch Corner for Lavatrae (Bowes) or Vinovia (Binchester. County Durhamj. The complementary eastern road began at the port and river crossing of Petuaria (Brough on Humber) and followed a parallel course up the Yale of York. with a fork to Derventio (Malton j. York was linked to both of these by the great transverse road from Deva (Chester) to Bridlington.

In the 6th century an Anglian invasion of the wolds and Holderness led to the development of the kingdom of Deira. Ella (or Aella), its first king. extended his territory north to the Wear and his son Edwin conquered western districts roughly equivalent to Yorkshire. The defeat of Edwin at Hatfield in 633 was followed by a succession of struggles between Mercia and Northumbria for the supremacy over Deira. After the Danish conquest of Deira, Guthrum in 875 apportioned the district among his followers, under whose lordship the English retained their lands. Cleveland came under strong Scandinavian influence, and it was probably about this date that Yorkshire was divided into thrydings (Ridings, thirds). which in turn were subdivided into wapentakes. The bounds of the three Ridings were so settled as to meet at York, the administrative centre which by A.D. 1000 had a population of over 30.000. At the battle of Stamford bridge in 1066 Harold Hardraade, who had seized York, was defeated and slain by Harold of England.

The name Yorkshire was taken from the city of York which in pre-Roman times was supposed to have been called Eboracon.

On the redistribution of estates aiter the Norman conquest, Alan Rufus, founder of Richmond castle, received the honour of Richmond, and Ilbert de Lacy the honour of Pontefract. Earl Harold's estate at Conisbrough passed to William de Warenne. earl of Surrey, together with Sandal castle. which in the 14th century was bestowed on Edmund Langley. duke of York. Other Domesday landholders were William de Percy, refounder of Whitby abbey; Robert de Bruce. ancestor of the royal line in Scotland. and Roger de Busli. The archbishop of Tork enjoyed the great lordship of Sherburn. and Howdenshire was a liberty of the bishop of Durham, whose predecessors had held Crayke from the 7th century and who received from William Rufus the manor and soke of Northallerton.

In 1138 David of Scotland was defeated near Northallerton in the battle of the Standard. Robert Bruce in 1318 destroyed Northallerton. Boroughbridge, Scarborough and Skipton. The forces of Edward II defeated the rebel barons in 1322 at the battle of Boroughbridge. The forces of the rebellious earl of Northumberland in 1408 were defeated at Bramham moor near Tadcaster. A skirmish at Stamford bridge in 1453 was an early event of the struggle between the houses of York and Lancaster. In 1460 the duke of York was defeated and killed at Wakefield, and next year the Lancastrians were defeated at Towton. The suppression of the monasteries roused deep resentment in Yorkshire. and the inhabitants flocked to join the Pilgrimage of Grace. The northern rebellion of 1j69 was largely enacted in northern Yorkshire. Sir William Savile captured Leeds and Wakefield for the king in 1642, and in 1643 the duke of Newcastle, having defeated the Fairfaxes at Adwalton Moor, held all Yorkshire except Hull. In 1644. however, the Fairfaxes secured the East and West Ridings. while Cromwell's victory of Marston Moor was followed by the capture of York and in the next year of Pontefract and Scarborough.

In the 13th century the diocese of York included in this county the archdeaconries of York, Cleveland. East Riding and Richmond. The latter archdeaconry was transferred in 1541 to Henry VIII's new diocese of Chester, but its Yorkshire deaneries were given to the Ripon see when that was created in 1836. In 1888 the area of the Ripon diocese was reduced by creation, of the see of Wakefield. now consisting of the archdeaconries of Halifax and Pontefract; whiie the diocese of Ripon consists of the archdeaconries of Richmond (within Yorkshire) and Leeds. York diocese comprises the iirchdeaconries of Tork and West Riding. East Riding and Cleveland. The bishoprics of Sheffield and Bradford were created in 1914 and 1919 respectively, the former containing the archdeaconries of Sheffield and Doncaster, the latter those of Craven and Bradford. The first archbishop of York was Ecgbert. a disciple of Bede, who was raised to archiepiscopal status by Gregory III in 735.

The woolen industry developed after the Conquest, and historical details may be found in the articles on the separate towns *(see* LEEDS, BRADFORD, etc.). The time of the American Revolution marked the gradual absorption by Yorkshire of the clothing trade from the eastern counties. Coal appears to have been used in Yorkshire by the Romans, and was dug at Leeds in the 13th century. The early fame of Sheffield (*q.v.*) as a centre of the cutlery and iron trade is demonstrated by a line in Chaucer. Forges of the 13th century are mentioned at Rosedale and at Gisburn. In the 16th century limestone was dug in many parts of Elmet, and Huddlestone. Hesselwood and Tadcaster had famous quarries; Pontefract was known for its licorice, Aberford for pins and Whitby for jet. Kolton market was an important distributive centre in the 17th century, and in 1787 there were 11 cotton mills in the county.

Architecture. — As a county which has always been prosperous, Yorkshire is naturally endowed with a great wealth of monumental and architectural antiquities. Of castles, the fine ruins at Knaresborough, Pickering, Pontefract. Richmond, Scarborough and Skipton are described under their respective headings. Barden tower, picturesquely situated in upper Wharfedale, was built by Henry de Clifford (d, 1523). Bolton castle in Wensleydale, built in Richard II's time by Richard Scrope, was besieged in 1645, but remains impressive and partially habitable. The unique Conisbrough castle, with its massive cylindrical keep reinforced by solid buttresstoners! stands by the Don between Rotherham and Doncaster. Middleham castle, within sight of Bolton, is well cared for by the ministry of works. like Bowes, where only the square keep remains. Cawood castle, near Selby, retains its gateway tower of Henry VI's time. Helmsley castle, of the late 12th century, is still interesting although much of its curtain wall has gone into the building of the town, and Sheriri Hutton, which once resembled Bolton, has been similarly mutilated since the 18th century. Harewood castle in lower Wharfedale has no portion earlier than the reign of Edward III. Snape is a 15th-century castle partly ruined, partly inhabited. Other remains deserving notice are Mulgrave, Ravensworth. Spofforth, Tickhill, Whorlton, Wressell and Sandal.

At :he time of the Dissolution there were in 1'0rkshire 28 abbeys; 26 priories, 23 nunneries, 30 friaries, 13 cells, 4 commanderies of Knights Hospitallers and 4 preceptories of Knights Templars. The principal monastic ruins are Bolton abbey (*q.v.*), properly a priory, of Augustinian canons; Fountains, finest and most complete of the ruined abbeys in England (see MONASTERY). Rievaulx (*q.v.*), perhaps the most beautiful, and Jervaulx. all Cistercian; Kirkstall near Leeds, also Cistercian; and the Benedictine abbey of St. Mary in York (*q.v.*). Also notable are the Premonstratensian abbey of Coverham and other important remains at Bridlington, Guisborough, Malton. Whitby, Easby (Richmond), Kirkham near Malton. Monk Bretton near Barnsley and Mount Grace near Northallerton. Byland abbey, of the early 12th century. is still handsome and like the Premonstratensian abbey oi Egglestone on the Tees has benefited by official custodianship. Reference must be made to the Cistercian foundations of Meaux in Holderness, Roche near Rotherham and Sawley in Ribblesdale; the Benedictine nunneries of Marrick and Rosedale; and the Gilbertine house of Watton in Holderness. Beverley (*q.v.*) minster is a magnificent mainly Perpendicular building; it was originally founded as a college of secular canons in the 7th century.

Scattered about the county is a great quantity of Anglian, Anglo-Danish and Anglo-Norse carved stones which collectively illustrate local arts and the vigour of the Christian faith betneen the 8th and 11th centuries Of these. W G Collingwood's *Northumbrian Crosses* of *the Pre-Norman Age* (London 1927) is a masterly study From many place names the presence of 8th–9th century crosses may be noted at Collingham Dewsbury, Northallerton and Otley. In Masham churchyard is the weathered loner part of a superb Anglian stone rood Brompton by Northallerton in the 10th century was a centre of such work some of its crosses and "hogback" grave covers remain in its church.

As the Yorkshire countryside varies so widely, from sheer sea cliffs and flat sandy shores, through reclaimed fens and sheltered levels, up windswept dales to the bald mountaintops; so its architecture varies with location and materials formerly available. Stone was used for the most ancient buildings that survive, the Saxon crypt under Ripon cathedral, the early-Norman aisled and apsed crypt (intended for a cell of Whitby abbey) under Lastingham church. Of notable churches this brief selection incidentally names some of the most attractive villages and small towns: Bedale, Birkin, Bolton, Cox\\-old. Easby by Richmond. Flamborough, Hirckness, Kirklington, North Newbald, Patrick Brompton, Patrington. Pickering. Romaldkirk. Skipwith, Snaith, South Skirlaugh. Stillingfleet, Swine! Thirsk and West Tanfield.

Of domestic architecture the earliest survivals are a Norman manor house associated with the great Inigo Jones mansion of Burton Agnes, a few medieval timber-framed dwellings and many small stone manor houses, usually with flagged roofs. In the Bradford-Halifax district is a group of broad. low-browed stone houses built by the 16th-century clothiers. Fountains hall, built in 1610 out of materials from the adjacent abbey, is an outstanding example of its type and period. Kiplin hall (1616), the home of Lord Baltimore. is still furnished, and Honsham is a school but other famous 17th-century houses have perished or been rebuilt. Of the vast 18th-century country houses. Harewood (home of the earls of Harewood) is fully maintained; Castle Howard, designed by Sir John Vanbrugh, was damaged by fire but retains much of its state; Wentworth Woodhouse has suffered many indignities; East Riddlesden hall. Nostell and Sunnington have passed to the National trust; others to municipalities.

Agriculture, Industries and Communications. — The North and East Ridings are mainly agricultural; in the West Riding there are mixed farms even in the areas chiefly devoted to steel! coal and wool; but in both the West and Sorth Ridings the extensive fells and moors, with their dales. are the homes of prosperous dairy and sheep farming. Almost all the chicory and licorice (this mainly around Pontefractj and nearly a third of the flax used in England are grown in Yorkshire and enormous quantities of rhubarb are raised in the Leeds-Wakefield area. Grain growing is chiefly in the East Riding. Selby is the centre of a leading potato-growing district, and beet sugar is grown in several areas.

Of greatest importance are the textile and steel areas of the West Riding, both now based on the equally significant coal area centred on Barnsley. In the North Riding is the iron and steel industry based on Middlesbrough and Tees-side; in the East Riding, Hull, a busy deepwater port and base for the northern-seas cod fishery, is fast developing as an industrial centre; other industries in the East Riding include aircraft manufacture at Brough and oil-cake and flour milling at Barlby, by Selby.

About three-quarters of all the workers in Great Britain's woolen trade are found in the West Riding, mostly in the area bounded by Keighley, Leeds, Wakefield and Colne and Holme valleys. The worsted industry dominates the area in the northwest, around Bradford, Keighley and Halifax, woolens being more important in the southeast toward Wakefield. Dewsbury, Batley and Ossett are centres of shoddy manufacture; Halifax makes carpets, Bradford is a dyeing town. Leeds is Britain's busiest centre for ready-made clothing, but like other Yorkshire cities has many different industries. Todrnorden and Hebden Bridge are the two biggest cotton centres; silk is spun at Brighouse. The steel industry is mainly based upon Sheffield, but has spread through Rotherham into the Don valley, Doncaster itself having become a considerable manufacturing town. The coal area extends from south of

Leeds and Bradford to Sheffield, Barnsley being a notable centre. The iron and steel working area of Middlesbrough was developed and brought to great prosperity upon ore from the neighbouring hills, but is now increasingly dependent on ores brought from a distance. Between Middlesbrough and the mouth of the Tees in the mid-20th century new major industries concerned with new chemical processes, the production of synthetic fibres and fabrics, etc., were being established. York. too, long famed for its railway works and chocolate manufacture, has many other industries and is a thriving business centre.

Industry is aided by the fact that the main road and rail routes from London to northeastern England and Scotland pass through Yorkshire. The Aire and Calder navigation was designed to link industrial Yorkshire and Lancashire respectively with the Mersey and the Humber, Goole being a transshipment port on the latter waterway. Hull and Middlesbrough are Yorkshire's chief ports for ocean-going vessels.

Population and Administration. — The population of the three Ridings of Yorkshire at the 1951 census was as follows:

Riding	Administrative county	Geographical county (*i.e.*, inc. county boroughs)
	211,799	
	378,209	510,904
West	1,589,118	3,586,274
Total	2,179,126	4,622,659

The population of the city of York in 1951 was 105,371. Within the geographical boundaries of the East Riding (which has its county council officesat Beverley) are the city and county borough of Kingston upon Hull; the municipal boroughs of Beverley, Bridlington and Hedon; six urban districts and eight rural districts. The North Riding (county council offices at Northallerton) has one county borough, Middlesbrough; four municipal boroughs, Redcar, Richmond, Scarborough and Thornaby-on-Tees; 10 urban and 20 rural districts. The West Riding (county council offices at Wakefield) has 10 county boroughs, Barnsley, Dewsbury, Doncaster, Halifax, Huddersfield, Rotherham and the four cities of Bradford, Leeds, Sheffield and Wakefield; 13 municipal boroughs including the city of Ripon; 55 urban and 21 rural districts.

Although Vorkshire has only one sheriff, the three Ridings have been separate administrative units from, probably, the 9th century; each has had its own court of quarter sessions since the 14th century. its own lord lieutenant for several centuries, and its own county council since 1889. The present petty sessional divisions in many cases approximate the ancient wapentakes and use the names of the latter. The county and boroughs of Yorkshire in 1956 returned a total of 56 members to parliament. The National trust owned 8,653 ac. in Yorkshire in 1956; 241 ac. were protected.

Education is headed by the universities of Leeds (1904), Sheffield (1905) and Hull (1954). Technical colleges are devoted primarily to the study of subjects related to the various Vorkshire industries. There are many famous schools, Nonconformist colleges and other denominational schools such as the school of the Society of Friends at Great Ayton and the Roman Catholic college of Ampleforth run by Benedictine monks.

The people of industrial Yorkshire are noted for their singing, the Leeds festival being one of the greatest in England. Also centred on Leeds is the County Cricket club—a game for which Yorkshiremen have enthusiasm and talent.

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(C. K. C. A.)

YORKTOWN, a town in the tidewater area of eastern Virginia. U.S., site of the concluding engagement of the American Revolution, is on the York river 10 mi. from its mouth and 60 mi. S.E. of Richmond; the seat of York county. The town was established in 1691 and there began almost immediately a steady 'prosperous growth which continued until the Revolution. Possessing an excellent deepwater harbour, Yorktown became in the 18th century a tobacco port of first importance and around 1750 had a population between 2.000 and 3,000. Yorktown's economic decline began with the outbreak of the American Revolution; the siege of the town in 1781, which gave it a permanent place in history, completed its decline.

The events which led up to the siege of Yorktown were connected with the attempts of the British after 1778 to subdue the southern colonies. By the spring of 1781 this task was still not accomplished, and one of the reasons was that Virginia was serving as an important source of men and supplies for the Continental army. Consequently, in May 1781, Lord Cornwallis, the British commander, moved his forces into Virginia. After some sparring with the patriot forces under the marquis de Lafayette, Cornwallis moved to Yorktown on Aug. 7, to be in close communication with the British army at New York. It was then that Gen. George Washington and the comte de Kochambeau combined their American and French armies in the north and marched rapidly to Virginia. With the aid of a French fleet under the comte de Grasse (see AMERICAN REVOLUTION, THE: The War at Sea) and additional French infantry they joined Lafayette and laid siege to Yorktown on Sept. 28. Cornwallis, after an unsuccessful attempt to escape, surrendered on Oct. 19, bringing to an end, for all practical purposes, the war in America.

In the 20th century Yorktown regained a measure of prosperity. There are several naval establishments nearby, and there is a marked movement of industry into the area. A national monument was established there in 1930 and in 1936 the area was designated as Colonial National Historical park. Among the colonial edifices still standing in Yorktown is the magnificent Georgian home of Thomas Nelson, Jr., signer of the Declaration of Independence, governor of Virginia after Thomas Jefferson and commander of the Virginia militia during the siege.

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(E. G. Ev.)

YORO, inland department in northern Honduras. Area 3,065 sq.mi.; pop. (1950) 98,700, about 80% rural, is concentrated mostly in Aguan lowlands in the east-central part and in Comayagua-Cuyamapa-Sulaco lowlands in the west and adjacent mountain valleys. Twenty per cent of the area is farm land, of which more than half is either cultivated or in pasture. The department produces bananas for export in the western and eastern lowlands which are served by railways, and coffee is grown in the southern mountains, served only by pack and cart transportation. Other products include rice, corn, potatoes, cattle, swine and poultry.

The departmental capital, Yoro (pop. [1950] 2,078), set in a primitive highland region, is the home of the Jicaque Indians and can be reached by air or mule. (C. F. J.)

YORUBA, an African people numbering over 5,000,000 who inhabit the southwestern corner of Nigeria and a small area in eastern Dahomey, largely concentrated in the Ibadan, Ondo, Oyo, Abeokuta, Colony and Ijebu provinces of the Western region and in the Ilorin and Kabba provinces of the Northern region of Nigeria. The Yoruba city of Ibadan, with a population of over 450,000, is the largest Negro city in Africa. Five other Yoruba cities had over 100.000 inhabitants and six others over 40,000 at the 1952 census. Despite a tradition of urban life, their economy is' based on farming, with yams and maize as the main food crops, and on handicrafts and trade. They produce over 90% of Nigeria's cocoa as a cash crop for export.

According to Yoruba traditions, the earth was created at Ife, where beautiful portrait heads in brass and terra cotta have been excavated. Odudua, the deity who spread earth on the primeval water, had 16 sons from whom Yoruba kings claim descent. Leaving the Oni as ruler of Ife, the others went out to found their own kingdoms: Oyo the largest and most powerful under the Alafin, Ijebu-Ode under the Awujale, Ondo under the Oshemowe, Ilesha under the Owa, and others. Descent was patrilineal, a king's successor being chosen from among the members of the royal lineage. Although the kings had great authority in theory, in practice they were advised by court councilors, and if overly oppressive they were invited to commit suicide or escape to exile. Under British administration, after 1893, many provincial and town chiefs claimed the right to wear a beaded crown, assuming the status of traditional kings.

Yoruba religion centred in the worship of a pantheon of deities including Obatala. god of whiteness: Ogun, god of iron: Shango, god of lightning; Yemaja, Oshun and Oya, goddesses of the rivers Ogun Oshun and Niger; Shopona or Obaluaiye, god of smallpox; Ifa, god of divination; and Eshu. a trickster who serves as the gods' messenger. The worship of these deities continues in the Americas where many Yoruba were taken as slaves, especially in Brazil and Cuba.

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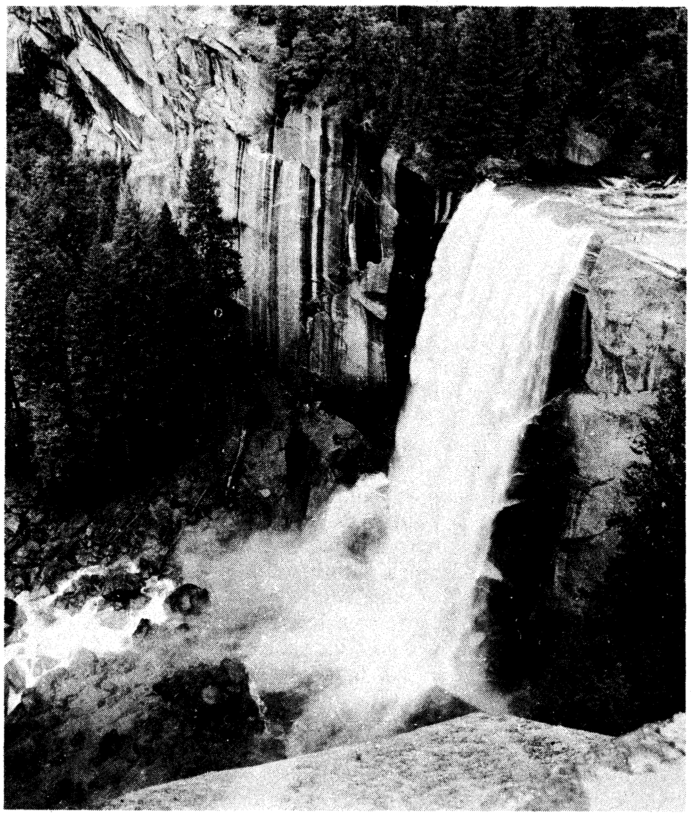
YOSEMITE NATIONAL PARK, a deep valley of the Merced river, tributary to the San Joaquin, in central California. It was established with the Mariposa Grove of Big Trees as a state park by an act of congress in 1864 which described it as "the Cleft, or Gorge, in the Granite Peak of the Sierra Nevada Mountains." From its floor at approximately 4,000 ft. above sea level the walls rise abruptly 3,000 to 4,000 ft. to a rolling plateau region culminating in mountain peaks 10,000 to 13,000 ft. high. The valley itself is about 7 mi. long and from ½ to 1 mi. wide. It presents a rare combination of unique form, enormous monolithic granite cliffs and domes, foaming waterfalls and the enchanting loveliness of woods and flowering meadows.

Principal features are the majestic rock forms—among them El Capitan, Cathedral Rocks, Cathedral Spires, Glacier Point, North Dome and the superb Half Dome, which dominates the head of the valley. Many sparkling waterfalls leap into the valley or drift down its granite cliffs in spring and early summer—Bridalveil, Ribbon, Yosemite, Illilouette, Vernal and Nevada. The Upper Yosemite fall has a drop of 1,430 ft.; from its lip to the foot of the Lower Yosemite fall the drop is 2,425 ft., making it the second highest fall in the world.

History.—Captain Reddeford Walker's party of trappers in 1833 may have looked either into Yosemite valley or Hetch Hetchy valley to the northwest. Apparently William Penn Abrams, a miner. saw Yosemite from Inspiration Point in 1849. Its existence was made known to the world in 1851, when Maj. James D. Savage and members of his Mariposa battalion pursued marauding Indians into their secret refuge. Lafayette Bunnell, a young physician, appears to have been the only one of the group impressed with the magnificent scenery; he gave names to many of the falls and rocks. He learned from Indians that the valley was called after the tribe occupying it—a name which Bunnell understood to be *Yo-sem-it-y*, meaning "grizzly bear." That name soon became established in its present form. The Yosemite Indians, still dwellers in the Stone Age, were of southern Miwok stock and were known among the settlers, along with other tribes, as "Diggers," because they lived largely on roots and acorns. Disease and intermarriage with the settlers diminished the original strain until scarcely a trace of Yosemite Indian blood remains.

The first party to enter Yosemite valley solely for the purpose of viewing its marvels and enjoying its beauties was led by James Hutchings in 1855. For more than 30 years he was identified with the valley as pablicizer, hotelkeeper and official guardian. An artist, Thomas Ayres, accompanied the original party. Lithographs based on his sketches were published by Hutchings and helped tb spread the fame of the valley throughout the world. Until 1874 access to Yosemite was by horseback or on foot over rough, steep trails. In that year the Big Oak Flat and Coulterville roads were completed into the valley on the north side and in 1875 the Wawona road was brought in from the south. In 1907 the Yosemite Valley railroad was completed up the Merced river as far as El Portal, at the edge of the park; it was discontinued in 1945. Although the first automobile entered the valley in 1900, motor travel was not authorized until 1913. Airplanes have, on a few occasions, landed and taken off from the valley floor, but this practice mas prohibited.

By 1885 visitors had reached an annual maximum of 3.000 (and even in those days a lady complained to the commissioners that crowds were ruining Yosemite). In 1908, the first year of rail travel to El Portal, the figure rose to 8,850. By 1922 visitors topped 100,000 and in 1927, after completion of the all-year highway from Merced, the figure jumped to 490,000. In 1954 it exceeded 1,000,000 for the first time. The great majority of visitors come in private automobiles, but regular bus schedules connect



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VERNAL FALLS. YOSEMITE NATIONAL PARK

daily with the main railroad lines. In summer a stage connects Yosemite with Lake Tahoe and with the Owens Valley stage lines by way of the Tioga road across the Sierra Nevada. Lodges, camps and the Ah ahnee hotel (an Indian name meaning "deep, grassy valley") provide a variety of public accommodations. With year-round accessibility, winter travel increased substantially, both for the beauties of the winter scene and for skiing. Badger pass, on the Glacier Point road, at 7,300 ft., was established as the ski centre in 1936.

Geologic History.—The striking evidence of enormous dynamic forces of nature everywhere visible in Yosemite valley invariably prompts the question: How was the valley formed? Josiah Dwight Whitney, head of the first California geological survey, proposed the theory of a vast cataclysm in which "the bottom of the valley sank down to an unknown depth." *(The Yosemite Guidebook,* 1869.) At a time when Whitney and his pupil, Clarence King, were declaring there was no proof that glaciers had ever entered the valley, a young naturalist, John Muir, who had recently come to California and become enamoured of the orderly and pure beauty of the Yosemite and its surroundings, proclaimed with enthusiasm that glacial erosion was the key to the whole process. Subsequently Muir's views gained support as others elaborated upon them and modified them. Geologists emphasized the importance of the rock structure and the slowness of the erosive process. Francois E. Matthes, of the U.S. geological survey. summarized the theory in 1930 as follows: "The story of the evolution of the Yosemite Valley, then, is a story of several chapters—of successive periods of valley and canyon cutting by the Merced river, induced by successive uplifts of the Sierra Nevada; of vigorous glaciation, several times repeated, during the ice age, the quarrying action of the ice being controlled and guided locally by the varying structure of the granite rocks and giving rise to exceptionally bold, clean-cut sculptural effects; and finally oi a period of dismantling, resulting in greater detail and intricacy of sculpture, the production of slopes of rock waste, and the formation of level valley floors." *(Geologic History of the Yosemite Valley*, 1930.)

The Yosemite museum has an excellent geological exhibit to demonstrate this theory of the valley's formation in various stages. (It also gives an answer to such queries as that most frequent one, "What became of the other half of Half Dome?")

Yosemite National Park.—In 1864 congress enacted a law, signed by Pres. Abraham Lincoln, by which Yosemite valley and the Mariposa Big Tree Grove were granted to the state of California with the stipulation that "the premises shall be held for public use, resort and recreation . . . inalienable for all time." In 1890 congress responded to the fervent pleas of John Muir, Robert Underwood Johnson of *Century Magazine* and others; it reserved and withdrew from settlement a large area of forested and mountainous land surrounding the Yosemite valley grant. The divided authority and conflicts inherent in this anomaly of a national park enclosing a state park within its boundaries continued until 1906. when congress accepted the recession of the state grant by the California legislature. Since then the entire area has constituted the Yosemite National park, which embraces about 1,200 sq.mi. From 1891 to 1914 the park was administered during the summer by troops of the U.S. cavalry. The national park service is charged with maintaining the park, protecting its vegetation and wildlife and making available to the public opportunities for wholesome recreation and for education in natural history and science. *(See* NATIONAL PARK *SYSTEM,* THE.)

Most of Yosemite National park lies within the basins of the Merced and Tuolumne rivers. Outstanding features. in addition to Yosemite valley, are Little Yosemite, Merced and Washburn lakes at the head of the Merced river; Tuolumne meadows, Benson and Tilden lakes and Jack Main canyon, the canyon of the Tuolumne river with its Waterwheel falls: the Hetch Hetchy valley, source of water and hydroelectric power for San Francisco by special act of congress in 1913; the Mariposa Grove of Big Trees with its giant sequoias. one of which (the Wawona tree) is pictured in every child's geography as the Tunnel Tree and the much smaller Merced and Tuolumne groves.

Among the vegetation of Yosemite there are more than 1.000 species and varieties, changing markedly from its lower borders to the bleak alpine conditions of the high mountains. In addition to the Big Tree groves, the park is notable for its forests; from the dry foothills with their Digger pine and blue oak the traveler climbs to the valley floor, where black oak. maple and dogwood edge streams and meadows, with tall yellow pines, cedars and Douglas spruce rising behind them. Along the Wawona and Big Oak Flat roads are fine stands of stately sugar pine; at higher levels noble forests of red fir are succeeded, on the Tioga road, by mountain hemlock interspersed with lodgepole, until at Tioga pass. near timberline, the weatherbeaten white-bark pine makes its spectacular appearance. The grizzly bear for which Yosemite was named is no longer found, but mule deer and the California black bear are abundant.

A galaxy of mountain peaks carries the crest of the Sierra Nevada through the park; Lyell (13,090), Dana (13,050), Conness (12,556), Clark (11,506), Hoffmann (10,921), Cathedral Peak (10,933) and others. The Tioga road, originally built as a wagon route for access to mines, has been regraded as a mountain highway and crosses the Sierra Nevada from Crane Flat on the Big Oak Flat road to Mono lake. In a circle from Tuolumne meadows on the Tioga road a few High Sierra camps provide food and shelter in summer. To the north of the Tioga road is a superb wilderness of lakes and deep canyons traversed only by trails, as is also the lofty southeastern corner of the park. The John Muir-High Sierra route starts from the Yosemite valley over the Sunrise trail to Tuolumne meadows and thence by Donohue pass on its mountain-studded way to Sequoia National park nearly 200 mi. south.

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(F. P. F.; M. C. T.)

YOSHIHITO (1879–1926), 123rd emperor of Japan, known posthumously as emperor Taisho. Third son of Emperor Meiji, he was born in Tokyo on Aug. 31, 1879, and was proclaimed crown prince on Nov. 3, 1889; the emperor's two elder sons had died in infancy. He married Sada-Ko, daughter of Prince Kujo in 1900, and had four sons: Hirohito (who succeeded to the throne in Dec. 1926), Yasuhito (Prince Chichibu, who died in 1953), Nobuhito (Prince Takamatsu) and Takahito (Prince Sumi). He ascended the throne on the death of his father on July 30. 1912, and, like him, was invested as a knight of the garter by Prince Arthur of Connaught. As the ally of Great Britain his envoys sat with representatives of the other victorious powers at the Versailles peace conference after World War I; he had been appointed a field-marshal of the British army in 1918. On his death in 1926 a special service was held in Westminster abbey, the first occasion when so signal a mark of respect had been paid to the head of a state who was not of the Christian faith.

During the last five years of his life the emperor lived in seclusion. He had always been of a delicate constitution and increasing ill-health necessitated a regency in 1921 under the crown prince, shortly after the latter's return from a visit to Great Britain and Europe. Yoshihito's reign did not compare in length or achievement with that of his father, but his country took part with the Allies in World War I; and the period of Taisho (Great Righteousness) was one of steady growth in military. economic and cultural fields. The throne retained the affectionate reverence of the people, a unique relationship contributing in no small degree to the strength of Japan. (F. S. G. P.)

YOUGHAL, a seaport and aatering place of County Cork, Ire., on the west side of the Blackwater estuary. 31 mi E.N.E. of Cork by road. Pop (1956) 4.841. Youghal was a settlement of the Northmen in the 9th century, and was incorporated by King John in 1209. The Franciscan monastery, founded there by Maurice FitzGerald in 1224, was the earliest house of that order in Ireland Sir Walter Raleigh was mayor of Youghal in 1588–89, and is said to have cultivated the first potato in Europe, and smoked the first tobacco, there The wide bridge which connects the counties of Cork and Waterford across the river Blackwater is a main link in the road communications of southern Ireland.

YOUNG, ARTHUR (1741–1820), English agricultural writer, was born in London on Sept. 11. He lived through the period when British agriculture was changing from its medieval to its modern form, and fen men did more to assist the change. After unsuccessful efforts at trade and journalism he started farming his deceased father's small estate at Bradfield, Suffolk, in 1763, but failed. Nevertheless, in 1767 he published his *Farmer's Letters to the People of England*—an act which he afterward described as "a sin of the blackest dye . . . nothing but ignorance, folly, presumption and rascality." But he quickly made ample amends. In the same year he began the series of agricultural *Tours* which not only gave the best accounts of the farming of England. Ireland and France, but uere of great educational value to farmers. First came *A Szx Weeks' Tour Through the Southern Countzes of Eng-*

land and Wales (1768), then *A Six Months' Tour Through the North of England* (1770) and the *Farmer's Tour Through the East of England* (1771). Nine years later he published his *Tour in Ireland* and later still (1792) his *Travels in France.* His *Farmer's Calendar* (first published in 1771) went through at least 20 editions. In 1784 he started his *Annals of Agriculture,* a monthly journal which he continued until 1809; it served a useful purpose in raising the standards of farming. Even George III wrote for it under the name of his Windsor shepherd, Ralph Robinson.

When William Pitt established the board of agriculture in 1793, Young was appointed secretary and, with the president Sir John Sinclair, organized the production and publication of valuable reports on the agriculture of the counties of Great Britain, he himself writing those for Suffolk (1794, 1797), Lincoln (1799), Norfolk (1804), Oxfordshire (1804) and Essex (1807). No such comprehensive series has since been prepared and it is frequently easier to obtain information about the agriculture of a particular county in the period 1780–1820 than at any subsequent time. Young was an attraceive writer with a vigorous style. His closing years were saddened by the death of his young daughter and by the loss of his eyesight, and he became afflicted with religious melancholia. He wrote a voluminous autobiography which M. Betham-Edwards published in a shortened version in 1898.

(E. J. R.)

YOUNG, BRIGHAM (1801–1877), U.S. Mormon leader, born at Whitingham, Vt., June 1, 1801. He moved to Mendon, N.'., in 1829, and three years later joined the newly organized Mormon Church. (*See* LATTER-DAY SAINTS.) He was appointed an apostle in 1835, played a leading role in the removal of the Mormons from Missouri to Illinois, and in 1840 was sent to Liverpool to direct Mormon missionary work in England. There he organized branch missions, established emigrating agencies and began publication of the *Millennial Star*. He returned to the U.S. two months after the death of the prophet, Joseph Smith (*q.v.*), to take over the leadership of the church. The people of Illinois having demanded the removal of the Mormons. Young was faced with the Herculean task of leading them to a new country where they would be free from interference. After organizing the groups and planning every move in detail, the migration of nearly 5,000 persons was gotten under way in 1846. In July 1847 Young, leading the advance band, reached the valley of Great Salt lake, and there decided to settle. He founded Salt Lake City, began the cultivation of crops by irrigation and directed the dispersal of the emigrant trains as they arrived. Both in moral and economic realms his word was law and he laid down the policies of the settlement. When the Territory of Utah was organized in 1850 he was appointed governor by Pres. Millard Fillmore and reappointed in 1854 Though not appointed again in 1858 because of his defiance of the United States in the so-called Mormon War, he continued to be the supreme power of the territory. He encouraged agriculture, developed natural resources, established manufactures, founded Deseret university at Salt Lake City and Brigham Young academy at Provo, built the Salt Lake theatre, laid the foundations of the Mormon temple, and created the Zion's Co-operative Mercantile institution which grew into the largest institution of its kind in the west. His genius as a leader is generally recognized, the settlement of Utah being one of the best examples of organic colonization in history. He followed the doctrine of plural marriage and at his death at Salt Lake City Aug. 29, 1877, was survived by 17 wives and 47 children.

For bibliography, *see* LATTER-DAY SAINTS, CHURCH OF JESUS CHRIST OF.

YOUNG, EDWARD (1683–1765), English poet, author of *Night Thoughts,* son of Edward Young, afterward dean of Salisbury, was born at his father's rectory at Upham, near Winchester, and was baptized on July 3, 1683. He was educated at Winchester college, New college and Corpus Christi, Oxford. His first publication was an *Epistle to . . . Lord Lansdoune* (1713). It was followed by a *Poem on the Last Day* (1713), dedicated to Queen Anne; *The Force of Religion: or Vanquish'd Love* (1714), a poem on the execution of Lady Jane Grey and her husband, dedicated to the countess of Salisbury; and an epistle to Addison, *On the Late Queen's Death and His Majesty's Accession to the Throne* (1714), in which he made indecent haste to praise the new king. About this time began his connection with Philip, duke of Wharton, whom he accompanied to Dublin in 1717, and with whom he had a lawsuit in 1740; the upshot was that Young was awarded an annuity of £100, but failed to secure a sum of £600 which he claimed.

Meanwhile, his plays, *Busiris* and *The Revenge,* were produced at Drury Lane in 1719 and 1721. Between 1725 and 1725 Young published a series of seven satires on *Love of Fame, the Universal Passion.*

Young was nearly 50 when he decided to take holy orders. In 1728 he was made one of the royal chaplains, and in 1730 was presented to the college living of Welwyn, Hertfordshire. He married in 1731 Lady Elizabeth Lee, daughter of the 1st earl of Lichfield. *The Complaint,* or *Night Thoughts on Life, Death and Immortality,* was published in 1742, and was followed by other "Nights." He died at Welwyn on April 5, 1765.

Other works by Young are: *Thr Instalment* (to Sir R. Walpole, 1726); *Cynthio* (1727); *A Vindication of Providence . . .* (1728), a sermon; *An Apology for Punch* (1729), a sermon; *Imperium Pelagi, a Naval Lyrick . . .* (1730); *Two Epistles to Mr. Pope Concerning the Authors of the Age* (1730); *A Sea-Piece . . .* (1733); *The Foreign Address, or The Best Argument for Peace* (1734); *The Centaw not Fabulous; in Five Letters to a Friend* (1755); *An Argument . . . for the Truth of His* [Christ's] *Religion* (1758), a sermon preached before the king; *Conjectures on Original Composition . . .* (1759), addressed to Samuel Richardson; and *Resignation . . .* (1762), a poem.

YOUNG, MAHONRI MACKINTOSH (1877–1957), U.S. sculptor, painter, etcher and art teacher, best known for his statuettes of figures of pugilists, labourers and cowboys, was born in Salt Lake City, Utah, on Aug. 9, 1877. He was a grandson of the Mormon leader, Brigham Young. He studied with J. T. Harwood, Salt Lake City, at the Art Students' league in New York city and at the Julian, Colarossi and Delacluse academies in Paris. His work was characterized by simplicity and dignity. Young's contemporary themes and realistic approach gave him much in common with such painters as John Sloan and George Bellows. Among his best known works are his bronzes, "Man With a Pick" and "Stevedore" at the Metropolitan Museum of Art, Hopi and Apache groups in the American Museum of Natural History, New York city, "Right to the Jaw" at the Brooklyn museum. "Bovet Arthur—a Laborer" and "The Rigger" at the Newark museum, the gull monument to the Mormon leaders in Salt Lake City, the statue of his grandfather in the U.S. Capitol, Washington, D.C., and "Monument to the Dead" (with Bertram Goodhue) in Paris. He taught sculpture, painting, printmaking and illustration at the Art Students! league and was a member of the National Academy of Design, the National Sculpture society and the Society of American Etchers. In 1947 he was elected a member of the American Academy of Arts and Letters. He died at Norwalk, Conn., on Nov. 2, 1957. (W. H. Gs.)

YOUNG, OWEN D. (1874–), U.S. lawyer and businessman, was born at Van Hornesville, N.Y., Oct. 27, 1874. He was educated at St. Lawrence university, Canton, N.Y., and at Boston university law school. He practised law in Boston until 1912 and then became general counsel for the General Electric company. Ten years later he became chairman of the General Electric board of directors, a position he held until 1939. Meanwhile, in 1919, he had organized the Radio Corporation of America and later became honorary chairman of its board of directors. Young was also a director of several other private and quasi-public corporations. He served in a number of public capacities, notably as a member of the first committee of experts appointed to advise the Reparations commission concerning the stabilization of the German currency after World War I. He was chairman of the second committee of experts that drafted a permanent plan generally known as the Young plan, for the settlement of reparations, and established the Bank for International Settlements. From 1942 to 1944 he emerged from retirement to help speed the war production program of the General Electric company. (FK. L. K.)

YOUNG, THOMAS (1773–1829), English physicist and physician, best known for his work in physical optics, was born at Milverton, Somerset, June 13, 1773. In 1799 he established himself as a physician in London; from 1801 to 1803 he was proiessor of physics at the Royal institution and from 1802 to 1829 foreign secretary of the Royal society, of which he had been elected a fellow in 1794. He died in London on May 10, 1829.

Young was the author of a series of researches which did much to establish the wave theory of light, and in 1301 he discovered the principle of interference of light. He gave the word "energy" its scientific significance and gave his name to Young's modulus. In 1793 he explained the mode in which the eye accommodates itself to vision at different distances; in 1801 he described the defect known as astigmatism; and in his lectures he put forward the hypothesis, afterward developed by H. von Helmholtz, that colour perception depends on the presence in the retina of three kinds of nerve fibres which respond respectively to red, green and violet light. In another field he was one of the first successful workers at the deciphering of Egyptian hieroglyphic inscriptions.

See Alexander Wood, *Thomas Young* (1954).

YOUNGBERRY, a vigorous, thorny vine of hybrid origin bearing dark purple berries of the blackberry type that turn black when thoroughly ripe. The fruit, which has a pleasant subacid flavour and ships well, is produced over a period of several months. The plant was developed in the United States in Louisiana and became popular as a garden and market fruit in parts of the south. (J. M. BL.)

YOUNGHUSBAND, SIR FRANCIS EDWARD (1863–1942), British soldier, explorer, writer and mystic whose travels, mainly in northern India and Tibet, yielded major contributions to geographical research, was born at Murree, India, on May 31, 1863. Educated at Clifton and Sandhurst, he entered the army in 1882 and in 1886–87 traversed central Asia from Peking to Yarkand and thence to India, crossing the Karakoram range by the long-disused Muztagh pass. He discovered the Aghil mountains and proved the Great Karakoram to be the water divide between India and Turkistan. On two later journeys beyond the Karakoram he traced the course of the Shaksgam to its junction with the Yarkand river and explored the Pamirs. In 1890 he transferred to the Indian political department and, after serving in northwest frontier stations and visiting South Africa (1896), he led the British mission to Lhasa which resulted in the Anglo-Tibetan treaty of Sept. 7, 1904. For this service he was, in the same year, created knight commander of the Indian empire. In 1905 he returned to England and became Rede lecturer at Cambridge, but a year later he went back to Kashmir as resident (1906–09). In 1917 he was created knight commander of the Star of India. In 1891 he had been given the gold medal of the Royal Geographical society and in 1919, after his retirement, he became its president and formed, and became chairman of, the Mt. Everest committee. He died at Lytchett Minster, Dorset, on July 31, 1942.

Deeply religious, Younghusband's view of the universe as a spiritual creation and his love of living things inspired him to acquire a wide knowledge of the various branches of natural science. Though intensely patriotic and a convinced imperialist, he recognized and welcomed the desire of India for self-government. His understanding of different religions and his belief that the same mystical experience, though variously expressed, is the root of them all led to his founding of the World Congress of Faiths (1936), and this he considered to be his highest achievement.

He expounded his beliefs in *Life in the Stars* (1928) and *The Living Universe* (1933). His other works include *Heart of a Continent* (1896), *South Africa of Today* (1898), *India and Tibet: Within* (1912) and *Modern Mystics* (1935).

See G. Seaver, *Francis Younghusband* (1953). (K. M.)

YOUNG MEN'S CHRISTIAN ASSOCIATION was founded in London in 1844 by George Williams and a group of associates who were employed in a drapery firm. The movement spread rapidly to other countries and by its semicentennial in 1894 had spread around the world. On this occasion, George Williams, who had become an outstanding business leader, mas knighted by Queen Victoria. In 1955 the World Alliance of Y.M.C.A.'s observed its centennial with a series of conferences held in Paris. These conferences were attended by about 8,000 delegates representing more than 4,000,000 members in 76 countries and territories. The first associations in North America were founded in 1851, one group organizing in Montreal, Can , and another in Boston, Mass. By the mid-1950s there were 1,916 associations in North America with a membership totaling more than 2,325,700. These Y M.C A.'s operate in large and small cities. rural areas, railroad and industrial centres, colleges and high schools. ·

Throughout its history the Y.M.C.A. has sought to develop high standards of Christian character through group activity and citizenship training. Its program includes sports and physical education, camping, counseling, formal and informal education, public affairs and citizenship activities. Such programs are designed to meet the needs of younger children, teen-agers and adults.

Y.M.C.A.'s of the U.S. served men in uniform during four wars, beginning with the American Civil War. During World War I it saw service among soldiers of many nations as well as among 6,000,000 prisoners of war. In World War II the Y.M.C.A., one of the six founding members of the United Service organization (U.S O.), helped to provide recreational programs among U.S. troops and conducted religious services for prisoners of war. Since 1889 the North American associations have sent trained leadership into 38 countries and have given material assistance to associations which suffered the effects of war and other disasters. Decisions were made in the mid-1950s to expand and intensify these efforts so that Y M.C.A.'s in other countries would be better able to meet the growing demands for their services. (C. M. CY.)

YOUNGSTOWN, a city of northeastern Ohio, U.S., and seat of Mahoning county, lies on both sides of the Mahoning river and is equidistant (65 mi.) from Cleveland and Pittsburgh. It is the industrial heart of the Youngstown-Warren standard metropolitan statistical area, listed as the fourth-ranking steel producing district in the nation in the 1960s. This area comprises Mahoning and Trumbull counties and includes the steel-mill cities of Warren (*q.v.*), Niles, Campbell, Struthers and Girard. The population of Youngstown was 166,689 in 1960. a decrease of 1% since 1950; however, the population of the standard metropolitan statistical area (Youngstown-Warren) was 509,006, an increase of 22.2%.

Northeastern Ohio was part of the Connecticut Western Reserve when John Young, after surveying in the area in 1796, purchased a tract of land in 1797 from the Connecticut Land company. In 1802 he laid out a town plat (Young's town) on the north side of the Mahoning river which still is the "public square." Col. James Hillman, a local trader, settled in the new village and remained a leader in its affairs. By 1805 the manufacture of iron was started by James and Daniel Heaton, who set up a crude smelter at Yellow Creek. Later the discovery that locally mined block coal could be used directly for iron smelting was a distinct advantage. Youngstown and the U.S. iron and steel industry grew together. Early production was based on available raw materials and local markets, served by the Pennsylvania and Ohio canal, opened in 1839. Shortly thereafter, in 1855, the Sault Ste. Marie canal around the falls of the St. Marys river was opened making available the rich ores from the upper lakes. To transport the millions of tons of raw materials required by the blast furnaces, four main railroad lines and four branch lines serve Youngstown. Because of the high demands by the steel industry for water, several reservoirs were constructed in the surrounding glaciated region.

Youngstown was incorporated in 1859 and replaced Canfield as seat for Mahoning county in 1876. The population grew slowly from 2,759 in 1860 to 44.885 in 1900; then, mainly due to an influx of Slovaks, Slovenians, Poles and Italians attracted by the steel industry, rapidly increased to 132,358 in 1920 and to 170,002 in 1930. The economic trend of the nation was reflected clearly in Youngstown's increasing blast furnace output from 2,604,344 tons in 1900 to 7,548,000 tons in 1920. The economic picture in the 1960s, however, showed greater diversity in industry which included aluminum extrusions, electric lamps, plastics, office furniture, coal-tar products, rolling-mill equipment, paperboard boxes and envelopes. Aircraft and automotive parts, awnings, conveyer belting, rubber hoses, storm windows and doors, crushed limestone, nonferrous castings and clothing were manufactured among the other products.

The Youngstown park and recreation system, along with Mill Creek park which is a natural gorge in the southwestern part of the city, covers more than 3,000 ac.

Youngstown university (established as a night school in 1888) offers both liberal arts and professional courses. The public library system has several branches in Youngstown and Mahoning county as well as a mobile service. Local culture is reflected in the Butler Institute of American Art, the Community playhouse and the Youngstown Philharmonic orchestra. (S. A. B.)

YOUNG WOMEN'S CHRISTIAN ASSOCIATION, an organization founded in 1855 by two ladies simultaneously. In the south of England Miss Emma Robarts started a prayer union with a purely spiritual-aim, and in London Lady Kinnaird commenced the practical work of opening homes and institutes for young women in business. In 1887 the two branches united in the Young Women's Christian association, which seeks to promote the all-round welfare of young women by means of residential and holiday homes, club and rest rooms, classes and lectures, and other useful departments. The association has spread all over the world, and the total membership is over half a million.

YOVKOV, YORDAN (1880–1937), Bulgarian writer whose mastery of prose is shown especially in his short stories, was born in Jheravna, a village in the Balkans, on Nov. 9, 1880. The region is rich in stories about the exploits of the *haiduks* (outlaws), which Yovkov used as background material for his famous *Staroplaninskiey Legendi* ("Balkan Legends," 1927). He grew up in the Dobruja where his father owned land and, after studying in Sofia, returned there as a village teacher. He later worked for a time in the press section of the Bulgarian legation in Bucharest. He died at Sofia on Oct. 15, 1937.

Yovkov's stories of village life are set mainly in the Dobruja, as is his novel *Chiflikat krai granitsata* ("The Farm by the Frontier," 1933). His experiences as an officer in the first Balkan War and World War I inspired some of his best stories. His gift for narrative and for realistic dialogue, his romantic imagination and his stylistic refinement make him a master of Bulgarian prose. His plays include *Albena* (1930), *Boryana* (1932) and a comedy, *Milionerat* ("The Millionaire," 1930). Some of his stories were translated in *The White Swallow and Other Short Stories* (1947).

(L. BY.)

YPRES, JOHN DENTON PINKSTONE FRENCH, 1ST EARL OF (1852–1925), British soldier, was born at Ripple, Kent, on Sept. 28, 1852. The son of a naval officer, he entered the Royal Navy, in which he served as cadet and midshipman from 1866 to 1870. Joining the militia he passed from this into the army in 1874 and was gazetted to the 19th Hussars. He served in the Nile expedition in 1884–85, and commanded his regiment from 1889 to 1893. After two years on the war office staff he commanded a cavalry brigade (1897–99), and on the mobilization of the expeditionary force for s. Africa in 1899 he was chosen to command the cavalry division and was promoted major general. Pending the assembly of this he served in Natal where he commanded the troops on the field at Elandslaagte and took part in the early combats near Ladysmith, but he proceeded to Cape Colony just before the place was invested. After a few weeks in charge of the force at Colesburg, he led the cavalry during Lord Roberts' advance from Cape Colony, relieved Kimberley, cut off the retreat of Cronje's army, and occupied Bloemfontein. During the subsequent advance into the Transvaal he was in command of the left wing, and at a later stage of the victorious campaign he played a prominent part in the move from Pretoria to Komati Poort. For these services he was given the K.C.B. During most of the second phase of the struggle he was in command of the forces operating against the enemy in Cape Colony, and he was on the conclusion of hostilities promoted lieutenant general and was given the K.C.M.G.

He commanded at Aldershot from 1902 to 1907, in which year he was promoted general, and he then became inspector general of the forces for five years. He was appointed chief of the imperial general staff in 1912 and was promoted field marshal in 1913. In April 1914 he vacated the post of C.I.G.S., owing to military troubles in Ireland in connection with Ulster, but four months later be was chosen to take charge of the expeditionary force on the outbreak of World War I, and he commanded the British army on the western front from the outset of the struggle until the end of 1915. The terribly costly and somewhat fruitless advances of this year, culminating in Loos, provoked criticism at the time, and controversy has raged over French's share in them since. He certainly failed signally to harmonize with Kitchener at the war office. He resigned in December of that year, Sir D. Haig taking his place, and he returned to England, to be raised to the peerage as Viscount French of Ypres and High Lake. Me then became commander in chief in the United Kingdom, and he held that appointment unfil May 1918, when he was selected to be lord lieutenant of Ireland. This position he occupied under most trying conditions until early in 1921. On resigning he was rewarded with an earldom. He died on May 22, 1925, at Deal Castle, Kent At the end of the war, Lord French published his personal narrative under the title. *"1914."*

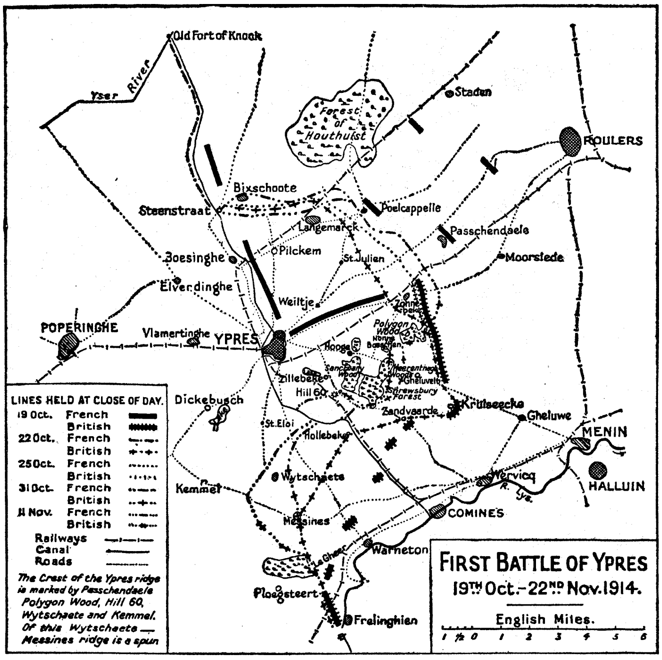
YPRES (Flemish *Yperen),* a town of Belgium in West Flanders, of which it was formerly considered the capital. Pop. (1955 est.) 17,159. It is situated 35 mi. S. of Ostend and 12 mi. W. of Courtrai, on the Yperlée, a small river flowing into the Yser, both of which have been canalized. In the 14th century it ranked with Bruges and Ghent. Its fine Halles or cloth market, with a façade of over 150 yd., was begun in 1201, completed in 1304, and reduced to ruins in World War I. The cathedral of St Martin dated from the 13th century, with a tower of the 15th century and was also ruined in 1914–18. Jansen, bishop of Ypres and the founder of the Jansenist school, is buried in the cathedral.

YPRES, THE BATTLE OF, 1914, is the name given to the heavy but indecisive fighting near Ypres at the close of the "race to the sea" (Oct. 19 to Nov. 22, 1914). It is commonly spoken of as the First Battle of Ypres.

Genesis of the Battle. — When in Oct. 1914 the British Expeditionary Force under F.M. Sir John French left the Aisne front to be transferred to Flanders, its various corps, as they arrived in succession on the left of the Allied line, at once came into contact with the enemy, for each of the two belligerent forces was simultaneously extending its front northwards. Thus the II. Corps (Smith-Dorrien) on Oct. 10 began the "battle of La Bassée," and the III. Corps (Pulteney) and the Cavalry Corps (the 1st and 2nd Cavalry Divisions under Allenby), on Oct. 12–13, the battles of "Armentières" and "Messines." On Oct. 14–15 the IV. Corps (Rawlinson), the Belgian army and a French Marine brigade, falling back from Antwerp, and de Mitry's cavalry corps and two French Territorial divisions, coming up from the west between Ypres and the Belgians, completed the Allied line to the sea. Of this line, the British held the portion from the La Bassée canal to Langemarck, north of Ypres. The general plan now was for the British, supported by the French and Belgians, to advance from the neighbourhood of Ypres, break through the enemy's front, cut off any Germans between the gaps thus made and the sea, and turn southward to roll up the German line.

The Opening of the Battle. — On Oct. 19, on the arrival behind Ypres of the I. Corps (Haig), Sir J. French sent forward Rawlinson's corps (consisting only of the 7th Division and the 3rd Cavalry Division) towards Menin, and directed Pulteney's and Allenby's corps to move down the Lys on both banks in the same direction. But on the day previous, the 18th, the enemy, with a general plan similar to that of the Allies, had also begun an advance, with a new IV. Army under Duke Albert of Württemberg, on a front from the Ypres-Gheluvelt (Menin) road to the sea. This army consisted of the new XXIT., XXIII., XXVI. and XXVII. Reserve Corps composed of young volunteers with 25% of old soldiers and the III. Reserve Corps of three divisions which had besieged Antwerp. Thus, as the German VI. Army, under Crown Prince Rupprecht of Bavaria, south of the IV. Army, also attacked, battle was engaged on the 19th on the whole front from La Bassée to the sea. In the sector between the river Lys and the sea, the German XIX. Corps attacked the left wing of Wilson's division (4th) of Pulteney's corps; four German cavalry corps advanced against Allenby's two cavalry divisions; whilst of the 11 divisions of the German IV. Army, four were sent against Capper's division (7th) and Byng's cavalry division of Rawlinson's corps, two and one-half against the French north of Ypres, and four and one-half against the Belgians.

On Oct. 21, just as Haig's corps, which had been put in on the left of Rawlinson's, was making good progress towards Langemarck, the French on its left fell back before the enemy to the Ypres canal. Haig, with his flank thus exposed to the attack of the XXIII. Reserve Corps, whilst engaged with the XXVI, on his front, had to use his reserve to cover his left, and his advance, thus deprived of any fresh impetus, came to an end. Elsewhere, the British were opposed to at least double their numbers: Capper's division to the XXVII. Reserve Corps, the three British cavalry divisions to eight German, and Wilson's division to the XIX. Corps. Nevertheless, they managed to hold their line unbroken on the 21st and 22nd. When on Oct. 23 the French IX. Corps (Gen. Dubois) reached Ypres and took over the Zonnebeke–Langemarck sector from Lomax's 1st Division of Haig's corps, a further slight advance was made; but the enemy was in superior numbers and had too much heavy artillery for any decisive success to be obtained. On the 24th Duke Albrecht equally abandoned any hope of a break-through until he could be reinforced; but desultory fighting continued, and on the 26th Capper's division lost the Kruiseecke salient, south-east of Gheluvelt. Meantime, the Belgians had been hard put to it and on Oct. 27 let in the sea at Nieuport to form an inundation in front of their line along the Yser.



The Second German Offensive.--On the same day, the 27th, Gen. von Falkenhayn, the chief of the German general staff, issued instructions for a new attack with increased forces. Six fresh divisions, brought from quiet parts of the line, to form under Gen. von Fabeck, the right of the VI. Army, were on the 30th to take the place of the four cavalry corps and attack Ypres from the south-east for the purpose of breaking through on the front Messines—Gheluvelt, which was held by two of the three cavalry divisions, now all united under Allenby's command, and Capper's division. At the same time, all the German troops north of the La Bassée canal were ordered to make a general attack. The addition of six divisions to the Ypres front gave, excluding cavalry, the Germans 15½ to the French and British six and one-half; but their artillery was even more overwhelming, for Fabeck, apart from what the other German commanders before Ypres possessed, was allotted over 250 heavy and super-heavy guns and howitzers, to which the Allies could only oppose 50, and of these more than half were of old and obsolete patterns.

There was some preliminary fighting on the 29th, when the British lost a little ground near Menin road. On this date, the eve of the second German offensive at Tpres, the line was held from the Lys to Zonnebeke by part of Wilson's division, the cavalry corps and the 7th, 1st and 2nd Divisions, all three since the 27th under Haig, who henceforward commanded in front of Ypres. Thence Dubois's IX. Corps and de Mitry's cavalry corps carried it on to the canal. The greater part of the Allied front maintained its ground on the 30th, but, under the heavy pressure of the six fresh German divisions, Allenby's cavalry divisions and Capper's division were forced back to the Messines-Wytschaete ridge, losing Zandvoorde and Hollebeke. Further danger in this sector was averted by Gen. Dubois, at Haig's request, sending his own reserve of four battalions and three batteries to the assistance of the British cavalry, and Gen. Haig himself despatching first two battalions and later three more, under Maj.-gen. E. Bulfin.

Gheluvelt, Oct. 31.—Matters, however, became more serious on the 31st, when, after a heavy bombardment, a convergent attack of five German divisions and three brigades on Haig's three divisions broke the line on a two battalion front at Gheluvelt, despite the desperate resistance of the 1st Battalion of the Queen's, which was annihilated. Elsewhere the front held, but at Messines part of the village was lost, and immediately south of the Menin road the line was pushed back. The situation was critical, and just at this time the staffs of Lomax's and Monro's divisions of Haig's corps were nearly all killed or disabled by a shell that struck Hooge Chateau.

A counter-attack ordered by Brig.-gen. H. Landon (3rd Brigade) drove back the Germans who had advanced from Gheluvelt along the Menin road; the village itself was recovered owing to the stout defence of the 1st South Wales Borderers north of the break, who held on to the park and chateau to the north of the village until a determined counter-attack of the 2nd Worcestershires initiated by Brig.-gen. C. Fitzclarence (1st Brigade) recaptured it; whilst south of the road a third counter-attack by the 2nd Royal Sussex, 1st Northamptonshire, and 2nd Gordon Highlanders, under the orders of Maj.-gen. E. Bulfin, regained all the ground that had been lost there, and more. At night, however, a retirement was made to a selected line east of Gheluvelt.

French Reinforcements.—On Nov. 1 the Germans continued to attack, and Messines was lost by Allenby's cavalry corps, but the French XVI. Corps (32nd, 39th and 43rd Divisions under Gen. Grossetti) arriving to relieve the cavalry, greatly strengthened the defence. Wytschaete and the rest of the ridge, however, were lost by the French next day. The Allied line was now held by the British and French alternately: from the Lys to opposite Messines by the British; thence as far as the Ypres-Comines railway by the French; thence along the front of Shrewsbury forest and Polygon wood to Zonnebeke by Haig's three divisions; and thence to the canal, by the French again; and this remained the distribution until the end of the battle. During Nov 3, 4 and 5 the German attacks somewhat died down; a composite division of Smith-Dorrien's II. Corps (under Maj.-gen. F. W. D. Wing) and the French 11th Division reinforced the Allies. But this assistance was counter-balanced by three out of five German divisions on the Belgian front being brought down against Ypres.

The Final German Effort.—The German supreme command now decided to attack the haunches of the Allied salient round Ypres from the north-east and south-east. Four more divisions, including a composite one of the Guard Corps, and the 4th (Pomeranian), one of the best in the whole army, were despatched to the sector with more heavy artillery. On the 4th, Crown Prince Rupprecht was given a definite order to break through south-east of Ypres, and whilst this offensive was in preparation to continue attacks all along the line, and the Duke of Wiirttemberg was ordered to move against the north-east part of Ypres. During the 6th, 7th, 8th and 9th the Germans managed to make a little progress at several points; they gained Le Gheer on the edge of Ploegsteert wood, and Zwarteleen near Hill 60, barely 2m. from Ypres; but elsewhere they were repulsed with heavy loss, and Grossetti's corps recovered ground lost between Wytschaete and St. Eloi. On the 10th, after a long and desperate defence, Dixmude (13m. north of Ypres) was lost by the Belgians, and a very heavy attack was deiivered against the French on the north-east and north of Ypres which gained a small amount of ground.

The Prussian Guard Attack on Nov. 11.—On Nov. 11 at 6:30 A.M., on a dark and misty morning, the Gennan artillery opened a terrific fire, increasing in intensity as 9 A.M. approached, at which hour the German infantry, under cover of the mist, advanced to the assault on the Lys-Polygon wood front. The British were weary with three weeks' continuous fighting without reliefs, the French nearly as tired. But, in spite of the German numerical superiority—23 divisions to 9½, with cavalry in about the same proportion—the Allied line resisted the enemy's repeated assaults except at two places—lust north of the Menin canal, where a detachment of Dubois's IX. Corps was driven back, and just north of the Menin road. South of and across this road, where the German 4th Division and Winckler's Guard Division attacked, a front of about 2m., stood Wing's composite division of Smith-Dorrien's II. Corps, its battalions so weak that it was about the strength of a brigade, the 2nd K. O. Scottish Borderers on the right, then the 2nd R. Irish Rifles, 1st Gordon Highlanders, 1st Cheshire, 2nd Bedfordshire, 1st Lincolnshire, 1st Northumberland Fusiliers, 4th Royal Eusiliers, and 2nd Duke of Wellington's. North of the road was Fitzclarence's brigade of the 1st Division (the 1st Scots Guards, 2nd Cameron Highlanders and 1st Black Watch), 800 men in all, with the 1st King's of Monro's division in Polygon wood beyond them. By the mere weight of the advance of the German 2nd Guards Brigade (six battalions of the 1st and 3rd Foot Guards Regiments), the front and support lines of Fitzclarence's three Scots battalions were overwhelmed. The attack passed over them, but fire from the 1st King's in Polygon wood, from three strong points (small defended posts with all-round defence) which formed Fitzclarence's third line of defence, and from various battalion headquarters in farms put in a state of defence, then held the Germans up and took heavy toll of them. About 400 or 500, however, pressed on into the Nonne Bosschen (wood), only to be met by the point-blank fire of Haig's field artillery in action beyond it; and the rifle-fire of some artillery men and engineers, including cooks and grooms, hastily collected. The final discomfiture of the German Guards was completed by a counter-attack of the 2nd Oxfordshire and Buckinghamshire through the Nonne Bosschen.

The Close of the Battle.—On the next day, Nov. 12, the weather began to break and become wintry; nevertheless, on this and the following days the Germans made several further attacks against the French in the Wytschaete area and against Wing's division south of the Menin road. These did not alter the situation, and the fighting then died down, and both sides set about completing their defences. With the end of the First Battle of Ypres, on the 22nd, open warfare ceased, and the operations of siege warfare, so-called trench warfare, begun on the Aisne in September, prevailed along the whole western front.

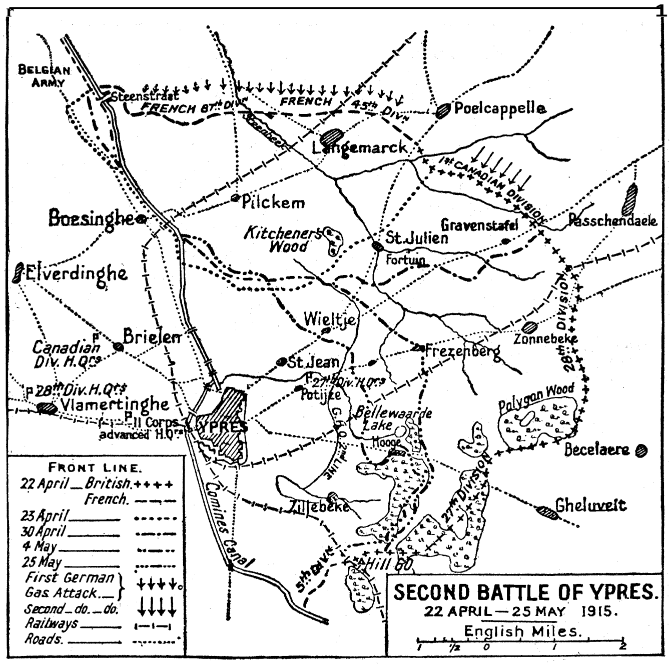
Opposed to more than double its own numbers, the British Expeditionary Force had held its own by sheer good shooting and superior training, and the skilful use by Gen. Sir Douglas Haig of his very small reserve. But such heavy losses had been incurred in the five weeks' battle and in the fighting at La Bassée and Armentières, which went on during the same period, that of the original British Expeditionary Force of fully trained officers and men very few remained, and for the future the empire was dependent on three divisions from overseas garrisons, on Territorial and New Army divisions, and dominion troops.

Bibliography.—"Military Operations, France and Belgium, 1914," *History of the Great War*, vol. ii. (1925), where there is a bibl.; Gen. Dubois, *Deux Ans de Commandement sur le front de France* (1920); *Die Schlacht an der Yser und bei Ypern* (1917), issued by the German General Staff. (J. E. E.)

YPRES, THE BATTLES OF, 1915, commonly called the second battle of Ypres, comprise the period of severe fighting that took place in front of Ypres beginning on April 22 with the first gas attack and continuing to May 25, 1915. It resulted in heavy casualties and considerable loss of ground round the town of Ypres, the base of the Allied salient, measured along the Ypres canal, being reduced from 8m. to 5½m., and its maximum depth from 6m. to 2½ miles.

Phases of the Battle.—For the purposes of general description, the battle is best divided into five phases (see sketch map): (1) the first German attack on April 22 against the French, resulting in the loss of the Pilckem area; (2) the second attack on April 24 against the Canadian Division, resulting in the loss of the St. Julien-Gravenstafel area; (3) the fruitless British counter-attacks; (4) the British withdrawal to the Frezenberg line, abandoning the Zonnebeke area; and (5) the renewed German attacks (Frezenberg-Bellewaarde), resulting in further loss by the British of a narrow belt of ground.

The Situation Before the Battle.—During the winter of 1914–15 the German Supreme Command had decided to carry out an offensive against Russia in 1915, and to stand on the defensive in the western theatre, leaving only sufficient troops there to hold the line. No general attack at Ypres was contemplated. It was, however, desired to try a new weapon, gas, thoroughly in the field, and the Ypres front was selected for the purpose on the advice of the German meteorological experts. Duke Albrecht of Wiirttemberg commanding the IV. Army, which held the sector from the Comines-Ypres canal to the coast, proposed to turn the use of gas to local advantage, to improve his position. If he could obliterate the Ypres salient and drive the Allies beyond the canal, he would deprive them of a bridgehead which gave them facilities for attack. The duke's forces consisted of the XV. Corps, the four new Reserve Corps, XXVII., XXVI., XXIII. and XXII., and two *Ersatz* and two *Landwehr* brigades which had fought at the first battle of Ypres. The Marine Division guarded the Belgian coast.



SECOND BATTLE OF YPRES. 22 APRIL—25 MAY 1915.

The Allied line from the Comines canal northward was held by part of the 5th Division (Morland), as far as Hill 60; the 27th Division (Snow); the 28th Division (Bulfin); and the 1st Canadian Division (Alderson). The last three formed the II. Corps (Plumer) of the II. Army (Smith-Dorrien). The 27th and 28th Divisions had been formed of troops from Indian and overseas garrisons, but, having suffered heavily from the winter conditions in Flanders, contained in April a considerable proportion of partially trained reinforcements. The Canadian Division had reached England in Oct. 1914, and had embarked for France in Feb. 1915. After being in the line at Neuve Chapelle, it had, between April 15 and 17, relieved French troops covering Ypres. The front defences taken over by the II. Corps were poor, but there was a well-developed back line known as "the G.H.Q. Line." The left of the Canadians extended as far as the Ypres—St. Julien—Poelcappelle road, beyond which were two French divisions under Gen. Putz: the 45th Division, which had arrived on April 16, containing nine newly raised Zouave battalions and three battalions of African natives, these latter being in the line; and the 87th Territorial Division, a division of elderly reservists.

The First Gas Attack.—On April 22, after an afternoon of comparative quiet, suddenly at 5 P.M. a yellowish cloud—now known to have proceeded from chlorine gas released from cylinders in the trenches—was seen to form on the German front opposite the African troops and French Territorials. It blew slowly towards them, whilst the German artillery opened with every kind of gun, firing on the French troops with shrapnel and bombarding all the villages in the salient and the town of Ypres with high-explosive shell. The French infantry in the line fled beyond the canal, leaving their artillery to be captured. abandoning a large area of ground and entirely exposing the British left flank (*see* sketch map). Fortunately for the Allies, the enemy had begun his attack so late in the afternoon that in the dusk he did not discover his immense success. Content with having secured Pilckem ridge and establishing outposts beyond it, about 7.30 P.M., according to plan, as it is asserted, but more probably in consequence of the stout defence put up by various small Canadian detachments, the Germans ceased any attempt to push into the gap, except at Steenstraat.

Gen. Plumer and his divisional commanders hurried what available troops they had to cover the gap, and when Gen. Putz in the course of the evening informed Gen. Smith-Dorrien that he meant to counter-attack at 4.30 A.M., and requested that the British should assist, arrangements were made to co-operate. But no movement of the French took place, nor were they in the succeeding days able to make any serious effort to recover the ground they had lost on the eastern bank of the canal.

Several counter-attacks were made by the British on April 23 to regain the ground lost by the French. They were carried out by the Canadians, the 13th Infantry Brigade, and Geddes's detachment—a temporary formation composed of six battalions of the 27th and 28th Divisions—without avail. The forces were too small, and there was not sufficient artillery or ammunition to support them. The Germans did no more than repel the counter-attacks on the 23rd, but from the 24th onward proceeded to follow two objectives: first to roll up the flank of the British line, aiming to get behind the troops still in position; secondly, to increase their gains across the canal near Steenstraat and separate the Belgians from the French and British. By the division of their forces, they failed to achieve either purpose.

The Second Gas Attack.--On April 24, at 4 A.M., the enemy released gas against the front of the 2nd and 3rd Canadian Brigades. In spire of having only extemporized means of protection (handkerchiefs, linen bandoliers, etc., dipped in water), they held fast for a time, but the enemy, after breaking in at one place, enlarged his gains, and the 3rd Canadian Brigade was gradually forced back, involving in the retirement through St. Julien the troops on the new left flank that had been built up. Gen. Snow, the only divisional general who had his headquarters east of the canal, at Potijze, took charge of the defence, and such reserves as could be hurried up were eventually placed by Gen. Plumer under his command, as communication across the canal between the headquarter? of the other commanders and their troops was constantly interrupted. Although the Germans were driven out of St Julien by a counter-attack of two battalions of the York and Durham Infantry Brigade of the Northumbrian (Territorial) Division. another large piece of the salient was lost, and after further German attacks on the 25th, Gravenstavel was abandoned, and the British line ran from the original left of the 28th Division past St. Julien, almost due west to the canal.

The British Counter-Attacks. — Counter-attack after counter-attack was now made by fresh troops hurried up to Ypres, the 11th Infantry Brigade (4th Division), the Lahore Division and the h'orthumberland Infantry Brigade (Northumbrian Division) with assistance on the left from the French. All were without success; they found the enemy well entrenched, and their only result was heavy casualties. In the operations of April 26, when some of the French 45th Division co-operated on the left of the Lahore Division, the Germans opened a few gas cylinders in defence, and broke the attack; whilst on the 27th gas shelling alarmed the African natives and caused them a second time to retreat in panic.

The position of the British troops in the narrow salient, projecting 6m. in front of Ypres and only some 3m. across was obviously untenable, as it was surrounded on three sides by the enemy and subject to constant bombardment. Gen. Smith-Dorrien proposed to withdraw to a line nearer Ypres. In consequence, however, of Gen. Foch's protests and promises that the French would regain the ground they had lost, and of the political desirability of not abandoning any more Belgian territory if it could be avoided, Sir John French agreed to leave his troops in their exposed position for some days longer. Gen. Joffre, having in preparation his great offensive which was to begin on May g, near Arras, was not disposed to allow Gen. Foch to employ any more troops near Ypres; and the French attacks languished.

The Withdrawal from the Apex of the **Salient.**—When on May 1 the French infantry in a projected attack failed to leave their trenches, all hope of their recovering ground came to an end, and Sir John French directed Gen. Plumer, who by his orders was now in special charge of the operations near Ypres, to begin the retirement to the Frezenberg line, abandoning a zone some 2m. deep. This retirement was carried out with complete success by the infantry brigades of the 27th, 28th and 4th (which had replaced the Canadian) Divisions in the line on the nights of May 1–2, 2–3, and 3–4. The French now held the $1\frac{1}{2}$m. of the left of the new semicircle round Ypres.

The Renewed German Attacks. — All hope of obtaining victory by gas attacks having disappeared, as the Allies were prepared for them, the Germans now tried by sheer weight of artillery to drive the British off their new position. After finally getting possession of Hill 60 on May 5–6, they made carefully prepared attacks on May 8 and on May 24. In spite of splendid defence and desperate British counter-attacks. in which the 4th, 27th, 28th, and Northumbrian Divisions and the Cavalry Corps troops were engaged, the enemy, dominating the situation with heavy artillery, gained a small amount of ground. Meanwhile, on the night of May 1j–16, he had been compelled by the French to abandon his position on the western bank of the canal. On May 25, after the II. Corps had established itself on a strong line, the Germans brought the battle to a close.

The total British losses in the Ypres and Hill 60 fighting were 2,150 officers and 57,125 other ranks, the total killed being 10,519. The German losses on the Allied front were returned at 860 officers and 34,073 other ranks.

See "Military Operations, France and Belgium, 1915," *History of the Great War based on Official Documents,* vol. i., with a bibliography (1927); Palat, *Grande Guerre sur le front Occidental*, vol. ix. (1922); M. Schwarte, *Der deutsche Landkrieg*, vol. ii. (1923). The French and German official accounts are not yet available, but official information furnished in advance is included in the British account. (J. E. E.)

YPRES, BATTLES OF 1917. Almost continuous fighting took place in the Ypres-Yser region during many weeks in the summer and autumn of 1917, but the operations as a whole may be said to have consisted of two distinct phases. First came the brilliantly successful combat, lasting a few hours, which has come to be known as the battle of Messines. Then, after a lull. there came to be launched immediately north of the scene of the Messines victory a series of attacks at short intervals which lasted four months. This was not a battle, but rather a campaign, with the fighting more defined than the purpose—of the nature familiar in the military annals of Flanders and the Low Countries generally. Like its German forerunners of 1914 and 1915, it achieved little except loss—in which, again, it repeated the earlier history of this theatre of war. So fruitless in its results, so depressing in its direction was this 1917 offensive, that "Passchendaele" has come to be, like Walcheren a century before, a name of ill-omen and a synonym for military barrenness.

An offensive in this sector had formed part of Haig's original contribution to the Allied plan for 1917. Its actual inauguration had been postponed by the unfortunate turn of events elsewhere. When the ill-success of the opening offensive in the spring at Arras (*q.v.*) and in Champagne was followed by the threatened collapse of the French army as a fighting force. Haig's "first-aid" treatment was to allow the British offensive at Arras by the III. Army to continue for some weeks longer, with the general object of keeping the Germans occupied, and with the local object of reaching a good defensive line. When successive thrusts, against an enemy now fully warned and strengthened, failed to reach this line, Haig decided to transfer the main weight of this effort northward to Flanders, as he had originally intended. His loyalty to his Allies and his acute sense of the common interest, inspired him to press on with an offensive policy.

It is right to emphasise that in May Haig's opinion of the policy to pursue was reinforced by the Prime Minister, Lloyd George, who, having committed himself to the Nivelle gamble for victory.

was equally ardent to continue the offensive. It is true, however, that on cooler reflection he subsequently tried in vain to check the policy which he had countenanced.

British Objectives. — The aim was the occupation of the whole of the belt of high ground which extends from a point about three miles north of Armentières, to near Dixmude. It rises some 100 to 150 ft. above the great Flanders plain, and reaches a height of over zoo ft. at some points. In the spring of 1917 its southern portion enclosed to a great extent the Ypres salient, although the Allies' trenches gave them possession of the lower slopes of their side of the high ground. Farther to the north the enemy held the whole of the high ground. The general plan of operations was to begin at the southern end and to work thence northwards. The capture of the high ground was to be followed by an advance in the coast district. But the axis of the attack diverged from, instead of converging on, the German main communications, so that an advance could not vitally endanger the security of the enemy's position in France.

But, worse still, the Ypres offensive was doomed before it began—by its own destruction of the intricate drainage system in this part of Flanders. The High Command had persevered for over two years with the method of a prolonged preparatory bombardment, believing that quantity of shells was the key to success. The offensive at Ypres, which was finally submerged in the swamps of Passchendaele in October, threw into stronger relief than ever before the fact that such a bombardment blocked the advance for which it was intended to pave the way—because it made the ground impassable.

THE BATTLE OF MESSINES

The preliminary move is known as the Battle of Messines, and its purpose was to gain the high ground about Messines and Wytschaete as a flank bastion for the subsequent advance from Ypres. For while in German possession it gave the enemy complete observation of the British trenches and forward battery positions, enabled them to command the British communications up to the Ypres salient, and to take in enfilade, or even in reverse, the trench positions therein. General Plumer and his II. Army, who had been acting as wardens of the Ypres front for two years, had been selected to carry out this operation, while the V. Army under General Gough had been transferred from the Somme to hold the line north of the II. Army. Preparations for the undertaking had begun nearly a year before although their real development dated from the winter. Thus when Haig asked Plumer, on hlay 7, when he would be ready to deliver the attack Plumer was able to say, "a month from to-day," and to keep his promise.

Messines was to be a strict siege operation, the capture of a fortified salient at the minimum cost of lives by the maximum substitution of mind (care in preparation) and material for man-power. Mines, artillery, gas and tanks all contributed. But a contrary wind curtailed most of the scheme of gas projection, and the effect of the mines and artillery was so overwhelming that the tanks were hardly needed. On the centre corps front alone, of about three miles, a total of 718 guns and howitzers, 192 trench mortars, and 198 machine-guns was concentrated.

For the defence of this salient the Germans depended on two separate trench systems coinciding in trace with its arc, the more advanced one pushed down the forward slope of the high ground while the rear one followed its crest; they had also constructed two chord positions, stretching along the base of the salient on the reverse slope. The troops of the II. Army detailed for the enterprise were, from right to left, the II. Anzac Corps, with the Australian 4th Division in support, the IX. Corps with the 11th Division in support, and the X. Corps with the 24th Division in support. There were thus nine divisions in front line and three in support. The fact that the attack would converge against a salient increased its chances, but it complicated the staff, troop, and artillery organization of the attack. For the sectors of each attacking corps were of varying depths, and contracted more and more in width up to the final objective which was the chord of the arc forming the salient. As, however, it was a siege operation, without any attempt at exploitation or a break-through, it was easier to avoid the congestion which had occurred at Arras (*q.v.*). The problem was further simplified by the plan of allotting sectors so that five of the divisions had sectors of equal breadth from front to rear, while the four which filled the interstices had smaller tasks. Further, when the main ridge was captured, fresh troops were to "leap-frog" through to gain the final Oosttaverne line across the base of the salient. The first bombardment and "wire-cutting" began on May 21, were developed on May 28 and culminated in a seven days' intense bombardment, mingled with practice barrages to test the arrangements. The loss of surprise did not matter at Messines as it was a purely "limited" attack.

At 3.10 A.M. on June 7 the nineteen mines—one only had previously been blown by the enemy—were exploded, wrecking large portions of the Germans' front trenches. Simultaneously the barrage fell. When the débris and shock of the mines subsided, the infantry advanced and within a few minutes the whole of the enemy's front line system was overrun, almost without opposition. Resistance stiffened as the penetration was deepened, but the training of the infantry and the efficiency of the barrage enabled continuous progress to be made, and within three hours the whole crest of the ridge was secured.

The New Zealand Division had cleared the intricate fortifications of Messines itself—here the pace of the barrage was regulated to 100 yards in fifteen minutes instead of the general pace of 100 yards in three minutes. The garrisons of Wytschaete and the White Chateau held out for a time, but the first village was captured after a fierce struggle by troops of the 36th (Ulster) and 16th (Irish) Divisions in a combined effort—a feat of symbolical significance. Perhaps the most difficult sector was that of the 47th (London) Division, which had not only to overcome the highly fortified position of the White Chateau but had the Ypres-Comines canal as an oblique interruption across its line of advance. The Londoners, however, overcame both and by 10 A.M. the objective of the first phase was reached along the whole attacking line. While it was being consolidated, over forty batteries were moved forward to support the next pounce.

At 3.10 P.M. the reserve divisions and tanks "leap-frogged" through and within an hour almost the whole of the final objective was captured. Some 7,000 prisoners had been taken, apart from dead and wounded. The success had been so complete that only feeble counter-attacks were attempted that day. When the expected general counter-attack was launched on the whole front on the morrow, it failed everywhere against defences that had been rapidly and firmly organized, and in the recoil yielded the British still more ground.

THE MAIN OFFENSIVE

A long pause now occurred while preparations for carrying out the rest of Haig's programme were being completed. Although Plumer's victory of June 7 had put an end to the enemy overlooking Ypres from the south, the Germans still, in a measure, dominated the place from the east, from the north-east and from the north. Thus the preparations could not be concealed and the Germans knew that they were being made. The plan at the outset was that, while the II. Army stood fast, the V. Army under Gough on its left with the French I. Army still further to the left, should attack the enemy front from near Hooge to north of Steenstraat on the Yser canal.

Nearly two months passed before the preparations for the main advance were completed. This gave the Germans, amply warned, time to make counter-preparations of characteristic thoroughness and ingenuity. Having learnt by experience that a continuous system of trenches did not offer a satisfactory form of defence unless there was abundant underground cover, and realizing that the waterlogged soil of Flanders handicapped the creation of subterranean galleries, they had established a system of numerous disconnected trenches and strong points, arranged in depth rather than in breadth, together with numbers of concrete blockhouses armed with machine-guns. As their front line near Ypres had been in existence since 1915, they trusted to the old system to meet the first shock of attack, and it was rather in the later offensive operations that the Allies found themselves confronted with these new defensive devices. A further new asset. was the introduction of mustard gas which the Germans used to cause serious interference with the attackers' artillery.

On July 22 the bombardment opened, by 2,300 guns, to continue for ten days, until on July 31 the infantry advanced on a fifteen-mile front to the accompaniment of torrential rain. On the left substantial progress was made, Bixschoote, St. Julien, and the Pilckem Ridge being gained, and the line of the Steenbeke reached. But in the more vital sector round the Menin road the attack was repulsed.

The second blow, on Aug. 16, was a diminished replica of the first in its results. The left wing was again advanced across the shallow depression formed by the little valley of the Steenbeke and past the ruins of what had been Langemarck. But on the right, where alone an advance might have a strategic effect, a heavy price was paid for nought, and even the tally of prisoners shrank to a mere two thousand. Nor did men feel that the enemy's skilful resistance and the mud were the sole explanation of their fruitless sacrifice. Severe complaints against the direction and staff work were general, and their justness seemed to receive recognition when Haig extended the II. Army's front northward to include the Menin road sector, and thereby entrusted to Plumer the direction of the main advance towards the ridge east of Ypres.

It was a thankless task at the best, for the experience of war attested the futility of pressing on in places where failure had already become established, and it seemed heavy odds that the laurels earned by Messines must become submerged in the swamps beyond Ypres. Yet, in the outcome, the reputation of Plumer and the II. Army staff, headed by Harington, was enhanced—less because of what was achieved in scale than because so much more was achieved than could reasonably have been expected.

Bad weather and the need for preparation delayed the resumption of the offensive until Sept. 20, but that morning the II. Army attack, on a four-mile front, achieved success in the area of previous failure—on either side of the Menin Road. Fractions of six divisions, the 19th, 39th, 41st, 23rd, 1st and 2nd Australian advanced at 5.40 A.M.; by 6.1j A.M. the first objective was gained almost unopposed, and, with the exception of one or two strong points, the third and last objective was gained soon after midday, and the counter-attacks were repulsed by fire. A fresh spring on Sept. 26, and another on Oct. a—the last a larger one on a six-mile front, by troops of the 37th, 5th, 21st, and 7th Divisions, the 1st, 2nd, and 3rd Australian Divisions, and the New Zealand Division—gained possession of the main ridge east of I'pres, with Gheluvelt, Polygon Wood, and Broodseinde, despite torrents of rain, which made the battlefield a worse morass than ever. On each occasion the majority of the counter-attacks had broken down under the British fire, a result which owed much to the good observation work of the Royal Flying Corps and the quick response of the artillery. Some 10,000 prisoners were swallowed in the three bites, and this frightened the enemy into modifying his elastic tactics and strengthening his forward troops—to their increased loss.

As a result of the operations begun on June 7 the crest of the long belt of high ground overlooking the Flanders plain had now, after four months of intermittent fighting, been secured from Messines northwards to within a few hundred yards of the Ypres-Roulers railway. And yet. regarding this Flanders offensive as a whole, the work was in reality only begun. The Houthulst forest, with the long line of high ground forming the quadrant of a circle beyond it, was still in the enemy's hands Until the ridge had been secured to the vicinity of Staden it would be premature to embark upon the second part of the general scheme of operations—an attack on the German positions along the coast between Nieuport and Ostend, for which the IV. Army under General Rawlinson had been assembled on the extreme left.

Unhappily, the Higher Command decided to continue the pointless offensive during the few remaining weeks before the winter, and thereby used up reserves which might have saved the belated experiment of Cambrai (see CAMBRAI, BATTLE OF) from bankruptcy. Having wasted the summer and strength in the mud, where tanks foundered and infantry floundered, they turned in November to dry ground—where a decisive success went begging for lack of reserves.

At Ypres minor attacks on Oct. g and 12 advanced the line a trifle, and then, after an interval, a combined attack by the V. Army and the French was tried, with small result, on Oct. 22. On Oct. 26 the II. Army, in torrents of rain, as usual, made a fresh effort, which was less successful than before, owing to the exhaustion caused by pushing forward over a morass and to the fact that the mud not only got into and jammed rifles and machine-guns but nullified the effect of the shell-bursts. The trials of the attackers were augmented by the enemy's increasing use of mustard gas, and by his renewed adoption of his tactics of holding the bulk of his troops well back for counter-attack. Thus when, on Nov. 4, a sudden advance by the 1st Division and 2nd Canadian Division gained the empty satisfaction of occupying the site of Passchendaele village, the curtain was at last rung down on the pitiful tragedy of "Third Ypres." It was the long-overdue close of a campaign which had brought the British armies to the verge of exhaustion, one in which had been enacted the most doleful scenes in their history, and for which the only justification evoked the reply that, in order to absorb the enemy's attention and forces the Higher Command had chosen the spot most difficult for the defender and least vital for the attacker.

(R. H. L. H)

YPSILANTI or HYPSILANTI, the name of a family of Phanariot Greeks claiming descent from the Comneni. ALEXANDER YPSILANTI (1725–1805) was dragoman of the Porte, and from 1774 to 1782 hospodar of Wallachia. He was again appointed hospodar just before the outbreak of the war with Austria and Russia in 1790. He allowed himself to be taken prisoner by the Austrians, and was interned at Briinn till 1792. Returning to Constantinople, he fell under the suspicion of the sultan and was executed in 1805. His son CONSTANTINE (d. 1816), who had joined in a conspiracy to liberate Greece and, on its discovery, fled to Vienna, had been pardoned by the sultan and in 1799 appointed by him hospodar of Moldavia. Deposed in 1805, he escaped to St. Petersburg, and in 1806, at the head of some 20.000 Russians, returned to Bucharest, where he set to work on a fresh attempt to liberate Greece. His plans were ruined by the peace of Tilsit; he retired to Russia, and died at Kiev. He left five sons, of whom two played a conspicuous part in the Greek war of independence.

ALEXANDER YPSILANTI (1792–1828), eldest son of Constantine Ypsilanti, accompanied his father in 1805 to St. Petersburg, and in 1809 received a commission' in the Imperial Guard. He fought with distinction in 1812 and 181;. losing an arm at the battle of Dresden. He was one of Alexander's adjutants at the congress of Vienna. In 1820, on the refusal of Capo d'Istria to accept the post of president of the Greek Hetairia *Philike,* Ypsilanti was elected, and in 1821 he placed himself at the head of the insurrection against the Turks in the Danubian principalities. With ocher Greek officers in the Russian service he crossed the Pruth on March 6, announcing that he had the support of a "great power." There followed a series of humiliating defeats, culminating in that of Dragashan on June 19 Eventually he crossed the frontier into Austria in the hope of finding an asylum. He was immediately thrown into prison, where he remained for seven years.

He died at Vienna on Jan. 31. 1828.

DEMETRIOS YPSILANTI (1793–1832), second son of Prince Constantine. fought as a Russian officer in the campaign of 1814, and in the spring of 1821 went to Morea, where the war of Greek Independence had just broken out. In January 1822 he was elected president of the legislative assembly; but retired early in 1823. In 1828 he was appointed by Capo d'Istria commander of the troops in East Hellas. He succeeded, on Sept. 25, 1829, in forcing the Turkish commander Aslan Bey to capitulate at the Pass of Petra, which ended the active operations of the war.

Ypsilanti died at Vienna on Jan. 3. 1832.

YSALGUIER, ANSELME D' (?*fl.* 1380–1420), French traveler. sometimes considered the first European to have seen the Niger river. According to the *Historia chronologica parlamentorum patriae occitanae* attributed to Guillaume Bardin he mas a member of a noble family of Toulouse; he reached Gao in 1405 married a native Moslem princess there then returned to Toulouse with his wife. their daughter, their two sons and some slaves (among them a physician who cured Charles VII of an illness). The *abbe'* Tricaud who, in his *Essnis de littérature pour la connaisance des livres* (1702). records this story, adds that D'Ysalguier wrote an account of his travels and produced a dictionary in Arabic Tuareg and Songhai. The whole episode is considered as true by C de la Roncikre in *La Découverte de l'Afrique au moyen âge,* vol. iii (1927). But it was later demonstrated that Tricaud copied the *Annales de Toulouse* of Lafaille (1687), an extremely unreliable nork. nhich embellished the *Historia chronologica* (itself a forgery). hloreover, a thorough study of the vast documentation concerning the family Ysalguier did not reveal the slightest hint about Anselme.

See F. Galabert, "Le Toulousian Anselme Ysalguier est-il allé au Niger au XV^e^ siècle?" Mém. Acad *Toulouse* (1933); *P.* Wolff, "Une Famille du XIII^e^ au XVI^e^ siècle, les Ysalguier de Toulouse," *Mélanges d'histoire sociale* (1942). (P. Wo.)

YSAYE, EUGÈNE (1858–1931), Belgian violinist, conductor and composer who was the main interpreter of the string works of the French and Belgian composers of his time. Born at Liège, July 16, 1858, he studied at the Liège conservatory and later with H. Vieuxtemps and H. Wieniawski in Brussels. After a year as leader of an orchestra in Berlin, he toured Norway, Russia and France.

Ysaÿe's early style was influenced by the violin sonata of César Franck. dedicated to him on his marriage in 1886. and he later inspired works by the principal French composers of his time. including Saint-Saens. Vincent d'Indy, Faure and Debussy. In 1894 he conducted the Ysaÿe orchestral concerts in Brussels and also visited the United States. From 1918 to 1922 he was conductor at Cincinnati, 0. Ysaÿe's playing was known for intensive use of vibrato.

His best works were his six sonatas for unaccompanied violin, containing novel chordal and pizzicato effects.

He died at Brussels. May 12, 1931.

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YSER, a small coastal river. 48 mi. long, of which 31 mi. are in Belgian territory. It is famous as marking the point. in World War I (1914–18), at which the German advance towards Calais and the English coast was checked. On Oct. 10, 1914, the Belgian army, after being forced to evacuate Antwerp and Ghent, retreated on the Yser; on the 16th the battle of the User began, and the Allied troops fought desperately for 1; days. Eventually, assisted by the floods which, beginning on Oct. 29, reached Dixmude by Nov. 2, the allies succeeded in establishing themselves in an impregnable position on the left bank of the Yser.

YSER, BATTLE OF THE. On Oct. 10, 1914, the Belgian field army encamped on the west bank of the Ghent-Terneuzen canal. The British Naval Division. which had embarked at St. Gilles-Waes. regained Dunkirk except two battalions. which were cut off. and passed into Holland; the French Fusilier Marine Brigade, half of the British 7th Division and the 4th Belgian Brigade were holding Ghent and had repulsed an attack on that city by the 1st Res. Ersatz Brigade.

Information had been received that a Bavarian cavalry division had advanced towards Deynze exploring between the Schclde and the Lys; that a column of 20.000 men had passed through Courtrai and Menin and that the German IV. Cavalry Corps was holding the region Tourcoing-Ypres-Poperinghe. The only way for the Belgian army to baffle the threat of envelopment on a iarge scale was an immediate march to the coast. It was decided to transport all the forces without delay to the region of Ostend-Thourout-Dixmude-Furnes, the infantry by rail, the artillery and transport by road, under the protection of all the cavalry and Rawlinson's Corps.

Plans of Opposing Commanders.—The "race to the sea" had in the menntime caused the Western Front to extend to La Bassée. The British army had been withdrawn from the region of the Aisne and was beginning to detrain west of Lille. A few French divisions, taken from other sectors, were given the same destination. It seemed to Gen. Joffre that the moment had come for bringing about the much-desired envelopment of the German right wing by a concentric offensive against Lille. The British army, the Belgian army and some French reinforcements would constitute, it was believed, under the high command of Gen. Foch, an *ensemble* capable of securing a decisive victory. Unfortunately, the assembling of the Allied troops by means of the Paris-Calais and Paris-Hazebrouck railways would take time. On the other hand, it was necessary to take in account that the Beseler Army Group would not fail to follow the Belgians.

The mission of the Belgian army was once again that of gaining time. The king, anxious to keep his left wing resting on the sea, and to preserve at all costs a fragment of national territory from invasion, thought best to entrench the army on the river Yser and the 1'pres canal.

Events soon proved the wisdom of this decision. The British II. and III. and Cavalry Corps were stopped at the Lys by the German IV., VII. and XIII. Corps; Rawlinson's Corps found Menin in the hands of the XIX. Corps. Beseler's troops now entered Bruges and Ostend. It was known that numerous detrainments were taking place west of Brussels and that a new German IV. Army had installed its headquarters at Ghent. In fact Falkenhayn, the new chief of the German general staff, had anticipated the Allies' projects and like them, considered the moment for a decisive victory to have arrived.

With four new army corps, composed mainly of volunteers, the XXII., XXIII, XXVI. and XXVII. Res. Corps, Beseler's group and the artillery park from the siege of Antwerp, Prince Albert of Württemberg was charged to proceed to the Yser with his right resting on the sea, in order to attack in flank and in rear the Allied left, whose front the VI. Army was engaging between Arras and Armentières. Falkenf ayn considered that: "The conquest of the coast was the sole means of frustrating the war of blockade which England contemplated and of retaliating through our destroyers, submarines, aeroplanes and Zepplins. . . . If we succeeded in driving the enemy out of the Yser valley and pursuing him at the point of the sword, there was no doubt that, having replenished our ranks and our stores, we should be in a condition to overthrow the western front."

Thus the Belgian army, which had only just moved into position in the general Allied line, found itself in focus for a new battle. It occupied a front of 40 km., from the sea to Boesinghe, with $4\frac{1}{2}$ divisions and $1\frac{1}{2}$ divisions in reserve behind the centre. The cavalry division was operating with de Mitry's French Cavalry Corps, east of the forest of Houthulst. On the army's right a French territorial division extended as far as Ypres and Rawlinson's Corps had entrenched itself along the line Passchendaele-Gheluvelt.

Opening of the Battle.—The battle commenced on the 18th with an attack by Beseler's corps (4th Ersatz and 5th and 6th Reserve Divisions) between the sea and Keyem. The Belgian outposts were only driven back after desperate fighting and the enemy did not even reach the Yser. On the morning of the 19th Ronarćh's Marine Brigade and the 5th Division debouched from Dixmude on the flank of the III. Res. Corps. Beerst and Vladsloo were retaken; but the intervention of the XXII. Corps, coming from Thourout, and the XXIII. coming from Cortemarck, foiled the counter-attack. By the 20th the fighting had become general all the way from the sea to Gheluvelt between the Duke of Württemberg's $5\frac{1}{2}$ divisions on the one hand and the Belgian army, de Mitry's Cavalry Corps and Rawlinson's Corps on the other. After 48 hours of obstinate fighting the Belgian positions remained practically unchanged.

The attack of the 4th Ersatz Division on Nieuport had failed, partly on account of the flanking fire from Admiral Hood's flotilla; while that of the XXII. Corps against the bridgehead at Dixmude had been checked by Meiser's Brigade. But in the night of the 21st–22nd the 6th Reserve Division made a surprise crossing of the Yser in the Tervaete salient and threw over $2\frac{1}{2}$ battalions to the west bank. Concentrated artillery fire prevented the division from making any progress on the 22nd, but a gallant counter-attack broke down completely under their machine-gun fire, owing to the exposed nature of the ground. The following night the Germans passed a second regiment into the bend without, however, extending their ground.

On the 24th, the whole of the III. Reserve Corps and half of the 43th Reserve Division, covered by a bombardment, broke through the front at St. Georges-Tervaete, only to find the Belgians deployed behind the Nieuport-Dixmude railway embankment, together with the French 42nd Division which had arrived in the meantime.

Finding themselves checked in this direction, the Germans renewed their attack on Dixmude. In spite of a threefold attempt it was completely repulsed b~ the 12th Belgian Regiment, assisted by some French companies of marines. A new attack on the night of the 25th–26th met with the same fate

Opening of the Nieuport Sluices.—On the 26th and 27th all the pioneers were set to stop up the 22 culverts of the Nieuport-Dixmude railway embankmrnt so as to prevent the liberating tide from invading the Belgian positions. On the 27th at damn a first attempt by the sluice of the Furnes canal, at high tide, failed to yield an effective result. Fresh attempts on the 28th and 29th proved that the inflow of water from this canal was too slight and too slow. Actually, another sluice, that of the Noordvaart, promised a larger delivery but as it lay in No Man's Land its utilization appeared hazardous. During the nirht of the 29th, however, a party of pioneers opened the Noordvaart sluice under the noses of the enemy. Driven by a strong gale the sea water rushed through in a flood. At dawn on the 30th, the three divisions of Beseler's corps attacked along the line of the railway, taking possession finally of Ramscapelle and Pervyse; but the drains were now overflowing; the flooded meadows soon made it impossible for the Germans to advance or even to stay; no alternative was left to them but a hasty retreat.

Checked along the coast line, the Germans moved the weight of their attack farther inland and made their assault on Ypres. *(See* also YPRES, THE BATTLE OF, 1914.) (R. VAN O.; X.)

YTTERBIUM is a rare metallic element belonging to the rare earth group. Its compounds were first separated by J. C. G. Marignac in 1878. Later (1907), G. Urbain found ytterbium to be composed of two elements which he called lutecium and neoytterbium. Neoytterbium later was called ytterbium; it has also sometimes been called aldebaraniuni. Ytterhium occurs in very small amounts in rare earth-containing minerals such as gadolinite, polycrase, bloinstrandine, etc. The common oxide, Yb_2O_3, is colourless and dissolves readily in acid to form colourless solutions of trivalent salts, which are paramagnetic. Ytterbium also forms a series of divalent compounds which were first prepared by W. Klemm and W. Schuth (1929) by hydrogen reduction of anhydrous ytterbium trichloride. They can also be prepared in a very pure form by electrolytic reduction of the trivalent salts. The divalent salts are soluble in water, but react slowly with it liberating hydrogen; they react rapidly with increased hydrogen ion concentration. The divalent solutions have a grayish colour.

Ytterbium is best separated iroin the other rare earths by taking advantage of its divalent state, and can be absorbed irom the other rare earths by extracting in sodium amalgam. It can also be separated in its trivalent form by ion-exchange methods. Thr metal is best produced by distillation. A mixture of Yb_2O_3 and lanthanum metal is heated in a vacuum and the ytterbium distilled out. It is a silvery, very soft metal which melts at 824° C. It has an appreciable vapor pressure at its melting point. The metal crystallizes on the face-centered cubic system, a = 5.4862 A, and has a calculated density of 6.959. Ytterbium's symbol is Yb, atomic number 70, atomic weight 173.04, stable isotopes Yb^{168} (0.140%), Yb^{170} (3.03%), Yb^{171} (14.31%), Yb^{172} (21.82%), Yb^{173} (16.13%), Yb^{174} (31.84%), Yb^{176} (12.73%). (*See* RARE EARTHS.) (F. H. SF.)

YTTRIUM (symbol Y), a metallic element usually associated and classed with the rare earths (*q.v.*), which it closely resembles in properties and from which it can be separated only with great difficulty. Its ore was discovered by J. Gadolin in 1794 at Ytterby, Swed. (whence it gets its name), and obtained in a more pure form by C. G. Mosander in 1843. It is a common ingredient of the minerals gadolinite, xenotime and euxenite.

Prior to 1945 yttrium was separated from other rare earths by fractional crystallization, usually of bromate salts. This process required many fractionation methods to obtain reasonably pure salts. Later, separation was achieved by ion-exchange methods and accompanied by eluting a long baud of mixed rare earths down a synthetic cation-exchange resin. Extremely pure yttrium can be obtained by this method.

The pure metal is produced commercially by the reduction of yttrium fluoride (YF_3) with calcium and is used for alloying purposes as a "getter" for oxygen and negative impurities in other metals. It shows promise of use in atomic reactor construction because of its low nuclear cross section. The spark spectrum of yttrium is very characteristic and strong.

Yttrium forms a white oxide (Y_2O_3) which dissolves in acids to form solutions of trivalent yttrium salts; these are colourless diamagnetic and possess no characteristic absorption spectra. Yttrium has an atomic number 39, atomic weight 88.92, stable isotope Y^{89} (100%), is hexagonal close-packed, $a = 3.647°$ K., $c = 5.713°$ K. and has a calculated density of 4.472. It melts at about 1,550° C. and boils in the neighbourhood of 3,500° C.

YUAN SHIH-K'AI (1859–1916), Chinese statesman, was born at Hsiang Cheng, a member of a family belonging to the smaller landed gentry of the province of Honan. His first important post was in Korea, where, as Imperial Resident and the trusted lieutenant of the Viceroy Li Hung-chang, he strove by adroit diplomacy to preserve China's shadowy suzerainty over the Hermit Kingdom and to check the steadiiy increasing ascendancy of Japan. After the Chino-Japanese war (1894–95) he held office as judicial commissioner, with military functions, under ihe viceroy Li, in Chihli, where he brought the troops to a remarkable standard of efficiency.

In Aug. 1898, the emperor Kuang Hsü, hoping to secure Yuan's services in support of his scheme to seize and imprison the empress dowager, summoned him to a special audience at the Summer Palace. The subsequent coup *d'état* by the empress dowager, which removed the emperor irom the throne and replaced him under severe tutelage, owed its success to Yuan's betrayal of the emperors confidence and to his active support of the conservative Manchu party. To the end of his unhappy career, the emperor never forgave Tuan s treachery, and on his death-bed (Nov. 1908) bade his brother, Prince Chun, see to it that he should not go unpunished.

Tuan received from the empress dowager the governorship of Shantung as reward for his services. In the summer of 1900, on the outbreak of the Boxer rising, he maintained order and protected foreigners throughout his jurisdiction. He had no sympathy with the empress dowager's anti-foreign policy, After the signature of the peace protocol (Peking 1901), as the aged Li Hung-chang desired to be relieved of further duty, Yuan was appointed to act in his place as viceroy of Chihli. At Li's death (Dec. 1901) the appointment was made substantive. Yuan now held the highest office in the gift of the Throne; at the same time he was made a Junior Guardian of the heir apparent. A month later the Yellow Jacket was conferred upon him, together with the appointments of consulting minister to the Government council and director general of the northern railway. In the following year he became a minister of the army reorganization council. During the five years of his viceroyalty, he raised and equipped six divisions of troops, greatly superior in every way to those of the Peking field force or the best provincial levies. But his rapid rise to place and power aroused much jealousy, and, in 1907, a cabal against him, led by his old rival, the ex-Boxer Tatar general Tieh Liang, persuaded the empress dowager to transfer him from the Tientsin viceroyalty to the capitai. He was made grand councillor and president of the Board of Foreign Affairs, which post hc held until the death of the dowager and the emperor in Nov. 1908.

For a month after the death of the "Old Buddha," rumours were rife in the north concerning the regent's, I'rince Chun's, vindictive intentions with regard to Tuan. But he merely deprived Yuan of office (Jan. 2, 1909) and ordered him into retirement at his native place in Honan. But on the outbreak of the revolution the regent, by an edict of Nov. 14, 1911, appointed him viceroy of Hunan and Hupeh, with a mandate to proceed south with his foreign-drilled troops and put an end to the insurrection. Yuan clearly foresaw and declared that if the monarchy were overthrown, the result would be chaos, "amidst which all interests would suffer and for several decades there would be no peace." Thus his avowed policy was to preserve a limited monarchy, pledged to systematic and practical reforms. Had he been loyally served by his representative, Tang Shao-yi, in the negotiations with the revolutionary leaders at Shanghai, above all, had he received the support which he was entitled to expect in the shape of a foreign loan, he might have won. As it was, he continued to fight on, practically singlehanded, against the forces of disruption. until Feb. 1912 when the terrified Manchu court decided to abdicate. Within two days of the issue of the abdication edict (Feb. 12), the southern revolutionaries, on the initiative of Sun Yat-Sen, exemplified the "unbroken continuity of immemorial tradition" in China by inviting him to stand for the presidency of the republic.

Yuan made a virtue of necessity, and on March 12 took the oath of office as president. Nevertheless, he continued to uphold the principles which he had publicly proclaimed in justification of his defense of the monarchy, and to insist upon maintenance of the continuity of the classical tradition of 'government and the preservation of the Confucian system. He was willing for a time to pay lip service to the republican formulas, but his actions proved clearly that he had no sympathy with Canton.

In the summer of 1913, a "war to punish Yuan" was started in the south by Sun Yat-Sen. Huang Hsing and other malcontents; but Yuan. having by this time secured a foreign loan and the moral support of the powers. had no difficulty in retaining the venal "loyalty" of the chief military commanders in the provinces; the Cantonese insurrection came. therefore, to a swift and inglorious end. But Yuan dissolved and proscribed the Kuomintang, and with it made an end of its farce of parliamentary government and representative institutions.

The movement for the restoration of the throne organized by Yuan's adherents: began to take shape in the autumn of 1915. The leaders of the movement failed especially to perceive the danger created by Japan's 21 demands (May 1915), and to realize that the active opposition of the Japanese government would in all probability be fatal to Yuan's ambitions. In October the state council referred the question of the monarchy to the provinces. The result (a foregone conclusion) was a practically unanimous vote in favour of Yuan's accession. Meanwhile. however, the Japanese minister at Peking, supported by his British and Russian colleagues, had made friendly representations to the Chinese foreign office, deprecating the restoration of the monarchical system at this juncture. But on Dec. 12 the monarchy was proclaimed and the enthronement ceremony fixed for Feb. 9, 1916. A week after this announcement, an insurrection, led by one of Yuan's own nominees! broke out in Yunnan. The movement spread rapidly, one province after another declaring its independence. On Jan. 22 Yuan announced the postponement and the establishment of the monarchy. Toward the end of April he consented, while retaining the presidency, to surrender all civil authority to the cabinet, under the premiership of Tuan Chi-jui. He died on June 6, 1916. With him passed the last of the great viceroys of the old regime.

YUCATÁN, a state in Mexico situated in the north of the Yucatán peninsula. Area 14,868 sq.mi.; pop. (1950) 516,899, (1960) 612.047.

Yucatán became a state in 1824. In 1902 the territory of Quintana Roo (*q.v.*) was sliced off, and in 1917 Campeche (*q.v.*) was similarly lost. In the early 1920s the governor of Yucatán, Felipe Carrillo Puerto, strove to break up the large hehequen plantations. He became a great popular hero, but in the Huerta counter-revolution the governor and three of his brothers were killed. The plantations were eventually expropriated and many of them subdivided into co-operative ejidos.

In the 1950s a program was begun to drain the swamp areas and to introduce a diversity of crops. Tourism became important with improved air services, and many old Mayan centres. hitherto inaccessible became popular excursion spots, notably the wooded region around Chichén Itzá. There is a modern hotel there and also one at Uxmal. The rural inhabitants are Maya and speak little Spanish.

The state capital, Mérida (*q.v.*) is a commercial centre which also serves as a tourist base for the Mayan ruins. Its seaport, Progreso, on the Gulf of Mexico, 24 mi. inland, is the chief port and point of entry by steamer for Yucatán. (J. A. Cw.)

YUCATAN PENINSULA (PENÍNSULA DE YUCATÁN), a northeastern projection of Central America lying between the Gulf of Mexico and the Caribbean sea. It includes in its area of 55,400 sq.mi. the Mexican states of Campeche and Yucatin (*qq.v.*) and the sparsely settled territory of Quintana Roo (*q.v.*), plus large parts of British Honduras and Guatemala. The peninsula has a mean breadth of about 200 mi.. and a coast line of 700 mi.

Geography. — The coast on the north and west is low, sandy and semibarren. There are a number of openings through the outer bank upon which several small towns or ports were built. The eastern coast consists of bluffs, indented with bays and bordered by several islands, the largest being Cozumel. There is good fishing all along the coasts and there are many excellent beaches.

The peninsula is almost wholly composed of a bed of coraline and porous limestone rocks, forming a low tableland, which rises gradually toward the south. It is covered with a layer of thin, dry soil, through the slow weathering of the coral rocks. Where the rocky surface is perforated there are natural wells (*cenotes*) and caverns (cavernas) around which the ancient Mayas built their centres. In the 20th century many windmills replaced old wells.

The climate of northern Yucatin is hot and dry, and the absence of high mountainous ridges to intercept the moisture-bearing clouds from the Atlantic, gives it a limited rainfall. Toward the south. moisture increases from 18 in, to a maximum of 80 in. a year, and the scrub forest gives way to tall trees. The temperature ranges from 75° to 98° F. in the shade. but the heat is modified by cool sea winds which prevail day and night throughout the greater part of the year. The atmosphere is also purified by the fierce *temporales*, or northers, which occasionally sweep across this open region. The dry season lasts from Dec. to May, and the hottest months are in May and June. Most of the peninsula receives adequate rainfall throughout the year, and the agricultural potential is great.

The regions toward Tabasco and British Honduras enjoy sufficient rainfall to support forests containing mahogany, sapodilla, several valuable cabinet woods, vanilla, logwood and other dyewoods. Logwood forests fringe all the lagoons and many parts of the seaboard, which are flooded during the rainy season. Oil was discovered in several parts of the peninsula. The chief cultivated plants are maize, sugar cane, tobacco, cotton, coffee and especially henequen (for sisal hemp). In 1502 Columbus wrote of meeting canoes manned by Indians whose gear was tied with henequen ropes. but it was not until 1811 that sisal was first produced commercially for export. After that, with the invention of cordage machines: the trade: including the making of hammocks. grew rapidly.

Animal life includes deer! jaguars, wild boars and monkeys; among the reptiles are big boas (harmless to man), rattlesnakes and iguanas; bird life abounds, especially turkeys, quails and parrots.

History. — The modern history of Yucatán, called Mayapán by the Mexicans for many years, begins with the expedition of Francisco Hernández de Córdoba, a Spanish adventurer from Cuba, who discovered the east coast of Yucatán in Feb. 1517, when on a slave-hunting expedition. In 1518 Juan de Grijalva followed the same route. In 1519 a third expedition, under Hernán Cortés, clashed with the natives of Cozumel Island. In 1525 the inland part of the peninsula was traversed by Cortés during an expedition to Honduras.

The conquest of the peninsula was undertaken in 1527 by Francisco de Montejo, who encountered a more vigorous opposition than Cortés had on the high plateau of Anáhuac. In 1549 Montejo succeeded in establishing Spanish rule over barely one-half of the peninsula, and it was never extended further. The Spaniards discovered the remains of a high aboriginal civilization which had already entered its decline. There were deserted cities falling into ruins. and others, like Chichén Itzá. Uxmal and Tulum. which were still inhabited by remnants of their former Maya populations.

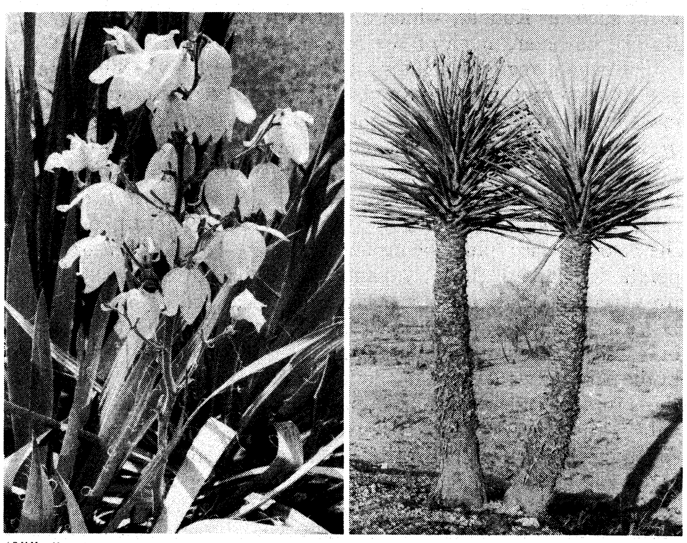
During the colonial period Yucatan remained a remote and unimportant part of the viceroyalty. Since the Spanish conquest, the rebellious Mayas clung to the inland rural areas of the peninsula. They seceded in 1839 and maintained their independence until 1843 In 1847 another revolt followed. and the Indians were practically independent throughout most of the peninsula until near the beginning of the administration of Jose de la Cruz Porfirio Diaz. In 1910 there was another revolt uith some initial successes, after which the Indians withdrew to the unknown fastness of Quintana Roo.

Population. — The population of Yucatán varies considerably in both density and racial composition Around Mérida (*q v*) large rural areas have a density of 125 or more persons per square mile. The population there and down to British Honduras is mostly Maya Indian and mestizo, with a few whites in the cities. In the territory of Quintana Roo the density declines to about 1 3 inhabitants per square mile. The regions around and including British Honduras have a population that is about 48% Negro and mulatto 24% Maya Indian and 28% mestizo dnd nhite.

The Economy. — The logging and chicle industries of the southern portions of the peninsula (and also of the states of Campeche and Tabasco) are carried on by roving workers who form no permanent settlements in the tropical rain forests.

In the Mexican and Guatemalan portions of Yucatán the language of the rural areas is Maya, and the majority of the natives speak little or no Spanish. Until the 20th century Yucatán was more closely connected with Europe than with the rest of Mexico. There was no railway linking the peninsula with Mexico until 1949 and there are still no highway connections. Not until 1957 was the narrow-gauge rail line of 1949 nidened to the standard width, thus facilitating the entrance and export of heavy freight However a network of airways connects all the important centres of the peninsula with Mexico and the outside world. (J. A. Cw.)

YUCCA, a genus of the family Liliaceae (*q.v.*), containing about 30 species. The plants occur in greatest frequency in Mexico and the southwest United States, extending also into Central America. and occurring in such numbers in some places as to form straggling forests. They have a woody or fibrous stem. sometimes short, and in other cases attaining a height of 30 to 40 ft., and branching at the top into a series of forks. The leaves are crowded in tufts at the ends of the stem or branches. and are generally stiff and sword-shaped, with a sharp point, sometimes flaccid and in other cases fibrous at the edges. The numerous flowers are usually white, bell-shaped and pendulous, and are borne in much-branched terminal panicles The three-celled ovary is surmounted by a short thick style, dividing above into three stigmas, and ripens into a succulent berry in some of the species, and into a dry three-valved capsule in others. The flowers are fertilized entirely through the agency of certain moths. *See* POLLINATION and YUCCA MOTH.



JOHN H. GERARD

DATIL YUCCA (Y BACCATA), LEFT. A SHRUB WITH A SHORT. PROSTRATE STEM AND TRECUL YUCCA (Y TRECULEANA) RIGHT A TREE USUALLY UNDER 15 FT.

A coarse fibre is obtained by the Mexicans from the stem and foliage, which they utilize for cordage, and in the southeast United States the leaves of some species, under the name bear grass, are used for seating chairs, etc. The fruits of some species are cooked as food, and the roots of others contain a saponaceous matter used in place of soap.

Some 15 species of yucca are native to the United States; of these nine attain the stature of small trees. Among the best known are the Spanish bayonet or aloe yucca (Y. *aloifolia*), the mound lily (Y. gloriosa), and the bear grass or Adam's-needle (Y. *filamentosa*), of the south Atlantic and Gulf coast, all of which are planted for ornament. Among the most conspicuous are the Joshua tree (Y. *brevifolia*), sometimes 35 ft. high, and the Mohave yucca (Y. *schidigera*), 8 to 15 ft. high. An almost stemless species (Y. *Whipplei*), called desert candle and Quixote plant, which rears a stout flower-stalk, 12 ft. to 15 ft. high, bearing an immense cluster. 3 ft. to 6 ft. long, of fragrant, creamy white, drooping bell-shaped flowers, is a strikingly handsome plant of the southern California chaparral (*q.v.*). The western Datil yucca (Y. baccata), found from New Mexico to California, bears a dark purple edible fruit.

YUCCA MOTH, the name given to a genus of moths. Tegeticula, the various species of which are each adapted to a separate species of the yucca (*q.v.*).

The moth emerges at the time of opening of the yucca flowers, which frequently remain open only for a single night. The female moth rolls together a ball of pollen. flies to another flower, lays four or five eggs in the pistil and inserts the pollen mass in the opening thus formed. Each larva, on hatching from the egg, requires about 20 seeds of the yucca plant as food. As the plant produces some 200 ovules, this leaves about 100 seeds over to perpetuate the plant. The yucca can be fertilized by no other insect.

YUCHI, an Indian tribe, formerly on the Savannah river in Georgia and South Carolina. constituting a separate linguistic stock. They gradually joined the Creek confederacy and, mixed with white and Negro blood. survive in the Creek area in Oklahoma. Their culture was marked by traits of Muskogi type.

YUDENICH, NIKOLAI NIKOLAEVICH (1862–1933), Russian soldier, was born July 18. 1862. He entered the army in 1879. and from 1887 to 1902 served on the general staff. In 1902 he became a regimental commander, in 1905 a general, an assistant chief of staff in 1907 and a chief of staff in 1913. At the beginning of World War I he commanded the II. Turkistan Corps. and was soon placed in command of all the military forces in the Caucasus, a post which he held till the arrival of the Grand Duke Nicholas in 191j. In March 1917 he resumed command, but further advance mas rendered impossible by the increasing disorganization of the Russian army. In 1919 Yudcnich led anti-Bolshevik forces in an attempt against Petrograd (Leningrad). This venture was a failure, and Yudenich retired.

YUE-CHI or **YUEH-CHIH,** the Chinese name of a central Asiatic tribe who ruled in Bactria and India, are also known as Kushans (from one of their subdivisions) and Indo-Scythians (*q.v.*). They appear to have been a nomad tribe, inhabiting part of the present Chinese province of Kan-suh, and to have been driven W. by Hiung-nu (*q.v.*) tribes of the same stock. They conquered a tribe called the Wusun, who lived in the basin of the Ili river, and settled for some time in their territory (*c.* 175–140 B.C.). They then attacked another tribe known as Sakas (*q.v.*) and drove them to Persia and India. For about twenty years it would seem that the Yue-Chi were settled in the country between the rivers Chu and Syr-Darya, but here they were attacked again by the Hiung-nu, their old enemies, with whom was the son of the defeated Wusun chieftain. The Yue-Chi then occupied Bactria (*q.v.*), and little is heard of them for a hundred years. During this period they became a united people, having previously been a confederacy of five tribes, the principal of which, the Kushans (or Kwei-Shwang), supplied the new national name.

The chronology of this invasion and of the history of the

Kushans in India is uncertain; available evidence seems to show that a king called Kozulokadphises, Kujulakasa or Kieu-tsieu-k'io (? A.D. 45–85) united the five tribes, conquered the Kabul valley and annihilated the remnants of Greek dominion. He was succeeded, possibly after an interval, by Ooemokadphises (Himakapisa or Yen-kao-tsin-tai), who completed the annexation of north India. Then followed Kanishka (?*c.* A.D. 123–53), who is celebrated throughout eastern Asia as a patron of the Buddhist church and convener of the third Buddhist council. He is also said to have conquered Kashgar, Yarkand and Khotan. His successors were Huvishka and then Vasudeva, who may have died *c.* A.D. 225. After Vasudeva's reign the power of the Kushans gradually decayed, and they were driven back into the valley of the Indus and northeast Afghanistan. There, according to Chinese authorities, their royal family was supplanted by a dynasty called Ki-to-lo (Kidara), who were also of Yue-Chi stock, but belonged to one of the tribes who had remained in Bactria when the Kushans marched to India. The subsequent migration of the Kitolo south of the Hindu Kush was a result of the movements of the Jwen-Jwen, who advanced west from the Chinese frontier. Under this dynasty a state known as the Little Kushan kingdom flourished in Gandhâra (east Afghanistan) about A.D. 430, but was broken up by the attacks of the Hunas.

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YUGOSLAVIA, a republic of southeastern Europe; formerly the kingdom of the Serbs, Croats and Slovenes (*Kraljevina* Srba, Hrvata i Slovenaca), proclaimed on Dec. 1, 1918, after the union of the kingdom of Serbia, Crna Gora or Montenegro and the South Slav (*i.e.,* Yugoslav) territories of Austria-Hungary; it changed its official name on Oct. 3, 1929, to Kingdom of Yugoslavia (Kraljevina Jugoslavija); on Nov. 29, 1945, it became a federal people's republic (Federativna Narodna Republika Jugoslavija). Having an area of 98,766 sq.mi. (255.804 sq.km.), it is the largest country in the Balkan peninsula. bounded by seven other states: on the north by Austria and Hungary, on the northeast by Rumania, on the east by Bulgaria, on the south by Greece, on the southwest by Albania and the Adriatic sea and on the west by Italy. Its population is overwhelmingly Slavonic and Christian (roughly, one-half Orthodox and two-fifths Roman Catholic).

NATURAL REGIONS

Geographically Yugoslavia presents a zonal pattern throughout almost its whole area, with trend lines running from northwest to southeast. This can be seen in its geological structure, its surface relief and drainage, its climate and its agricultural products. Only in the extreme northwest and in northeast Serbia are east-west trends shown in the Alpine ridge and valley country and the Balkan mountains respectively. The major zones are: (1) the Pannonian lowland, (2) the Slovene Alps, (3) the Morava-Vardar depression, (4) the coastal belt and (5) the Dinaric mountain belt.

Though Yugoslavia is physically a part of the Balkan peninsula and as such has been regarded as a Mediterranean land, it has much in common with the central European countries. Its severe snowy winters and hot rainy summers have produced a vegetation and forced upon the inhabitants a pattern of living very unlike those of Italy or Spain or even Greece. Again, though it has a long coastline on the Adriatic and though the Aegean port of Salonika is within a short distance of its frontiers, the main direction of its commerce is northwest; *i.e.,* toward Vienna and Trieste.

The Dinaric coastal belt enjoys a truly Mediterranean climate but this changes to a central European type as the Pannonian lowland is approached. Deciduous trees such as oak and chestnut form an important part of the forest vegetation. The production of food grains provides a surplus in the northeast but is insufficient over all the western mountain zone. Maize is more widely grown than wheat and yields a greater total crop. Cattle and sheep are reared in all parts, but the former are most numerous and the latter least so in the Alpine regions of Slovenia. Swine are generally important but much more numerous in the more heavily cultivated north and northeast.

1. The Pannonian Lowland.—This obtains its name from the old Roman province of Pannonia, the name being applied by geologists to a great depression between the Alps on the west and the Transylvanian mountains on the east which was flooded by water during the Tertiary period. The water was finally drained off by the Danube as it cut its way through the encircling mountain rim by the gorge which forms the Iron Gate. Northward the plain left by the ebbing of the waters extends far beyond the limits of Yugoslavia; southward, beyond the plain which fringes the Sava-Danube, it gives place to an undulating platform which seems to represent the shore of the old lake. This hill country forms part of northern Bosnia and Serbia, extending in the latter country southward to the hills west of Nis (Nish), notably the Jastrebac and Kopaonik ranges.

That part of this productive Tertiary hill country which extends eastward from the Kolubara to the Morava and is bounded to the south by the valley of the Western Morava forms the Sumadija of the Serbs and constituted the heart of modern Serbia. Originally thickly forested—*šum* means forest—the woods have been largely cleared except on the islandlike mountains of older rock, such as Rudnik, which rise from the general surface. In Bosnia, however, much of the original woodland remains.

The whole region, including plains, river valleys, hill country and isolated mountains and uplands, constitutes economically the most important part of the state and has a considerable variety of resources. In Serbia the characteristic occupation is mixed farming carried on by peasants on small holdings. The cereals include maize, wheat, barley and oats. A great variety of vegetables is grown for local use, and there are numerous orchards, the characteristic plum being accompanied by all the usual temperate fruit trees. Local advantages of climate and soil account for certain special crops, such as tobacco (especially near Titovo Uzice in the valley of the Djetinja); the vine for table grapes or wine in the more sheltered areas, especially near Smederevo in the Morava valley and in the lower Timok valley; sugar beet in the Morava valley; flax, especially in the Drina and Kolubara valleys; mulberry for silkworm-rearing in the Morava valley, and so on. Of stock animals the pig is particularly important but cattle and horses are reared, with many sheep on the uplands.

In the Vojvodina (*i.e.,* a province lying north of the Sava-Danube line), conditions are broadly similar, but cereal production, especially of wheat, is more important, and the farming is of a more advanced type. There is a correspondingly greater development of the industries using local raw material, such as flour milling, sugar extraction, brewing and distilling, ropemaking from local hemp, the making of linen and silk goods. etc., and as a consequence tonns are more numerous and larger. The greater variety of the surface in Croatia brings certain modifications. Orchards are numerous. and to the plums, grapes, apples. pears, etc., of Serbia are added walnuts and chestnuts. Stock rearing is extensively practised, and the fact that there are large forested areas results in a great development of industries based on wood and wood products.

The part of Bosnia included within the region may be said to resemble a more backward Serbia. Maize is the most important cereal, and since there has been less clearing for agriculture there, extensive and valuable forests remain. As in Serbia the plum is by far the most important fruit tree.

2. The Slovene Alps.—This includes east-west ranges of the Alpine zone and parts of the upper Drava and Sava valleys. Because of the limited amount of arable land, not only is there no surplus of cereals, such as is found in the Pannonian lowland, but there is an actual deficiency, so that additional supplies have to be obtained from Croatia and Vojvodina. On the other hand, the 1%-ell-organized dairying industry permits a considerable export of dairy products. Ljubljana and Maribor are not only centres of this trade but also of a number of minor industries similarly dependent on the extensive rearing of livestock, such as meat-packing, the making of margarine, soap, candles and so forth. Further, the valleys and the margins of the basins yield fruit, including walnuts, chestnuts and grapes, especially in the Drava valley where Maribor carries on a considerable trade in wine of good quality, as well as small fruits.

Forests are not only extensive but include both conifers and such hardwoods as beech, oak. chestnut, etc., and industries dealing with timber are important. Since water power is abundant and coal also occurs, and the forests are widely distributed, many of the industries are of old standing and of the small. scattered type rather than commercialized undertakings. The products, notably furniture, show the influence of localized skill and tradition. Minerals, in addition to coal. are of some importance.

3. The Morava-Vardar Depression.—This not very appropriate name may be given to the region which extends from the southern margin of the Sumadija to the Greek frontier. It is traversed by a series of basins strung along the Morava and Vardar systems and affording a continuous route from north to south. Structurally the region is remarkably complex, for it represents the zone of weakness where the fold mountains of the west and northeast abut upon the central crust block of the peninsula. Instead of the continuous and extensive depression which gave rise to the Pannonian basin to the north, earth movements were limited and localized, producing numerous small basins, originally flooded by water but now largely drained by river action. These basins are floored by soft deposits and are in consequence fertile, containing arable land. With them alternate great mountain masses such as the Kopaonik, Golija. Sar and Crna Gora (north of Skoplje). The two last-named, with the Kacanik pass between them, mark the frontier between Kosovo-Metohija to the north and Macedonia to the south.

Among the more important rivers may be noted the Nisava, a right-bank tributary of the Southern Morava which allows the passage of the railway from Nis to Sofia and Istanbul. The Toplica, a left-bank tributary of the Southern Morava. drains a fertile valley. The long stream of the Ibar has a small headstream, the Sitnica, which drains a part of the productive Kosovo Polje, or plain of the blackbirds, with the town of Pristina. The Ibar itself passes through a wide valley containing the towns of Mitrovica and Raska and enters the Western Morava at Kraljevo (renamed Rankovicevo). In a side valley to the west lies the town of Novi Pazar, which has a large Moslem element.

As regards resources the arable plains and basins produce a considerable variety of crops. becoming more and more southern in type as the Greek frontier is approached. The mountains and uplands allow for a notable development of the livestock industry. Finally the mineral resources are considerable, especially around Skoplje, Veles and Kumanovo. Coal, copper, silver-lead, chrome ore, iron and antimony all occur.

Among the products of the livestock industry is wool of good quality, particularly from the sheep reared on the eastern uplands. This forms the basis of the celebrated carpet industry of Pirot, in the upper Nisava valley, the carpets being noted for their excellent colours and designs.

The crops of Old Serbia or Raska are generally similar to those of the Sumadija, but in Macedonia they are more varied. Thus the Bregalnica valley near Kocani is famous for its rice fields and, near Stip, for opium poppy yielding a high percentage of opium, exported from Salonika. In the Strumica valley farther south, cotton. rice, sesame, tobacco, with much fruit and a variety of other crops, all occur. Gevgelija, the frontier station on the Skoplje-Salonika line, is famous for its silk production and silk factories.

4. The Coastal Belt.—The general geographical interest of this region far exceeds its economic one. Even the name is somewhat deceptive, for parts of the coast are as barren and arid as the karst lands of the interior. Characteristic Dalmatian landscapes are best seen in such areas as the Riviera of the Seven Castles, which stretches from Split to Trogir. forming a narrow, fertile strip about 10 mi. in length, watered by short, spring-fed streams and backed and sheltered by bare and waterless limestone hills; or around Dubrovnik, one of the most perfect examples of the Mediterranean city-state in miniature. The olive grows around Split, but olive oil is imported from Italy.

The coastal belt is for the most part unsuited to cereals, which are grown in the *poljen* of the interior. But the marshy area around the mouth of the river Neretva forms an exception to the general statement. Wine is made and exported. Special products of some interest are the liqueur maraschino, distilled from cherries at Split, Sibenik and Zadar; insect powder made from locally grown and wild pyrethrum, and a variety of substances obtained from the aromatic plants of the maquis. Among the last, rosemary (especially from the islands of Hvar and Vis), sage and noble laurel may be named. Apart from the shrubs, wood is rare.

Minerals are not important. but large beds of cement stones occur near Split and form the basis of a considerable industry using the water power of the short river Jadar, which gushes out of the limestone near by. The water power of the river Krka near Sibenik and of the river Cetina near Omis is also used for such industries as the making of calcium carbide and cyanamide. Fishing is of some importance, especially on the islands, where Vis has a canning industry. The catch includes tunny, sardines, mackerel and crabs and lobsters.

5. The **Dinaric** Karst and Mountain Region.—If the coast of Dalmatia is likely to be estimated too highly, precisely the reverse is true of this region which is less unproductive than it appears at first sight. From the human standpoint the contrasts are striking, for if Dubrovnik and Split are western, with many evidences of a great past, towns like Sarajevo, Mostar and Trebinje are thoroughly eastern in appearance, and the rural population is in many ways highly primitive and backward.

Crna Gora or Montenegro is particularly well fitted for livestock rearing because of the appearance of schists in the mountain belt which lies east of the Zeta valley. There is a better and more permanent water supply and a richer growth of grass there. Cereals, especially maize, with wheat and barley, tobacco and wine are produced in the depressions of the mountain region.

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(M. I. N.; T. HER.)

HISTORY

For the history from the earliest times down to 1919 of the countries comprised within Yugoslavia and of the formation of the state itself, consult the following articles: SERBIA; CROATIA-SLAVONIA; BOSNIA AND HERCEGOVINA; MONTENEGRO; MACEDONIA; DALMATIA; ILLYRIA; and BALKAN PENINSULA. The present article deals with the united state, after 1919.

The Parties, 1919–21.—The new state of Yugoslavia emerged from World War I weak and disunited. War casualties had been far higher in Serbia than in the other provinces, but economic hardships had affected all. Countries that not only had different histories, but possessed different currencies and different legal and administrative systems, had to be fitted together. The spirit of social revolt was widespread among the peasants, and the myth of the Russian revolution appealed to workers and intellectuals. The non-Serbian nationalities were at best bewildered, at worst hostile. The only forces that could be relied on to maintain public order were the Serbian army and police, and their actions in many cases increased both social and national discontent. But the forces of revolt were scattered and without leadership. By the end of 1919 the government had established relative stability. By this time, too, a number of political groups could be clearly distinguished.

First were the Serbian parties. The strongest were the Radicals, led by the veteran Nikola Pasic. They still stood in principle for parliamentary democracy, with a certain emphasis on peasant interests. In practice they reflected the interests of the rising middle class rather than those of the peasants, and they stressed above all the interests of state unity. The Radicals were centralists and Serbian nationalists, opposed to all demands of the non-Serbs for autonomy or federalism. They were the party of bureaucracy and of "strong government." The second party were the Democrats, a combination of the Independent Radicals of prewar Serbia led by Ljubomir Davidovic and of the Serbs of former Austro-Hungarian territories led by Svetozar Pribicevic. In principle the policy of the Democrats differed little from that of the Radicals; in practice their emphasis was on liberalism rather than on Serbian nationalism. The two sections of the party were not always agreed; Davidovic was essentially a liberal, while Pribicevic at this time was nearer to Pasic in his conception of a strong united state. The third party, the Agrarians, was the smallest. Its formal program was similar to the other two, but its practical emphasis was on the social interests of the peasants.

In the second category were the non-Serb national groups. Of these, far the most important was the Croatian Peasant party, led by Stjepan Radic. This turbulent and inconsistent man was at this time a champion of the peasant against the towns and the bureaucracy, a republican and an antimilitarist. He believed in unity of all South Slavs, even including in this notion the Bulgarians. He was thus not opposed to the formation of a Yugoslav state; he objected only to the existing state, because it was a monarchy and based on the Serbian army. Among the Slovenes of the northwest, the most culturally advanced of all the Slav subjects of the new state, the strongest group was the People's party led by Msgr. Anton Korosec. Though reserved toward the Belgrade politicians, the Slovenes welcomed the new state as a defense against Italy. The Moslem Slavs of Bosnia formed a group of their own The German minority in Vojvodina and the Albanian minority in the southwest also had their organizations.

The third category was the Communist party. Formed in 1919 by a majority at a congress of Socialist parties of all the territories united in the new state, the Communist party was able to exploit social antagonisms, national discontents and the tendency of the South Slavs—especially of the Serbs—to put their hopes in the U.S.S.R. During 1919 the Communists had strong support among the railway men and in the municipalities of Belgrade and Zagreb.

At the election to the constituent assembly in Nov. 1920, the Democrats won 92 seats, Radicals 91, Communists 58, Croatian Peasant party 50, the rest 128. Radicals, Democrats and Moslems supported a centralist constitution. The Croatian Peasant party refused to take part in the assembly. The centralist draft proposed by the government was carried in June 1921 by 223 votes, with 35 against and 161 abstentions. In the following July the Communist party was banned, after a Communist had assassinated the minister of the interior, Milorad Draskovic. Thereafter the Communists suffered from police repression and also lost the support of those who had earlier placed their hopes in them. In particular, the nationalist discontent in Macedonia, Montenegro and Croatia, which had been an important factor in Communist successes in 1919–20, was exploited by specifically nationalist parties and groups.

Alexander I (*q.v.*), who had been prince-regent of the Serbs, Croats and Slovenes since Dec. 1, 1918, became king on Aug. 16, 1921, at the death of his father, King Peter I of Serbia.

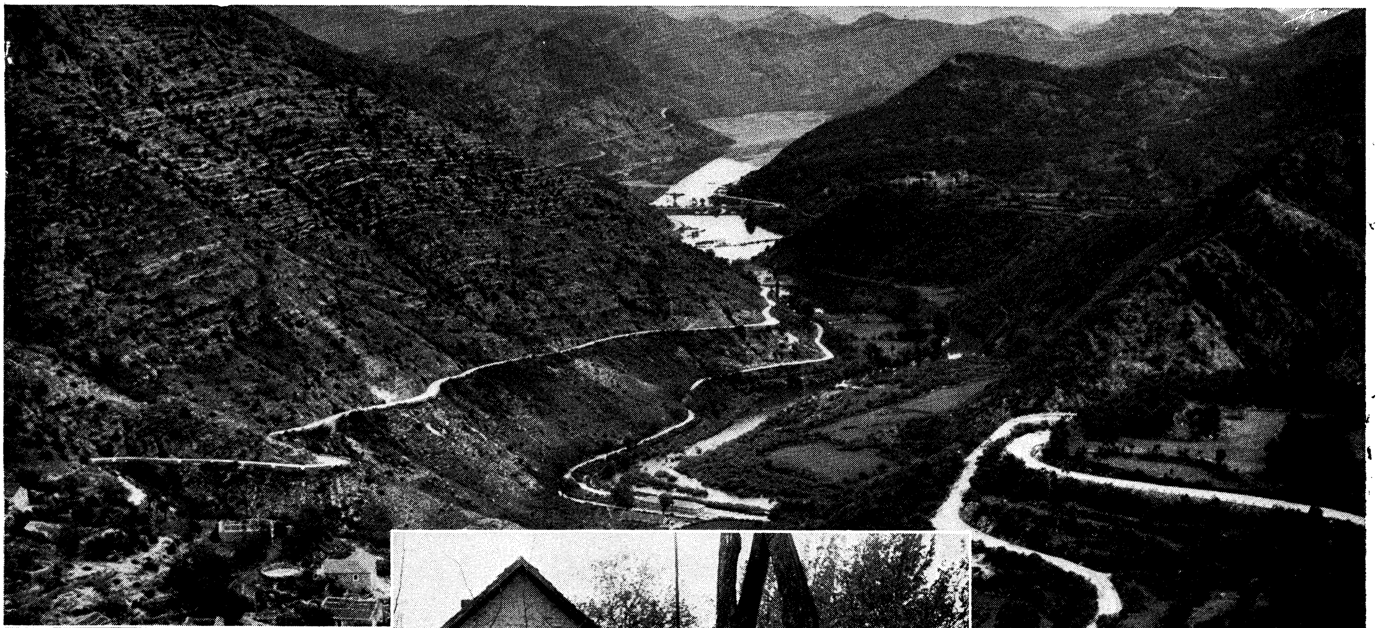
Parliamentary Politics, 1922–28.—The most important issue of Yugoslav internal politics during the period of parliamentary government, which lasted until the end of 1928, was the opposition of the Croats to the centralist constitution. Radic was for a time in prison and then went abroad, first to western Europe and then to the U.S.S.R. His party, which at the parliamentary election of 1923 increased its seats to 70, continued to abstain. Pasic and the Radicals stayed in power with the support of the German and Albanian minority groups. In 1924 Radic and his party returned to parliament, thereby putting Pasic in a minority. For a few months in the second half of 1924 the Serbian Democrat leader Davidovic was premier, and there was some hope both of more liberal government and of an understanding with the Croats. But Davidovic made himself powerful enemies by seriously attempting to investigate corrupt practices of the preceding period. In Nov. 1924 he was dismissed by King Alexander, and Pasic and Pribicevic—who had broken with Davidovic and formed his own party—together continued the centralist policy. In July 1925 Radic suddenly announced his conversion to the monarchy and his admiration for Pasic. A Pasic-Radic government was formed. Real agreement could not be made, however, and in April 1926 this unnatural alliance was dissolved. Soon after this Pasic died, but the Radical party remained in power, with the support of Democrats, Slovenes and Moslems. In 1927 there was another sensational change when the arch-centralist Pribicevic was reconciled with Radic, and their two parties formed a close alliance in opposition.

Thus the two really important issues that underlay Yugoslav politics—the conflicts between Serbian centralism and Croatian federalism and between bureaucratic despotism and democratic government—were confused by the rivalries and maneuvers of the chief personalities. The rivalries were not necessarily petty or ignoble; Pasic was sincerely convinced that only centralism and strong methods could hold the state together; Radic, for all his sudden changes of tactics, was sincerely devoted to the interests of the Croatian peasants and commanded their devoted loyalty; Pribicevic became convinced, by the experience of himself and others, that centralism was the wrong policy and, having made his peace with Radic in 1927, never again swerved from a policy of federalism and of democratic liberties. But the forces were too evenly balanced, and the Democrats, who could have decided the issue if they had joined Radic and Pribicevic, could not choose between their democratic principles and their Serbian nationalism. During 1927 and the first half of 1928 the deadlock continued.

The crisis came on June 20, 1928, when, during a debate in the house, Punisa Racic, a Montenegrin member, shot two Croatian members dead and mortally wounded Radic himself. The Croatian Peasant party and the Independent Democratic party of Pribicevic then left the parliament, and the breach between Croatia and Serbia was complete.

The only person who could hope to bridge the gulf was King Alexander himself. On Jan. 5, 1929, he consulted Radic's successor Vladko Macek and Pribicevic. They proposed a reorganization of the state into seven federal units. This would not only have given the Croats the home rule that they demanded, but would also have separated from Serbia the lands of Vojvodina, Montenegro, Bosnia and Macedonia, which most Serbs regarded as Serbian lands. Finding these proposals unacceptable and having no confidence in the majority of Serbian politicians, the king decided to take all responsibility into his own hands and on Jan. 6, 1929, proclaimed a royal dictatorship.

Foreign Policy, 1919–29.—The most important of Yugoslavia's neighbours was Italy. The withdrawal from Balkan politics of Germany and the U.S.S.R. encouraged Italy to take upon itself the role of chief power in southeastern Europe. The major obstacle in its path was Yugoslavia, successor on the eastern shore of the Adriatic to the vanished Austrian empire. The treaty of Rapallo (Nov. 12, 1920) fixed a frontier which left several hundred thousand Slovenes and Croats under Italian rule in Istria and in the district of Gorizia. The status of Fiume (Rijeka) was another cause of friction until it was settled by a further agreement in Rome in 1924. Italo-Yugoslav rivalry was also fierce in Albania. In 1924 the Albanian exile Ahmed Zogu returned from Yugoslav soil with an army and seized power. But once master of Albania, Zogu showed himself ungrateful to his former patrons and accommodating to their rivals. In 1926 and 1927 he made treaties with Italy which placed Albania in the position of an Italian satellite. Mussolini also gave some support to the extreme Bulgarian nationalists, who had designs on Macedonia and supported the Macedonian terrorist organization on Yugoslav soil—the Internal Macedonian Revolutionary organization (I.M.R.O.). *(See* BULGARIA.) The overthrow of Aleksandr Stamboliski's Agrarian government in Bulgaria in June 1923 had strengthened the influence of the extremists. Mussolini also made himself the patron of Hungarian revisionism, one of whose aims was the recovery of the province of Vojvodina, in which about one-third of the population was Hungarian. The essence of Mussolini's Balkan policy was the encirclement and disruption of Yugoslavia. His final object being Italian domination of the whole Mediterranean, he had first to dominate the Adriatic, and this required the destruction of Yugoslavia, which, though not a great power, was a state strong enough to be a nuisance to Italy, especially if, as was at this time the case, it had friendly relations with Italy's chief European rival, France.



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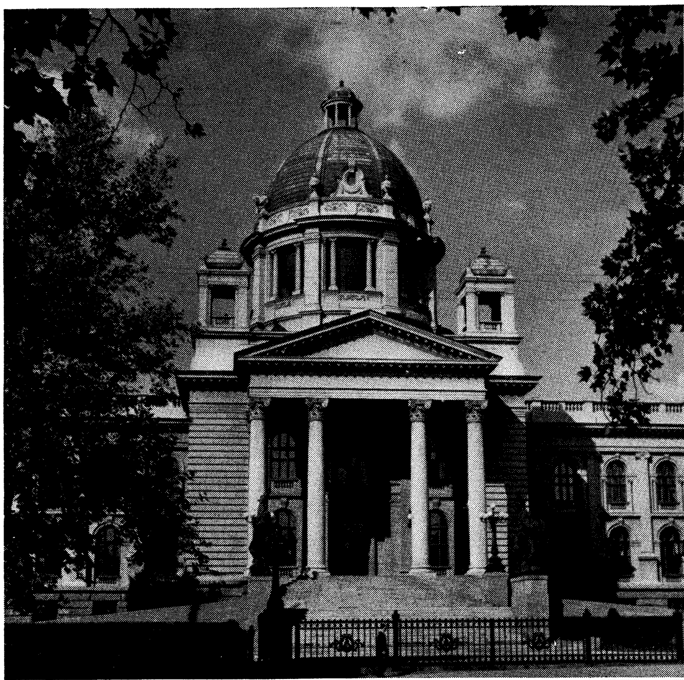
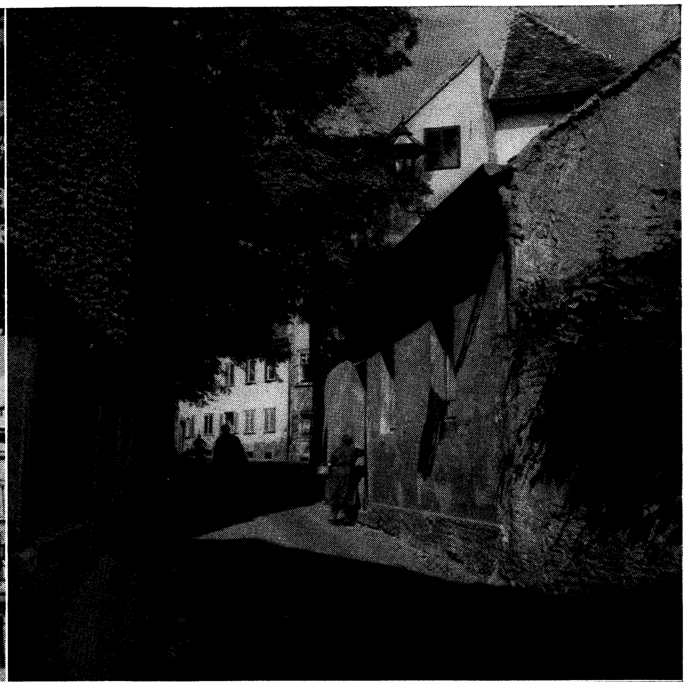
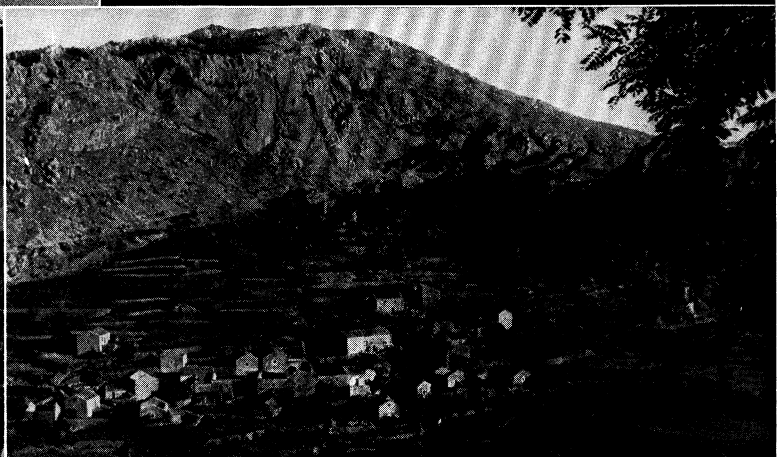
THE LAND AND THE PEOPLE OF YUGOSLAVIA

Top: Rugged hills and valleys of Crna Gora (Montenegro) near Titograd
Centre left: Peasant woman using a distaff for gathering wool
Centre: Women of a co-operative farm at the well
Centre right: Girl of Sinj, near the Dalmatian coast, in national dress
Bottom left: Serbian brandy maker filling a bottle from wooden cask
Bottom centre: Turkish lemonade seller of Belgrade
Bottom right: An old man in the national dress of Montenegro







PHOTOGRAPHS, (TOP LEFT, CENTRE RIGHT) FENNO JACOBS FROM BLACK STAR. (TOP RIGHT) EVANS FROM THREE LIONS, (BOTTOM LEFT) EWING GALLOWAY, (BOTTOM RIGHT) PREINDL FROM MONKMEYER

CITIES AND VILLAGES OF YUGOSLAVIA

Top left: House of parliament, Belgrade
Top right: A narrow street in the old town section of Zagreb
Bottom left: View down a hilly street of Sarajevo
Centre right: Mountain village of Crna Gora (Montenegro)
Bottom *right:* Dubrovnik, on the Adriatic sea. Building on the right is the Rector's palace

Yugoslavia formed with Czechoslovakia and Rumania, by treaties signed in 1920 and 1921, the alliance known as the little entente, which was directed against Hungary. As Yugoslavia had also a treaty of friendship with France, concluded in Paris on Nov. 11, 1927, it was generally regarded as a member of the French system. The little entente (*q.v.*), however, merely united against one small and demilitarized state three larger and armed states, any one of which could, with little difficulty, have defeated it in the event of aggression; but it offered no defense against any of the three great powers that represented real dangers to the contracting parties as Germany did to Czechoslovakia, Italy to Yugoslavia and the U.S.S.R. to Rumania.

King Alexander's Dictatorship, 1929–34.—Alexander changed the official name of the country from Kingdom of Serbs, Croats and Slovenes to Yugoslavia. He was determined that Serbian, Croatian or Slovene nationalism should give place to a wider loyalty, Yugoslav patriotism. He disliked Serbian nationalism as much as Croatian nationalism and wished to protect the interests of the people, which he believed that he understood better than the politicians. Unfortunately neither of these high aims was achieved; his regime perpetuated the hegemony of Serbia and increased all the abuses of bureaucracy and police repression.

The administrative reorganization of Oct. 1929, which created nine provinces (banovine), with boundaries designed to break up the historic regional divisions, operated to the disadvantage more of the non-Serbs than of the Serbs. The abolition of political parties of a religious or regional nature crippled all political parties, Serb and non-Serb alike. In his choice of political collaborators, Alexander tried to enlist persons of all nationalities. In practice, however, he was unable to detach Croats of any importance irom the Croatian Peasant party, which now assembled under its banners almost the whole Croatian nation; but he was able to recruit individual Serbs of some standing. The result was that Serbian opposition to his regime, though widespread and bitter, was political—the opposition of democrats against dictatorship—while Croatian opposition was national—the opposition of the Croatian nation against Belgrade. The Croatian Peasant party lost much of its original character; it became less a social movement of the peasantry than a nationalist movement in which middle-class lawyers and intellectuals played a larger part than peasants.

The king's first premier, Gen. Petar Zivkovic, quickly resorted to traditional Balkan methods of military and police despotism. A Law for the Deiense of the Realm, which imposed drastic penalties for terrorism, sedition and the propagation of Communism, was so interpreted as to justify arrests and maltreatment of the government's critics. The Communist bogey became the favourite excuse for abuses of power. The dictatorship also dissolved elected local authorities and suspended the irremovability of judges. A law of Jan. 1930 abolished the self-governing bodies of the Moslem religious community in Bosnia. The replacement of Zivkovic by a civilian in April 1932 brought no improvement. The new constitution introduced in Sept. 1931 provided a legal façade for the dictatorship. It was accompanied by an electoral lam which, in conjunction with the ban on religious and regional parties, ensured a large governmental majority.

Opposition to the regime was partly silenced, but was not destroyed. It was most effective, because most united, in Croatia. The misdeeds in Croatia of the gendarmerie—staffed by Serbs—created bitter hatred which was exploited by a group of extreme separatists led by the exiled Ante Pavelic, who received support irom the Italian and Hungarian governments. The great majority of Croats, however, followed Macek and the Croatian Peasant party, with which Pribicevic's Independent Democratic party was still firmly allied. In Nov. 1932 the leaders of the two parties met in Zagreb and published a resolution denouncing the hegemony of old Serbia and demanding that the state be reorganized, the situation of Oct. 1918 being taken as the starting point, so as to ensure that no single nation of Yugoslavia should dominate the others. The principles of the resolution were later approved by representatives of the Serbs of Vojvodina, of the Slovenes and of the Moslems of Bosnia. The government's reply was to intern the Slovene and Moslem leaders and to put Macek on trial under the Law for the Defense of the Realm. He was condemned in April 1933 to five years' imprisonment.

In Serbia the regime was no more popular than in Croatia. The Serbian democratic leaders expressed their sympathy with the demands of the Croats ior democratic liberties. They were divided, however, on the question of Serbian hegemony. Some supported the Croatian proposal for a federal reorganization; others feared that this would cause the state to disintegrate. Even those who accepted federation found it hard to agree with the Croats on the status, in a federal state, of Vojvodina and Bosnia. No Serbian political leader could envisage autonomy for Macedonia.

Throughout the years between World Wars I and II Macedonia was subject to a special regime. The Macedonian dialect could not be used in public, and no Macedonian political party could operate, even before 1929. Under the surface, extremist trends, both Communist and Fascist—the latter supported irom Bulgaria and Italy—had a substantial following.

Under the royal dictatorship Yugoslavia's foreign policy changed little; Italy was still the main danger, France and the little entente were the best iriends. The main difference was a growing friendship for Germany. The Yugoslav-German trade treaty of 1934 was of great advantage to Yugoslavia, whose grain exports could not easily find a market during the slump years 1930–32. As tension grew between Germany and Austria, Yugoslavia showed greater sympathy ior Germany In Belgrade a restoration of the Habsburg dynasty in Vienna was considered a greater danger than an *Anschluss* between Austria and Germany The Balkan entente (*q v.*), with Greece, Rumania and Turkey guaranteeing Balkan frontiers, was created in 1934.

On Oct. 9, 1934, Alexander mas assassinated at Marseilles, France, together with the French foreign minister, Louis Barthou, by a Macedonian terrorist who had connections with Pavelic and with the Italian and Hungarian authorities.

The Regency, 1935–41.—On behalf of Alexander's young son King Peter, the country was ruled by three regents, the first of whom was the former king's cousin Prince Paul. In May 1935 a parliamentary election was held in conditions of greater freedom. Macek had been previously released irom prison. His list of candidates was supported by most of the Serbian opposition. Though the government was able, by familiar methods, to win almost all seats in Serbia, Macek's list had an overwhelming victory in Croatia. Impressed by this evidence, Prince Paul entrusted the premiership to Milan Stojadinovic, a Serbian banker with international connections, who was believed to favour conciliation with the Croats. In Sept. 1935 Stojadinovic formed a new party, the Yugoslav Radical Union (J.R.Z.), composed of a section of the Serbian Radicals, the Slovene People's party and the Bosnian Moslems.

During the two years from the summer of 1935 to the summer of 1937 Macek had sporadic contacts with Prince Paul, with Stojadinovic and with the Serbian democratic parties. Macek believed in the good will of Prince Paul, but distrusted Stojadinovic. In the summer of 1937 a government proposal for a concordat with the Vatican, whose main sponsor was the Slovene leader Korosec, aroused a storm of opposition in Serbia. The Serbian Orthodox Church felt itself threatened and rallied around itself a heterogeneous company. There were Serbian nationalists who feared that through the Catholic Church the Croats would gain a commanding position in the country; there were Serbian democrats who aimed at agreement with the Croats but were glad of any opportunity to attack the government; even the Communists took a hand in the agitation. Since the 7th congress of the Comintern (summer, 1935), the Yugoslav Communists had adopted the policy of a popular front, which in the Yugoslav context meant an alliance of all groups which were against the dictatorship and against Fascism, at home or abroad. This policy had the advantage of coinciding with the feelings of most Yugoslavs. In these years the Communists, who since 1921 had ceased to count except in the negative sense of a bogey to be exploited by the police, recovered ground, not so much among the workers as among the intelligentsia and especially among the students of Belgrade university.

The demonstration by the anticoncordat agitation of the government's unpopularity in Serbia warned Macek that if he made an agreement with Stojadinovic this might later be disowned by the Serbian people. He therefore came to terms with the Serbian democrats and formed with them in Oct. 1937 a United Opposition. This alliance reached the height of its popularity in Aug. 1938, when Macek visited Belgrade and rvas welcomed by great crowds of Serbian townsmen and peasants. It now seemed that only the ill will oi the dictatorship stood in the way of a firm friendship between the Serbian and Croatian peoples. These high hopes mere defeated by international developments.

Under the regency, German influence, first economic and then political, grew in Belgrade. It was partly responsible for the Yugoslav-Bulgarian treaty of Jan. 1937. In May 1934 Damian Velchev's coup *d'état* in Sofia had offered promise of a reconciliation between the two states, but the overthrow of the Velchev group by King Boris and the murder of King Alexander had postponed this hope. Now it received formal fulfillment. But this was no reconciliation between two nations; it was an arrangement between two unpopular and weak dictatorships, made with the blessing of Germany and Italy and valid only so long as Germany and Italy would wish it so. In March 1937 came an Italo-Yugoslav treaty, which represented a temporary reversal of Italy's traditional policy of encirclement and disruption and mas also a concession to Germany. German policy was not to disrupt Yugoslavia but to keep it whole and to make this largest of the Balkan states a dependency of Germany. The Italo-Yugoslav treaty for a time was a real factor in European politics It was cemented by a personal friendship between Stojadinovic and Count Ciano and by Stojadinovic's increasing sympathy for Fascist forms and methods of government. Its most important result was the abandonment in all but name of the little entente Stoiadinovic welcomed the German annexation of Austria in Feb 1938 and made clear to the axis governments during the summer of 1938 that he had no objection to the destruction of Czechoslovakia.

Stojadinovic fancied himself as the Fuhrer of Yugoslavia, and believed himself master of the country But the power really lay with Prince Paul. A parliamentary election in Dec. 1938 gave the governmental J R.Z 54% of the votes and the United Opposition 44% In Croatia Macek was again triumphant. As the danger of mar approached, Prince Paul felt it essential to solve the Croatian question and understood that Stojadinovic mas an insuperable obstacle In Feb. 1939 he replaced him as premier with Dragisa Cvetkovic. The Italian invasion of Albania in April was a further warning. After some setbacks, an agreement with the Croats was achieved before war broke out. The Cvetkovic-Macek compromise of Aug. 1939 set up a single Croatian *banovina,* which included most territories of Croatian population. The administration of this area was placed in the hands of Macek and his party, which was also represented in the central government. The agreement had an uncertain reception in both Serbia and Croatia; the Serbian democrats felt betrayed by Macek, who appeared to have made a deal with the dictatorship at the expense of the Serbian people; and on the Croatian side, though the majority accepted the arrangement, a powerful minority remained implacably opposed to Yugoslavia and hoped that the triumph of German arms and Fascist ideas would enable them to set up an independent Croatian state under their control. The axis powers, distrusting Prince Paul as an Anglophile, renewed their interest in the exiled Pavelic.

World War II.—The Italian invasion of Greece in Oct. 1940 brought war to Yugoslavia's frontiers. Prince Paul, whose sympathies lay with Great Britain, wished to preserve neutrality but decided that he could not withstand axis pressure. On March 25, 1941, Cvetkovic and his foreign minister Aleksandar Cincar-Markovic signed the axis three-power pact. Two days later the government was overthrown by a conspiracy led by officers of the air force. A new government was formed of representatives of the Serbian opposition parties, under Gen. Dusan Simovic. The Croatian and Slovene ministers of the old cabinet remained in the new. Though the sympathies of the new leaders were undoubtedly with Great Britain, they did not want war and tried to convince the axis powers of their loyalty to the pact. But Hitler, who had already had one big disappointment in Yugoslavia when Stojadinovic was dismissed in Feb. 1939 and who now saw the government that after so much trouble he had at last brought into line thrown out in its turn, was not prepared to take any more chances. On April 6 the Germans invaded Yugoslavia from Hungary, Bulgaria and Rumania. In a few days the Yugoslav army, badly led and organized and incompletely mobilized, was routed. The victors carved up the defeated country. Germany and Italy divided Slovenia between them. Italy took part of Dalmatia on its own behalf and the Kosovo district and western Macedonia on behalf of Albania and set up a protectorate over Montenegro. Bulgaria annexed most of Macedonia, Hungary the western half of Vojvodina (Backa) and some small districts on the Croatian border. Pavelic was presented by his patrons with the control of an Independent State of Croatia; this included all Bosnia but not all Dalmatia and was nominally a kingdom, with Aimone, duke of Spoleto, second son of the duke of Aosta, as its absentee sovereign. The rump of Serbia was placed under German military occupation and was allowed from Aug. 1941 to have a puppet government of its own under Gen. Milan Nedic. The eastern half of Vojvodina (Banat) had a separate German military administration, in which members of the local German minority played the chief part.

Armed resistance to the occupation began in Bosnia, and there the Croatian Fascists began a massacre of Serbs which, in the whole annals of World War II, was surpassed for savagery only by the mass extermination of Polish Jews. The Serbs took to the hills and forests to defend themselves. In Serbia itself a force led by the regular army colonel, Dragoljub (Draza) Mihajlovic, fought Germans in the early summer. After Hitler attacked Russia, the Yugoslav Communists, who had already made military preparations, took the field in Serbia and Montenegro. By September a large part of both these lands was liberated by these two forces, which at first helped each other but then came to blows. In November the Germans drove all resistance forces out of Serbia and massacred thousands of people in reprisal.

In the following three years the Communist forces grew, while the forces of Mihajlovic lost ground. One reason was that Mihajlovic came to depend on the support of various Serbian armed units in Italian-occupied territory which fought under Italian command against the Communist partisans. Another was that the partisans attracted thousands to their ranks by their slogan of unity of all Yugoslav nations against the invaders and the traitors. This slogan provided the only alternative to the fratricidal massacres, first of Serbs by Pavelic's Croatian Fascists and then of Croats and Moslems by Serbian nationalist *četnici* (Chetniks) owing allegiance to Mihajlovic. In their liberated territory the Communists, led by Josip Broz, known as Tito, a Croat, built not only an army but a crude civil administration, enlisting local persons of ability and initiative who had played no part in political life under the old regime and now had the opportunity to make careers. The administrative organizations were called people's committees. Though enlisting persons of various political opinions or of none, they were firmly controlled at the top by the Communists. In Nov. 1942 the Communists announced the creation of a provisional legislative body, the Anti-Fascist Council of National Liberation of Yugoslavia (A.V.N.O.J.), and, a year later, of a provisional government.

From the summer of 1943 the British Mediterranean command had had liaison missions with the partisans, and the British and U.S. governments now made efforts to reconcile Tito's authorities with the Yugoslav government and king in exile. In Jan. 1942 the exiled government had appointed Mihajlovic its war minister. Reconciliation between Tito and the exiles would have required the abandonment of Mihajlovic, with whom Tito was engaged in a civil war no less bitter than his national war against the invaders. The exiles refused to abandon Mihajlovic until June 1944, when Ivan Subasic, who had been governor of the Croatian *banovina* from 1939 to 1941, was appointed premier by the king The entry of the Soviet army into Serbia in Oct. 1944 and the increasingly arrogant tone of Tito toward the western powers made it clear that there would be no reconciliation but only a surrender by the western powers to Tito. Formal respectability was given to the surrender by the formation in Jan. 1945 of a regency, to which King Peter transferred his powers, and by the return to Yugoslavia of Subasic and some other exiled political leaders.

Communist Yugoslavia.—The new government ruled in the name of the People's Front, the political body created during the resistance and allegedly representing all social classes and shades of political opinion. In fact all power was held by the Communists, among whose leaders the former university students of the 1930s were numerous. Army and police were firmly held by the Communists, and a totalitarian dictatorship was extended to the whole country. The returning democratic exiles had no power within the cabinet and had no choice but to resign. By Nov. 1945 they were deprived of any means of public expression of their views. The election to a constituent assembly, on Nov. 11, was of the Soviet one-list type. The subservient assembly proclaimed a republic on Nov. 29, 1945, and passed the new constitution on Jan. 31, 1946. Its main feature was the creation of six constituent republics: Serbia, Croatia, Slovenia, Bosnia-Hercegovina, Montenegro and Macedonia. Vojvodina and the Albanian-inhabited Kosovo-Metohija district were autonomous provinces within the Serbian republic. This was not a federal regime, for the republics were subordinated in all matters to the central government, as under the Stalin constitution of 1936 for the U S.S.R., of which the Yugoslav document was a faithful copy. Decentralization in matters of language and personnel was accompanied by the extreme centralization of the state bureaucracy and of the Communist party which controlled it. Of the six republics, the one that gained most was certainly Macedonia, whose people were for the first time allowed to use their language in public and to call themselves Macedonians.

Tito's foreign policy was one of extreme subservience to the U S.S.R. and extreme hostility to the western powers, not only on account of Trieste—which was occupied by western troops and which Tito wished to annex—but also on general ideological grounds. Relations with the Vatican became extremely strained when, on Oct. 11, 1946, the Roman Catholic archbishop of Zagreb, Aloysius Stepinac, was sentenced to 16 years' imprisonment for having collaborated with Pavelic during the war. Relations with the eastern and northern neighbours, whose countries were occupied by the Soviet army, were outwardly good. This was especially the case with Bulgaria, with whom the ancient dispute about Macedonia was declared to be solved.

In June 1948, however, the Cominform denounced Tito for various heresies, and this excommunication was followed by violent propaganda campaigns from Moscow and the Soviet satellite capitals and by a commercial boycott, which became complete in the summer of 1949. The underlying cause of the breach was the fact that, in contrast to those of the neighbouring satellite states, the army and civil bureaucracy of Yugoslavia had been created not by emissaries of Moscow but by the Yugoslav Communists themselves during the national and civil war and were therefore considered in Moscow to be unreliable This was also the cause of the regime's survival; the first loyalty of army officers and civil bureaucrats was to Tito, not to Moscow

The Soviet boycott caused Tito to seek economic aid from the United States and from western Europe. This led to some modification of his economic policy and to a certain mildness in the political regime itself. Economic management and even political administration were decentralized, and elected workers' councils were given large powers. In 1952 a new constitution was prepared (see *Government, Administration and Defense).* All political and economic hierarchies continued to he controlled by the Communist party, which was as rigidly centralized as ever (G. H. N S.-W.)

Tito's state visit to Great Britain in March 1953 was followed by similar visits to Turkey in April 1954 and to Greece in June 1954, resulting in the signature of the Balkan alliance between the three countries on Aug. 9 at Bled, Yugos. The signature in London, on Oct. 5, 1954, of the Italo-Yugoslav agreement on Trieste removed the main obstacle to co-operation between the two Adriatic states.

The year 1955 was eventful because on May 26, N A Bulganin, the Soviet prime minister, and N. S. Khrushchev, the first secretary of the Communist Party of the Soviet Union, arrived in Belgrade to improve their country's relations with Yugoslavia, and a joint statement affirmed the principle of coexistence. On Nov 6, 1955, John Foster Dulles, the U S. secretary of state, visited Tito at Rrioni In June 1956 Tito paid an official visit to the Soviet Union Yugoslav-Soviet relations did not, however, develop satisfactorily, so Khrushchev visited Belgrade again on Sept. 19, and Tito flew back with him to the Crimea on Sept 27 But the Hungarian revolution strained Yugoslav-Soviet relations once more. Moscow decided to delay for five years the credit of $110,000,000 promised in Jan 1956; a joint Soviet-Eastern German credit of $175,000,000 promised in Aug. 1956 was also "postponed" (see *Industrialization).*

In Sept 1957 Wladyslaw Gomulka, first secretary of the Polish United Workers' (Communist) party, visited Yugoslavia and on this occasion the Yugoslav government recognized the Oder-Neisse line as the "only possible frontier between Poland and Germany." In September Yugoslavia recognized the German Democratic Republic. This caused the German Federal Republic to sever its diplomatic relations with Yugoslavia. In Nov. 1957 Tito was absent irom the celebrations of the 40th anniversary of the Communist revolution in Moscow and the Yugoslav delegation declined to sign the declaration of the 12 Communist parties representing the Communist states.

In Jan. 1935 Milovan Djilas and Vladimir Dedijer, two of Tito's innermost circle since 1941, were tried for hostile propaganda against the state. In 1954 Djilas' writings had been repudiated and Dedijer, who had come to his deiense, was dismissed from his post as editor of the daily newspaper *Borba*. Both men received suspended sentences, but after Djilas had praised the Hungarian revolution in an article in the U.S. weekly *New* Leader in Oct. 1956 he was sentenced to three years' imprisonment. Following the publication of his book The *New* Class in New York in Aug. 1957, he was tried again and sentenced to an additional seven years.

Elections were held on March 23, 1958, ior a new iederal people's assembly which, on April 17, re-elected Tito as president of the republic. From April 22 to 26 the 7th congress oi the League oi Communists was held at Llubljana. It was criticized in the Soviet and Chinese press as being revisionist of hlarxist-Leninist doctrine. Tito was again in disgrace with Moscow because Yugoslavia refused to join the Warsaw treaty powers and to follow Soviet leadership.

TERRITORY AND POPULATION

Yugoslavia is divided into six iederal republics. These are listed in Table I with their areas and populations. (See also separate articles.)

TABLE I.—Areas and *Populations*

Federal republics	Area (sq. mi.)	Population		
		1931	1953	1961
Serbia*	34,116	5,795,724	6,979,154	7,629,113
Croatia	21,829	3,360,459	3,941,817	4,148,122
Slovenia†	7,819	1,144,298	1,505,425	1,584,368
Bosnia-Hercegovina	19,741	2,323,555	2,817,790	3,274,886
Macedonia	9,928	949,958	1 , 3 0 5	1,404,883
Crna Gora (Montenegro)	5,333	360,044	119,873	471,133
Total	98,766	13,934,038	16,998,573	18,512,805

*Including the autonomous province of Vojvodina (area, 8,303 sq.mi.; pop. [1961] 1,851,448) and the autonomous region of Kosovo-Metohija (area, 4,203 sq.mi.; pop. [1961] 963,565). †Including Zone B of the former Free Territory of Trieste.

Between World Wars I and II Yugoslavia occupied an area of 95,446 sq.mi. The country was enlarged by 3,623 sq.mi. by the peace treaty between the Allies and Italy signed in Paris on Feb. 10, 1947, the increase including the acquired territory oi the Julian March, the Italian enclave oi Zadar (Zara), and the islands of Cres (Cherso), Losinj (Lussin), Lastovo (Lagosta) and Palagruza (Pelagosa), After the partition of the Free Territory of Trieste between Italy and Yugoslavia on Oct. 5, 1954, a iurther area of 202 sq.mi. was added to Yugoslavia. The population was 11,984,911 in 1921 and rose to about 15,703,000 by Jan. 1940. It was estimated that 1,700,000 oi the population was lost during World War II. Nevertheless the 1948 census revealed a total of 15,372,098. The 1953 census showed the population to be 16,998,573, and by 1961 the number had risen to 18,512,805. The birth rate was 25.7 per thousand in 1956, that is, almost the same as in 1939 (25.9 per thousand), but the death rate decreased from 14.9 per thousand in 1939 to 11.1 per thousand in 1956. The average annual natural population increase during the period 1952–56 was 16.4 per thousand, after Poland the second highest in Europe.

Serbia.— Together with the autonomous regions of Vojvodina and Kosovo-Metohija, Serbia is the largest iederal republic and its capital, Belgrade, is also the capital of Yugoslavia. The Serbian republic proper is, in fact, the kingdom of Serbia within the irontiers of 1878 with the addition oi the province oi Kovi Pazar, which was Turkish until 1912. With the exception oi a Rumanian-speaking minority of about 30,000 in the northeastern corner of the country and about 60,000 Bulgars in the Pirot area, the population oi the republic is purely Serbian; almost all its inhabitants are Orthodox.

Vojvodina is a province composed of parts of territories which were Hungarian beiore 1918: Backa between the Danube and Tisza rivers, the western part oi the Banat and Srem lying between the Danube and the Sava rivers. The majority of the population (1,712,619 in 1953) are Serbs and are either Orthodox or Roman Catholic. About 500,000 Magyars comprise the strongest national minority, and there are also about 50,000 Germans (one-sixth oi the prewar number); both are mainly Roman Catholic, but there is also a Protestant minority. The Rumanians, who inhabit the Yugoslav region of the Banat, number about 34,000 and are Orthodox.

Four out of the 18 towns of Yugoslavia with a population of more than 40,000 (see Table II) are in Vojvodina: Novi Sad, the provincial capital, Subotica, Pančevo and Zrenjanin.

The autonomous region of Kosovo-Metohija (pop. [1961] 963,565), with its capital Pristina (pop. 40,071), has a mixed population in which the Albanians outnumber the Serbs by three to one. The Serbs are Orthodox, the Albanians are mainly Moslem.

Croatia.— This iederal republic is composed of Croatia proper, which until 1918 was attached to the kingdom of Hungary; of Dalmatia,

TABLE 11.—Towns *of More* Than 40,000 Inhabitants

Town	1931	1961	Town	1931	1961
Belgrade	266,849	587,899	Niš	35,465	81,076
Zagreb	185,581	427,319	Subotica	100,058	74,433
Skoplje	68,334	161,983	Osijek	40,337	71,843
Sarajevo	78,173	142 423	Banja Luka	22,165	50,463
Ljubljana	59,767	133,386	Bitola	33,024	49,101
Novi bad	63,985	102,385	Zrenjanin†	32,831	48,956
Rijeka*	....	100,339	Kragujevac	27,208	44,271
Split	43,711	99,462	Pančevo	22,089	40,740
Maribor	33,331	82,387	Priština	....	40,071

*Before World War II Rijeka (Fiume) was part of Italy (pop [1936] 53,896); Susak, a suburb of Rijeka, was part of Yugoslavia (pop. [1931] 16,111). †Formerly Nagybecskerek, Veliki Beckerek or Petrovgrad.

which was part of the empire of Austria, and of the greater part of Istria, Austrian until 1918, and Italian between World Wars I and II and assigned to Yugoslavia in 1947. The population is Croatian and Roman Catholic. Serbs and Croats share the same language, described by linguists as Serbo-Croatian; the Croats use the Latin alphabet, but the Serbs use Cyrillic. The capital oi Croatia is Zagreb; other important cities are Rijeka, Osijek, Split and Dubrovnik (pop. [1961] 22,961).

Slovenia.— The population of the republic of Slovenia is predominantly Roman Catholic and highly westernized, but the Slovene language, also using the Latin alphabet, differs irom the Serbo-Croatian. Occupying an area subjected to German and Italian political and cultural pressure, great numbers of Slovenes were germanized in Carinthia and Styria, italianized in the Julian March and even magyarized north of the Mur river. Prekmurje, a small area until 1918 part of Hungary, was attached to Slovenia in 1920. In 1954 Zone B and a iew villages of Zone A of the iormer Free Territory oi Trieste were incorporated into Slovenia. The capital of the republic is Ljubljana; other important cities are Maribor and Celje (pop. 119611 16,487).

Bosnia-Hercegovina.— Nominally Turkish until its annexation by the Habsburg monarchy in 1908. Bosnia-Hercegovina was administered by the Austro-Hungarian government aiter 1878. Bosnia-Hercegovina is the only one of the six component republics which is not established on a dominant nationality basis. The population is mostly of pure Slavonic stock: about two-fifths are Moslems. The remaininn three-fiiths are Christians in the proportion roughly oi two Orthodox to one Roman Catholic At the 1948 census, 1,136,116 inhabitants (44 3%) declared themselves as Serbs, 614,123 (24%) as Croats and 788,403 (30 7%) as Moslems The capital of Bosnia-Hercegovina is Sarajevo, where a new university was founded in 1946, and other important towns are (pop 1961): Banja Luka (50,463), Mostar (35,242), Tuzla (37,673) and Zenica (33.271)

Crna Gora (Montenegro).— This is the smallest of the federal republics both in area and population, with the lowest number of inhabitants per square mile. Until 1918 it was an independent kingdom Although its population is Serbian and Orthodox, its incorporation into Yugoslavia in 1918 would have been more difficult than it was, had not the last king, Kikola Petrovic-Kjegos, attempted to negotiate with Austria-Hungary during World War I In 1945 the town and the fjord of Kotor were incorporated into the territory of Crna Gora Its capital was transferred irom hardly accessible Cetinje to Titograd (iormerly Podgorica; pop. [1961] 29,100), which was later linked by a narrow-gauge railway via Niksic with Dubrovnik and Sarajevo

Macedonia.— The most successful results of Yugoslav iederalism are to be iound in Macedonia. Liberated irom Turkish rule in 1912–13, it was partitioned between Serbia, Greece and Bulgaria With the exception of the district of Strumica, which Bulgaria ceded to Yugoslavia in 1919, the 1913 partition remained and was confirmed by the 1947 settlement In Yugoslav Macedonia the population is mixed, but the Macedonians are in the majority (about 850.000 in 1953); there were also about 180,000 Albanians and 150,000 Turks.

In 1945 Macedonia became one of the six constituent republics of iederal Yugoslavia Its national language is Macedonian, akin to Bulearian and Serbian and written ın the Cyrillic alphabet In 1946 a hlacedonian university was founded in Skoplje, the capital (in Macedonian, Skopje).

Nationalities.— Before World War II the kingdom of Yugoslavia was ruled bv the Serbs as a kind of Greater Serbia. Official statistics described the Macedonians as southern Serbs and there was a difference of opinion between the Serbs and the Croats as to the nationality of the Bosnian Moslems. During World War II, when Bosnia was part of the Croatian state backed by the Axis powers. Croats and Serbs engaged there in a fratricidal war. The Yugoslav iederal system introduced in 1945 smothered those embers of racial and religious hatred.

The official 1953 analysis of national minorities grouped in Table III under "others" was as iollows: Albanians 754,245; Magyars 502,-175; Turks 259,j3j; other Slavs (Slovaks, Bulgars, Czechs, Ukrainians, Russians and Poles) 235,992; other non-Slavs (Italians, Germans, Vlachs, Rumanians, Gypsies and Jews) 287,076; undeclared 4,550; other 6,389

Religion.— According to the 1931 census religious divisions mere as follows Orthodox 6,785,301 (48 7%); Roman Catholic 5,217,847 (37.45%); Protestant 231,169 (1.66%), other Christian 68,152 (0.49%); Moslem 1,561,166 (11.2%); and others 70,203 (0.5%). No

TABLE III.—*Nationalities* in Yugoslavia

Groups	1931*		1948		1953	
Serbs	5,574,000	40.0%	6,547,117	41.5%	7,065,923	41.8%
Croats	3,484,000	25.0	3,784,353	24.0	3,975,550	23.5
Slovenes	1,254,000	9.0	1,415,432	9.0	1,487,100	8.8
hlacedonians	600,000	4.3	810,126	5.1	893,247	5.3
Montenegrins	400,000	2.9	425,703	2.7	466,093	2.7
Undefined	750,000	5.4	808,921	5.1	998,698	5.9
Others	1,872,000	13.4	1,980,446	12.6	2,049,962	12.0
	13,934,000		15,772,098		16,936,573	

*Estimate based on 1921 census. †Mainly Bosnian Moslems in 1931 and 1948, "Yugoslavs" in 1953.

Sources: Royaume de Yougoslavie, Statistique Générale d'État, *Résultats définitifs du recensement de la population du 31 mars 1931*, vol. i-ii (Belgrade, 1937–38); F.P.R. of Yugoslavia, Federal Statistical Office, *Population. by Ethnic Nationality, 1948* (Belgrade, 1954); *Statisticki Godisnjak F.N.R.J., 1957*.

questions about religion were asked at the 1948 census, but the following semiofficial estimate was published in 1954: Orthodox 49.53%; Roman Catholic 36.7%; other Christian 1.14%; Moslem 12.52%; Jewish 0.04%; other 0.07%. In the 1953 census to the inquiry as to religion 13.6% of the population declared that they had none.

Equality of status is granted to all recognized religions, and the churches are separated from the state. Although church revenues are provided by the state, the Communist attitude is that, as the churches are reactionary, a struggle against them is inevitable.

The self-governing Serbian Orthodox Church is ruled by a patriarch and a holy synod. Established in 1346, the Serbian patriarchate, after suppression by the Turks in 1766, was reconstituted on Sept. 12, 1920. The seat of the patriarch is in Belgrade. By 1940 there were 21 bishoprics (the bishops of Cetinje, Sarajevo, Skoplje and Zagreb having the rank of metropolitan), 3,021 parishes and 206 monasteries. In 1950 the Orthodox Church of Macedonia was made independent of the Serbian patriarchate.

The Roman Catholic Church is divided into three provinces: Belgrade with two suffragan sees, Sarajevo with two and Zagreb with four and jurisdiction over the Uniate bishop of Krizevci. In 1940 there were 1,971 parishes and 349 monasteries or convents.

The Moslem Religious union is headed by a *reis-ul-ulema* whose seat is at Sarajevo.

Education.—The Communist regime proclaimed the raising of the general education level as one of its major concerns. The constitution provides for compulsory elementary education at the expense of the state; schools are separated irom the churches and private schools are prohibited.

The system of education is propagandist in character, and emphasis is on technical rather than humanistic training. With these reservations in mind, it must be recognized that considerable progress was made in the first nine years after the liberation. The proportion of illiterates (48.6% in 1921 and 44.6% in 1931) was reduced to 24.9% in 1953.

TABLE IV.—*Education, 1938–39* and *1955–56*

Schools	1938–39			1955–56		
	No	Pupils	Teachers	No.	Pupils	Teachers
	8,956	1,428,223	32,144	[illegible]	1,548,302	[illegible]
	439	167,848	8,126	2,361	576,379	27,213
	770	69,872		931	120,539	10,101
Primary / Secondary vocational	53	10,689		190	41,942	4,014
Secondary / Teachers' training	37	4,268	6,197	84	20,499	1,569
Junior vocational	21	3,173	879	179	20,693	2,219
Secondary vocational	21	3,175	232	91	5,935	678
Teachers' training / Art education	29	4,008	311		44,898	5,323
Art / Higher education	26	16,978	1,204		69,650	5,853

There were universities at Belgrade, Zagreb, Ljubljana, Skoplje and Sarajevo.

GOVERNMENT, ADMINISTRATION AND DEFENSE

The kingdom of the Serbs, Croats and Slovenes, formed on Dec 1, 1918, received its constitution on May 12, 1921. Modeled on that oi Belgium, this provided that laws passed by the unicameral legislature, the *skupština,* were not subject to the crown veto. Deputies elected on a basis of proportional representation served for four years. Because oi the illiteracy of hali the population, the prevalence of local patriotisms and the absence of a tradition of democratic participation in the government, the constitution proved unworkable.

A new constitution, promulgated on Sept. 3, 1931, reserved to the king the right to suspend it whenever public order was threatened. The king became commander in chief oi the armed forces, appointed and dismissed ministers, promulgated laws and safeguarded the unity of the state. A bicameral legislature was introduced. The members of the senate were elected for six years, hali of them being re-elected every three years; the king had the right to nominate a number of senators equal to the number elected. The members of the *skupština* were elected for four-year terms on the basis oi universal suffrage by open ballot. The new constitution failed to stabilize the situation; the Croats in particular continued to press for political equality and the decentralization of Yugoslavia into a federal state.

A third constitution was promulgated on Jan. 31, 1946, by a constituent assembly elected on Nov. 11, 1945, in which the Communist-controlled People's Front had an overwhelming majority. Yugoslavia became a iederal people's republic with a federal people's assembly (*savezna narodna skupština*) consisting of two chambers, the iederal council (*savezno veće*) representing the interests of all citizens and the council oi nationalities (*veće* naroda) representing the interests of each federal unit. The real power was vested in a supreme presidium of 39 members, headed by a chairman. Justice mas administered by people's courts, from whose verdict there was no appeal excent to the supreme presidium.

On Jan. 13, 1953, both houses of the national assembly adopted by acclamation the fourth constitution. This, is was claimed, was based on a return to original Marxist teachings in order to avoid a reversion to state capitalism, as had happened in the Soviet Union.

The federal national assembly remained bicameral. The iederal council of 352 deputies (instead oi 405) was composed of two kinds oi members: 282 were elected by secret, universal suffrage; in addition, 60 were elected to the federal council by the republican councils of the six republics, 6 by the provincial council of Vojvodina and 4 by the regional council oi Kosovo-Metohija. If legislation were to be introduced affecting relations between the republics as laid down in the constitution, the last-named 70 deputies might segregate themselves and sit as the council oi nationalities. An innovation was the producers' council (vete *proizvodača*), the new second chamber of 202 members elected by organized industrial workers, artisans and peasants in proportion to each group's contribution to the country's total production. Both chambers mere elected ior four years.

No political organizations existed other than the Socialist Alliance of Working People and the League of Communists of Yugoslavia, but under the electoral law promulgated in May 1953 it mas theoretically possible for individuals of independent views to be elected. The League of Communists was the name for the Communist party adopted at its 6th congress held at Zagreb in Nov. 1952. Between 1952 and 1956 its membership fell from 779,382 to 624,806. In April 1958 it rose again to 755,055.

The presidium of the national assembly was superseded by the federal executive council of 37 members elected from the ranks of the iederal council; it was the assembly's supreme executive organ and the seat of political government. On the national assembly rested responsibility ior electing a president of the republic who mould preside at meetings of the executive council and assume direction of the armed forces as commander in chief. There mas no cabinet or council of ministers, and federal administration consisted of the five state secretariats of foreign affairs, defense, internal affairs, national economy and the budget.

The internal administration of six federal republics and two autonomous units was not defined in the new constitution, which, however, stated that these would be organized according to the basic principle of the government of the federation.

Defense.— Yugoslavia before 1941 was divided into six army commands (Novi Sad, Sarajevo, Skoplje, Zagreb, Nis and Mostar) with 16 infantry and 2 cavalry divisions. The peacetime strength of the army in 1938 was 9,245 officers, 9,883 senior noncommissioned officers and 115,000 corporals and other ranks. The air force had a total of 535 first-line aircraft. The navy comprised one small cruiser serving as training Lip, one flotilla leader, sir torpedo boats, eight motor torpedo boats and four submarines. The total active service strength of the navy comprised 580 officers and 7,200 men. Even had it been adequately armed. the royal Yugoslav army would have had no chance in face of-the attack on April 6, 1941, by the Germans advancing from Austria, Hunrary and Bulgaria and bv the Italians invading Dalmatia. It disintegrated in ten days.

A new armv, controlled bv the Yugoslav Communist party, was born of the resistance. With British and US. help in war matériel and with weapons seized from the Italians after the events of July–Sept 1943, Marshal Tito was able to build a national liberation army which by May 1945 had grown to 51 Soviet-type divisions.

After the war a new peacetime army of 30 infantry and 2 armoured divisions was formed. In 1958 there were four army commands (Belgrade, Zagreb, Sarajevo and Skoplje). The standing army comprised 2j infantry divisions, 3 armoured divisions and 4 armoured brigades, 4 mountain brigades and 1 parachute brigade, the total effectives amounting to 253,000. The air force had about 600 aircrait, part of them U S. jets. The navy had 2 destroyers, 4 frigates, 2 submarines and about 60 small craft. The total effectives of the armed forces, including the security troops, mere estimated at about 400,000. The League of Communists controls the armed forces, and almost 90% of the officers and 70% of other ranks were party members.

Even before the crisis of June 1948, supplies of tanks, modern artillery and aircraft from the Soviet government were inadequate. The economic blockade started in 1948 by the Soviet Union and its satellites made difficult the creation of a Yugoslav armament industry. Nevertheless, in March 1951, Col. Gen. Ivan Gosnjak, secretary of state oi national defense, announced that the country had about 47 armament factories

On Nov. 14, 1951, an agreement provided that the United States would supply Yugoslavia with mar matériel. Great Britain, too, was supplying military equipment. On Dec. 16, 1957, a joint communiqué announced that the U.S. military aid to Yugoslavia was terminated. It was disclosed at the same time that from 1950, excluding the economic aid (see Foreign Trade below), the United States had given Yugoslavia about $1,000,000,000 worth of military matériel including cannon, tanks, aircraft and engineering equipment. The defense budget for 1956 was reported at 157,457,000,000 dinars, or 44% of the total expenditure.

NATIONAL ECONOMY

Not without reason the leaders of Yugoslavia aiter World War II described their country's prewar national economy as among the most backward in Europe. They embarked on a policy of collectivization of agriculture and of industrialization. Comparison 12 years later with Yugoslavia's prewar national economy showed that the social structure of the population had considerably changed, that the mining and manufacturing industries had made great progress, but that agriculture had remained at a standstill and crops were even less than before the war.

The total population of the country rose between 1939 and 1957 by about 2,500,000. The number of persons employed in the economy, excluding agriculture, rose from 652,000 in 1946 to 2,171,000 in 1956.

Agriculture.— Prewar Yugoslavia was a land of small peasant property. Out of 1,986,000 holdings only 6,800 exceeded 50 ha. and these occupied 7% of all agricultural land. Of the holdings 68% averaged about 2.2 ha., which did not offer the minimum conditions for subsistence. As well as 1,348,000 holdings with insufficient land, there were 490,000 families of landless agricultural workers. The 1945 land reform abolished all the large estates and limited peasant holdings to a maximum of 4; ha. of agricultural land, including from 25 ha. to 35 ha. of arable land. About 797,400 ha. were distributed. In view of the fact that in 1945 there were 106 inhabitants for every 100 ha. of agricultural land, no agrarian reform could solve the problem of the population surplus in the countryside. Industrialization opened vast possibilities for employment, but, at the same time, much damage was done to agricultural production by enforced collectivization. Under its 1947–51 five-year plan the government intended to collectivize 50% of the land.

In 1951 there were 6,694 producers' co-operatives (zadruga, pl. zadruge) in which were grouped 429,784 peasant holdings totaling 2,595,000 ha. Including the state farms (*državna* dobra), collectivized land covered 36.1% of the total agricultural land. But, as the peasants resisted collectivization, the sown area mas on an average 237,000 ha. less during 1949–53 than before 1939.

By a series of decrees the government revised its agrarian policy. In 1951 it authorized the dissolution of the zadruge where conditions were unsuitable for collective farming. In 1953 it abolished the compulsory annual purchase by the state of cereals from the peasants. Individual peasants and *zadrugari* were thereafter entitled to dispose of their produce on the free market. In 1953 a decree permitted the liquidation of any zadruga where the majority desired it. In 1953, in order to save its face, the government promulgated a new land reform laying down an upper limit of 10 ha. for private holdings. After abandoning the policp of collectivization, the government decided in 195; to raise the price of bread, fats and tobacco as part of a program of incentives to farmers.

In 1956 all agricultural land was estimated at 15,000,000 ha., including 12,057,000 ha. of cultivable land and about 7,600,000 ha. of arable land. At the end of 1956 only 3.2% of cultivable land was included in three categories of *zadruge*. In addition, 5.8% of cultivable land belonged to three categories of state farms. (See Table V.)

TABLE V.—Agricultural Holdings, *1956*

	No.	Area (in ha.)
Collectivized sector:		
State farms	914	586,000
Farms of agricultural institutions and schools	456	110,000
Farms of nonagricultural organizations	141	8,000
	1,511	704,000
Producers' co-operatives:		
Peasant work co-operatives (S.R.Z.)	688	233,000
General agricultural co-operatives	1,028	107,000
Other holdings	1,288	46,000
	3,004	386,000
Private sector:		
Holdings of members of the S.R.Z.'s	47,786	46,000
Individual farms	2,319,709	10,921,000
Total	2,372,010	12,057,000

TABLE VI.—*Agricultural Production*
(in ooo metric tons)

Crops	1934–38	1948–52	1954	1955	1956	1957
Maize	4,691	3,078	3,004	3,900	3,370	5,560
Wheat	2,467	2,174	1,385	2,436	1,606	3,110
Barley	407	323	253	390	344	604
Oats	317	286	233	278	324	484
Rye	208	248	191	262	205	280
Potatoes	1,631	1,486	1,876	2,260	2,190	...
Sugar beet	509	1,179	1,249	1,380	1,200	...
Tobacco	17.2*	23.7	29.2	41.5	30.7	...

*1935–39.

TABLE VII.—*Livestock*
(in ooo heads, estimated in January of each year)

Livestock	1947–50	1952	1953	1954	1955	1956
Sheep	10,554	10,518	11,404	12,116	11,979	11,360
Cattle	4,915	4,821	4,995	5,097	5,285	5,220
Pigs	3,951	3,990	4,527	4,310	4,780	4,699
Horses	1,040	1,102	1,126	1,193	1,242	1,311

Industrialization.— Yugoslavia's natural resources offer great possibilities of industrialization. After Norway, it has the greatest unexploited reserves of hydroenergy in Europe. A considerable electrification program was drawn up in 1946.

Large deposits of coal and lignite occur in many parts of the country, but until World War II it was believed that there was no coking coal. The discovery of a coke-producing process for medium-hard and brown coal enabled the government to build two coking plants, one of which started production in 1952. Since iron ore of good quality also occurs in vast quantities near the suriace at Vares and Ljubija in Bosnia and at Topusko in Croatia, a sound basis was available for a national iron and steel industry.

There are deposits of crude oil in Croatia and Bosnia. Extraction started on a small scale beiore World War II, and by 1957 it had reached 394,000 tons.

Nonferrous ores assure Yugoslavia of a prominent place among European producers. It is one of the richest countries in deposits of high-quality bauxite, mainly in Dalmatia and Hercegovina. An aluminum foundry at Strnisce started production in 1953. Bor, in northeast Serbia, has the largest copper mine and foundry in Europe, and four-fifths of the Yugoslav lead output comes from Trepca in Kosovo-Metohija province.

The ambitious five-year plan 1947–51 had to be abandoned when the Soviet government started the economic boycott of Yugoslavia. A new five-year plan 1957–61 was adopted by the federal people's assembly on Dec. 4, 1957. It provided for raising agricultural production by 42.7% and industrial production by 68%; employment in the economy, excluding agriculture, would be brought to 2,880,000. (*See* Table VIII.)

Among many new projects the 1957–61 plan foresaw the construction of a synthetic nitrogen plant, a superphosphate factory, a thermal power station of 100,000 kw. installed capacity, as well as modernization of three existing coal mines. On Jan. 12, 1956, the U.S.S.R. assumed the obligation to supply the necessary equipment for these projects to the amount of $110,000,000. Another project was the construction of a large aluminum plant. On Aug. 1, 1956, the Soviet and German Democratic governments jointly undertook to equip this plant and granted to this effect a credit of $175,000,000. On May 27, 1958, however, the U.S.S.R. iniormed Yugoslavia that both credits had to be "postponed" for five years.

TABLE VIII.—*Industrial Production, 1939–57*
(in ooo of metric tons if not otherwise stated)

Item	1939	1948	1955	1956	1957	1961 (Plan)
Coal	1,410	952	1,137	1,232	1,227	
Brown coal*	4,312	6,272	7,682	8,442	8,525	25,300
Lignite*	1,310	3,420	6,388	7,427	8,255	
Crude petroleum	1	37	257	294	395	850
Electricity (000,000 kw.hr.)	1,173	2,061	4,340	5,048	6,252	9,300
Iron ore†		878	1,398	1,725	1,876	...
Pig iron		172	514	631	714	...
Crude steel	235	368	805	887	1,049	1,370
Copper ore	984	1,050	1,477	1,741	1,953	...
Copper, electrolytic	12.5	1	24.8	25.1	30.1	40
Lead-zinc ore	775	851	1,650	1,726	1,764	...
Lead, refined	10.7	49.2	75.6	75.8	78.5	...
Zinc, crude	4.9	7.2	13.8	19.9	29.5	...
Bauxite	719	144	791	881	888	...
Aluminum	1.8	1.9	11.5	14.7	18.1	135
Cement	894	1,169	1,577	1,555	1,983	2,400
Sulfuric acid	23.2	43.6	70.0	106.7	123.9	...
Artificial fertilizers	72.8	...	203.5	267.8	365.5	750
Tractors (units)	—	—	2,000	2,961	...	6,450
Trucks (units)	—	—	2,160	2,765	3,459	6,000
Vessels, sea-going (g.r.t.)	...	—	30,600	54,400	...	112,000
Cotton yarn	18.9	27.8	38.2	39.8	44.2	...
Woolen yarn	6.2	13.0	10.7	11.3	13.1	...

*The thermic equivalents are as follows (quantities per ton of coal): brown coal 1.6; lignite 2.5. †45% metal content.

Source: *Indeks, Monthly* ***Resiew*** *of Yugoslav Economic Statistics* (Belgrade).

Foreign Trade.—As a result of a Soviet and satellite blockade of Yugoslavia, all trade with this part of the world ceased in 1949, but the aid supplied by the United States, the United Kingdom and France helped bridge the gap. As can be seen from Table IX, the total deficit in Yugoslavia's foreign trade for the years 1951–54 amounted to $975,107,000, of which $698,553,000 or 71.6% was covered by foreign aid (mainly U.S.).

The main sources of Yugoslav imports in 1956 were: United States (27.3%), U.S.S.R. (14.9%) and the German Federal Republic (10%). The main destinations of exports were: the German Federal Republic

(15.3%), Italy (14.2%) and Rumania (13.1%). In 1956, 31.8% of Yugoslav imports mas represented by foodstuffs, 19.9% by machinery and transport equipment, 15.9% by raw materials (mainly textile fibres) and 9.9% by mineral fuels and lubricants. Exports consisted of manufactured goods (27.6%), foodstuffs (25.7%), raw materials (23.7%), and beverages and tobacco (8.1%).

TABLE *IS.— Foreign Trade*
(in 000,000 of dinars: $1=300 dinars)

	1951	1952	1953	1954	1955	1956
Imports	1	9	118,591	101,819	132,288	142,243
Including western aid*	44,581	30,493	41,172	27,076	34,196	32,048
Exports	52,618	72,058	55,704	72,113	76,026	97,011
Deficit	61,498	37,967	62,797	29,706	55,362	45,232

*Mainly U.S aid, but also British and French.
Source: *Statistics of Foreign Trade of the F.P.R. of Yugoslavia* (Belgrade, 1957).

Transport and Communications.— The contour of the land and the distribution of cultivated land and consequently of population explain the fact that communications are satisfactory only in the north of the country. In 1939 there were 9,647 km. of railway; in 1956 there were 11,735 km., including 2,909 km. of narrow-gauge track. The most important lines built after World War II were the Samac-Sarajevo standard-gauge line and the Trebinje-Niksic-Titograd narrow-gauge line. Highways in 1955 totaled 81,681 km., including 3.359 km of concrete or asphalt and 48,389 km. of macadamized roads. In 1956 there were 14,664 motor cars, 21,112 trucks and 2,705 buses.

In Jan. 1957 the Yugoslav merchant marine had 222 vessels totaling 325,373 gross registered tons, as compared with 410,000 g.r.t. in 1939 and 137,800 g.r.t. in 1945. Among the Yugoslav seaports Rijeka is the largest: in 1956 its turnover of merchandise was 3,693,000 metric tons, including 746,000 tons in exports.

Air transport figures (Yugoslav airways only) in 1956 were (1939 in parentheses): flights 7,084 (2,776); km. flown 3,101,000 (623,000); passengers carried 93,914 (12,687); passenger-km. 47,574,000 (3,627,-000); freight. ton-km. 779,000 (70,000).

In 1956 Yugoslavia had 160,609 telephone subscribers and 710,694 licensed radio receiving sets.

Finance and Banking.— After liberation in 1944-45, there were seven legal currencies: Serbia had its dinars, Croatia its kunas, while in the areas annexed by greater Germany, Italy, Hungary, Bulgaria and Albania there were reichsmarks, lire, pengos, levas and leks. Under the conversion scheme put into force between April and June 1945 a new dinar was introduced and exchanged at 20 old dinars for 1 new; Croatian kunas were converted at 40 to 1 and later at 100 to 1; 100 lire were exchanged ior 30 new dinars, pengos at 1 to 1 and leks at 2 to 1 dinar.

The total value of old currencies exchanged amounted to more than 250,000,000,000 old dinars, as compared with a total circulation of 13,834,000,000 in 1940. The maximum amount which could be paid out in cash to any one holder was fixed at 5,000 new dinars, the balance being blocked for three months and subjected to a special graduated levy. The amount of new notes issued as the result of conversion was about 6,000,000,000 dinars. The official exchange rate was fixed at 50 dinars to the U.S. dollar. By Dec. 1951 the currency circulation amounted to 39,640,000,000 dinars, and on Jan. 1, 1952, the dinar mas devalued to one-sixth of its rate. This raised the exchange rate in Yugoslavia of the U.S. dollar to 300 dinars and of the pound sterling to 840.

In Dec. 1957 currency circulation was 126,000,000,000 dinars and deposit money 244,000,000,000 dinars.

TABLE X.—*Federal Budgets, 1952–56*
(in 000,000 of dinars)

	1952	1953	1954	1955*	1956*
Revenue	297,412	297,609	435,495	344,576	309,063
Expenditure	306,102	292,434	427,790	359,294	355,103

*Estimates.

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(K. SM.)

YUKAWA, HIDEKI (1907–), Japanese physicist who won the Nobel prize for physics in 1949 for investigations in theoretical physics, especially the theory of elementary particles (*see* PARTICLES. ELEMENTARY: *Breakdown of Electrodynamics; Mesons*). He was born Jan. 23, 1907, in Tokyo. He graduated from Kyoto university in 1929. In 1935, while a lecturer at Osaka university: he proposed a new theory of nuclear forces in which he predicted the existence of mesons. or particles that have masses between those of the electron and the proton.

The discovery of one type of mesons among cosmic rays by U.S. physicists in 1937 suddenly established Yukawa's fame as the founder of meson theory, which later became an important part of nuclear and high energy physics. After devoting himself to the development of meson theory, he started work in 1947 on a more comprehensive theory of elementary particles based on his idea of the "nonlocal field."

Yukawa was professor of theoretical physics at Kyoto from 1939 to 1950 when he became emeritus, and in 1953 he was made director of the newly created Research Institute for Fundamental Physics there.

He was visiting professor at the Institute for Advanced Study, Princeton. N.J., 1948–49, and at Columbia university, New York city. 1949–53.

In 1946 Yukawa founded a new journal in English, *Progress of Theoretical Physics.* (Y. N.)

YUKON RNER. The headwaters of the Yukon river gather in a group of lakes on the border between the Yukon Territory and British Columbia in Canada. Its length of 1,979 mi. makes it the fifth longest river system in North America. For about 700 mi. of its length it crosses southern and western Yukon Territory; it then flows across central Alaska to empty into the Bering sea.

Atlin lake, with 308 sq.mi., at an elevation of 2.200 ft., is the largest of the headwater lakes. It drains into long and narrow Tagish lake (138 sq.mi.), and combined with smaller Lake Bennett to the westward, they form the headwaters of the Yukon river. Boats that floated down the Yukon river in the gold rush days at the end of the 19th century used Lake Bennett as a starting point for river traffic, since it lies directly north of White pass which crossed the Coast mountains. The present White Pass and Tukon railway, with its southern terminal at Skagway, Alaska. runs along the steep and scenic shores of Lake Bennett on the way to the Yukon capital of Whitehorse.

The cold. glacier-fed waters of these several headwater lakes come together in the area between the villages of Carcross and Teslin. and then broaden out once more into Marsh lake. The outlet of Marsh lake is the real beginning of the Yukon river itself. South of Whitehorse the water rushes rapidly between the steep walls of Miles canyon and tumbles over rocky ledges in the Whitehorse rapids. This section was dammed in 1958 to produce hydroelectric power. Although most maps showed this section of the river under the name Lewes river, locally it was always known as the Yukon river. The Canadian government recognized local usage by changing the name after World War II.

North of Whitehorse, the Yukon river is navigable for a distance estimated at 1.775 mi., to Bering sea. Because of numerous sand bars, shifting channels, and some fast water, the boats which used the Yukon river were always shallow-draft vessels drawing only four or five feet. The navigation season used to start in about mid-May, after the ice broke up in Lake Laberge (87 sq.mi.), and would continue into early October. With the improvement in air transport after World War II. and the completion of an all-season gravel road between Whitehorse, Mayo and Dawson. water transport on the Tukon river ceased in some years.

North of Whitehorse the Takhini river, which flows through a broad valley along which the Alaska highway was built, is the first major west bank tributary. North of Lake Laberge. Teslin river joins the Tukon from the southeast. As the Yukon plateau, or interior basin. broadens to the northward numerous other tributaries such as the Big Salmon. Nordenskiold and the Pelly add their waters to the Yukon. The Yukon river valley is broad and well-forested across central Yukon Territory. and the river itself meanders back and forth between islands and sand bars in the valley bottom. The only serious rapids in the river are found about 25 mi. N. of Carmacks where Five Finger rapid is caused by rocky islands in the channel; 6 mi. beyond, Rink rapids tumble over submerged ledges.

At the village of Minto, the Mayo highway bends to the north and crosses Pelly river. The small trading post of Selkirk is located at the junction of the Yukon and Pelly rivers. West and north of this junction the Yukon is a clear and gentle river, frequently flowing between high gravel banks, and having numerous islands in the river course. Silt-laden White river comes in from the west, draining from the glaciers of the St. Elias mountains in southwestern Yukon; and a few miles northward, the largest eastern tributary. the Stewart, adds its waters.

At Dawson the Klondike river enters from the east. It was along the Klondike, and particularly its south bank tributaries such as Bonanza, Eldorado and Hunker creeks, that gold was discovered in the fabulous days of the 1897–98 gold rush.

It is about 320 mi. from Dawson to the next large tributary, the Porcupine, which joins the Yukon at the village of Fort Yukon, Alaska. In Alaska, the Yukon river valley becomes very broad, and hills are sometimes 5 to 15 mi. from the river; the braided river has many channels which entwine through numerous low islands and sand bars. The flats end at the Ramparts, where the river cuts through a low mountain barrier and once more flows between steep banks.

At Tanana another main tributary, the Tanana river, comes in from the southeast. The Alaska highway follows the Tanana river west of Yukon Territory, terminating at the city of Fairbanks, on the north bank of the river. Beyond Tanana it is about 800 mi. to the broad, swampy and lake-covered delta of the Yukon river. Low mountains rise north of the river, and the last large north bank tributary, the Koyakuk, drains out of the rugged mountains of Brooks range. Near its delta mouth the Yukon bends sharply north to empty into Norton sound, an arm of Bering sea. Apoon channel, the easternmost of many branching channels in the low delta, is the usual navigation route. Although the Yukon river was important as a transport route during the gold rush days at the turn of the 19th century, it has been mostly replaced by road, rail and air routes to the main towns along its course. (J. L. R.)

YUKON TERRITORY is located in northwestern Canada, lying north of the province of British Columbia and east of the U.S. state of Alaska. Its southern boundary is the 60th parallel of latitude and its western boundary is drawn along the 141st meridian of longitude. The territory extends northward to the Beaufort sea and its eastern boundary mainly follows the drainage divide between tributaries of the Yukon river and the hlackenzie river .of the Northwest Territories. The territory occupies a strategic position in northwestern North America, being on the Great Circle airline routes between the central United States and the orient and eastern Soviet Gnion. Area 207,076 sq.mi., of which 1.730 sq.mi. are inland lakes. Pop. (1961) 14.628. The administrative capital is in the largest town, Whitehorse, pop. (1961) 5,031.

PHYSICAL GEOGRAPHY

Physiography.— The I'ukon is a mountainous region. The west central part of the territory is occupied by an interior basin or dissected plateau. which slopes down toward Alaska. The Yukon river and its numerous branching tributaries flow in broad valleys below the general upland level of the flat-topped hills. These rivers drain the surrounding, higher, rugged mountains. To the southwest rise the jagged, ice-capped peaks of the St. Elias mountains, which are partly in Alaska. Seven peaks there are above 15,000 ft. and the range is crowned by the highest mountain in Canada, Mt. Logan, 19,850 ft. To the southward the Coast and Cassiar mountains of British Columbia terminate in low mountains just north of the Yukon border. Eastward the jagged peaks and linear ranges of the Mackenzie and Selwyn mountains form a little-known barrier between the Yukon and Northwest Territories. Many peaks are above 7,000 ft. The barren. rounded peaks of the Ogilvie mountains rise along the northern rim of the central Yukon plateau.

In addition to the central Yukon basin, there are smaller basins or lowlands in the southeast and north. In the southeast the Liard river lowland is a gap between the Rocky and Mackenzie mountains and is traversed by the Alaska highway. To the north the Porcupine river basin and Peel river plateau lie between the Ogilvie mountains and the northern Richardson and British mountains. A narrow, emergent coastal plain faces ice-covered Beaufort sea and extends from the Mackenzie river delta westward into Alaska

Climate.— In the valleys and basins the climate is subarctic, but in the mountains and uplands arctic climates prevail. There are only a few scattered weather stations in the Yukon and these are all located in settlements in the sheltered valleys so that their data do not describe directly much of the mountainous Yukon. There are no climate records for the northern half of the Territory.

Average uinter temperatures are extremely cold over most of the Yukon but are somewhat milder in the southern sections which receive an occasional warm air mass from the Pacific ocean. The rest of the Yukon lies under a cold high-pressure system much of the winter or is crossed by a flow of cold, relatively moist air from the northwest sources of the Arctic ocean or Bering sea. January average mean temperatures are below $-20°$ F. at Dawson and $-10°$ to $-15°$ at Mayo but at Whitehorse in the south are close to $0°$. These latter averages indicate southern Yukon winters are about the same as those of southern Manitoba. At some time in nearly every winter temperatures have dropped below $-50°$ F and in some winters extremes of $-65°$ have occurred. In 1947 the airport at Snag, in western Yukon, recorded $-81°$ F.

Summer temperatures are warm in the Yukon valleys. July average mean temperatures at Dawson are 60° F.. equal to average summer conditions in the agricultural regions of the clay belt of northeastern Ontario. Every summer has extreme temperatures above 80° F. and occasional extremes above 90° F. have been recorded.

Average annual precipitation is low, as it is in other parts of northwestern Canada and adjoining Alaska. Between 10 to 15 in. of precipitation is recorded at the weather stations in the southern and central valleys; about 40% to 50% of it falls as rain during the four summer months.

Vegetation and Animal Life.—The valleys of the Yukon are clothed in a coniferous forest of the Canadian boreal forest. White spruce is dominant on the valley floors, and black spruce grows in the poorly drained areas; alpine fir and lodgepole pine are found along the Alaska highway across southern Yukon. Potentially commercial forests grow only on the lower slopes. up to about 3.500 ft. altitude. and the upper tree line is at about 4.500 to 5,000 ft. The uplands and upper mountains of much of the Yukon are therefore barren and treeless. For several decades wood was cut along the banks of the Yukon river for the wood-burning river boats and wood is still the common local fuel in winter. The largest stands of potentially commercial forest are in the Liard vallev of southeastern Yukon.

A great variety of wild animal life roams the forests. The larger mammals include black, brown and grizzly bears; caribou, deer and moose; mountain goats and sheep. Timber wolves are common. The usual game birds are found. notably grouse and ptarmigan, and waterfowl include a wide range of geese, swans and ducks. The common fur-bearers trapped by the Indian population include muskrat, mink. marten, lynx, weasel, fox and fisher. Great numbers of squirrels are also taken.

HISTORY

The Yukon was the last major land mass area of Canada to be explored. Robert Campbell of the Hudson's Bay company explored the Liard and Pelly rivers and headwaters of the Yukon in 1840–48 and established fur-trading posts to deal with the local

Indians. At the same time John Bell. of the same fur-trading company, crossed from the Mackenzie river delta to the Porcupine river of northern Yukon and established a trading post at Fort Yukon. in what is now Alaska Because of hostility of the Indians the trading posts in southern Yukon were abandoned in the 1850s. When the United States bought Alaska from Russia in 1867 the Hudson's Bay company moved its trading post eastward along the Porcupine river to near Rampart House: nhen a boundary surrey indicated that the post nas still in Alaska it was abandoned.

After the gold rushes to central and northern British Columbia in the 1860s and 1870s, prospectors began to penetrate northnard into the Yukon in the 1870s and 1880s. Alluvial gold was being obtained in good quantities on the Lewes. Stewart and lower Yukon rivers in the late 1880s and a few stores were opened to supply the increasing mining population. River steamers began to operate from the mouth of the Yukon river. bringing prospectors from Alaska. The fabulous Klondike gold rush began in 1897 after gold was discovered in the gravels of several tributaries of the Klondike river. Dan-son City arose at the junction of the Klondike and Yukon rivers to supply and entertain the miners in the surrounding area. The boom town had a population estimated at 10.000 in 1900, nith about 22.000 in the nearby valleys. It has been estimated that about $100 000 000 north of gold was obtained from the rich placer deposits of the Klondike region between 1897 and 1904. Prior to 1895 the Yukon had been part of the unorganized Northwest Territories, but in that year it nas made an organized district and a detachment of the Royal North West Mounted Police was placed at the Fortymile Creek mining centre. In 1898 it nas made a separate territory.

The economy of Yukon Territory nas at its height at the turn of the 20th century River steamers to Dawson operated on both the upper and lower Yukon river. The White Pass and Yukon railway was completed in 1900, connecting the Alaskan port of Skagway with the head of water transportation at Whitehorse. Early in the 20th century, however, the easily worked gravels of the Klondike area were depleted and miners began to drift away. The official Canadian census of 1901 reported 27 219 people in the territory but by the next census. in 1911. the population had dropped to 8,512. There was a revival of mining after 1913 when lode deposits of rich silver-lead ores were shipped out of the Mayo region. About the same time gold production revived a little in the Dawson area folloning the introduction of dredges and the consolidation of claims. The trend in population and mining was downward. hon ever, despite another revival in 1932 when drilling in the Klondike discovered some underground gravels rich in alluvial gold.

In 1941 the Yukon population was only 4.914 when wartime activity brought another boom. The construction of airports for the northwest staging route to Alaska and the service road between the airports (which was to become knonn as the Alaska highway) brought a population of about 15,000 persons to Whitehorse. This boom collapsed at the end of the war but the Yukon was no longer as isolated as it had been during the Klondike period and by 1951 the population of the territory had fallen only to 9,096. After that time an increased tempo of transportation development and mining exploration slowly increased the local population.

GOVERNMENT

When the Yukon act created a separate territory in 1898 it also gave local government under a commissioner and an appointed legislative council. In later years the numbers in the council were increased and some were made elective. In 1919 the council nas reduced to three elected members holding a three-year term of office but after 1952 there nere five elected councilors. The commissioner administers the territory under the jurisdiction of the department of northern affairs and national resources in Ottawa. The Yukon territorial council operates in a manner similar to that of the provincial governments but on a smaller scale. It passes ordinances related to local civil government. licences and business. The federal government from Ottana still controls matters related to the sale of lands and resource development. The enforcement of lan and order is the responsibility of the Royal Canadian Mounted Police. The federal cabinet approved the transfer of the seat of local government from Dawson to Whitehorse in 1951 but the first session in the new capital did not take place until April 1953. 4 federal government order-in-council of May 1955 confirmed the establishment of the Yukon local capital at Whitehorse.

POPULATION AND SETTLEMENT

As has been indicated, the population of the Yukon has fluctuated greatly. The largest share of the white population is urban. living in several small settlement's along the southern and central river valleys. Whitehorse, pop. (1961) 5.031. is the largest to n and chief transportation centre. It is the northern terminal of rail connections to the Pacific coast and the southern terminal of highways leading north to Mayo, Dawson and beyond. The east-west Alaska highway passes through Whitehorse and it is the chief airport of northwestern Canada.

Dawson. pop. (1961) 846, is a shadow of its former glory but still attracts some summer tourist visitors. Gold dredges operating in the nearby Klondike river are the main economic support of the tonn. The village of Mayo, (1961) pop 332. is the supply and transport centre for the nearby Keno Hill mine. Other villages such as Carcross. Carmacks and Selkirk are primarily trading posts Along the Alaska highway supply centres such as Watson Lake Teslin and Burwash have grown up around a few stores and service stations.

The native Indian population of Yukon Territory has probably never been very large and totaled only 1,868 in 1959. The Indians of central and northern Yukon are part of the Dene or Athabascan tribe. which roamed over much of northwestern Canada. The Loucheux group follow a hunting and trapping life in the drainage basin of the Porcupine and Peel rivers and have their largest village at Old Crow. The Kutchin group live in the Yukon river basin and have been more modified by continuous contact with whites. A different tribe. the Tlingits, occupy the headwaters of southern and southwestern Yukon, having pushed in from their former homes on the Pacific coast of adjoining Alaska. Although trapping is still carried on in winter, most of the southern Indians work as labourers or in some form of transportation during the summer.

From time to time a few Eskimos are recorded in the Yukon census These have been occasional Eskimo families who lived in temporary camps on the arctic coast or in a semipermanent settlement on Herschel Island in Beaufort sea.

NATURAL RESOURCES

Mineral Resources. — These have been the main support of the Yukon population and economy throughout the 20th century. Despite the decline in the producrion of gold, it is significant that the Klondike placers have produced for more than 60 years and are among the world's leading gold fields Although most of the alluvial gold comes from the dredges of the Dawson area, gold has also been produced in smaller quantities intermittently from streams across southern Yukon.

With the decline in gold values. the rich silver-lead ores of Keno Hill became the most valuable mineral resource of the Yukon Development of the mine was assisted by the construction of an all-season gravel road from Whitehorse to Mayo about 1950: formerly the concentrates had to be moved by barge on the Stewart and Yukon rivers in the short summer season. Transportation costs were still high, however, because the concentrates had to be carried by truck, rail. boat and rail again to the smelter at Trail in southeastern British Columbia.

Other mineral resources of the Yukon have been produced intermittently Small amounts of Mesozoic bituminous coal have been mined near Carmacks for local heating. Copper was mined near Whitehorse until 1920 and other marginal copper deposits are knonn in several places across southern Yukon. Tin and tungsten placers yielded some wealth occasionally. Nickel mineralization has been reported near Kluane lake and nickel and base metals are known in southeastern Yukon near the former Canol road. Asbestos deposits have been investigated northwest of Dawson.

Agriculture and Forestry.—Despite its northern latitude and climatic hazards hardy grain and vegetable crops can grow in the Yukon but the lack of a local market does not make agriculture profitable. The 1956 census reported a farm population of 40 persons, only 16 farms in the whole territory and less than 1,000 ac. under cultivation. Gardening is common at all of the settlements, however, and a good supply of local vegetables and small fruits are produced during the long days of the summer. Reconnaissance soil surveys indicate that there are at least 100,000 ac. of arable land along the Alaska highway west of Whitehorse and probably 60,000 ac. in small patches along the terraces of the Yukon river.

Forestry resources are of similar potential value rather than of immediate use. Estimates indicate that 40% of the Yukon is covered with forests and that 20% can be classed as productive and potentially commercial. Small sawmills supply local lumber to Whitehorse, Dawson and Mayo but the annual cut of forest products is small. (See also *Physical* Geography: Vegetation and Animal Life, above.)

Animal Resources.—The search for furs led to the first settlements in the Yukon in the middle of the 19th century. Since that time furs have been trapped by the small Indian population and by a few hundred white residents, but the annual catch of the Yukon is a very small portion of the Canadian total. The most valuable pelts sent from the Yukon are squirrel, beaver, marten, lynx, mink and weasel.

The hunting of game animals is permitted for all local residents who obtain a licence for a nominal fee and game meat makes up a large part of the local food requirements. Nonresidents, or visitors, may also hunt or fish upon the payment of a larger fee for a licence.

Other Resources.—The Yukon is well supplied with water power. Most of the potential power is widespread in the headwaters of the many tributaries of the Yukon, Liard, Peel and Porcupine rivers but is troubled by variations in seasonal flow. A diversion of the Klondike river supplies hydroelectric power for the mining industry and homes in Dawson and a dam across the Yukon river at Miles canyon, south of Whitehorse, supplies the capital.

TRANSPORTATION AND COMMUNICATION

Until the middle part of the 20th century, water transport was the chief means of personal travel and freight movement in the Yukon; even in winter snow-covered trails connected with the frozen rivers to form transport lines. Air service, which had just started prior to World War II, was expanded during the war, because of the territory's strategic location. Roads were also constructed, notably the Alaska highway and a road along the Canol pipeline from Whitehorse through the Mackenzie mountains to Norman Wells, Northwest Territories. The road to Norman Wells was abandoned for about a decade after the war but the western end was then improved and some bridges restored. With the improvements in roads and air service the water transport system lost freight and passengers and gradually declined. In some years there were no steamers operating on the Yukon river.

A government telegraph system serves the Alaska highway and the highway to Dawson. The department of national defense and department of transport maintain radio stations for radio-telegraph at many points throughout southern Yukon and most immediate communication is by radio. Bus service operates along the Alaska highway from Edmonton to Fairbanks; a railway connects Whitehorse to Skagway and Pacific coastal steamers.

See Department of Northern Affairs and National Resources, Northern Affairs Administration, "Yukon Territory—History, Administration, Resources and Development" and D. F. Putnam (ed.), "The Canadian Northland," Canadian Regions, a *Geography* of Canada, ch. 22 (1952). Both publications list additional references. (J. L. R.)

YUMA, a city in the southwestern corner of Arizona, U.S., on the Colorado river at the mouth of the Gila; the seat of Yuma county. It is the centre of large irrigation districts which have created rich farming land from the desert. With a year-round growing season, agricultural products include lettuce, citrus fruits, cantaloupes and alfalfa. Manufactures include water softeners, fertilizer and building materials. The tourist trade is also important. Always a strategic river crossing, the site was probably first visited by the Spaniard Alarqon in 1540. Several Spanish settlements in the area failed and it was not until 1854 that the town was laid out. Known as Colorado City and Arizona City in its early years, Yuma was incorporated in 1871. Two years later a dispute with California over which state the city belonged to was settled in Arizona's favour. For comparative population figures see table in ARIZONA: Population. (W. F. H.)

YUMA DESERT (also known as the Sonoran desert and in part as the Colorado desert) is an arid region of northwestern Mexico and southwestern United States. It extends from about the 34th parallel (Blythe and Banning, Calif.) to the 26th (Topolobampo, Sinaloa); and from the mountains of southern California and Lower California east ard to the Sierra Madre Occidental of Mexico and the mountains of central Arizona.

Its scanty rainfall (less than ten inches per year, often under five) comes partly as summer thunderstorms and partly as winter frontal rain. Summers are exceedingly hot (maxima usually over 110° F.); winters are warm (maxima 60° F. to 70° F., minima 40° F. to 50° F.). Frosts occur, but are neither common nor severe.

The area has typical mountain-and-basin topography: steep, rugged mountains rise abruptly above broad basins floored smoothly with gravel and sand. The northwestern extremity—the Coachella-Imperial valley—is an exceptional basin with its floor far below sea level. It and a few other basins have central salt lakes or playas; but most of the area drains to the sea. The few permanent streams (the Gila, Salt, Colorado, Yaqui and Fuerte) all have their sources in distant mountain areas.

Despite the desert conditions, vegetation is surprisingly varied. Along dry stream courses, trees and tall brush are common. In the north, basin areas have only scattered low shrubs, especially creosote bush (Larrea tridentata) and bur sage (*Franseria deltoidea*), but on the rocky hillsides, cacti are plentiful, including the giant saguaro (Cereus gigantea). In Sonora, surprisingly thick growths of tall brush and cacti cover the entire landscape.

A few primitive hunting and gathering Indians (Pima and Papago in Arizona and Papago, Seri and Yaqui in Sonora) still roam vast tracts. Modern irrigation permits commercial agriculture in the Coachella, Imperial, Colorado, Gila and Salt valleys (winter vegetables, cotton, flax, citrus fruits, dates and alfalfa) and in the Sonora, Yaqui and Fuerte valleys (wheat and cotton). The warm winters attract vacationers to resort cities like Palm Springs, Tucson and Phoenix, to scattered dude ranches and to the reservoirs along the Colorado river. See also MOJAVE DESERT.

See Edmund Jaeger, North *American* Deserts (1957). (R. F. LN.)

YUMAN, a speech stock of American Indians, named from the Yuma tribe, living about the lower Colorado river and occupying a distinctly desert habitat. The groups that belong are the Havasupai, Walapai and Yavapai of the mountains of western Arizona; the Mohave (*q.v.*), Yuma, Kamia and Cocopa (*q.v.*) in the Colorado river bottomlands; the Maricopa (*q.v.*), Halchidhoma, Kohuana, Halyikwamai, once on the river but driven out and the remnants, except the Maricopa, lost to tribal identity; the Diegueño to the rear of San Diego in California; and the Akwa'ala, Yukiliwa, Cochimi and other groups known under varying local names in Mexican California. Of these tribes, the most advanced were those on the Colorado, who have changed little since their discovery by Hernando de Alarqon in 1540. They have always been warlike and turbulent, but chiefly among one another. They are agricultural, marking the northwestern frontier in the continent of native maize farming. They make pottery but no basketry. They are divided into totemic patrilineal clans.

YÜ-MEN, an ancient oasis town in northwest Kansu province, China, at the foot of the Nan Shan, watered by the Su-lo Ho (Shuleh river), and a station on the old Kansu corridor caravan road. Yu-men, meaning "jade gate," was named for the nearby ancient "gate" at the end of the Great Wall.

Oil production began at Lao-chun-miao, situated 40 mi. S.E. of Yü-men, in 1939 in one field of a 700-mi.-long petroliferous zone. Refineries were built, and until reached by the Sinkiang railroad from Lan-chou in 1956, petroleum products were moved eastward *and westward by truck tanker fleets. Expansion of the original field began in 1949. and a new field began production in 1957. Irrigation systems expanded agriculture, and Yü-men. in the early 1960s, was rapidly growing into a transport and petroleum centre, with refineries. by-product plants, and oil-well machinery plants.* (J. E. Sr.)

YUNG LO (*Chc Ti or Ch'eng Tsu*) (1360–1424), *third emperor of the Ming dynasty (see* China: *History). His actual name was Chu Ti Hung Wu's fourth son. He was granted the title prince of Yen in 1370; his seat of power was at Peking (Peiping). When Hung W u named his grandson Chu Yün-wen the heir designate upon the death of his eldest son Chu Pioa in 1392, the prince plotted actively for the usurpation of the throne. By making alliances with imperial officialsin the north and with court eunuchs the prince began his rebellion after the death of his father, in 1398. The march toward Nanking nas a triumphal one, although great sections of the north were devastated. Nanking was captured in 1402.*

Once on the throne, the usurper brought the Ming dynasty to the zenith of its power. Annam was reincorporated into the empire in 1407; Japanunder Xshikaga Yoshimitsu paid tribute; campaigns were continued against the Mongols; for anhile the Chinese controlled the caravan route into Sinkiang; and Shahrukh (1404–47), Timur's fourth son who ruled at Herat in central Asia. sent an embassy to the Ming court. Great naval expeditions, seven altogether. were sent between the years 1403 and 1433 to southeast Asia and as far anay as Aden and the Somali coast of Africa.

Yung Lo had no love for Nanking, and in 1421 he moved the imperial capital to Peking. which was rebuilt; the Forbidden city was completed in 1422. Another accomplishment was the compilation of the Yung-lo ta-tien, a great compendium ordered in 1403 and completed in 1408. Its 22.877 chapters in 11,095 volumes contained excerpts and entire works pertaining to practically all subjects. (*D. B. Ch.*)

YUNG-NING: *see* Nan-ning.

YUNNAN (Yün-nan *Sheng*). *a mountainous plateau province of southwest China averaging about 6.000 ft. altitude. but with its western half (inaccessible and sparsely settled) comprising deep longitudinal gorges separated by ridges rising to over 18,000 ft. in the north. Area 154.054 sq.mi.; pop. (1953) 17.472,-737. The Salween (Nu chiang). Mekong (Lan-ts'ang chiang) and upper Yangtze (Chin-sha chiang) rivers enter the province in the northwest. the former two flowing southward through Yunnan, and the latter looping eastward through northern Yunnan into Szechwan. In the eastern half, the Red river (Yuan chiang) runs southwest into Vietnam, and tributaries of the Tangtze and Hsi chiang of south China cut the plateau. A number of lake basins in the central sections form the agricultural and politico-cultural heart of the province dominated by the provincial seat at K'unming (q.v.). Climatically, the southerly latitudes, together with the high altitudes, provide a mild, springlike climate most of the year. with altitudinal zonation from tropical lowland valleys in the south to alpine heights in the north. Rainfall. which is heaviest in summer, averages from 50–60 in. in the southwest and south to under 40 in. in the area south of K'un-ming and parts of the north. Winters are dry, sunny and mild. In the late 1950s there were about 7,000,000 ac. under cultivation, comprising only about 6.7% of the total provincial area. Paddy rice is the dominant summer crop. Other food crops include winter wheat, barley, corn, kaoliang, sweet potatoes and sugar cane. Industrial crops include cotton, hemp, tobacco and tree crops such as tea, tung oil nut, walnut, fruits and mulberry, the latter for silkworm culture. Opium and medicinal herbs also are produced. Extensive coffee tree planting was begun in the late 1950s. Numerous livestock such as yellow cattle and mules, as well as pigs are raised and Yunnan ham is famous in China.*

Yunnan has a variety of mineral resources: including the country's largest reserves of tin and nonferrous metals. Coal is found in several areas, including Kuang-t'ung (formerly I-p'ing-lang) west of K'un-ming, and eastern Yunnan where an estimated 1,500,-000,000 ton deposit was found. Tin is mainly mined south of K'un-ming at Ku-ch'iu, Shih-p'ing and Meng-tzu, while large lead and zinc mines are at T'ung-ch'uan in northeastern Yiinnan. Narrow-gauge railroads connect the tin and coal mines with K'unming. while the line northward to Szechwan is partially constructed. K'un-ming is the important industrial centre. with two small steel plants and numerous light industries such as textiles and machinery.

The provincial area was the site of the early Nan-chao and Ta-li kingdoms. It was completely conquered by Kublai Khan in the 14th century, and became part of the empire in the 17th century. A Turkish governor from Hsin Chiang initiated the conversion of hundreds of thousands of west Yunnan people to Islam, who revolted against Chinese oppression from 1855–73 (Panthay Rebellion) and maintained an independent state in the west around Ta-li. During World War II the Burma road lifeline leading to Szechwan was maintained through Yiinnan.

After 1949 thousands of Nationalist troops and adherents fled to southwestern Yunnan frontiers and for years afterward harassed the Chinese Communist government, often from Burmese territory. About 60% of the population are composed of more than 50 minority ethnic tribes differing from the Chinese who form the largest single group. Many areas are organized into so-called minority autonomous districts. Yunnan's western borders nith northern Burma are unsettled. (H. J. Ws.)

YUNUS EMRE (*d.* 1320), *Turkish poet and mystic, who has exercised a powerful influence on Turkish literature, was born in Anatolia. Though legend obscures the facts of his life he seems to have traveled extensively, meeting other great mystics of the time, and becoming an ardent follower of Jalal ud-din Rumi and a leading representative of the mystic movement in Anatolia. He nas venerated as a saint after his death. His poems, which are mainly devoted to the themes of divine love and human destiny. are characterized by deep religious feeling. In striking contrast to the divan poets, he wrote in a straightforward, almost austere. stvle and mainlv in the traditional svllabic metre of folk poetry. His work had a profound influence on later mystics and inspired the poets of the Turkish renaissance of national poetry after 1910.*

See A. Golpinarli, Yunus Emre Divani, 3 vol. (1943–1948) ; *E. Rossi,* "Il *poeta mistico turco Yunus* Emre," *Oriente Moderno, vol. 20 (1940).* (F. I.)

YUROK, *a tribe on the lower Klamath river, asserted but also disputed to be of Algonkin speech lineage, is perhaps the nuclear group of the northwest California Indian culture. principal others being the Hokan Karok upstream, the Athabascan Hupa (q.v.) of Trinity, the Chilula of Redwood, the Tolowa of Smith river, and the Algonkin (?) Wiyot of Humboldt bay. The Yurok once numbered about 2,400 in over 50 villages; 500 remain.*

YURUCAREAN, *a small group of tribes of South American Indians, constituting an independent linguistic stock. The Yurucares live in Bolivia on the eastern slopes of the Andes and the lowlands along the Chaparé, Isiboro and Securé rivers, tributaries of the Mamoré. They are a tall, well-built folk, slightly lighter in colour than the Quechua of the highlands, who gave them the name by which they are known. signifying "white men." Their dress consisted of a poncholike garment. without sleeves, of bast, decorated nith geometric patterns printed by means of large wooden dies. The Yurucares are sedentary agriculturalists and hunters. living in open thatched shelters.*

See A. D'Orbigny, *L'Homme Americain (1839); L. E. Miller, "The Yurucare Indians of Eastern Bolivia," Geog. Review, pp. 450–464 (1917).*

YUSAFZAI, *a large group of Pathan tribes. originally immigrants from the neighbourhood of Kandahar, nhich includes those of the Black mountain, the Bunerwals, the Swatis. the people of Dir and the Panjkora valley, and also the inhabitants of the Yusafzai plain in Peshawar district of the Northwest Frontier province of India. Three sections of the tribe, the Hassanzais, Akazais and Chagarzais, inhabit the western slopes of the Black mountain, and the Yusafzai country extends to the Utman Khel territory.*

YUST, WALTER (1894–1960), *editor of Encyclopædia Britannica, was born in Philadelphia, Pa., on May 16, 1894. After* graduating from the University of Pennsylvania. Philadelphia. in 1917. he worked for the *Philadelphia Evening Ledges* and later for newspapers jn New Orleans and for other publications. He became literary editor of the *Philadelphia Public Ledges* in 1926. In 1929, upon writing a review of the 14th edition of *Encyclopedia Britannica*, Yust came to the attention of its president. William Cox. The following year he was named advertising manager for the encyclopaedia. He became associate editor in 1932 and in succession to Franklin H. Hooper was editor in chief of all Britannica publications from 1938 until his retirement in 1960—longer than any of his predecessors. He died in Evanston. Ill., on Feb. 29, 1960.

Under his direction. Encyclopædia Britannica. Inc., issued a number of important reference publications, and the company developed and expanded its editorial program of continuous revision. The editorial department expanded from a small group who had worked on the 1929 edition to an organization of 250 staff members in Chicago and London, and 150 consultants and advisers in all parts of the world. *See* ENCYCLOPAEDIA. (J. V. D.)

YVES, SAINT, OF BRITTANY (1253–1303), was born in 1253 at Kermartin. near Tréguier, Brittany. His father was Hkloury, seigneur of Kermartin, and his mother Azou de Quenquis. In 1267 he went to Paris to study law, and ten years later to Orleans to study canon law. On returning to Brittany he was appointed ecclesiastical judge under the archdeacon of Rennes. In 1285 he was ordained priest and appointed first to the parish of Trkdrez and afterward to Louannec. where he died on May 19. 1303. He was buried in the cathedral of Tréguier. and was canonized by Clement VI in 1347. As a lawyer and judge he was famed for his rectitude and wisdom and for his zeal in defending the cause of widows and orphans. His feast is celebrated on May 19. Me is the patron saint of lawyers for he was "*advocatus et non latro, res miranda populo*" (a lawyer and not a thief, a marvel to the people).

Z This letter together with Y was adapted by the Romans from the Greek alphabet after the conquest of Greece for use in Greek words borrowed or transliterated. It mas the seventh letter of the Greek alphabet and had the form I or Z. It was present in the Etruscan, Oscan, and Umbrian alphabets, and according to a tradition unsupported by actual inscriptional evidence it had at one time been present in the Latin alphabet also, probably with the value of the voiced *s* which must have been an intermediate stage in the change of intervocalic *s* to *r*. Its place in the alphabet was filled by the letter G adapted from *C* to represent the voiced velar stop. The letter corresponded to Semitic I (zayin).

The minuscule letter has generally retain$ the form of the majuscule, though in certain hands the form ʒ has developed.

The sound represented by the letter in Greek is not precisely known. It mas, at least in certain cases, a double sound and probably varied in separate dialects as well as in different words between *z, ž, zd, dz* or *d;*. In Latin it was probably the voiced sibilant corresponding to *s* and this value it has retained till modern times. (B., F. C. A.; J. W.P.)

ZABRZE: *see* HINDENBURG.

ZACATECAS, a state of Mexico. Area 28.125 sq.mi.; pop. (1960) 798.232. It belongs wholly to the great central plateau, with an average elevation of about 7.700 ft. The state is traversed in the west by lateral ranges of the Sierra Madre Occidental, and by numerous isolated ranges in other parts. There are no large rivers. The climate is dry and generally healthful, warm in the valleys and temperate in the mountains.

The agricultural products are cereals. sugar and maguey; the first depends on the rainfall which often fails altogether, the second on irrigation in the lower valleys and the third doing best in a dry climate on a calcareous soil with water not far beneath the surface.

Mining for silver, gold, mercury, copper, iron, zinc, lead. bismuth, antimony and salt is carried on. The state's mineral wealth was discovered soon after the conquest, and some of its mines are among the most famous of Mexico, dating from 1546. Manufactures are limited chiefly to the reduction of mineral ores; extraction of rubber from guayule; making of sugar, rum, mescal, pulque, woolen and cotton fabrics; and some minor industries of the state capital, Zacatecas. Other principal towns are: Fresnillo (*q.v.*), a silver and copper mining centre, Sombrerete, Concepción del Oro, and Tlaltenango.

The state is traversed by rail, highway and air routes. Its principal attractions are the many ultrabaroque churches of the colonial period, paid for by the torrent of silver which rich men gave as they vied with each other in trying to erect the most lavish monument possible. (J. A. Cw.)

ZACATECAS, capital of the state of Zacatecas. Mex.. 442 mi. by rail from Mexico City. Pop. (1960) 28.473. The city. a mining and agricultural centre. lies in a deep narrow ravine and has an elevation of 7,377 ft., although the surrounding table lands rise above 8,000 ft. The high altitude and severe winds make the climate one of the least healthful in the republic.

Zacatecas was founded in 1538, following the discovery of silver-bearing veins in the area in 1546 by Juan de Tolosa, and made a city in 1585 by Phillip II. The *real de minas* (mining district) of Zacatecas is credited with having yielded a fifth of the world's silver before the 19th century. . Its name is apparently derived from the Zacatec Indians and the Aztec *Zacatlán* (country where the Zacate grass grows.)

The cathedral, which is noted for its highly carved portico, was begun in 1612 and completed in 1752. It contained rich paintings from Europe and elaborate silver and gold work until the reforms of the 1850s and 1860s, when most of them were confiscated. The extensive Indian ruins of Chicomostoc. as yet largely unrestored, are 28 mi. N.W. of Zacatecas. (J. J. J.)

ZACCONI, LUDOVICO, Italian musical theorist. was born about the middle of the 16th century at Pesaro. the years of his birth and death being unknown. He made his home in Venice, where he became an Augustine monk and was appointed *maestro di cappella* at the church of his order. After a short time spent in the service of Wilhelm. duke of Bavaria in 1592. and a longer period in Vienna with the archduke Charles, he returned in 1619 to Venice. Zacconi's fame is based on a single monumental work, the *Prattica di musica utile et necessaria si al compositore . . . si anco al cantore* (2 pt., Venice, 1596 and 1619). It is one of three standard theoretical works of the Polyphonic period, the others being the *Dodecachordon* of Glareanus and the *Musicae activae Micrologus* of Ornithoparcus; Zacconi's work, being the latest of the three, treats of the methods of the ripest period of the Polyphonic school.

ZACHARIÄ VON LINGENTHAL, KARL SALOMO (1769–1843), German jurist and politician who was distinguished both in the practical and academic fields, was born on Sept. 14, 1769, at Meissen in Saxony, the son of a lawyer, and was educated there and at Leipzig university. He was professor of law at Wittenberg (1798), and at Heidelberg from 1807 till his death there on March 27, 1833. From 1820 to 1829 he mas a strongly Conservative member of the new parliament of Baden. and it was the growth of liberalism that induced him to retire in 1829 and thereafter devote himself entirely to juridical work. The German universities still had their old jurisdiction in legal questions of international importance, and Zacharia had referred to him such points as the claim of Sir Augustus d'Este to the dukedom of Sussex, and the dispute about debts due to the elector of Hesse-Cassel, confiscated by Napoleon. He was ennobled in 1842.

His writings deal with almost every branch of jurisprudence, and relate to Roman, Canon, German, French and English law. The first book of much consequence which he published was *Die Einheit des Staats und der Kirche mit Rücksicht auf die Deutsche Reichsverfassung* (1797). a work on the relations of church and state, with special reference to the constitution of the empire. In 1806 appeared *Die Wissenschaft der Gesetzbung*, an attempt to find a new theoretical basis for society in place of the opportunist politics which had led to the French Revolution. This basis he seemed to discover in something resembling Jeremy Bentham's utilitarianism. Zacharia's last work of importance was *Vierzig Bücher vom Staate* (1839–43), to which his admirers point as his enduring monument.

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His only son, KARL EDUARD ZACHARIÄ (1812–1894). also an eminent jurist, was born in Heidelberg on Dec. 24, 1812. and studied at Leipzig, Berlin and Heidelberg. He made Roman and Byzantine law his special study and traveled abroad extensively in his researches, visiting St. Petersburg, Copenhagen, London and Oxford. His *Jus Graeco Romanorum* (1856–84) and the *Geschichte des griechisch-römischen Rechtes* (1856–64) are of the greatest importance in the field of the history of Byzantine law, especially for his views on the Farmer's law (*nomos gcorgikos*), although A. A. Vasiliev criticized his work for overemphasizing the impact of the Slavs upon the internal customs of the Byzantine empire (see *Bibliography*). He was professor at Heidelberg university from 1832 to 1845, when he retired and lived thereafter on his estate in Saxony. There he died on June 3, 1894.

For a list of Zacharia's works, see *Allgemeine Deutsche Biographie*, vol. 44 (1898) and the bibliography in A. A. Vasiliev's *History of the Byzantine Empire* (1952). (J. F. LR.)

ZACHARIAS, SAINT (d. 752), pope from 741 to 752, was a Greek by birth and appears to have been on intimate terms with

Gregory III, whom he succeeded in Nov. or Dec. 741. Contemporary history dwells chiefly on his personal influence with the Lombard kings Liutprand and Rachis. It was due largely to his tact in dealing with these princes in a variety of emergencies that the exarchate of Ravenna (*q.v.*) was rescued from becoming part of the Lombard kingdom. The correspondence between Zacharias and Boniface. the apostle of Germany, shows how great was the influence of the pope on the events then passing in the Frankish kingdoms. In 751 he gave his moral support to the deposition of Childeric III, the last Merovingian king, and authorized Boniface to anoint Pippin as king of the Franks. The action of Zacharias in the transference of the royal crown to the house of Pippin (Carolingians) established a precedent that was of the greatest significance in the future relations between pope and emperor, and was of extreme importance to the theorists and controversialists at the time of the Investiture (*q.v.*) controversy. Zacharias is known in the east for his translation of the *Dialogues* of Gregory the Great and for his Catholic attitude toward the Iconoclastic controversy.

He died on March 14 or 22, 752. He is commemorated in the Roman martyrology on March 22. (R. E. McN.)

ZADAR, in Italian called ZARA, a town on the Dalmatian coast of Yugoslavia. 72 mi. N.W. of Split, stands on the northwestern end of a low-lying peninsula separated by the Zadar channel from the islands Ugljan and Pasman. The inlet between this peninsula and the adjacent mainland forms a natural, deep-water harbour. The Venetians made the town still more secure by digging a deep ditch on the landward side. Zadar and its suburbs cover 35½ sq.mi., of which the inner town occupies nearly 9 sq.mi.

The ancient Liburnian town of Iader became Roman in 100 B.C. Spared in the Avar and Slav invasion of Dalmatia (*c.* A.D. 600), the town became the capital of Dalmatia under the existing Byzantine administration and remained Byzantine till 882, after which it had to pay to Croatia 110 ducats yearly for possessions on Croatian territory. It became a Croatian protectorate in 923 but fell under the Venetian doge at the end of the century. There followed a long struggle for Dalmatia between Venice. Croatia and Byzantium, the chief prize being Zadar, which came under Croatian rule for a short time at the end of the 11th century but then reverted to Venice; and wars for Zadar between Venice and Croatia went on for 300 more years. Finally sold to Venice by the Croat-Hungarian king in 1409, it remained Venetian till the end of the republic (1797). Zadar was then ceded to Austria, but passed temporarily into French possession and formed part of the kingdom of Illyria until 1813, when the French were driven out. Austria retained Zadar until in 1918 Italian troops entered the town, which was ceded to Italy by the treaty of Rapallo (1920). Its transference. when the rest of Dalmatia became Yugoslav, was based on the London treaty of 1915 and justified by the large population and by the continuity of Latin culture and speech. After Italy's capitulation in World War II, Zadar was occupied by the Germans. Liberated by the Yugoslavs, on Nov. 1, 1944, it was subsequently incorporated in Yugoslavia. During the mar Zadar had suffered damage from Anglo-American bombing, 75% of its buildings bring destroyed. The population, which amounted to 22,844 in 1936, was reported as 25,132 in 1961.

The secularized church of S. Donato probably dates from the early 9th century. The cathedral is oi the 13th century and possesses some fine Dalmatian silver work.

Zadar has well-developed industries: shipbuilding. distilleries, processed food (particularly tinned fish), fishing equipment, etc. In 1935 a university was founded.

See G. Dainelli, *La Dalmazia,* with atlas (Novara, 1918), V. Brunelli, *Storia della citta di Zara* (Zara, 1913), A. Nani, *Notizie storiche della città di Zara* (Zara, 1883).

ZAGAZIG (Zaķāzīk), a town of Lower Egypt, capital of the province of Sharkia. Pop. (1957 mun.) 109.939. It is built on a branch of the Fresh Water or Ismailia canal, and on the Al-Mo'izz canal (the ancient Tanitic channel of the Nile), and is 47 mi. N.N.E. of Cairo by rail. Situated on the Delta in the midst of a fertile district. Zagazig is a great centre of the cotton and grain trade of Egypt. It has large cotton factories and the offices of numerous European merchants. About a mile south of the town are the ruins of Bubastis (*q.v.*).

ZAGHAWA: see NUBA.

ZAGHLUL, SAAD (1860–1927), Egyptian patriot, came of fellahin stock in the district of Ibian, Gharbia province. He was educated at the village school and at the university of El Azhar, in Cairo. In 1880. he became editor of the *Official Journal.* Later he was nominated a Moawin under the Ministry of the Interior and eventually became chief of the Contentieux for the province of Giza. Involved in the Arabi revolt, he was one of the ,many notables detained on the occupation of Egypt by British troops in 1882. In 1884 he began to practise at the bar, and in 1893 became a judge in the native court of appeal. He became minister of education in 1906, and in 1910 minister of justice. At the ministry of justice he made a charge of corruption against the khedive Abbas Hilmi, and was asked (1912) by Lord Kitchener to resign. Zaghlul's evidence was insufficient, but he mas thought to have been fundamentally justified, and his fierce opposition to British domination was undisguised irom that time. He then became vice-president of the legislative assembly.

On the signing of the Armistice (Nov. 1918) Zaghlul, who had for long been considered the principal spokesman of the Nationalist party, appealed to the residency in Cairo ior the recognition of Egyptian independence, basing his demand on Pres. Woodrow Wilson's self-determination policy and the British proclamation defining the status of the other countries liberated from Turkish rule by World War I. His proposal that he, with other representative Nationalists, should visit London to press their views was refused by the government, and his attitude was so hostile that he and three others were arrested on March 8, 1919, and deported to Malta. This mas the signal for a murderous outbreak in Egypt and serious disturbances (*see* EGYPT: *History: Modern Period*). Zaghlul and his friends were later released by Lord Allenby, and a special mission under Viscount Milner was sent to Egypt in Nov. 1919 to report on the situation.

Zaghlul returned to Egypt early in 1921, where he represented the extreme Nationalist party in opposition to the more moderate ministry under the presidency of Adly Pasha. At the end of the year, when trouble again broke out in Egypt, Zaghlul was arrested once more and deported, first to Aden and then to the Seychelles. In Sept. 1922 he was transferred to Gibraltar, whence he was released on April 4, 1923, on the grounds of ill-health. After the promulgation of the new constitution, martial law was abolished and Zaghlul was free to return to Egypt. He was enthusiastically received, and in the elections of Jan. 1924 his supporters gained an overwhelming majority. Yehia Ibrahim Pasha resigned and Zaghlul formed a ministry. Conversations to secure a settlement between England and Egypt took place in London (Sept. 25–Oct. 3) between Zaghlul and Ramsay Macdonald; Zaghlul refused to modify his intransigent attitude, and no agreement was reached. On Nov. 19, 1924, Sir Lee Stack, the sirdar, was assassinated and Zaghlul was forced to resign. Nevertheless he became president of the new chamber of deputies. From that time the history of Zaghlul Pasha is the history of Egypt (*q.v.*).

Zaghlul died at Cairo on Aug. 23, 1927. His health had long been failing, hut he was to the end the life and soul of Egyptian nationalism.

ZAGREB, the capital of the Republic of Croatia in the federal people's republic of Yugoslavia. and the seat of a Roman Catholic archbishop. is situated between the slopes of the Medvęđica hills to the north and the Sava river to the south. Pop. (1961) 327,319.

The old town is composed of the two settlements, Gradac and the Kaptol. The new town was extended toward the south after the 17th century and its growth became particularly rapid during 1860–1914. Between 1807 and 1910 the population rose from 7,706 to 74,703. The city continued to grow between World Wars I and II. and after 1945 it spread on to the right bank of the Sava which there flows in an easterly direction, The centre of the new town is the Trg Republike (Square of the Republic). From there radiate main streets and avenues with their modern buildings. The city is most attractive. with many open squares and parks (Zrinjevac, Botanical gardens, Tuskanac. Maksimir).

Zagreb is the cultural centre of Croatia. It is the seat of the Yugoslav Academy of Science and Arts. There are a large university library, several picture galleries with old and modern paintings and a collection of engravings. various museums, a university, and academies of arts, music and theatrical art; an astronomic observatory and a nuclear energy institute named after Rudjer Boskovic (*see* BOSCOVICH, RUGGIERO GIUSEPPE).

The city is an important junction of roads and railways from western and central Europe to the Adriatic sea and southeastern Europe. It is connected by airlines with many European capitals from the airport at Lucko, 10 mi. from the town. Zagreb is one of the most important industrial and .manufacturing centres of

Yugoslavia. About 43% of the population is employed in industry, chiefly in the manufacture of machines. metal and electrotechnical products. textiles, chemicals, printing, leather and food. The Zagreb fair has an international character.

History. — Zagreb was first mentioned in the documents of 1093, when Ladislas I, king of Hungary and Croatia, established the Roman Catholic bishopric there. Of the settlements that previously existed on the site, the most important were Gradac (now the upper town) and the Kaptol, between whom a bitter feud raged for centuries. After the Tatar invasion in 1242 Bela IV, king of Hungary and Croatia, proclaimed Gradac a free and royal town. Then began the building of fortifications of which the towers of Lotrscak. Popov Toranj and Kamenita Vrata have survived. The upper town contains among its notable buildings the Gothic church of St. Marcus. the baroque church of St. Catherine, the palaces Zrinski and Orsic, a former Jesuit monastery and the neoclassic Draskovic palace. The Kaptol, fortified after 1466, has a Gothic cathedral (13th–I jth century) in the sacristy of which is a fresco of the 13th century; the cathedral was restored at the end of the 19th century. Near the cathedral is the archbishop's baroque palace with a chapel of St. Stephen (mid-13th century).

As a political centre, Zagreb played an important role in the history of Croatia, especially in the 1830s, the date of the Croatian national revival. It was also the centre of a strong Yugoslav movement of which Bishop J. G. Strossmayer (*q.v.*) was the intellectual inspirer. He was among the founders of the Southern Slav academy (1867) and of the Zagreb university (1874).

On Oct. 29, 1918, a national assembly met in Zagreb and decided that all links with the Austrian empire and the kingdom of Hungary should be severed, proclaiming Croatia, Slavonia and Dalmatia (with Rjeka) an independent state. On Nov. 24 the national council proposed to proclaim the unification of Croatia with Serbia and Slovenia. In 1921 the city's administrative area was increased to 27 sq.mi. and its population reached 108,338. Soon after the creation of a Yugoslav state serious differences arose between Croatian national aspirations for autonomy and Serbian tendencies to ard centralization. Zagreb became the centre of an autonomous movement. In April 1941, during World War II, Zagreb became the capital of the newly created independent Croatia. In April 1945 it was liberated from the axis powers by the Yugoslav partisan forces of Marshal Josip Broz (Tito) and became the capital of Croatia, one of the six component parts of the new federal people's republic of Yugoslavia. (See also YUGOSLAVIA: History.) (K. Š.-Š.; Mo. Š.)

ZAHARIAS, BABE (MILDRED ELLA) **DIDRIKSON** (1914–1956), U.S. athlete, one of the greatest of the first half of the 20th century, was a champion performer in basketball, track and field, and golf. Born June 26, 1914, at Port Arthur, Tex., she was a record breaker while still a high-school student. She was an All-American basketball player in 1930; won eight events and tied for a ninth in women's national track and field championships from 1930 to 1932 (1930, baseball and javelin throws; 1931, 80-m. hurdles, broad jump and baseball throw; 1932, 80-m. hurdles, javelin and baseball throws, and tied for the high-jump title), and captured two events in the 1932 Olympic games (q v., for her records there), setting a new record in winning the javelin event and establishing a new U.S. outdoor mark in the 80-m. hurdles. Miss Didrikson turned professional in the mid-1930s and gave athletic exhibitions throughout the country. In 1935 she began playing golf (with amateur standing) and soon became the leading woman golfer in the U.S. In 1947 she won 17 straight golf titles, including the British Women's Amateur, of which she was the first U.S. winner. She later became a professional golfer. In 1953 she underwent a cancer operation and appeared to be recovered when she later won the U.S. National Open and All-American Open in 1954. In 1956 she again submitted to cancer surgery and died Sept. 27, 1956, at Galveston, Tex. She married George Zaharias, the wrestler, in 1938. Her autobiography, This Life I've Led (1955), reveals her as a delightful and courageous woman as well as a great athlete. (D. SR.)

ZAHAROFF, SIR BASIL (1849–1936), financier and politician, was born in Mughla, Anatolia, of Greek parents, on Oct. 6, 1849. He was reputed to be one of the world's richest men. his fortune being built up from munitions plants, shipbuilding, oil and other enterprises. He exerted a strong if indirect influence during World War I and at the Paris conference, being a close friend and political adviser of Lloyd George, Venizelos, Clemenceau and Briand. During this period he extended very considerable financial aid to the British and French governments, and later was honoured by these countries for his war services. He is said to have given Greece $2,500,000 a year during the Balkan War, and half that sum during World War I. To the American Near East Relief fund for refugee relief projects in Greece he contributed several thousand pounds and he gave 1,000,000 fr. to France for the "save the franc fund." He established chairs of aviation at the universities of Paris, Petrograd and London, and endowed the Marshal Foch professorship of French literature at Oxford university and the Field-Marshal Haig chair of English literature at Paris university. He died Nov. 27. 1936.

ZAHN, ERNST (1867–1952), Swiss novelist and poet, was born at Zurich on Jan. 24. 1867. Long associated with his father in the management of the railway restaurant at Goschenen, at the entrance to the St. Gotthard tunnel, he became in turn councilor, judge and president of the diet of Canton Uri; but he later devoted himself wholly to literature. His first book was *Kämpfe* (1893), a romance; his most popular novel was Lukas *Hoch*strassers *Haus* (1907). Other notable volumes are *Blancheflur* (1923), Frau *Sixta* (1926), and two collections of short stories, Helden des *Alltags* (1906) and Das Licht (1912). *Herrgottsfäden* (1901), dealing with the St. Gotthard tunnel, was translated into English under the title of Golden Threads (1908). He died on Feb. 22, 19j2, at Zurich.

See a study by H. Spiero, *Ernst* Zahn (1927).

ZAISAN ("Noble"). (1) A lake of the Kazakh Soviet Socialist Republic. U.S.S.R., situated in a valley between the Altai range on the northeast and the Tarbagatai on the south, at an altitude of 1,266 ft. Its area is 707 sq.mi., and its surface is dotted with islands; it is 60 to 65 mi. long and 10 to 20 mi. wide and receives the drainage of ten rivers, including the Black Irtish and the Kendyrlyk; the White Irtish forms the northwestern outlet of the lake Roach, perch, carp, trout, nyelma and sterlet abound during the fishing season, May to August. The lake has a depth of 50 ft. and is navigable for steamers; and barges ascend the Black Irtish into Mongolia. (2) A town in the Kazakh Soviet Socialist Republic, U.S.S.R., in 47° 32′ N., 84° 56′ E., situated on a route into Mongolia, at an altitude of 2,200 ft. It lies southeast of Lake Zaisan and south of the Black Irtish. Pop. 8,130. Its tanning and leather industry is important and it is a centre for trade between Kazakhstan and Mongolia. Topolni Mis, on Lake Zaisan, acts as a port for it.

ZAKOPANE, a town of Poland in Krakow province, situated amid superb scenery in the heart of the Tatra mountains; a health resort both in summer and winter; the most frequented holiday resort of Polish tourists and rock climbers. It has important thermal springs. The town lies 1,000 m. above sea level and has an alpine climate. Pop. (1950) 20,600.

Zakopane was occupied by Germany in Sept. 1939, but was returned to Poland in 1945.

ZALEUCUS, of Locri Epizephyrii in Magna Graecia (fl. c. 660 B.C.), Greek lawgiver, is said to have been the author of the first written code of laws among the Greeks. The story has some familiar features. The Locrians were distressed at their own lawlessness; they commissioned Zaleucus, a slave, to draw up a code and he did so under divine inspiration. The code was a severe one of the Draconian type which remained unchanged for centuries. The story ends with the episode of the lawgiver committing suicide on discovering that he had inadvertently broken one of his own laws.

ZALMOXIS or ZAMOLXIS, a semimythical social and religious reformer, regarded as the only true god by the Thracian Getae. According to Herodotus (iv, 94), the Getae, who believed in the immortality of the soul, looked upon death merely as going to Zalmoxis. It is probable that Zalmoxis is Sabazius, the Thracian Dionysus or Zeus; Mnaseas of Patrae identified him with Cronus. In Plato *(Charmides,* 158 B) he is mentioned with Abaris as skilled in the arts of incantation. No satisfactory etymology of the name has been suggested.

ZAMA, BATTLE OF, 202 B.C. One of the most decisive battles in military history in its military result. Zama ranks above any, save perhaps Waterloo, for its decisive effect on the course of world history. For the defeat of Hannibal. the first and only true defeat in his career. left Carthage naked, and her surrender put an end to the long struggle between Rome and Carthage *(see* PUNIC WARS) for the mastery of the Mediterranean world.

The prologue to Zama had been the invasion of Africa by Scipio (*q.v.*), almost in defiance of the Roman senate nhich wished him instead to attack Hannibal, who still stood unconquerable in Southern Italy. In Africa Scipio's brilliant series of victories over less formidable generals had forced Carthage to sue for peace before Hannibal could answer the summons of recall. But while the peace negotiations were being conducted in Rome, Hannibal landed at Leptis, whereupon the Carthaginians broke the truce, and Scipio's military position was gravely compromised—isolated on hostile soil and with part of his force detached to assist his ally Masinissa in securing his new kingdom of Numidia. Instead of awaiting Hannibal near Carthage, Scipio cut himself off from his base and marched on a divergent path into the interior. Security lies often in calculated audacity, and an analysis of the military problems makes it highly probable that his march inland up the Bagradas valley was aimed, by its menace to the rich interior on which Carthage depended for supplies, to force Hannibal to push west to meet him instead of north to Carthage. By this clever move he threatened the economic base of Carthage and protected his own, also luring Hannibal away from his military base—Carthage. A complementary purpose was that this line of movement brought him progressively nearer to Numidia, shortening the distance which Masinissa would have to traverse with his expected reinforcement of strength.

It had the intended effect, for the Carthaginians sent urgent appeals to Hannibal to advance towards Scipio and bring him to battle, and within a few days he marched west, and arrived by forced marches at Zama. He then sent out scouts to discover the Roman camp and its dispositions for defence—it lay some miles farther west. Almost coincidently Masinissa arrived with 6,000 horse and 4,000 foot, and Scipio then broke up his camp and moved to a fresh site near the town of Narragara, his position being well chosen tactically, and having water "within a javelin's throw." Hannibal also moved his camp forward to meet him.

A parley between the two commanders led to no result, and both thereupon prepared to decide the issue by arms. The dispositions made by the rival leaders have several features of note. Scipio placed his heavy Roman foot—he had probably two legions—in the centre; Laelius with the Italian cavalry on the left wing; and on the right wing Masinissa with the whole of the Numidians, horse and foot. The heavy infantry were drawn up in the normal three lines: first, the *hastati;* then the *principes;* and finally, the *triarii.* But instead of adopting the usual chequer formation, with the maniples of the second line opposite to and covering the intervals between the maniples of the first line, he ranged the maniples forming the rear lines directly behind the respective maniples of the first line—thus forming wide lanes between each two cohorts.

The Carthaginian had eighty elephants, more than in any previous battle, and in order to terrify the enemy he placed them in front of his line. Supporting them, in the first line, were the Ligurian and Gallic mercenaries, intermixed with Balearic and Moorish light troops. In the second line were the Carthaginian and African levies, their combined strength probably exceeding that of the first line. Finally, Hannibal's own troops from Italy formed the third line, held back more than zoo yards distant from the others, in order evidently to keep it as an intact reserve. On the wings Hannibal disposed his cavalry, the Numidian allies on the left and the Carthaginian horse on the right. His total force was probably in excess of 50,000, perhaps 55,000. The Roman strength is less certain, but if we assume that each of Scipio's two legions was duplicated by an equal body of Italian allies, and add Masinissa's 10,000, the complete strength would be about 36,000.

The battle opened, after preliminary skirmishing, with Hannibal's order to the drivers of the elephants to charge the Roman line. Scipio promptly countered by a blast of trumpets along the whole line. The strident clamour so startled and terrified the elephants that many of them at once turned back on their own troops. This was especially the case on the left wing, where they threw the Numidians, Hannibal's best cavalry wing, into disorder just as they were advancing to the attack. Masinissa seized this golden opportunity to launch a counter-stroke, which inevitably overthrew the disorganized opponents. With Masinissa in hot pursuit, they were driven from the field, and so left the Carthaginian left wing exposed. The remainder of the elephants wrought much havoc among Scipio's *velites,* caught by their charge in front of the Roman line. But the foresight that had provided the "lanes" and laid down the method of withdrawal was justified by its results. For the elephants took the line of least resistance, penetrating into the lanes rather than facing the firm-knit ranks of the heavy infantry maniples. Once in these lanes the *oelites* who had retired into the lateral passages, between the lines, bombarded them with darts from both sides. Their reception was far too warm for them to linger when the door of escape was held wide open. While some of the elephants rushed right through, harmlessly, and out to the open in rear of the Roman army, others were driven back out of the lanes, and fled towards the Carthaginian right wing. "It was at this moment that Laelius, availing himself of the disturbance created by the elephants, charged the Carthaginian cavalry, and forced them to headlong flight. He pressed the pursuit closely, as likewise did Masinissa." Both Hannibal's flanks were thus stripped bare.

In the meantime the infantry of both armies had slowly advanced on each other, except that Hannibal kept his third line back. At first the Gauls and Ligurians had the balance of advantage, through their personal skill in skirmishing and more rapid movement. But the Roman line remained unbroken, and the weight of their compact formation pushed the enemy back despite losses. Another factor told, for while the leading Romans were encouraged by the shouts from the rear lines, coming on to back them up, Hannibal's second line—the Carthaginians—failed to support the Gauls, but hung back in order to keep their ranks firm. Forced steadily back, and feeling they had been left in the lurch by their own side, the Gauls turned about and fled. When they tried to seek shelter in the second line they were repulsed by the Carthaginians, who deemed it essential to avoid any disarray which might enable the Romans to penetrate their line. In a short time the relics of the first line had dispersed completely, or disappeared round the flanks of the second line. The latter, however, showed their fighting quality by thrusting back the Roman first line—the *hastati.* In this they were helped by a human obstacle, the ground encumbered with corpses and slippery with blood, which disordered the ranks of the attacking Romans. Even the *principes* had begun to waver when they saw the first line driven back so decisively, but their officers rallied them, and led them forward in the nick of time to restore the situation. This reinforcement was decisive. Hemmed in, because the Roman formation produced a longer frontage and so overlapped their line, the Carthaginians were steadily cut to pieces. The survivors fled back on the relatively distant third line, but Hannibal continued his policy of refusing to allow the fugitives to mix with and disturb an ordered line.

The curtain now rose on what was practically a fresh battle. The Romans "had penetrated to their real antagonists, men equal to them in the nature of their arms, in their experience of war, in the fame of their achievements. . . ." Livy's tribute is borne out by the fierceness and the long uncertain issue of the subsequent conflict, which refutes the suggestion that Hannibal's "Old Guard" was but a shadow of its former power—in the days of Trasimenus and Cannae. The Romans had the moral advantage of having routed two successive lines, as well as the cavalry and elephants, but they had now to face a compact and fresh body of probably 24,000 veterans, under the direct inspiration of Hannibal. And no man in history has shown a more dynamic personality in infusing his own determination in his troops. The Romans, too, had at last a numerical advantage, not large, however—the forces were "nearly equal in numbers" according to Polybius—and in reality still less than it appeared. For while all Hannibal's third line were fresh, on Scipio's side only the *triarii* had not been engaged, and these represented but half the strength of the *hastati* or *principes*. Further, the *velites* had been so badly mauled that they had to be relegated to the reserve, and the cavalry were off the field, engaged in the pursuit. Thus it is improbable that Scipio had at his disposal for this final blow more than 18,000 or 20,000 infantry, less the casualties these had already suffered.

His next step is characteristic of the man—of his cool calculation even in the heart of a battle crisis. He sounded the recall to his leading troops, and then, in face of an enemy at hardly more than a bow-shot distance, he not only reorganized his troops but reconstructed his dispositions. His problem was this: against the first two enemy lines the Roman formation, shallower than the Carthaginian phalanx and with intervals, had occupied a wider frontage, and so enabled him to overlap theirs. Now, against a body double the strength, his frontage was no longer, and perhaps less, than Hannibal's. His appreciation evidently took in this factor, and with it two others. First, that in order to concentrate his missile shockpower for the final effort it would be wise to make his line as solid as possible and this could be done because there was no longer need for or advantage in retaining intervals between the maniples. Second, that as his cavalry would be returning any moment there was no advantage in keeping the orthodox formation in depth and using the *principes* and *triarii* as a direct support and reinforcement to his front line. The blow should be as concentrated as possible in time and as wide as possible in striking force rather than a series of efforts. He, therefore, made his hastati close up to form a compact centre without intervals. Similarly he closed each half of his *principes* and *triarii* outwards, and moved them forward to extend the flank on either wing. He now once more overlapped the hostile front. The rôle of Scipio's infantry in the final phase was to fix Hannibal's force ready for the decisive manoeuvre to be delivered by the cavalry. For this rôle violence and wideness of onslaught was more important than sustenance. Scipio made his redistribution deliberately and unhurriedly—the longer he could delay the final tussle, the more time he gained for the return of his cavalry. It is not unlikely that Masinissa and Laelius pressed the pursuit rather too far, and so caused an unnecessary strain on the Roman infantry and on Scipio's plan. For Polybius tells us that when the rival infantries met, "the contest was for long doubtful, the men falling where they stood out of determination, until Masinissa and Laelius arrived providentially at the proper moment." Their charge, in the enemy's rear, clinched the decision, and though most of Hannibal's men fought grimly to the end, they were cut down in their ranks. Of those who took to flight few escaped.

The completeness of the victory left no room for a strategic pursuit, but Scipio did not linger in developing the moral exploitation of his victory. An immediate move on Carthage achieved its object, a bloodless capitulation.

ZAMBEZI, the fourth in size of the rivers of Africa, and the largest of those flowing eastward to the Indian ocean. Its length (taking all curves into consideration) is about 2,200 mi. The area of its basin, according to Dr. Bludau, is 513,500 sq.mi., or rather less than half that of the Nile. The main channel is clearly marked from beginning to end. The river takes its rise in 11° 21' 3" S., 24° 22' E. The source lies in British territory in a depression of an undulating country 5,000 ft. above the sea, covered with bracken and open forest. The water, like that of all the rivers of the neighbourhood, issues from a black marshy bog. Eastward of the source the water parting between the Congo and Zambezi basins is a well-marked belt of high ground, falling abruptly north and south, and running nearly east and west between 11° and 12° S.

The Upper River.—The infant Zambezi, after pursuing a southwesterly course for about 150 mi., turns more directly south and receives on either side numerous small tributaries. A few miles above Kakengi (in 12° 24′ S.), the Zambezi, narrow, picturesque and tortuous, suddenly widens from 100 to 350 yd. Below Kakengi are a number of rapids ending (13° 7 S.) in the Suapuma cataracts. At this point the river flows tumultuously through a rocky fissure,

The first of its large tributaries to enter the Zambezi is the Kabompo, a left-hand affluent. It joins the main stream in 14" 26' S. A little lower down (14" 18' S.) the Zambezi receives from the west the waters of a much larger stream than the Kabompo, namely, the Lungwebungu. The land, from 5,000 ft. at the source, falls gradually to 3,600 ft. at Kakengi—a distance of 220 mi. From this point until the Victoria falls are reached—500 mi.—the level of the Zambezi basin is very uniform, the fall being in this distance 600 ft. only. Twenty miles below the confluence of the Lungwebungu the country becomes flat, and in the rainy seasons is largely covered by floods. From the east the Zambezi continues to receive numerous small streams, but on the west is without tributaries for 150 mi., when the great river formerly misnamed the Chobe, but known to the natives as Kwando or Linyante, joins it (17° 47′ S.).

The Middle **Zambezi.**—The Victoria falls (*q.v.*) are reached some 60 mi. below the Kwando confluence. The surrounding country is formed of horizontal flows of basic lavas, which are traversed by two well-marked sets of joints. Along these the river has eroded a great canyon. The middle course of the river may be said to extend for 800 mi. below the Victoria falls to the Kebrabasa rapids, where the Zambezi crosses the great East African escarpment, and enters the coastal belt.

The Lower **River.**—The lower Zambezi—400 mi. from Kebrabasa rapids to the sea—presents no obstacles to navigation save the shallowness of the stream in many places in the dry season. This shallowness arises from the different character of the river basin. Instead of, as in the case of the middle Zambezi, flowing mainly through hilly country with well-defined banks, the river traverses a broad valley and spreads out over a large area. Only at one point, the Lupata gorge, 200 mi. from its mouth, is the river confined between high hills. There it is scarcely 200 yd. wide. Elsewhere it is from 3 to 5 mi. wide, flowing gently in many streams. The river bed is sandy, the banks are low and reed-fringed. At places, however, and especially in the rainy season, the streams unite into one broad swift-flowing river. About 100 mi. from the sea the Zambezi receives the drainage of Lake Nyasa through the river Shiré. On approaching the ocean, which it reaches in 18° 50′ S., the Zambezi splits up into a number of branches and forms a wide delta. Each of the four principal mouths—Milambe, Kongone, Luabo and Timbwe—is obstructed by a sand bar.

Mileage of Navigable Water.—Zambezi, like all other large African rivers, suffers because of the bar at its mouth, the shallowness of its stream, and the rapids and cataracts which interrupt its course. Nevertheless, it is navigable (1) from the sea to the Kebrabasa rapids, 400 mi.; (2) from Chikoá (above Kebrabasa) to within 140 mi. of the Victoria falls, 700 mi.; (3) from the rapids above the Victoria falls to the Katima Molilo rapids, 100 mi.; (4) above the Gonye falls to the Supuma cataract, 300 mi.; (5) above the Supuma cataract, 120 mi.

Several of the Zambezi affluents are also navigable; the sum of such navigable reaches within the Zambezi basin is nearly 4,000 mi.

Exploration of the River.—The Zambezi region was known to the medieval geographers as the empire of Monomotapa and the course of the river, as well as the position of lakes Ngami and Nyasa, were filled in with a rude approximation to accuracy in the earlier maps. These were probably constructed from Arab information. The first European to visit the upper Zambezi was David Livingstone in his exploration from Bechuanaland between 1851 and 1853. Two or three years later he descended the Zambezi to its mouth and in the course of this journey discovered the Victoria falls. During 1858–60, accompanied by John (later Sir John) Kirk, Livingstone ascended the river by the Kongone mouth as far as the falls, besides tracing the course of its tributary, the Shiré, and discovering Lake Nyasa.

See David and Charles Livingstone, *Narrative of an Expedition to the Zambesi and its Tributaries* (1865); A. de Serpa Pinto, *How I Crossed Africa* (1881). (*F. R. C.*)

ZAMBOANGA, a former province of the Philippine Islands, now divided into the provinces of Zamboanga del Norte (pop. [1959 est.] 205,443) and Zamboanga del Sur (pop. 433,967). The total population has increased by more than 70% since 1939. Together these provinces occupy the major part of the Zamboanga peninsula on the western side of the island of Mindanao. The border between the provinces is marked by a range of mountains, which culminates in Mt. Dapiak (8,586 ft.) in the northeast. Major stands of high-grade Philippine mahogany and other hardnoods are found here. Rice, corn and coconuts are leading crops while cassava and tropical fruits are secondary; in the late 1950s the cultivation of coffee and cacao mas developing. Gold, long known in Zamboanga del Sur. has not been produced commercially since 1941. Coal. both soft and hard, is mined in limited quantities near Malangas, Zamboanga del Sur. Dipolog, a trading and fishing centre on the north coast, and Pagadian on the south coast are the respective provincial capitals. After 1948 there were substantial movements of pioneer settlers from northern islands to these provinces, especially to the central portion of Zamboanga del Sur. (R. E. HE.)

ZAMBOANGA, CITY OF, a chartered city on the southwestern tip of Mindanao Island, Republic of the Philippines. The city is actually an extensive area that comprises 3 municipalities and 37 barrios (villages) in addition to the administrative centre (población). The population (1959 est.) of the city was 126.570, with about 22,000 in Zamboanga población. The city has a good port on Basilan strait, protected by Basilan Island; its large T wharf accommodates interisland and ocean-going vessels. Zamboanga exports Philippine mahogany and other fine hardwood; it is also a centre for processing and exporting copra.

A native settlement had long existed on the site when the Spanish town was founded in 1635. Fort San Pedro, which protected the harbour and was a centre for expeditions against the Moros both under the Spanish and the American regimes. stands as a national monument. The beauty of the población with its Spanish-style buildings, two fine hotels, excellent beaches, mountainous backdrop and a climate cooler and less rainy than Manila's make this a favourite tourist spot. It is a centre for Moro handicrafts, a collecting point for shells (exported or used locally for button manufacture) and a modest fishing port. (R. E. HE.)

ZAMIA, a genus of cycads that comprises about 30 species of small fernlike plants, native to tropical and subtropical America. They have a turniplilre, mostly underground stem surmounted by a crown of leaves, one to two feet long, surrounding large fruiting cones. The crushed stems yield starch used for food, after washing to extract an alkaloid. Two species, *Z. floridana* and *Z. pumila,* known as coontie or comfortroot, occur in southern Florida.

ZAMORA, an inland province of Spain, one of the three into which the former province of León was divided in 1833; bounded W. by Portugal and Orense, N. by León, E by Valladolid. S. by Salamanca. Pop. (1950) 316,493; area 4,082 sq.mi. Zamora is traversed from east to west by the river Duero or Douro (*q.v.*); the Tormes also skirts the southwestern boundary for about 25 mi. Except in the northwest, where it is entered by two outlying ridges of the Cantabrian mountains, the Sierra de la Culebra and Sierra de Peña Negra, the surface is a level or slightly undulating plateau; its lowest point is 1.070 ft. Its plains, especially the valley of the Esla, yield much grain and pulse; wine and flax are also produced; and on the higher grounds many merino sheep and goats are reared.

ZAMORA, an episcopal city, and the capital of the Spanish province of Zamora; on the right bank of the river Duero (Douro). Pop. (1950) 35,392. In the early period of the Christian reconquest Zamora was a place of considerable strategic importance. Ferdinand I of Castile and Leon in 1061 gave it to his daughter Doña Urraca. After his death in 1065 his son Sancho II disputed. possession with Urraca and laid siege to the city, but without success, although the famous Cid Ruy Diaz de Bivar mas among his warriors. Zamora became subject to Alphonso VI in 1073. Zamora occupies a rocky height overlooking the Duero, a little below its confluence with the Valderaduey. The river is crossed by a fine 14th-century bridge of sixteen pointed arches. The citadel of Zamora dates from the 8th century. The small but beautiful Romanesque cathedral, one of four 12th-century churches, was completed about 1175.

ZAMOYSKI, JAN (1541–1605), Polish statesman, was the son of Stanislaw, Castellan of Chelm. and Anna Herburtowna, a noble Polish lady. After completing his education at Paris. Strasbourg and at Padua, where as rector of the academy he composed his celebrated work *De senatu romano* (Venice, 1563), he returned home in 1565, one of the most consummate scholars and jurists in Europe, and at once entered politics. He played a leading part, after the death of Sigismund II. in remodeling the Polish constitution and procuring the election of Henry of Valois. After the flight of that prince Zamoyski seems to have aimed at the throne himself, but quickly changed his mind and supported Stephen Báthory, whose election he prepared and uhose foremost counselor he became. Appointed chancellor on May 1, 1576, immediately after the coronation. as *wielki hetman,* commander-in-chief, in 1580, Zamoyski strenuously supported Stephen during his long struggle with Ivan the Terrible. He also enabled the king in 1585 to bring the traitorous Samuel Zborowski to the scaffold. On the death of Stephen, the Zborowski recovered their influence and did their utmost to keep Zamoyski in the background. At the election diet of July 9, 1587, however, Zamoyski triumphed over his rivals, and rejecting an offer from the Habsburgs of the title of prince, with the Golden Fleece and 20,000 ducats, procured the election of Sigismund of Sweden, son of Catherine Jagiellonica (Aug. 19). The opposite party immediately elected the Austrian archduke Maximilian, but Zamoyski routed and captured the archduke at Byczyna (Jan. 24, 1588).

From the first there was a certain coldness between the new king and the chancellor, Sigismund desiring an alliance with the Habsburgs, which Zamoyski feared. Friction became acute when Sigismund appointed an opponent of Zamoyski vice-chancellor, and made other ministerial changes which limited his authority; though ultimately, with the aid of his partisans and the adoption of such desperate expedients as the summoning of a confederation to annul the royal decrees in 1592, Zamoyski recovered his full authority In 1595 Zamoyski, in his capacity of commander-in-chief, at the head of 8,000 veterans, dethroned the anti-Polish hospodar of Moldavia and installed in his stead a Catholic convert, George Mohila. On his return he successfully sustained in his camp at Cecora a siege by the Tatar khan. Five years later (Oct. 20, 1600) he won his greatest victory at Tirgoviste, over Michael the Brave, hospodar of Walachia and Moldavia. But beyond securing the Polish frontier Zamoyski would never go. He refused to wage war with Turkey even under the most favourable circumstances, nor could he be drawn into the Holy league against the Ottomans in 1600, making conditions for Poland's co-operation which its allies could not possibly accept. Statesman though he was, Zamoyski cannot, with all his genius and valour, be called a true patriot. Sigismund was undoubtedly right when he attempted to reform the Polish constitution in 1605 by strengthening the royal power and deciding all measures in the future by a majority of the diet. These reforms Zamoyski strenuously opposed. His last speech was in favour of the anarchic principle of free election. He died suddenly at Zamosć, June 3, 1605.

ZAMUCAN, a group of tribes of South American Indians constituting an independent linguistic stock and occupying an area lying west of the Paraguay river in the Paraguayan and Bolivian Chaco. The most important tribes are the Zamuco proper (from whom the name Zamucan derives), the Guaraiioca, the Chamacoco, the Tsirakua and the Moro. Living in a subdesert area, they are seminomadic hunting people, only a few of whom practise agriculture. They construct flimsy temporary huts made of mats and, like all Chaco tribes, make bags and clothing from the fibres of the Bromelia plant. They are divided into limited bands consisting of a few families under the loose authority of a chief. The Chamacoco are the only tribe whose religious life is known. They have a cult devoted to the worship of a Supreme Goddess, mother of the universe, and propitiate the spirits by singing and dancing. At the close of the initiation ceremonies for young men, masked men impersonate spirits at a great feast. Women are not allowed to observe these rites lest they die. Diseases are treated by shamans who are in close touch with the supernatural world.

The ancient Zamucos have disappeared. Chamacoco who have come under the influence of white men have lost their aboriginal culture and are dwindling in number. The Tsirakua and the Moro of the northern Chaco and of Chiquitos (Bolivia) have remained hostile to whites and are practically unknown. See also INDIAN, LATIN-AMERICAN.

See G. Boggiani, "I Ciamacoco," *Bolletino della Società geografica italiana,* ser. 3, vol. 7, pp. 466–510 (1894) ; A. Métraux, "Ethnography of the Chaco," *Handbook of South American Indians,* vol. i (1946). (A. Mx.)

ZANESVILLE, a city of southeastern Ohio, U.S., 55 mi. E. of Columbus at the confluence of the Muskingum and Licking rivers; the seat of Muskingum county. Zanesville's outstanding landmark is a Y-shaped concrete bridge completed in 1902 to connect the east bank of the Muskingum with both sides of the Licking on the west bank. The site was on the route of Zane's trace, a road from Wheeling, W.Va., to the Ohio river opposite the town of Limestone, now Maysville, Ky., cleared by Ebenezer Zane under act of congress of 1796. Zane, who received land in payment for opening the road (later a part of the old national road), staked out a section at the present city but later sold it to his son-in-law John McIntire who, seeing the advantages of the water power and transportation facilities, laid out the town in 1799 and named it in honour of Zane. Through McIntire's efforts it became the county seat in 1804 and from 1810 to 1812 was also capital of Ohio. It was incorporated as a city in 1850 and has a council-manager form of government, in effect since 1958.

From the early 19th-century stoneware industry grew several pottery and tile plants that made Zanesville "the clay city" from 1890 to 1930. After World War II its industry became more diversified, including not only a large tile plant but also plants for the manufacture of glass, electrical equipment, sheet metal, alloy steel, batteries, farm machinery and cement. Zanesville also has a branch of Ohio university (see OHIO: *Education*); Muskingum, a Presbyterian college chartered in 1827, is located 16 mi. E. at New Concord. The city has a municipal auditorium and stadium, radio and television stations and an art institute. As a result of the 1913 flood in the Muskingum valley, congress authorized a network of 14 reservoirs which was completed in 1938; the Dillon dam and reservoir, 4 mi. N. of Zanesville on the Licking river, was completed in 1960.

The novelist Zane Grey (*q.v.*), a descendant of Ebenezer Zane, was born in Zanesville. For comparative population figures see table in OHIO: Population. (N. F. S.)

ZANGWILL, ISRAEL (1864–1926), Jewish man of letters, was born in London on Feb. 14, 1864. His early childhood was spent in Plymouth and at Bristol. When he was nine his parents settled in Spitalfields, and he entered the Jews' Free school, where eventually he became a teacher while working for his university degree. He soon gave up teaching for journalism, however.

He made his literary reputation with a novel, The Children of the Ghetto (1892), followed by Ghetto Tragedies (1893); Dreamers *of* the Ghetto (1898); and other tales and novels of great interest dealing with Jewish life. The Children *of* the Ghetto was produced as a play in New York city with success in 1899, and was later extensively played both in English and Yiddish.

He was greater as a playwright than as a novelist, and was a skilful painter of Jewish ideals and problems. Merely *Mary* Ann (1903) and Too Much Money (1918) represent his lighter gift; The *Melting* Pot (1908), The War God (1911) and others deal with serious social questions. Zangwill was an outstanding personality in the Jewish world. He was at one time president of the Jewish Territorial Organization for the Settlement of Jews Within the British Empire, and later a fervent supporter of the Zionist movement. He died on Aug. 1, 1926.

ZANTE (ZÁKYNTHOS; anc. ZACYNTHUS), southernmost of the Ionian Islands, west of Greece, 25 mi. long, about 12 mi. broad and 64 mi. around, with an area of 154 sq.mi. and a population in 1951 of 38,054. Zante lies 8 mi. S. of Cephalonia (Kefallinia), forming with it, Leucas (Leukas) and Ithaca (Ithake) a crescent-shaped group, the crest of a submerged limestone ridge facing the Gulf of Patras. Zante is of somewhat irregular oval shape, indented by a deep inlet at its south end. A wide fertile central plain is skirted on the west by bare limestone hills 1,000 to 1,200 ft. high, which fall gently landward, but with steep sea cliffs culminating northward in Mt. Skopos (anc. Elatos, 2,461 ft.). On the east the plain is also limited by a low ridge. These hills are still densely clothed to the summit with olives, figs, myrtles, laurels, oranges, aloes, vines and other subtropical plants. The central plain is an almost continuous stretch of gardens and vineyards, with a few cornfields and pastures. The peculiar dwarf vine, the currant (from Corinth) of commerce, is the staple export of Zante, as of the neighbouring mainland. It grows to 3 ft., begins to yield in seven years and lasts a century. Earthquakes are frequent and at times disastrous. Other volcanic indications are the oil springs on the coast and in the bed of the sea near Cape Skinari on the north. and especially the bituminous wells in a swamp near the coast village of Chieri.

Zante, capital and seaport, on the east side, with a population (1951) of 11,126, occupies the site of ancient Zacynthus, said to have been founded, like the neighbouring citadel of Psophis, by Zacynthus, son of Dardanus, a legendary Arcadian chief.

Traditionally Zacynthus belonged to Ulysses, king of Ithaca, and was peopled by settlers from Achaea or Arcadia. It figures occasionally in history as a base for belligerents. Thus during the Peloponnesian War and again in 374 B.C. the Athenians used it; in 357 it was the headquarters of Dion on his expedition against Syracuse; in 217 it was seized by Philip V of Macedon. The Romans captured it in 211 but restored it temporarily to Philip; in 191, to keep it out of the hands of Greek powers, they annexed it themselves. Under the Roman empire, Zante was included in the province of Epirus. In the 11th century it passed to the Norman kings of Sicily; after the fourth crusade it belonged at various times to the despots of Epirus, the emperors of Constantinople and the Orsini counts of Cephalonia. After remaining from 1357 to 1482 in the hands of the Tocco family it became a Venetian possession. In 1797 it was ceded to France, and after a short occupation by the Russians was brought under British protection; in 1864 it was ceded with the other Ionian Islands to Greece. During World War II, it was occupied by Italy.

ZANZIBAR, a sultanate and British protectorate of east Africa. The sultanate, formerly of a much larger extent (see History), is now reduced to the islands of Zanzibar and Pemba, some adjacent islets and the nominal sovereignty of a strip of coast line—10 mi. deep—forming the protectorate of Kenya (see KENYA). The collective area of the sultanate (Zanzibar and Pemba) is 1,020 sq.mi.

Topography. — The island of Zanzibar is situated in 6" S. latitude and 39° E. longitude, and is separated from the mainland of Africa by a channel 22½ mi. across at its narrowest part. It is the largest coralline island on the east coast of Africa and forms part of a coralline reef extending from Pemba (*q.v.*) to the north down to Mafia in the south and constituting a sort of outer coast line to the main continent. The island of Zanzibar is about 52 mi. long and approximately 27 mi. broad (maximum measurements) and has an area of 640 sq.mi. About 4 mi. off the northwest coast of Zanzibar and forming part of the coral reef is the densely wooded island of Tumbatu. The island of Zanzibar is not exclusively of coralline formation; in the central parts of the island there are a number of gently sloping heights of reddish ferruginous clay, the highest of these being the Mazingini ridge (390 ft.).

The seasons are well defined. From December to March the northeast monsoon blows and the climate is hot and comparatively dry. Heavy rains fall during April and May. The coolest and driest period of the year is from June to October, when the southwest monsoon is blowing. The lesser rains fall in November and December. Normal annual rainfall is about 58 in., the precipitation in the western part of the island being heavier than in the eastern. The climate is tropical, but throughout most of the year the heat is tempered by sea breezes which blow with great regularity except daring the period of the change of the monsoons.

Flora and Fauna.— Very little now remains of the extensive forests which formerly covered the island. The western part has been cleared for cultivation and the eastern part is mostly covered with low scrub.

Among cereals rice is the most ubiquitous crop, both the swamp and the hill varieties being planted. The next most important are maize, sorghum and millet. Vegetables include cassava, sweet potatoes, pumpkins and various kinds of beans and peas. Sugar cane is still popular, though not cultivated as extensively as formerly. Zanzibar also enjoys a great variety of tropical fruits. Though clearances for clove and coconut plantations have in the past led to much disafforestation, a number of solitary giant trees have been left and also a few small forest belts. The largest of these is at Jozani, in the southern portion of the island and is about 2½ sq.mi. in area.

Among the mammals of Zanzibar are a few species of monkey, including the Colobus *kirkii*, now virtually extinct. Two species of lemur are quite common. The African bush pig is found in the less populated districts. The carnivora include the leopard (still to be found in the more remote areas), the civet cat, genet cat and the mongoose. Rodents are not numerous, the most common being the squirrel and giant rat as well as the ubiquitous house rat and mouse. Insectivora include the elephant shrew (first found in Zanzibar) and the shrewmouse. Among the birds are many beautifully coloured tropical forms; game birds are not common. There are very few poisonous snakes but pythons are common, and a few specimens of cobra and adder have been found. The lizards include the giant monitor.

HISTORY

The past history of Zanzibar has been to a very large extent shaped by two things, namely: (1) the monsoons; and (2) its close proximity to the main continent. The regular annual recurrence of the monsoons has made possible its close connection with India and the countries bordering the Red sea and the Persian gulf. The close proximity of the island to the continent has made it a suitable jumping-off point for trading and exploring ventures not only along the coast of east Africa but also into the interior of the continent.

Though the first references to Zanzibar occur only after the rise of Islam. there would appear to be little doubt that its close connection with southern Arabia and the countries bordering the Persian gulf began long before the Christian era. It is possible that it is the island of Menuthias which is mentioned in the Greek treatise known as the *Periplus* and written about A.D. 60. Zanzibar is first mentioned in the 11th century when one of the Persian rulers of Kilwa fled before some invaders and took refuge in Zanzibar. A Kufic inscription at Kisimkazi at the south end of the island records the founding of a mosque by a local ruler in A.H. 500 (A.D. 1107). Writing at the beginning of the 13th century, the Arab geographer Yakut records that in his time the people of Lenguja (viz., Unguja, the Swahili name for Zanzibar) had taken refuge from their enemies on Tumbatu, the inhabitants of which mere Moslems. At the close of the 15th century sultans ruling in Zanzibar more than once intervened in disputes as to the succession to the sultanate of Kilwa. Native traditions go to show that at this date there was more than one ruler in the southern portion of Zanzibar Island and that the northern portion thereof was ruled by a Sheha living on Tumbatu.

In 1503 Zanzibar Island was attacked and made tributary by the Portuguese and appears to have remained in that condition for about a quarter of a century, though the Portuguese frequently found great difficulty in collecting their dues. Thereafter the relations between the rulers of Zanzibar and the Portuguese seem to have been those of allies, the people of Zanzibar more than once co-operating with the Portuguese in attacks upon Mombasa. In 1571 the then "king" of Zanzibar, in gratitude for Portuguese assistance in expelling certain African invaders, donated the island to his allies, but the donation was never implemented. A Portuguese trading factory and an Augustinian mission were established on the site of the modem city of Zanzibar and a few Portuguese appear also to have settled as agriculturists in different parts of the island. When the Arabs captured Mombasa in 1698 all these settlements were abandoned and (except for a brief Portuguese reoccupation in 1728) the island came under the domination of the rulers of Oman. For more than a century those rulers left the government of Zanzibar to local hakims (governors). The first sultan to take up his residence in Zanzibar was Said bin Sultan, who arrived there in 1828 and subsequently greatly extended his influence along the whole of the east African coast from Mogadishu as far south as Cape Delgado. On Said's death in 1856 his son Majid succeeded to his African dominions, while another son, Thuwaini, succeeded to Oman.

As the result of an award made in 1861 by Lord Canning, governor general of India, the former African dominions of Said were declared to be independent of Oman. Majid died in 1870 and was succeeded by his brother Barghash (Burgash). Toward the end of the latter's reign the mainland dominions of the sultans of Zanzibar suffered dismemberment. The coastal territories were divided among the European powers. Barghash died in 1888. Both he and Majid had acted largely under the influence of Sir John Kirk (*q.v.*), who was British consular representative at Zanzibar from 1866 to 1887. It was by Kirk's efforts that Barghash consented in 1873 to a treaty for the suppression of the slave trade throughout his dominions. Had an offer made by Barghash in 1877 been accepted, the whole of his mainland territories would at that date have been leased to a British company.

British Protectorate.— In 1890 what was left of the sultanate was proclaimed a British protectorate, in conformity with conventions whereby France and Germany recognized the supremacy of British interests in Zanzibar and the British government agreed to renounce all claims to Madagascar in favour of France and ceded Heligoland to Germany. In the same year a constitutional government was instituted under British auspices with Sir Lloyd Mathews as first minister. In Aug. 1896, on the death of the then sultan, Hamad bin Thuwaini, the royal palace at Zanzibar was seized by Khalid, a son of Sultan Barghash, who proclaimed himself as sultan. The British government disapproved this claim, and, as he refused to submit, the palace was bombarded by British warships. Khalid escaped and took refuge at the German consulate, whence he was conveyed to German East Africa. Hamud bin Mohammed was then installed as sultan (Aug. 27, 1896). In 1897 the legal status of slavery was finally abolished, compensation being given to the slave owners, who were mostly Arabs and had mainly employed slave labour on their clove and coconut plantations.

In 1913 the control of the protectorate passed from the foreign office to the colonial office,when the posts of consul general and first minister were merged in that of British resident, who was appointed subject to the control of the governor of the British East Africa protectorate as high commissioner. At the same time a protectorate council was constituted as an advisory body. In 1925 the post of high commissioner was abolished and the British resident was made directly responsible to the colonial office. At the same time the advisory council was replaced by nominated executive and legislative councils.

Khalifa bin Harub (b. 1879) became sultan in 1911. As the leading Moslem prince in east Africa his moderating influence did much to steady Moslem opinion in that part of Africa at times of political crisis, especially during the two world wars. During World War I the most dramatic incident for Zanzibar was the sinking on Sept. 20, 1914, of the British cruiser "Pegasus," while it lay at anchor in Zanzibar roadstead undergoing repairs, by the German cruiser "Königsberg." Though Zanzibar was never a theatre of operations during World War II, many of its inhabitants served with the forces in East Africa and Burma.

SOCIAL CONDITIONS, ADMINISTRATION AND ECONOMY

Population.— The southern and eastern portions of the island are mainly populated by a Bantu-speaking people known as the Wahadimu; the northern part of Zanzibar Island and the adjacent Tumbatu Island are peopled by another Bantu-speaking people known as the Watumbatu. These two groups represent the earliest arrivals in Zanzibar. Throughout the 19th century and after, they have been expropriated from the western and more fertile parts of the island by later arrivals and still tend to keep aloof from the rest of the inhabitants. They are for the most part fishermen. Cattle raising was formerly one of their industries, but of recent years their herds have greatiy diminished. Ropemaking (from coir) is carried on extensively by the Wahadimu women in the southern villages of the island. The remainder of the population is of a very heterogeneous character, including Arabs, Indians, Goans, Europeans, Swahili and representatives of tribes from many parts of east Africa. The census of 1948 showed a population in Zanzibar and Pemba of 264,162, the Arabs 44.560, the Indians 15,892, the Goans less than 700 and the Europeans under 300. The population of Zanzibar Island was 149,575 and that of Pemba 114,587. The only large town is the city of Zanzibar itself, with a population of 45,284.

Education.—During 1950 there were in the protectorate 41 government primary schools. 13 grant-aided schools, two government secondary schools (one for boys and one for girls), one rural middle school (junior secondary), one male teaching-training centre for secondary teachers and two other teaching-training centres for primary schools (one for men and one for women). There are also four small independent schools—the Comorian school and three catering for younger children of various Indian sects. In addition there are several hundred nongovernment Koran schools scattered throughout the island, each a one-teacher one-class school giving purely religious instruction. Girls' schools were not organized until 1927 and at the present time boys attending schools outnumber girls by about 5 to 1. The grant-aided schools include schools managed by the Christian missions operating in the island (the Universities Mission to Central Africa, the Society of the Holy Ghost and the Friends' Industrial).

Administration.—In Sept. 1956 important changes were made in the constitution. A privy council was constituted, which, when so requested by the sultan, tenders advice to him in relation to the exercise of any powers vested in him and the performance of any of his duties, and also performs such other functions as may be prescribed by any law. The privy council consists of the British resident, chief secretary and attorney general and not more than three other persons appointed by the sultan. There is also an executive council presided over by the British resident and comprising four ex-officio members, three nominated official members and three representative members. The legislative council is also presided over by the British resident and comprises 4 ex-officio members, 9 nominated official members and 12 representative members. In May 1957 another change in the constitution provided for six representative members to be elected. The first election was held in July 1957 on a qualitative, all-male franchise, and 90% of the 40,000 voters went to the polls.

In civil matters fundamental law is Moslem law except in so far as the same may be modified or repealed by any law in force Legislation consists of decrees of the sultan, orders in council of the British sovereign and certain English statutes of general application. The sultan's decrees are binding upon all persons when countersigned by the British resident.

Economic Conditions.—The modern development of Zanzibar began at about the time of the first arrival of Said bin Sultan in 1828. Clove cultivation began a few years before that date, but owed its expansion largely to the example and encouragement of Said. In addition the contemporaneous opening up of the interior of Africa provided Zanzibar with a considerable trade in ivory, slaves, cotton goods and rice. Many merchants from India settled in Zanzibar and—apart from the traffic carried on in dhows with Arabia—the trade fell very largely into their hands. Many Arabs who owned clove and other shambas (plantations) failed to adapt themselves to the changed conditions resulting from the abolition of slavery with the result that their shambas passed into other hands. Clove cultivation is at the present time carried on by Africans and Indians as well as Arabs. The protectorate produces more than 80% of the world's supply of cloves, the yearly average export of which for the years 1952–56 amounted to 204,000 centals (100 lb), the area under clove cultivation being about 50,000 ac. The coconut industry ranks next in importance, copra products such as coconut oil, soap and oil cake forming some of the protectorate's main exports. Chilies, coil tobacco, citrus and other fruits also form part of the export trade. Rice is grown on a fairly extensive scale for local consumption. The principal imports are grains, grain products and cotton piece goods. In 1952–56 the yearly average value of imports was £5,272,469 and the yearly average value of exports was £5,242,749. The East African Currency board shilling (of 100 cents) became the standard coin in 1936, replacing the Indian rupee. Indian and South African banks have branches in Zanzibar. Total revenue amounted in 1956 to £2,350,871, including £1,699,628 from customs; total expenditure in the same year was £2,429,044.

Communications.—The port of Zanzibar is well served by British and other European and American shipping companies. The Zanzibar government also maintains a regular steamship service with Pemba and Dar es Salaam Cable service is provided by Cable and Wireless, Ltd., with Europe and southern and eastern Africa. Scheduled air services are operated to and from Zanzibar from and to other places in east Africa. These services connect with such international terminals as Nairobi and Entebbe. There are no railways in the island, but there are 200 mi of road, of which 150 mi. have a bituminous surface.

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ZANZIBAR, an east African seaport, capital of the island and sultanate of the same name. Pop. (1948 census) 45,284. The town is situated on the western side of the island, 26 mi. N.E. of the mainland port of Bagamoyo. Zanzibar is built on a triangular peninsula. about 1½ mi. long, which runs from east to west, forming a safe and spacious roadstead, with a minimum depth of water exceeding five fathoms. In addition to this anchorage, there is a concrete wharf 800 ft. long, capable of berthing ships up to 400 ft. The architecture is mainly Arabic with narrow winding streets, open-fronted shops and many mosques. Characteristic are the massive carved and brass-studded wooden doors, whose blackness contrasts with the white stone of the houses and the bright red of the acacias in the garden enclosures. The Anglican cathedral (built 1873–79), a semi-Gothic coral building, occupies the site of the old slave market, which was closed in 1873 The Roman Catholic cathedral is a fine building in the Renaissance style.

The motley population of Zanzibar—the chief elements are African. Arab and Indian—is indicative of the commercial importance of the city. Its geographical position made it the key of east Africa from Cape Guardafui to Delagoa bay. "When you play on the flute at Zanzibar" (says an Arab proverb) "all Africa as far the lakes dances." The Americans were the first among white merchants to realize the possibilities of the port, and a United States consulate was established as early as 1836.

ZAPARAN, a group of tribes of South American Indians forming an independent linguistic stock. The Zaparos live in the region of the Peruvian-Ecuadorian border, on the Curaray and Napo rivers and the lower Aguarico. They are a tall, robust people. rather light in skin colour, with prominent noses and are said sometimes to have blue eyes. The men wear a tree-bast poncholike garment, ornamented with painted designs. The women wear only a small fringed apron. Their houses are merely thatched shelters with no sides. Their weapons are bows, spears and blowguns, poison being used on the darts for the latter and for their arrows. They depend mainly on hunting and fishing for food, although growing some sweet potatoes and bananas.

ZAPOROZHE (formerly ALEXANDROVSK), a town of the Ukrainian Soviet Socialist Republic, in 47° 51′ N., 35° 10′ E., on the left bank of the Dnieper river. Pop. (1956 est.) 381,000. Its name means "beyond the rapids," and it is situated south of the falls on which the Dnepropetrovsk hydraulic station was constructed. Factories produce agricultural machinery; the town is also a railway junction.

Zaporozhe is opposite to Khortitsa Island, a former camp of the Zaporozhian Cossacks and kurgans (tumuli) are numerous in the district. Zaporozhe was captured by Germany in 1941 and was retaken by Soviet troops in 1943.

ZARAGOZA, an inland province of northern Spain, one of the three into which Aragon was divided in 1833; bounded on the north by Logrofio and Navarre, northeast and east by Huesca, southeast by Lérida and Tarragona, south by Teruel and Guadalajara and west by Soria. Pop. (1950) 609,393; area, 6,608 sq.mi. Zaragoza belongs wholly to the basin of the Ebro (*q.v.*). The main valley is bounded on the southwest by the Sierra de Moncayo (with the highest elevation 7,707 ft.).

Zaragoza is traversed by the Ebro Valley railway, which connects Miranda with Lérida, Barcelona and Tarragona, and has a branch to Huesca; it also communicates via Calatayud with Madrid and Sagunto; and there are local lines to Carifiena (southwest from Saragossa) and to Tarazona and Borja (near the right bank of the Ebro). The only towns with over 5,000 inhabitants (mun. pop. 1950) are Saragossa (*q.v.*) (244,015); Calatayud (18.318); Tarazona (11,988). an episcopal see. with a curious 13th-century cathedral; Caspe (10,128); Ejea (8,729); Tauste (6,565); Épila (5.462); and Alagón (5,484). *See* also ARAGON.

ZARATHUSTRA: *see* ZOROASTER.

ZARIA, a province occupying a central position in the Northern region of Nigeria. It has an area of 17,642 sq mi and a population (1960 est.) of 1,000,505. The greater part of the province is open savanna or orchard bush which becomes denser in the south. The gently rolling landscape is broken by massive outcroppings of rock. It is drained by the Kaduna river and its tributaries. The rainy season lasts from May until the end of October, with the average rainfall being about 45 in.

The chief town is the old walled city of Zaria (pop. [1960 est.] 37,400 Africans), the capital of the province. Outside the remains of the walls of the old city has grown up a new town housing a trading area and settlers from other parts of Nigeria. Another town of growing importance is Zonkwa from which the southern part of the province is administered. The province consists of an emirate and four small independent districts. The emir rules through district heads and is advised by a native council and a British resident. Most of the people are Hausa-speaking farmers. Kaduna, the capital of the Northern region, was made a separate enclave in 1956 and is administered separately.

The principal crops are guinea corn, millets, ginger, cotton and peanuts. Tobacco is on the increase and there is a flourishing sugar-crushing industry. There is tin mining at Xnchau in the east and at Kwoi and Kagoro in the southeast.

Zaria has become the centre for many of the regional educational institutions such as the Institute of Administration, the pharmacy school, the agricultural school and the North Regional Literature agency. The Nigeria College of Arts, Science and Technology has been built near the city, and the imposing offices of the Gaskiya corporation, founded to supply educational reading matter to the Northern peoples, lie outside the walls.

The ancient state of Zaria, called Zazau or Zegzeg by the historians of the middle ages, was one of the original seven Hausa states. At later periods it submitted in turn to Kano, Sonrhai (Songhai) and Bornu. At the end of the 18th century it was an independent state under its own Habe Mohammedan rulers but like the rest of northern Hausaland it was conquered by the Fulani during their jihad and a Fulani emir was installed in 1804. Zaria was brought under British administration in 1902.

ZARLINO, GIOSEFFO (1517–1590), Italian musical theorist, surnamed from his birthplace ZARLINUS CLODIENSIS. was born at Chioggia, Venetia, in 1517. Studying in his youth for the church, he was admitted to the minor orders in 1539 and ordained deacon in 1541 at Venice; but he soon devoted himself entirely to the study of music under the guidance of Adrian Willaert. then choirmaster at St. Mark's. Though remembered chiefly as the earliest advocate of a system of equal temperament for fretted and keyed instruments and for his invaluable contributions to the theory of music. he was both a practical musician and a composer. His printed works consisted of a volume entitled *Modulationes Sex Vocum* (1j66) and a few motets and madrigals scattered through the collections of Scotto and other contemporary publishers, but he also produced and superintended the public performance of some important pieces in the service of the republic. The only extant example of his compositions on a grand scale is a manuscript mass for four voices. He died at Venice on Feb. 14, or, according to some, Feb. 4, 1590.

Zarlino's first theoretical work was the *Istitutioni Armoniche* (1558). This was followed by the *Dimostrationi Armoniche* (1571) and by the *Sopplimenti Musicali* (1588). Finally, in a complete edition of his works published shortly before his death Zarlino reprinted these three treatises, accompanied by a *Tract on Patience*, a *Discourse on the True Date of the Crucifixion of Our Lord*, an essay on *The Origin of the Capuchins*, and the *Resolution of Some Doubts Concerning the Correction of the Julian Calendar* (1589).

The *Istitutioni* and *Dimostrationi Armoniche* deal, like most other theoretical works of the period, with the whole science of music as it was understood in the 16th century. The earlier chapters, treating chiefly of the arithmetical foundations of the science, differ but little in their line of argument from the principles laid down by Pietro Aron, Zacconi and other early writers of the Boeotian school; but in book ii of the *Istitutioni* Zarlino boldly attacks the false system of tonality to which the proportions of the Pythagorean tetrachord, if strictly carried out in practice, must inevitably lead. Again. Zarlino was in advance of his age in his classification of the ecclesiastical modes. These scales were not wholly abolished in favour of modern tonality in the 17th century. Eight of them, it is true, fell into disuse; but the medieval Ionian and Hypoionian modes are absolutely identical with the modem natural scale of C; and the Aeolian and Hypoaeolian modes differ from the minor scale, not in constitution, but in treatment only. Medieval composers, however, regarded the Ionian mode as the least perfect of the series and placed it last in order. Zarlino thought differently and made it the first mode, changing all the others to accord with it. His numerical table, therefore, differs from all others made before or since, prophetically assigning the place of honour to the one ancient scale now recognized as the foundation of the modern tonal system.

These innovations were violently opposed by the apostles of the monodic school. Vincenzo Galilei led the attack in a tract entitled *Discorso Intorno alle Opere di Messer Gioseffe Zarlino*, and followed it up in his famous *Dialogo*, defending the Pythagorean system in very unmeasured language. It was in answer to these strictures that Zarlino published his *Sopplementi*.

ZAUSCHNERIA, a genus of North American plants of the evening-primrose family (Onagraceae, *q.v.*), comprising several species native to California and adjacent Mexico. They are low, slightly shrubby perennials, with small narrow or ovate leaves and large, scarlet, fuchsialike flowers. *Z. californica*, known as California fuchsia and Mexican balsamea, is planted in flower gardens.

ZEALAND (Dan. *Sjaelland*), the largest island of the kingdom of Denmark 2,709 sq.mi. in area, lying between Fyn (11 mi. distant) on the west, and southern Sweden (only 3 mi. distant at the sound) on the east. The surface is undulating, but little above sea level, and the outline very irregular. On the island are the old cathedral city of Roskilde, the Danish capital, Copenhagen, and the historic port of Helsingor (Elsinore).

Pop. (1960) 1,771,537. *See* DENMARK.

ZEAMI (SEAMI) **MOTOKIYO** (1363–1443), the greatest playaright, critic and actor of the Japanese nō theatre. The son of the almost equally celebrated dramatist KANAMI KIYOTSUGU (1333–84), he first attracted attention when at the age of 11 he performed before the shogun Yoshimitsu at the Imakumano shrine in Kyōto. Yoshimitsu was so captivated by the youthful Zeami that he extended his patronage to the nō, and this shogunate connection (which was maintained for 500 years) enabled the no to shake off the crudities of its past and to develop as a complex and aristocratic theatre.

After his father's death in 1384, Zeami became the chief figure in the nō. He not only continued to perform brilliantly but wrote about 200 plays, 124 of which have remained in the nō repertory. In his later years Zeami's concern over the future of the nō moved him to write for the guidance of later men a number of treatises on the "secrets" of the medium. His old age was darkened by the death of his son and intended successor. and by his exile to the island of Sado imposed in 1434 (for reasons now unknown) by the tyrannous shogun Toshinori. Zeami returned to Kyoto at the end of his life, probably after Yoshinori's death in 1441.

Zeami's success as a dramatist was closely linked to his career on the stage. The rigorous discipline he later prescribed for nō actors in such works as Kadensho (1400–02) and *Shikadōsho* ("Book of the Way of the Highest Flower." 1420) doubtless reflects the 'training he himself received. The actor, Zeami said. must master three basic roles — the warrior, the woman and the old person, including the singing and dancing appropriate to each. The proper training can enable him to display high and higher "flowers" of acting artistry, until he reaches complete mastery. The two main elements in nō acting were *monomane* and *yūgen. Monomane* meant "an imitation of things" and was the representational aspect of the nō. An actor portraying a demon, for example, had to seem convincingly demoniacal. Honever, *yūgen,* the symbolic aspect of the nō, not only took precedence over the requirements of *monomane,* but became the touchstone of excellence in the nō. Zeami wrote, "The essence of *yūgen* is true beauty and gentleness." He described in various essays how these might be achieved, but the final object of *yūgen* was not mere outward beauty. It had to suggest behind the text of the plays and the noble gestures of the actors a world impossible to define yet ultimately real. Such plays as the lovely *Matsukaze* have a mysterious stillness that seems to envelop the visible or audible parts of the work. In others of Zeami's dramas there is less *yūgen* and more action, and occasionally even realism.

Zeami wrote his plays bearing in mind the ability of the actors of his day and the tastes of his audiences. On occasion he would freely revise his father's or his own earlier works to make them fit changed conditions. However, so great did Zeami's prestige become that later actors hesitated to alter a word of his texts, resulting in the fossilized state of the nō in later centuries.

See also Nō Drama.

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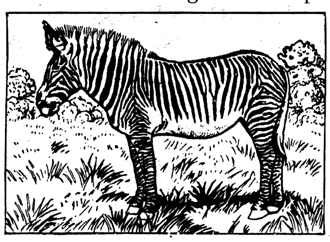
ZEBRA, the name for the African striped members of the horse tribe. The true or mountain zebra (*Equus* zebra) maintains a precarious foothold in the mountainous region of Cape Colony and also inhabits Angola. It stands about 4 ft. at the shoulder. with fairly long ears, a tail scantily clothed with hair, and a short mane. The ground colour is white and the stripes, absent only on the abdomen and inside of the thighs, are black. The lower part of the face is brown. The stripes on the haunch do not reach the median dorsal stripe and there are a number of transverse short stripes on each side of the midline. These are absent in Burchell's zebra (E. *burchelli*), which has broader stripes, often with shadow stripes between them. The typical race is extinct. but other races of this species are common from the Transvaal to Uganda. The ground colour is pale buff. the stripes, which in the southern race do not extend to the lower limbs. dark brown or black.



Grevy's zebra (Equus grevyi) distinguished by its numerous stripes and asslike ears

The East African race (*E.b. boemi*) has the lower parts striped and shadow stripes are usually lacking. The closely related quagga (*q.v.*) is extinct. Grévy's zebra (E. *grevyi*) of Somaliland. northern Kenya and parts of Ethiopia. is distinguished by its long head, large ears and numerous narrow stripes. Zebras occur in large herds and are preyed upon chiefly by lions. They have been crossed with the domestic horse but the resultant hybrid is not as valuable as the horse, mule and ass.

Fossil horses. with teeth closely resembling those of zebras, have been found in the Pleistocene of North America. (*See* Horse; Equidae.) (J. E. Hl.)

ZEBU (Bos *indicus*), an Indian species of ox, characterized by light colour and a hump. The sacred bulls of India belong to this species. which is used for draught work, and supplies milk. In many places it is crossed with domestic cattle.

(See Cattle.)

ZEBULUN (Zebulon; in the Douai version of the Bible, Zabulon), a tribe of Israel, named after the sixth son borne by Leah to Jacob (Gen. xxx. 20). The fertile territory occupied by the tribe lay roughly northeast of the plain of Jezreel. The somewhat obscure text of Gen. xlix, 13 seems to imply that at one time Zebulun extended to the seacoast and marched with Phoenician territory. The tribe appears to have furnished valiant warriors, and receives special mention in the Song of Deborah for its martial exploits (Judg. v, 14, 18).

See Twelve Tribes of Israel.

ZECHARIAH, the eleventh in order of the minor prophets of the Old Testament. He was associated with Haggai (*q.v.*) in stimulating the rebuilding of the temple at Jerusalem, begun in 520 (Ezra iv, 24) and completed in 516. A previous attempt made by returned exiles in 537 seems to have been checked by local opposition and not renewed because of economic pressure.

In 520, however. the political disturbances of the Persian empire (of which the Jewish community in Palestine was a negligible part) were interpreted by these two prophets as a sign that the Messianic expectations were now to be realized. and that the "Day of Yahweh" was at hand. Haggai gave the first impulse to the new attempt; two months later! Zechariah joined him in encouraging the fainthearted. His prophecies, exactly dated in 520 (i, 1. 7) and 518 (vii. 1), are to be found in the first eight chapters of the book now bearing his name.

Their central feature is a series of night visions (i, 8. iv. 1), intended to show Yahweh's immediate and effective intervention on behalf of His people. They are arranged with literary art in connected sequence, beginning with the vision of horsemen who report that the expected Messianic crisis has not yet come (i, 11. *cf.* Hagg. ii, 21 seq.), and culminating in the vision of Yahweh's war chariots dispatched to execute His vengeance upon the heathen, especially on Babylonia (vi, 8).

The six intervening visions (all the eight are ascribed to a single night) reveal in succession four horns, representing the heathen powers of the four quarters of the earth, cast down by four craftsmen (i. 18–21), a man with a measuring line, whose narrow ideas of the future city are replaced by the conception of a city without walls because of its great extent, to which Yahweh's protection will be a wall of fire (ii, 1–5), the formal acquittal and restoration of Joshua the high priest, representing the community (iii. 1 seq.), the seven-branched lampstand, representing Yahweh's watchful eyes. with two olive trees! representing Joshua and Zerubbabel (iv, 1–14, but see the commentaries), the flying roll which brings its ubiquitous curse on evildoers (thieves and false swearers), and so cleanses the land of moral evil (v, 1–4), the woman carried off in an ephah, representing the removal of guilt (v, 5–11).

These visions are then prefaced by a call to repentance and the promise of forgiveness (i, 2–6), in which Zechariah's appeal to "the former prophets" (like the detail of an interpreting angel in the visions themselves) reminds us that the great prophetic period (8th–6th centuries) lies in the past, and that the conception of revelation itself has lost something of its original simplicity and spontaneity.

The night visions are followed, two years later (vii, 1), by a divine oracle which directs that the fasts kept throughout the exile should now become festivals (viii, 18 seq.). The enquiry which led to the oracle (vii, 3) is made the occasion of warning against the externality of fasting. of appeal for true conduct, and of an idyllic picture of the happiness of the coming Messianic age. In this happy future the prophet expected that Zerubbabel would be the Messiah, and the bringing of an offering of gold and silver from Jews in Babylon led Zechariah to crown him symbolically in the name of Yahweh.

The darkness that falls on Jewish history with the completion of the second temple suggests that these words and deeds may have thrust Zerubbabel into a dangerous political prominence, leading to his removal by the Persian authorities, and the eclipse of Alessianic expectations.

The remainder of the present book of Zechariah (ix–xiv) is of an altogether different character, and is generally admitted to belong to a period later than the Persian (as indeed the direct reference to Greece in ix, 13 implies). This portion of the book is divided by the titles in ix, 1, xii, 1. ("The burden of the word of Yahweh"). into two distinct collections, each of which it seems necessary to divide again, so that there are four groups of prophecies, distinguished by their subject matter.

The first (ix–xi. 3) deals nith the recovery of Palestine by Yahweh's victories over Syria, Phoenicia and Philistia (ix, 1–8), the coming of the Messianic king to the restored and victorious Israel (ix. 9–17), the overthrow of the (foreign) "shepherds" or rulers, and the gathering of exiled Israelites (x, 1–12), closing nith a figurative dirge over the fall of these "shepherds" (xi, 1–3). The second group (xi. 4–17. nith the misplaced xiii. 7–9) describes the rejection of the prophet, representing a worthy shepherd, and the accursed doom of a worthless one, a purified third of the people alone remaining. The third (xii, xiii. 1–6) pictures an attack of the nations upon Jerusalem, in which Judah is first a foe and then a victorious friend to the mother city; this is follovved by elaborate mourning for an unnamed martyr (xii, 10. R. V mg), and the cleansing of Jerusalem from idolatry and prophecy. The fourth division (xiv) describes the delivery of Jerusalem from the heathen, that it may become the metropolis of religion for all the world. The last two of these divisions are of a markedly eschatological character, and even the first two could be so regarded (so Sellin).

These nritings are perhaps the most obscure of the Old Testament, chiefly because there is no sufficient clue to the historical allusions, such as the cutting off of three shepherds in one month (xi. 8), the pierced martyr (xii, 10) and the antagonism of Judah and Jerusalem (xii, 2. xiv, 14). By some scholars these chapters have been brought down as late as the Maccabean age, the events of which are supposed to explain these and other allusions. But the fact is that we are almost nholly ignorant of Jewish history during the earlier part of the Greek period (from 331 B C), to which these writings might equally well belong.

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ZEDEKIAH (Hebrew, "righteous is Yah[weh]"), the name of four figures in the Old Testament, of whom only one, the last king of Judah, is important.

Zedekiah, son of Josiah, succeeded his older brothers Jehoahaz II and Jehoiakim and his nephew Jehoiachin in 598 B.C. (events related in II Kings xxiv, 17–xxv, 26; Jer. xxxix, 4–8, and lii, 1–11; and II Chron. xxxvi, 10–21). The Babylonian Chronicle (see BABYLONIA AND ASSYRIA), which relates the main political and religious events of the 7th and 6th centuries from the Babylonian viewpoint, records the siege of Jerusalem in the 7th year of Nebuchadrezzar (598 B.C.) and the capture of the city in the 2nd day of Adar (March 16) of that year. Its king, Jehoiachin, was captured and carried to Babylon, where he was maintained as a hostage, and Nebuchadrezzar set up in his place Mattaniah, his uncle, with the throne name Zedekiah. Zedekiah held his position as a vassal under an oath of allegiance. but under local pressure he began an intrigue with Moab, Edom, Ammon, Tyre and Sidon which the prophet Jeremiah vigorously denounced (Jer. xxvii et seq.; Ezek. xvii, 11–21).

In the 9th year of Zedekiah, as a result of his conspiracy with Egypt to revolt against the Babylonians, a Babylonian army lay siege to Jerusalem. An Egyptian army came to assist Zedekiah, and there was a temporary withdrawal of the Babylonians, but with the retreat of the Egyptians the siege was renewed. During the siege Jeremiah constantly urged patient submission to the dominion of the Babylonians, which he regarded as an expression of the will of God, but the royal officials and Jewish notables denounced him and demanded his execution for his bad influence on the morale of the people (Jer. xxxviii, 4).

Some Jews deserted to the Babylonians during the siege, and Jeremiah, accused of desertion, was imprisoned. King Zedekiah, though he surreptitiously sought the advice of Jeremiah (Jer. xxxvii, 3 et *seq.*), did not follow the advice because he feared the princes.

After six months of siege a breach was made in the city walls, and Zedekiah and his men fled by night toward the Jordan river, but they were soon captured in the Jordan valley. He and his leaders were taken before King Nebuchadrezzar at Riblah, in Syria, where Zedekiah's sons were slain in his presence, and he, a disloyal vassal, was blinded and carried in chains to Babylon, where he was imprisoned until his death. The walls and houses of unfaithful Jerusalem were destroyed, its temple was sacked and burned and the people, except for the poorest of the land, were deported to Babylon. Judah lost its status as a kingdom and became a Babylonian province under the governor Gedaliah, with a new capital at Mizpah (probably modern Tell en-Nasbeh). (RD. A. B.; X.)

ZEELAND, the most southerly maritime province of the Netherlands, has a remarkable geographical structure. It consists of Zeeuwsch-Vlaanderen. a strip of the Flanders mainland, south of the Westerschelde, bordered by Belgium, and further of six islands: Schouwen-Duiveland, Tholen, North Beveland, Walcheren, South Beveland and St. Philipsland. The latter three are in fact no longer islands but peninsulas since South Beveland and St. Philipsland have been connected with the province of North Brabant, and Walcheren with South Beveland, by dams.

The map of Zeeland has changed continuously. In the middle ages each island consisted of a number of smaller islands. which were gradually increased by alluvial deposition and united by dikes. In the course of the ages there were many inundations, some of which took away substantial areas Significant names are those of the Verdronken (Drowned) Land of South Beveland and of Saaftinge (Refuge) at the eastern ends of the Oosterschelde and Westerschelde respectively. The history of this province is more than that of any of the other ten Dutch provinces marked by the permanent struggle against the waves, which is indicated by the heraldic device of Zeeland: Luctor et *emergo* ("I struggle and I emerge").

With the exception of small parts of the western coast, which have dunes, all the isles and also Zeeuwsch-Vlaanderen—for the greater part lying below sea level—are protected against the sea by artificial dikes, with a total length of about 250 mi. In spite of that the province was struck very seriously by the big flood disaster of Feb. 1, 1953, which caused the death of more than 1,800 people and enormous material damage. In order to avoid a repetition of the disaster in the future the Dutch government started the execution of the Delta plan (see LAND RECLAMATION), that included the construction of big enclosing dams of the sea channels Haringvliet, Brounershavensche Gat and Oosterschelde. By this big project not only the geographical structure of Zeeland would change again, but also the economic and social conditions would be influenced considerably as the construction of the new dikes mould make it possible to trace new roads from central Holland (especially from Rotterdam) to the isles that were rather isolated before.

Zeeland is 653 sq.mi. in area, the smallest Dutch province but one. With regard to the number of inhabitants (1957 est.) it is the smallest. There were not many industries, no large towns. Municipal estimates (1957) made Vlissingen (Flushing), with 28,148 inhabitants, the largest; it had an important shipbuilding industry. The capital of the province is Middelburg (pop. 21,968). Goes (14,353), chief town of South Beveland, with its well-known. horticultural auction, was developing rapidly into an important centre of trade and commerce. Tholen (3,289) and the old town of Zierikzee (7,223) are the market centres of Tholen and Schouwen-Duiveland respectively. Terneuzen (14,666), in Zeeuwsch-Vlaanderen at the end of the canal from Ghent to the Westerschelde, was a growing industrial centre. In this part of Zeeland there were also glass, metal and chemical industries at Sas van Gent (4,114). The textile industry should be mentioned especially for the eastern part of Zeeuwsch-Vlaanderen with Hulst

(4,930) as the main seat.

Agriculture in Zeeland is important. Of the cultivated land, mainly consisting of sea-clay soils, the greater part (73%) is used for arable farming, 23% for grassland and 4% for horticulture. In general the farmers are far advanced with mechanization and methods for manuring and weed control. Yields per acre are high. A large variety of crops is grown: cereals (wheat, barley, oats), potatoes (for both consumption and seed), sugar beet and other cash crops, such as flax (especially in Zeeuwsch-Vlaanderen), rape seed, maw seed, caraway, etc. An intensive kind of crop growing is that of onions. Well known are the strong horses of Zeeland used in agriculture. Pedigree draft-horse breeding is held in esteem.

Fruit farming is of great importance in particular on South Beveland, known as "Zeeland's fruit garden."

Considerable changes occurred in the islands of Walcheren and Schouwen-Duiveland after the inundation of World War II and by the flood disaster of 1953. In both areas, after the repairing of the dikes, a total rural reconstruction was carried out. An extensive land reallocation scheme was applied, new roads were laid, destroyed farmhouses were rebuilt at more adequate spots near the farmland and drainage systems were improved. A number of farmers from Zeeland settled in the Northeastern Polder of the Zuider Zee reclamation scheme; the land they left was used to enlarge other small farms. The result of all these measures was that agriculture on these two islands was thoroughly rationalized.

As regards fisheries, the oyster breeding and mussel culture should be mentioned in the first place. The chief centre is Yerseke. This means of subsistence was seriously threatened by the Delta plan, since the sea channels where the mollusks had been bred would contain fresh water after the execution of the plan. Other fishing villages are Bruinisse, Philippine, Terneuzen and Hontenisse. Seaside resorts with pleasant surroundings in the dunes are Renesse, Haamstede and Burgh on Schouwen, Domburg on Walcheren and Cadzand in Zeeuwsch-Vlaanderen. The only railway in Zeeland runs from Roosendaal (North Brabant) through South Beveland to Middelburg and Flushing on Walcheren. Ferry-boats connect many different parts of Zeeland.

Archaic customs and costumes as well as a conservative religious outlook are preserved. (C. A. P. T.)

ZEEMAN, PIETER (1865–1943), Dutch physicist awarded the Nobel prize for physics in 1902 with Hendrik Antoon Lorentz for work on the influence of magnetism on radiation, was born at Zonnemaire, Zeeland, on May 25, 1865. He studied at Leiden, where he taught from 1890 to 1900. In 1900 he was appointed professor of physics at Amsterdam, and in 1908 director of the Physical institute in that city.

Zeeman's best-known work in physics is the so-called Zeeman effect (*q.v.*), the splitting up of spectral lines in a magnetic field, which he discovered in 1896. The theoretical explanation was first given by Lorentz soon after the effect was observed. This phenomenon was used by astronomers for the detection of magnetic effects at the surface of the sun. Later Zeeman worked on the propagation of light in moving media, making observations in water, quartz and flint.

Zeeman died in Amsterdam on Oct. 9, 1943.

ZEEMAN EFFECT is the phenomenon observed in spectroscopy (*q v.*) when light sources are operated in magnetic fields. In 1896 Pieter Zeeman (*q.v.*) placed a sodium flame between the poles of a powerful electromagnet and observed in a large grating spectroscope that the bright yellow, lines were broadened when the magnet was animated. H. A. Lorentz immediately predicted from his electron theory of matter and radiation that the light should be polarized by the magnetic field. and Zeeman found that the outside edges of the widened images were indeed polarized. According to the simple classical theory an observer receiving light perpendicular to the field of force sees a central component polarized parallel to the field and on either side a component polarized perpendicular to the field (Lorentz triplet, fig. 1b); whereas if he looks along the field through a hole bored in one of the poles, the central image vanishes and the two lateral components are circularly polarized in opposite directions (fig. 1c).

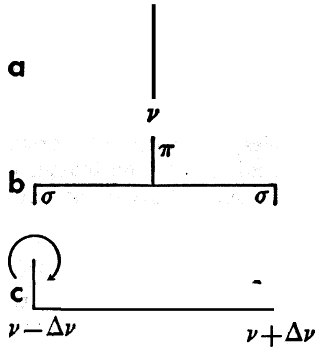


FIG. 1.—NORMAL ZEEMAN EFFECT. (A) UNDISPLACED SPECTRAL LINE: (B) TRANSVERSE ZEEMAN EFFECT, π = PARALLEL POLARIZATION, σ = PERPENDICULAR POLARIZATION; (C) LONGITUDINAL ZEEMAN EFFECT, CIRCULAR POLARIZATION

Observation perpendicular to the field is preferred since this shows all the components and avoids distortion of the magnetic field which occurs when a pole piece is drilled. Without an analyzer the two kinds of plane polarized components are indistinguishable, but with a Nicol (calcite) prism between the source and the spectroscope either kind may be transmitted separately, and with a M'ollaston (quartz) prism both can be viewed simultaneously, vertically separated. The components having electric vectors parallel to the magnetic field are called a components, and those with electric vectors perpendicular to the field are called a components (from senkrecht).

In a Lorentz triplet the frequency displacement Av of either a component from the π component, or from the no-field position of the spectral line, is proportional to the strength of the magnetic field, and in frequency units it is

$$\Delta\nu=\frac{e}{m}\cdot\frac{H}{4\pi c}$$

where e is the electronic charge (in electrostatic units), m is the mass of the electron (grams), c is the velocity of light (centimetres per second) and H is the magnetic force in oersteds. Since spectroscopists work with wave lengths λ, and convert these to wave numbers ($\text{cm.}^{-1}=\frac{1}{\lambda_{\text{vac}}}$) rather than to frequencies v, and since $\frac{1}{\lambda_{\text{vac}}}=\frac{\nu}{c}$, this displacement expressed in wave numbers equals $\frac{e}{m}\cdot\frac{H}{4\pi c^2}=4.67\times10^{-5}H\ \text{cm.}^{-1}=\text{L}\ \text{cm.}^{-1}$, which is called the Lorentz unit.

Simple Lorentz triplets were promptly observed in the spectra of cadmium and zinc; their measurement, together with a determination of H, yielded a value for the ratio of electronic charge to mass e/m in agreement with that obtained from the deflection of cathode rays, and indicated that atomic spectral radiation involved the motion of negatively charged electrons.

However, within a year, further experiments by Zeeman and others disclosed that the Zeeman effect was much more complicated than was first assumed. Relatively few spectral lines (only those arising from transitions between singlet spectral terms) were found to exhibit the simple Lorentz triplet; all others had either greater or smaller displacements and usually a larger number of components. For example, the sodium lines, 5890 A and 5896 A, which Zeeman first observed as widened by magnetic force, when fully resolved showed six and four components, respectively. The first class (Lorentz triplet) was said to exemplify the normal Zeeman effect, and the second class the anomalous Zeeman effect. Typical magnetic splittings of spectral lines are shown in fig. 2 in conventional manner with π components above a horizontal line and a components below, the lengths of the vertical lines being proportional to the intensities. All attempts to account for the anomalous Zecman effect by classical electromagnetic theory failed, and a quarter of a century passed before an explanation was found in quantum theory.

In the meantime the discovery of two empirical rules (T. Preston's and C D T Runge's) concerning types and structures of Zeeman patterns contributed toward a solution of the problem. In 1898 T Preston found that two lines exhibit the same Zeeman pattern if they belong to the same spectral series, or if they are members of different series (*e.g.*, principal and sharp) which arise from similar term combinations. or if they belong to analogous series occurring in different spectra. For instance. any $^2S_{\frac{1}{2}}-{}^2P^\circ_{\frac{3}{2}}$

line of sodium shows the same Zeeman pattern as any $^2P^\circ_{\frac{3}{2}}-{}^2S_{\frac{1}{2}}$ line of sodium or of any other one-electron spectrum. In terms of the vector model of the atom (see SPECTROSCOPY) Preston's rule means that the Zeeman type is a function of the L, S and J vectors of the two combining terms, but not of the principal quantum number n (shell) nor of the inner electron groups or atomic number Z.

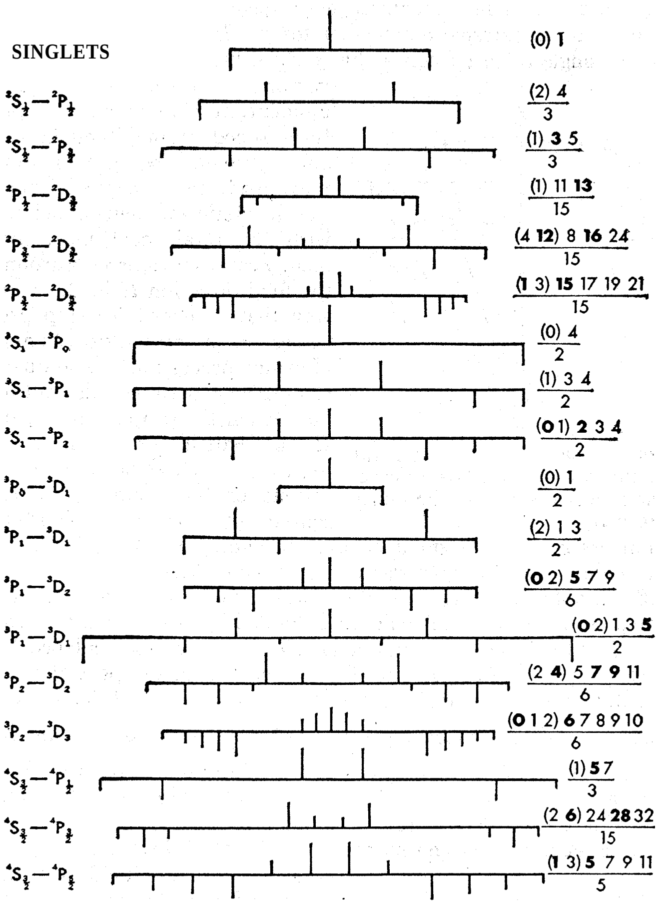


FIG. 2.—TYPICAL ZEEMAN PATTERNS OF SINGLET, DOUBLET. TRIPLET AND OUARTET COMBINATIONS

Because the displacements of the Zeeman components depend on the strength of the magnetic field, they are conveniently expressed in Lorentz units which vary with the field. In 1907 C. Runge expressed anomalous Zeeman patterns in Lorentz units and announced that all known patterns could be represented as rational multiples of the normal triplet separations. Thus, the observed displacements of the n- and σ components are, respectively, $+\$$ and $+^{*}$ Lorentz unit for $^2S_{\frac{1}{2}}-{}^2P^\circ_{\frac{1}{2}}$ (*e.g.*, sodium 5,896 A), whereas they are $\pm\frac{1}{3}$ and $\pm\frac{3}{3}$, $\pm\frac{5}{3}$ Lorentz unit for $^2S_{\frac{1}{2}}-{}^2P^\circ_{\frac{3}{2}}$ (*e.g.*, sodium 5,890 A). The conventional abbreviations for these patterns are $\frac{(2)\ 4}{3}$ and $\frac{(1)\ \mathbf{3},\ 5}{3}$ Lorentz unit (*see* fig. 2). Examples of other Zeeman types with their proper Runge fractions are shown in fig. 2, the n- components being enclosed in parentheses and the strongest components printed boldface. Runge's and Preston's rules had great heuristic value In that they permitted a comparison of the anomalous patterns nith each other and a correlation with spectral-term quantum numbers, thus leading to the discovery of simple relationships.

Since the multiplet structure of atomic spectra was ascribed to a splitting of spectral terms (*see* SPECTROSCOPY), it was natural to assume that Zeeman patterns represented a magnetic splitting of atomic energy levels. In order to distinguish the individual magnetic levels it was necessary to invent a magnetic quantum number M, analogous to the inner quantum number J which differentiates the levels of polyfold spectral terms. Successive values of M were assumed to'differ by unity and to range from $-J$ to $+J$. The same selection rule was assumed to govern combinations of M as govern those of J ; viz., $\Delta M=0, \pm 1$ (barring o to o). Finally, combinations $\Delta M=0$ always represent n-components and $\Delta M=\pm 1$ yield u components. Having these simple rules in mind, A. Landé saw how any Zeeman pattern could be arithmetically derived from the magnetic quantum numbers M, and the magnetic splitting factors g, appropriate to each type of atomic energy level. For example, if $g=2$ for $^2S_{\frac{1}{2}}$ and $g=\frac{4}{3}$ for $^2P^\circ_{\frac{3}{2}}$ the Zeeman pattern for $^2S_{\frac{1}{2}}-{}^2P^\circ_{\frac{3}{2}}$ is derived directly from the vertical and diagonal differences of gM products as follows:

M values	$-\frac{3}{2}$	$-\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{2}$
gM for $^2S_{\frac{1}{2}}$		-1	1	
gM for $^2P^\circ_{\frac{3}{2}}$	$-\frac{6}{3}$	$-\frac{2}{3}$	$\frac{2}{3}$	$\frac{6}{3}$
Zeeman components	$-\frac{5}{3}$ $-\frac{3}{3}$ $(-\frac{1}{3})$		$(\frac{1}{3})$ $\frac{3}{3}$ $\frac{5}{3}$	
Zeeman type	$\frac{(1)\ \mathbf{3},\ 5}{3}$			

Similarly, if $g=\frac{3}{2}$ for $^3P_2$ and $g=\frac{7}{6}$ for $^3D_2$, the empirical rules yield the observed Zeeman pattern for $^3P_2-{}^3D_2$:

M values	-2	-1	0	1	2
gM for	$-\frac{6}{2}$	$-\frac{3}{2}$	0	$\frac{3}{2}$	$\frac{6}{2}$
gM for $^3D_2$	$-\frac{14}{6}$	$-\frac{7}{6}$	0	$\frac{7}{6}$	$\frac{14}{6}$
Zeeman components	$-\frac{11}{6}$ $-\frac{9}{6}$ $-\frac{7}{6}$ $-\frac{5}{6}$ $(-\frac{4}{6})$ $(-\frac{2}{6})$ $(\frac{2}{6})$ $(\frac{4}{6})$ $\frac{5}{6}$ $\frac{7}{6}$ $\frac{9}{6}$ $\frac{11}{6}$				
Zeeman type	$\frac{(2,\ \mathbf{4})\ 5,\ \mathbf{7},\ \mathbf{9},\ 11}{6}$				

A comparison of such arrow schemes with observed Zeeman patterns led Landé to the following qualitative intensity rules for Zeeman components. If the J values of the combining terms are unequal, the vertical differences in the middle of the scheme and the diagonal differences at the ends give, respectively, the strongest π and σ components. If the J values are equal, the vertical differences at the end of the scheme and the diagonal differences at the centre give, respectively, the strongest π and σ components, except that for terms of odd multiplicity the intensity is zero for the transition $M=0$ to $M=0$. (*See* fig. 2.)

By an inductive process based upon empirical g values of certain terms Landé found a general formula expressing g as a function of the quantum numbers that specify spectral terms. This formula was found to hold for all types and multiplicities (assuming LS coupling of electrons); expressed in standardized notation it is

$$g = 1 + \frac{J(J+1) + S(S+1) - L(L+1)}{2J(J+1)}$$

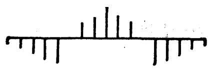
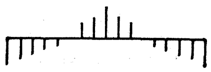
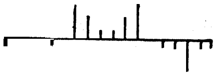
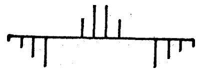
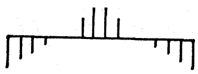
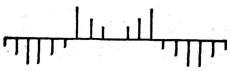
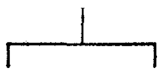
Some g values characteristic of atomic energy levels are shown in Table I. Instead of showing the simplest form in every case, the fractions in each vertical column have all been converted to the same common denominator for the reason that inspection of this table shows simple progressive differences between the numerators and denominators of the g's in vertical. horizontal and diagonal rows, thus facilitating extension of the table to larger L values (up to 12 are possible) and to higher multiplicities (up to 11 are possible) without recourse to the formula.

The g formula makes g indeterminate when $J=0$ but gM is actually zero in these cases since $M=0$. The transition $^5D_0-{}^5F_1$ is of special interest since g=o for both levels and consequently spectral lines resulting from this combination are unique in being unaffected by a magnetic field. This empirical formulation of the Zeeman effect by Landé in 1923 arbitrarily required half-integral J values for levels of even multiplicity, and indicated (except for singlets) $g=2$ for all S terms. In 1925 S. Goudsmit and G E. Uhlenbeck showed that these requirements could be explained by postulating that an electron possessed a mechanical

TABLE I.—*Magnetic Splitting Factors (g) of Spectral Terms*

L \ J	0	1	2	3	4	5	6	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{5}{2}$	$\frac{7}{2}$	$\frac{9}{2}$	$\frac{11}{2}$	Term
	singlets ($S=0$)							doublets ($S=\frac{1}{2}$)						
0	$\frac{0}{0}$							$\frac{6}{3}$						S
1		$\frac{2}{2}$						$\frac{2}{3}$	$\frac{20}{15}$					P
2			$\frac{6}{6}$						$\frac{12}{15}$	$\frac{42}{35}$				D
3				$\frac{12}{12}$						$\frac{30}{35}$	$\frac{72}{63}$			F
4					$\frac{20}{20}$						$\frac{56}{63}$	$\frac{110}{99}$		G
	triplets ($S=1$)							quartets ($S=\frac{3}{2}$)						
0		$\frac{4}{2}$							$\frac{30}{15}$					S
1	$\frac{0}{0}$	$\frac{3}{2}$	$\frac{9}{6}$					$\frac{8}{3}$	$\frac{26}{15}$	$\frac{56}{35}$				P
2		$\frac{1}{2}$	$\frac{7}{6}$	$\frac{16}{12}$				$\frac{0}{3}$	$\frac{18}{15}$	$\frac{48}{35}$	$\frac{90}{63}$			D
3			$\frac{4}{6}$	$\frac{13}{12}$	$\frac{25}{20}$				$\frac{6}{15}$	$\frac{36}{35}$	$\frac{78}{63}$	$\frac{132}{99}$		F
4				$\frac{9}{12}$	$\frac{21}{20}$	$\frac{36}{30}$				$\frac{20}{35}$	$\frac{62}{63}$	$\frac{116}{99}$	$\frac{182}{143}$	G
	quintets ($S=2$)							sextets ($S=\frac{5}{2}$)						
0			$\frac{12}{6}$							$\frac{70}{35}$				S
1		$\frac{5}{2}$	$\frac{11}{6}$	$\frac{20}{12}$					$\frac{36}{15}$	$\frac{66}{35}$	$\frac{108}{63}$			P
2	$\frac{0}{0}$	$\frac{3}{2}$	$\frac{9}{6}$	$\frac{18}{12}$	$\frac{30}{20}$			$\frac{10}{3}$	$\frac{28}{15}$	$\frac{58}{35}$	$\frac{100}{63}$	$\frac{154}{99}$		D
3		$\frac{0}{2}$	$\frac{6}{6}$	$\frac{15}{12}$	$\frac{27}{20}$	$\frac{42}{30}$		$-\frac{2}{3}$	$\frac{16}{15}$	$\frac{46}{35}$	$\frac{88}{63}$	$\frac{142}{99}$	$\frac{208}{143}$	F
4			$\frac{2}{6}$	$\frac{11}{12}$	$\frac{23}{20}$	$\frac{38}{30}$	$\frac{56}{42}$		$\frac{0}{15}$	$\frac{30}{35}$	$\frac{72}{63}$	$\frac{126}{99}$	$\frac{192}{143}$	G

TABLE II —*Basic Types of Zeeman Patterns*

Type	Multiplicity	J and g	Appearance
1	odd	$J_x>J_y$, $g_x<g_y$	
2	odd	$J_x>J_y$, $g_x>g_y$	
3	odd	$J_x=J_y$, $g_x\neq g_y$	
4	even	$J_x>J_y$, $g_x<g_y$	
5	even	$J_x>J_y$, $g_x>g_y$	
6	even	$J_x=J_y$, $g_x\neq g_y$	
7a	odd	$J_x>J_y$, $g_x \gtrless g_y$	
		$J_y=0$	limiting case of types 1 and 2
7b	odd or even	$g_x=g_y$	limiting case of types 1, 2, 3, 4, 5, 6

moment of $\frac{1}{2}h/2\pi$ and a magnetic moment of $-\frac{e}{2mc}\cdot h/2\pi$; *i.e.*, twice that given by classical theory. These results were thereupon derived theoretically from quantum mechanics.

At first sight it appears that the variety of g values corresponding to J and L values in systems of different multiplicity would entail almost an infinite variety of Zeeman patterns. However, Back and Landé showed that on the basis of intensity relations among n and *a* components all Zeeman patterns could be reduced to seven basic types which are summarized in Table II, where x and y distinguish the two combining spectral terms.

According to the elementary principles of quantum mechanics (*q.v*), an atom in a magnetic field behaves like a spinning top subject to an external moment of force. In the case of an atom with a single valence electron, fig. 3, the orbital angular momentum vector l and the axial angular momentum s precess with uniform speed around their resultant vector j. When this atom finds itself in a magnetic field, the magnetic moment associated with the total mechanical moment j causes it to precess around the field direction H in the same way that a mechanical top precesses in a gravitational field (Larmor precession). The quantum theory permits this motion only when the projection of j on H takes half-integral values from $-j$ to $+j$. These discrete orientations of the atom are represented by magnetic quantum numbers m, and the small changes in energy resulting from the magnetic precession give rise to the various Zeeman levels. The difficulty of visualizing the motions when two or more electrons are collaborating can be conveniently removed by postulating that the l, s, j and m vectors of individual electrons may be replaced by their resultants. L, S, J and M. For each type of spectral term the permitted number of Zeeman levels, $2J+1$, is always determined by the total mechanical moment $J\frac{h}{2\pi}$ of the atom, but the separation of these Zeeman levels is determined by the field strength H and the magnetic moment which are implicitly contained in the Landé g factor. (See fig. 4.)

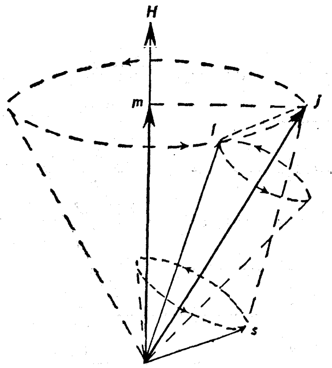


FIG. 3.— PRECESSION OF THE TOTAL ANGULAR MOMENTUM j OF AN ELECTRON IN AN EXTERNAL MAGNETIC FIELD H

The Zeeman effect (normal or anomalous) is observed when the external magnetic field is weak compared with the internal fields because of the spins and orbital motions of the electrons. When the external field is much greater than these internal fields the internal motions are greatly perturbed and the Zeeman effect is transformed into the Paschen-Back effect. The latter effect was discovered experimentally in *1912* by F. Paschen and E. Back who found that close doublets and triplets which were expected to exhibit the anomalous Zeeman effect actually gave normal (Lorentz) triplets in strong magnetic fields.

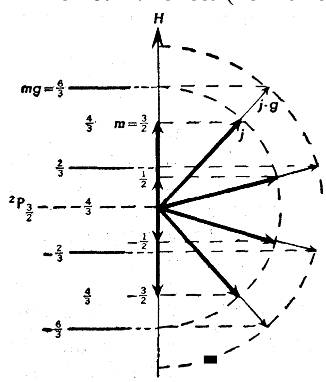


FIG 4.— QUANTIZED VECTOR DIAGRAM OF AN ATOM SHOWING HOW A MAGNETIC FIELD H SPLITS THE $^2P_{\frac{3}{2}}$ LEVEL INTO FOUR ($=2J+1$) ZEEMAN LEVELS, mg, SEPARATED BY $\frac{4}{3}$ LORENTZ UNIT

Just as the multiplet fine-structure separations (caused by electron spin) are a measure of the frequency with which L and S precess around their resultant J, so the Zeeman separations of the individual energy levels (J values) in a weak magnetic field are a measure of the frequency with which J precesses around H. For the Zeeman effect the first precession is much farter than the second, but when the second becomes much faster than the first, L and S are uncoupled, J becomes meaningless and the Paschen-Back effect is produced. In other words, the Paschen-Back triplet replaces the anomalous Zeeman effect of lines composing a multiplet when the magnetic splitting is much greater than the no-field fine structure in a spectrum. External fields of magnetic force must not be regarded as weak or strong in the absolute sense, but only relative to internal fields of the atom. The external field is weak if the Zeeman splitting is small compared with the multiplet (*e.g.,* doublet, triplet, etc) structure in question. and strong if large compared with such structure. When a multiplet arises from two polyfold terms for one of which the external field is strong, but weak for the other, a partial Paschen-Back effect is observed.

Most of the experimental work on the Zeeman effect has been done with magnetic fields between 20.000 and 40.000 oersteds conveniently obtained with yoke-type electromagnets fed by currents of the order of 100 amp. Such magnets combined with the best diffraction gratings permit a resolution of components separated by $\frac{1}{10}$ Lorentz unit. G. R. Harrison in 1939 succeeded in resolving $\frac{1}{20}$ Lorentz unit in complex spectra by placing the light source in the axis of a water-cooled copper solenoid carrying 8,000–10.000 amp. and thus producing fields of 80,000–100,000 oersteds. Momentary fields up to 320.000 oersteds were produced in 1938 by P. Kapitza who short-circuited a large generator uith a coil and studied the Zeeman and Paschen-Back effects for several spectral lines.

Recalling that a Lorentz unit is $4.67 \times 10^{-5}H$ cm.$^{-1}$, a field of 30,000 oersteds produces a spectral displacement of 1.4 cm.$^{-1}$, 100,000 oersteds gives 4.7 cm.$^{-1}$ and 320,000 oersteds gives 15.0 cm.$^{-1}$. Since the spin-doubling separation of the ^{2}P levels from which the first principal series doublet originates is 0.31 cm.$^{-1}$ for lithium and 17.2 cm.$^{-1}$ for sodium, it is obvious nhy the Paschen-Back effect has been observed for the former but not for the latter. Except for hyperfine structures and a relatively small number of narrow multiplets the complete Paschen-Back effect cannot be attained in other spectral lines (multiplets) because of experimental difficulties in generating magnetic fields of sufficient strength. In the great majority of spectra the J levels of terms are separated by hundreds or even by thousands of cm.$^{-1}$, and in most of these cases the Paschen-Back effect is inappreciable. This is most fortunate since othernise the Zeeman effect would have little practical value. Both the normal Zeeman effect and the complete Paschen-Back effect are ambiguous with regard to J and do not differentiate g. On the other hand, the resolved anomalous Zeeman effect definitely discloses, for both combining levels, the J values (in the number of components) and the g values (in the separations of the components). It is this feature of the Zeeman effect that has made it the most powerful aid in the analysis of spectral structure and in the positive determination of the electronic structure of atoms and ions (*see* SPECTROSCOPY). The Zeeman effect has also revealed some interesting magnetic properties of the stars. (W. F. M.)

ZEISS, CARL (1816–1888), German industrialist, a leading manufacturer of optical instruments, was born in Weimar on Sept. 11, 1816. In 1846 he opened at Jena a workshop for microscopes and other optical instruments. Having the foresight to recognize early that progress in building better microscopes would depend on a better scientific foundation, he engaged as research worker Ernst Abbe (*q.v.*), professor of physics and mathematics at the University of Jena. Subsequently Abbe became a partner in the firm. Xbbe and Zeiss engaged Otto Schott, a glass chemist who, in the years 1882 and following, invented and developed about 100 new kinds of optical glasses and new types of heat-resisting glasses After the death of Zeiss in Jena on Dec. 3, 1888, Xbbe, then sole onner of the Carl Zeiss firm, donated his firm and his share in the glassworks to the Carl Zeiss foundation. In 1923 Schott joined his share to the foundation. In 1945, after World War II, the board of management and about 100 scientists and technicians of the Carl Zeiss firm of Jena mere evacuated to west Germany by U.S. forces. They re-established in west Germany the Carl Zeiss foundation at Heidenheim. with the Carl Zeiss factory at nearby Oberkochen and the Schott glassworks at Mainz, independent of the Jena works in the communist-controlled zone of east Germany. (K. A. BA.)

ZEITZ, a town in the district of Halle. Ger., on the Weisse Elster. 28 mi. S.S.W. of Leipzig. Pop. (1959 est.) 45,142. Zeitz is an ancient place of Slavonic origin. From 968 until 1028 it was the seat of a bishopric, afterward removed to Naumburg, and styled Naumburg-Zeitz. From 1653 to 1718 Zeitz was the capital of the dukes of Saxe-Zeitz and remained in the possession of the electors of Saxony until 1815, when it passed to Prussia.

ZELAYA, JOSÉ SANTOS (1853–1919), Nicaraguan politician who governed the country with an iron hand for 16 years, 1893–1909. He is best remembered for his efforts to unite Central America by force, and as an unscrupulous dictator whose actions provoked U.S. Secretary of State Philander C. Knox to denounce him as a "blot on the history" of Nicaragua. In 1893 Zelaya came to power through a successful Liberal revolt which ended a prolonged period of Conservative dominance and earned a reputation as the troublemaker of Central America. In 1907 he helped oust the government of neighbouring Honduras and installed his ally, Miguel Dávila, as president there. His subsequent efforts to foment a revolution in El Salvador brought the area to the verge of war and led to the Washington conference of 1907. Zelaya's unwillingness to recognize the right of the United States to intervene in Central American affairs and his continued efforts to exert his hegemony over his neighbours led to a progressive worsening of U.S.-Nicaraguan relations. When in 1909 Zelaya executed two U.S. soldiers of fortune who held commissions in a revolutionary army, the United States broke off diplomatic relations. Zelaya resigned in favour of a fellow Liberal and left the country, dying in exile in New York city on May 17, 1919. (R. M. Sc.)

ZELAYA, a large department (comprising nearly 38% of the total national area) in Nicaragua. It embraces the Caribbean lowlands, most of the eastern slopes of the central highlands and the Corn Islands. Area 21,616 sq.mi., pop. (1959 est.) 71,196, of which two-thirds was rural. The region has most of the country's timber, principally mahogany, pine, cedar, dyewood and lignum vitae, which are cut and floated down rivers for domestic use and export. Western Zelaya has many gold and silver mines, two of which (Bonanza and Siuna mines, served only by air transportation) produce half of the nation's gold. The departmental capital Bluefields is the principal port on the Caribbean. Located near the mouth of the Escondido river, which is navigable for 60 mi. to Rama. Bluefields is connected by a modern highway with Managua, 175 mi. away. (C. F. J.)

ZEMARCHUS (fl. 568), Byzantine general and traveler. The Turks, by their conquest of Sogdiana in the middle of the 6th century. gained control of the silk trade which then passed through central Asia into Persia. But the Persian king Chosroes Nushirvan refused to allow the old commerce to continue, and the Turks in 568 sent an embassy to Constantinople to form an alliance with the Byzantines and "transfer the sale of silk to them." The offer was accepted by Justin II, and in Aug. 568 Zemarchus the Cilician, left Byzantium for Sogdiana. On reaching the Sogdian territories the travelers proceeded to the camp of Dizabul (or rather of Dizabul's successor, he having just died) apparently in some locality of the Altai. They found the khan and accompanied him some way on his march against Persia, passing through Talas or Turkistan in the Syr-Darya valley.

Near the river Oekh (Syr-Darya?) he was sent back to Constantinople \\-ith a Turkish embassy and with envoys from various tribes subject to the Turks. Halting by the "vast, wide lagoon" (of the Aral sea?), Zemarchus sent a messenger to announce his return to the emperor; marched 12 days; crossed the Emba, Ural, Volga and Kuban; and arrived safely at Trebizond and Constantinople. For several years this Turkish alliance subsisted but from 579 the friendship rapidly began to cool. (C. R. B.)

ZEN (CH'AN in Chinese, abbreviated from *ch'an-na,* a transcribed form of dhyana in Sanskrit) is a school of Buddhism claiming to transmit the spirit or essence of Buddhism, which consists in experiencing the enlightenment (*bodhi*) Buddha possessed. Zen thus refuses to follow blindly the instructions or teachings given by the Buddha during his long years of peregrination. Zen regards words or letters as merely indicative of the goal where the Buddhist life starts and ends.

Zen is legendarily thought to have originated in India and to have been taken to China in a finished form by Bodhidharma early in the 6th century A.D. Its actual origin was in China beginning with Hui-neng (d. 713), regarded as the 6th Chinese patriarch. It was he who strongly upheld the awakening of *prajna* against the idea of the all-importance of *dhyana* and this fact marks the beginning of Zen as it has been understood since. The practice of *dhyana* may finally bring out *prajna* but it is not to be thought of as the goal of Zen; what Zen proposes is the awakening of *prajna* from the depths of consciousness where it ordinarily lies dormant.

Prajna stands against *vijnana*. If *vijnana* is taken to mean relatively limited human knowledge, *prajna* corresponds to an intuition of the highest order. Hui-neng emphasized the awakening of *prajna* as opposed to the one-sided mental absorption in the tranquilizing practice of *dhyana* that was the prevailing tendency in his day. Hui-neng thus caused a revolutionary movement in the history of Chinese Buddhism.

In Indian philosophical thought Nagarjuna's Madhyamika school points out the significance of *prajna,* which sees into the abyss of *sunyata* ("emptiness"). What most conspicuously distinguishes Chinese Zen from all the types of philosophical thought originating in India is its complete lack of concern with abstract metaphysical speculations wandering far away from the concrete world of finites. Zen demonstrates this characteristic feature in the form of questions and answers (*mondo*). These *mondo* are refreshing and full of vivacity because they spring from life itself and deal with it directly without any intermediary agent such as intellection or symbolization.

There are no references in the *mondo* to any of the subjects usually considered religious or spiritual, such as God, salvation, revelation, sin or guilt, forgiveness, etc. The absence is singularly noticeable. What meaning has the awakening of *prajna* for daily life, not to mention one's highest spiritual aspirations? Does Zen find salvation in washing dishes, in cultivating the ground or in peddling articles? Is there any revelation in looking at the flowers or in exchanging greetings? Is there some kind of emancipation in uttering an unintelligible cry as sometimes given out by the Zen master? Zen disavows arguing, theorizing, sermonizing or trying to explain. Zen, on the contrary, urges its follower to find in himself the answer to any question raised from within himself because the answer is where the question is. The Zen master would say, "My words are mine and not yours and do not belong to you. All must come out of your own being."

When Zen emphasizes the awakening of *prajna* in oneself this does not mean that Zen repudiates Buddhism as a whole, as is sometimes imagined. On the contrary, Zen lives within the framework of Buddhist teaching, which consists of two factors: *prajna* ("wisdom") and *karuna* ("love"). Thus Zen also upholds the *karuna* aspect of the Buddhist experience, *i.e.,* the creating agent that produces all kinds of contrivances to help fellow beings to come to the realization of *prajna*.

A monk asked the master, "What kind of person is one before he experiences enlightenment?" "He is an ordinary man just as we all are." he was told. "What then after the enlightenment?" asked the questioner. "His head is covered with ashes and his face smeared with mud." The monk further asked, "What does all this finally amount to?" The answer was, "Not much, just so."

"The head covered with ashes and the face smeared with mud" is typical Zen phraseology. It means that a Zennist works hard in every walk of life for the general welfare of humanity. "Have a cup of tea" is another popular Zen expression symbolizing the Zennist's social concern. In Zen, as in all other schools of Buddhism, *karuna* and *prajna* co-operate like the two wheels of a cart.

A monk taking leave of Hsueh-feng (822–908) visited Ling-yun and asked, "How was the world before Buddha appeared?" Ling-yun raised the *hossu* (an instrument originally used to brush away insects, now a kind of religious implement). "How is the world after Buddha's appearance?" the monk demanded. Ling-yun raised the *hossu* as before. The monk went back to Hsueh-feng, who asked him, +'Why do you come back so soon?" The monk told the master all about his encounter with Ling-yun, adding that he altogether failed to understand the latter. Hsueh-feng said, "You ask me and I'll tell you." When the monk repeated the first question Hsueh-feng also raised the *hossu*. When the second one was asked Hsueh-feng threw the *hossu* down. Thereupon the monk bowed and the master struck him. In this incident the use of the *hossu* is *prajna,* whereas the master's striking is *karuna*.

Zen flourished best in China in the T'ang (618–906) and Sung (960–1279) periods and began to show signs of decline in the Ming (1368–1644). Considerable interest in Zen was seen in the west during the decades immediately following World War II, perhaps in part reflecting a general awakening of interest in Japanese life and culture. Only in Japan is Zen still a living force; there its adherents in the late 1950s numbered approximately 4,500,000. *See* also BUDDHISM; MAHAYANA. (D. T. SU.)

ZENAGA, a Berber tribe of southern Morocco who gave their name to Senegal, once their tribal home. With other tribes under Yusef bin Tashfin, they crossed the Sahara and gave the Almoravide dynasty to Morocco and Spain. The Zeirid dynasty which supplanted the Fatimites in the Maghrib and founded the city of Algiers was also of Zenaga origin.

ZENATA or ZANATA, a Berber tribe of Morocco in the central Atlas district. Their tribal home seems to have been south of Oran in Algeria, and they early claimed an Arab origin, though the Arabs called them descendants of Goliath; *i.e.,* Philistines or Phoenicians.

The Beni Marin and Wattasi dynasties, of Zenata origin, reigned in Morocco from 1213 to 1548.

ZEND-AVESTA: *see* AVESTA.

ZEND LANGUAGE: *see* IRANIAN LANGUAGES.

ZENGER, JOHN PETER (1697–1746), American colonial printer, was the defendant in the famous case that established the first important victory for freedom of the press in the colonies Born in Germany in 1697. he nent to New York in 1710, and from 1711 to 1719 served an apprenticeship with the printer William Bradford. In 1720–22 he lived in Chestertown, Md. later he worked in partnership with Bradford, and in 1726 Zenger established his own printing business.

On Nov. 5, 1733, he published the first issue of the *New-York Weekly Journal,* the political organ of a group of New Yorkers who opposed the policies of the colonial governor. William Cosby. For a year the paper continued scathing attacks on the governor until, in Nov. 1734, Cosby issued a proclamation condemning the "divers scandalous, virulent, false and seditious reflections" and offering a reward for the apprehension of their author. On Nov 17, 1734, Zenger was arrested for libel and until the following August remained in prison, continuing to edit the *Journal* from his cell. When his case finally came to trial on Aug. 4, 1735, he was defended by a noted Philadelphia lawyer, Andrew Hamilton. Hamilton offered to prove the truth of the statements in Zenger's paper but, in accordance aith English law, the judge, a supporter of the administration, refused to allow that procedure; instead he instructed the jury simply to decide whether the statements in question had actually been printed and to leave the decision as to whether they uere libelous to the court. Hamilton, honever, urged the jury to consider itself competent to make that decision and stated Zenger's cause so eloquently that it returned a verdict of not guilty. This early recognition of the right of juries to decide whether statements said to be libelous actually were libelous was an important step toward the freedom of the press from censorship by a biased judiciary. although for many years the principle was not established as a legal precedent

Zenger subsequently served as public printer in both New York and New Jersey. His account of the trial was published in 1736 in the *Journal* and was aidely circulated both in the United States and in England He died July 28, 1746.

See Vincent Buranelli (ed.), *The Trial of Peter Zenger* (Sew York, 1957).

ZENITH TELESCOPE, a form of telescope specially devised for the accurate determination of latitude. It is used in geodetic surveys and, at fixed stations, for measuring the variation of latitude.

The usual form of the instrument consists of a telescope which is free to move in the plane of the meridian about a horizontal east-west axis. The telescope can be clamped to this axis, which can be rotated, end for end, about a vertical axis. Thus, if the telescope points to a certain distance north of the zenith it will point to the same distance south of the zenith after reversal. A sensitive level is used for finding the difference in inclination of the telescope to the vertical in the two positions.

Two stars of known declination δ_1 and δ_2 are chosen which transit within a few minutes of one another, one north and the other south of the zenith at nearly equal zenith distances. If ϕ is the latitude. the respective zenith distances are $\delta_1 - \phi$ north and $\phi - \delta_2$ south. so that the small difference between them is $\delta_1 + \delta_2 - 2\phi$. Settings of a micrometer wire are made on each star in turn. the telescope being rotated from the north to the south direction between the two observations. The distance that the wire has to be moved measures the quantity $\delta_1 + \delta_2 - 24$ and hence determines ϕ.

The method described is generally known as the method of Andrew Talcott. who used it in boundary surveys (1834). It is characteristic of the Talcott method that the derived latitude depends upon the accuracy of the level: of the micrometer and of the assumed star positions. but is independent of a precisely graduated circle. The correction for refraction is nearly zero because the north and south measures are made at nearly the same altitude.

The floating zenith telescope, designed by B. Cookson, employs a basin of mercury for rotating the telescope and for fixing the position with respect to the vertical. Trails of a pair of stars are obtained close together on a photographic plate.

The photographic zenith tube. which is used at a number of observatories, makes use of a reflecting basin of mercury to define the vertical. Exposures made in two positions of the lens and photographic plate determine the zenith distance and the latitude. *(See* TIME MEASUREMENT: *Practical Determination of Rotational Time: Photographic Zenith Tube.)* (W. Mz.)

ZENO, East Roman emperor from *474* to 491, was an Isaurian of noble birth. Of his early life nothing is known; after his marriage to Ariadne, daughter of Leo I, in *468* he became patrician and commander of the imperial guard and of the armies in the east. In 474 Leo I died after appointing as his successor Leo, the son of Zeno and Ariadne; Zeno, however. succeeded in getting himself crowned also, and on the death of his son in the same year became sole emperor. In the following year, in consequence of a revolt fomented by Verina in favour of her brother Basiliscus, he was compelled to take refuge in Isauria. The growing misgovernment of Basiliscus ultimately enabled Zeno to re-enter Constantinople unopposed (476); his rival was banished- to Phrygia, n-here he died soon afterward. The remainder of Zeno's reign was disturbed by numerous other less formidable revolts. Since 472 the aggressions of the two Ostrogoth leaders. both named Theodoric. had been a constant source of danger. In 487 Zeno induced Theodoric. son of Theodemir, to invade Italy and establish his new kingdom. In ecclesiastical history the name of Zeno is associated with the *Henoticon* or instrument of union. promulgated by him and signed by all the eastern bishops, with the design of terminating the Monophysite controversy.

See J. B. Bury, *The Later Roman Empire* (1889), i, pp. 250–274; E. W. Brooks in the English *Historical Review* (1893), pp. 209–238; W. Barth. *Der Kaiser Zeno* (Basel, 1894).

ZENO (OF ELEA) ib. probably *c.* 500 B.C.), Greek philosopher. regarded as the inventor of "dialectic" in virtue of his method of indirect argumentation. was famous for the paradoxes whereby, in order to recommend the Parmenidean doctrine of the existence of "the one" (*i.e.,* indivisible reality). he 'sought to controvert the common-sense belief in the existence of "the many" (*i.e.,* distinguishable qualities and things capable of motion). Zeno was the son of a certain Teleutagoras and the pupil and friend of Parmenides. In Plato's *Parmenides,* Socrates, "then very young," converses with Parmenides and Zeno, "a man of about forty"; but it may be doubted whether such a meeting was chronologically possible. Plato's account of Zeno's purpose (*Parmenides,* 128 *et seq.*), however. is presumably accurate. In reply to those who thought that Parmenides' theory or' the existence of "the one" involved inconsistencies. Zeno tried to show that the assumption of the existence of a plurality of things in time and space carried nith it more serious inconsistencies In early youth he collected his arguments in a book. which. according to Plato. nas put into circulation without his knowledge.

Of the paradoxes used by Zeno to discredit the belief in plurality and motion. eight survive in the writings of Aristotle and Simplicius. They are commonly stated as follows:

1. If the existent is many, it must be at once infinitely small and infinitely great—infinitely small, because its parts must be indivisible and therefore without magnitude; infinitely great, because, for any part having magnitude to be separate from any other part. the intervention of a third part having magnitude is necessary, and, ior this third part to be separate from the other two, the intervention of other parts having magnitude is necessary, and so on ad infinitum.

2. Likewise, the many must be numerically both finite and infinite—numerically finite. because there are as many things as there are, neither more nor less; numerically infinite, because! for any two things to be separate. the intervention of a third thing is necessary, and so on ad infinitum. (An alternative interpretation of either or both of these arguments would have Zcno referring to the intervention of a part *within* rather than *between* each part.)

3. If all that is is in space, space itself must be in space, and so on ad'infinitum.

4. Ii a bushel of corn turned out upon the floor makes a noise, each grain and each part of each grain must make a noise likewise; but, in fact, it is not so.

5. Before a body in motion can reach a given point, it must first traverse the half of the distance; before it can traverse the half, it must first traverse the quarter; and so on ad infinitum. Hence, ior a body to pass irom one point to another, it must traverse an infinite number of divisions. But an infinite distance (which the paradox does not distinguish from a finite distance infinitely divided) cannot be traversed in a finite time. Consequently, the goal can never be reached.

6. If the tortoise has the start of Achilles, Achilles can never come up with the tortoise; for, while Achilles traverses the distance from his starting point to the starting point of the tortoise, the tortoise advances a certain distance, and while Achilles traverses this distance, the tortoise makes a further advance, and so on ad infinitum. Consequently, Achilles may run ad infinitum without overtaking the tortoise. (This paradox is virtually identical with the preceding one, the only difference being that there are two bodies instead of one moving toward a limit. The "infinity" of the premiss is an infinity of subdivisions of a distance which is finite: the "infinity" of the conclusion is an infinity oi distance.)

7. So long as anything is in a space equal to itself, it is at rest, An arrow is in a space equal to itself at every moment of its flight and therefore also during the whole of its flight. Thus the flying arrow is at rest.

8. Two bodies moving with equal speed traverse equal spaces in equal time. But, when two bodies move with equal speed in opposite directions, the one passes the other in half the time in which it passes a body of equal length. which is at rest. (The concealed point is. almost certainly, that the actual division of an instant is implied.)

It will be seen that Zeno made use of three premisses: first. that any unit has magnitude: second, that it is infinitely divisible: and third. that it is indivisible. Yet he incorporated arguments for each: for the first premiss. he argued that that which added to or subtracted from something else does not increase or decrease the second thing is nothing; for the second. that a unit, being one. is homogeneous and that therefore, if divisible, it cannot be divisible at one point rather than another; for the third, that a unit, if divisible. is divisible either into extended minima, which contradicts the second premiss or. because of the first premiss, into nothing. He had in his hands a very powerful complex argument in the form of a dilemma, one horn of n-hich supposed indivisibility. the other infinite divisibility, both leading to a contradiction of the original hypothesis. Thus. in refuting the hypothesis of motion, paradoxes *5* and 6 postulated infinitely divisible stretches, paradoxes 7 and *8* indivisible stretches. His method had great influence and may be summarized as follows: he continued Parmenides' abstract, analytic manner. but started from his opponents' theses and refuted them by *reductio ad absurdum.* It was probably the tn-o latter characteristics which Aristotle had in mind when he called him the inventor of dialectic.

Zeno may have been arguing against actual opponents. Pythagoreans who believed in a plurality composed of numbers that were thought of as extended units. This is controversial. It is not likely that any mathematical implications (*e.g.,* doubts about using infinitesimals in geometry) received attention in his lifetime. But in fact the logical problems which his paradoxes raise about a mathematical continuum are serious. fundamental and inadequately solved by Aristotle.

By Plato's time. at least. Zeno's paradoxes had been applied to another problem which was to be of much importance in philosophy. This was the problem of predication. In the *Parmenides* we are told that the first argument of Zeno's book reduced "the many" to absurdity by showing that they are simultaneously "like and unlike." Socrates claims that this is a commonplace in the case of changing particulars (as the *Phaedo* had pointed out. the same individual is. relatively, both tall and short); what would be a marvel. he suggests, would be to show that it held in the case of universals—if unity. say. were many or plurality one. This leads in the *Sophist* to the doctrine of the communion or mingling of the Platonic forms. which amounts to tackling the problem of class-inclusion instead of class-membership. At the same time both dialogues can turn the tables on Eleatic monism. For when Zeno had argued that the "unit" of the pluralists was self-contradictory, he had referred to the units into which total reality was supposed to be divided. Plato (following the lead of Gorgias) simply uses the same arguments against the unitary reality itself. Since this now contains differences. the "not-being" which Parmenides had asserted to be impossible finds a place as "difference": "*A* is-not *B*" means "*A* is different from, or other than. *B*."

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ZENO (THE STOIC) (*c.* 320–*c.* 250 B.C.), sometimes also called ZENO THE PHOENICIAN, founder of the Stoic philosophy, was a native of Citium in Cyprus. who came to Athens as a youth and, although refusing an offer of citizenship, remained there until his death. After studying under Crates the Cynic, under Stilpo the Megarian and in the Old Academy, he began to teach in the *Stoa poikile* ("painted stoa" or "porch"). His *Life* by Diogenes Laërtius (vii, 1) contains an outline of his teaching which was dogmatic, prophetic and paradoxical rather than philosophical in the manner of his Greek predecessors. Dividing philosophy into logic, physics and ethics and taking as his criterion of truth the *kataleptike phantasia* ("indubitable impression"), he made ethics central and taught that happiness lies in conforming the to the divine reason which governs the universe. None of his many treatises on logic, physics, ethics and rhetoric, written in harsh but forceful Greek: is extant save in fragmentary quotations.

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ZENOBIA, queen of Palmyra, one of the heroines of antiquity. Her native name was Septimia Bathzabbai. This remarkable woman was well fitted to be the consort of Odainatti (*see* ODAENATHUS) in his proud position as Dux Orientis; during his lifetime she actively seconded his policy, and after his death in A.D. 266–67 she determined to surpass his position and make Palmyra ruler of the Roman empire in the east. Wahab-allath or Athenodorus (as the name was Grecized), her son by Odainath, being still a boy, she took the reins of government into her own hands. Under her general in chief Zabda, the Palmyrenes occupied Egypt in A.D. 270 under the pretext of restoring it to Rome; and Wahab-allath governed Egypt in the reign of Claudius as joint ruler. In Asia Minor Palmyrene garrisons were established as far west as Ancyra in Galatia and Chalcedon opposite Byzantium. When Aurelian became emperor in 270 he quickly realized that the policy of the Palmyrene queen was endangering the unity of the empire and instantly took measures; Egypt was recovered for the empire by Probus (270), and the emperor himself prepared a great expedition into Asia Minor and Syria. Toward the end of 271 he marched through Asia Minor and, overthrowing the Palmyrene garrisons in Chalcedon, Ancyra and Tyana, he reached Antioch, where the main Palmyrene army under Zabda and Zabbai, with Zenobia herself, attempted unsuccessfully to oppose his may. The queen was defeated at Emesa (Homs) and fell back upon Palmyra, where Aurelian followed her and laid siege to the city. The queen and her son fled to seek help from the Persian king, but were captured on the bank of the Euphrates, and the Palmyrenes, losing heart, capitulated (A.D. 272). Zenobia probably retired at Tibur, where she lived the life of a Roman matron with her sons. A few months after her fall Palmyra revolted again; Aurelian unexpectedly returned and destroyed the city.

Among the traditions relating to Zenobia may be mentioned that of her discussions with the Archbishop Paul of Samosata on matters of religion. It is probable that she treated the Jews in Palmyra with favour; she is referred to in the Talmud as protecting Jewish rabbis (Talm. Jer. *Ter.* viii, 46 b).

The well-known account of Zenobia by Gibbon (*Decline and Fall*, i, pp. 302–312, Bury's edition) is based upon the imperial biographers (*Historia Augusta*) and cannot be regarded as strictly historical in detail. *See* further PALMYRA. (G. A. C.; X.)

ZENODOTUS OF EPHESUS (fl. *c.* 280 B.C.), Greek grammarian who made the first critical edition of Homer, lived in the reigns of the first two Ptolemies. He was a pupil of Philetas of Cos, and the first superintendent of the famous library at Alexandria: where he arranged the work of the epic and perhaps of the lyric poets. After comparing different manuscripts of Homer, he obelized (deleted) doubtful lines, transposed others and made emendations. His edition, knowledge of which is derived almost entirely from later scholia on Homer, was severely criticized by Aristarchus, but had some influence on the poetry of Zenodotus' younger contemporaries, Callimachus and Apollonius Rhodius. It was he who divided the *Iliad* and the *Odyssey* into 24 books each. He compiled a Homeric glossary, and besides editing the *Theogony* of Hesiod he published studies of Pindar, traces of which survive in a papyrus from Oxyrhyncus (no. 841). He is also said to have written epic poetry.

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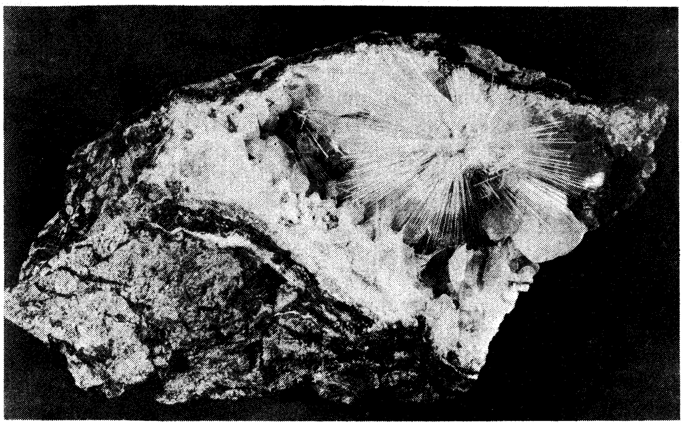
ZEOLITE, a numerous and complex family of hydrous aluminum silicate minerals containing one or more of the alkali and alkaline earth metals. Natural and synthetic zeolites have been much used as water softeners, and occasionally as absorbent materials (see *Base Exchange*, below) with increasing application in industrial sieving processes as molecular sieves to separate molecules of different sizes (as various hydrocarbons) and molecules of the same size but different electrical properties (as water and natural gas). The name is derived from the Greek words for "to boil" and "stone" in allusion to the distinctive property of appearing to boil when heated. The effect is a consequence of the easy fusibility and, at the same time, loss of considerable amounts of water of crystallization.

Species.—The most important species belonging to the family are identified in the accompanying table.

Zeolite Family

Group	Species	System of crystallization	Formula
Natrolite group	Natrolite	Orthorhombic	$Na_2Al_2Si_3O_{10} \cdot 2H_2O$
	Mesolite	Monoclinic	$Na_2Ca_2[Al_2Si_3O_{10}]_3 \cdot 8H_2O$
	Thomsonite	Orthorhombic	$NaCa_2[Al_2Si_2(Al,Si)O_{10}]_2 \cdot 5H_2O$
	Gonnardite	Orthorhombic	$(Ca,Na)_3[(Al,Si)_5O_{10}]_2 \cdot 6H_2O$
	Scolecite	Monoclinic	$CaAl_2Si_3O_{10} \cdot 3H_2O$
	Edingtonite	Tetragonal	$BaAl_2Si_3O_{10} \cdot 3H_2O$
Heulandite-stilbite group	Heulandite	Monoclinic	$CaAl_2Si_7O_{18} \cdot 7H_2O$
	Stilbite / Epistilbite	Monoclinic / Monoclinic	$CaAl_2Si_6O_{16} \cdot 5H_2O$
	Brewsterite	Monoclinic	$(Sr,Ba,Ca)Al_2Si_6O_{16} \cdot 5H_2O$
Laumontite group	Laumontite	Monoclinic	$Ca[AlSi_2O_6]_2 \cdot 4H_2O$
	Gismondite	Orthorhombic	$CaAl_2Si_2O_8 \cdot 4H_2O$
	Mordenite	Orthorhombic	$(Ca,K_2,Na_2)[AlSi_5O_{12}]_2 \cdot 7H_2O$
Phillipsite group	Phillipsite	Monoclinic	$KCaAl_3Si_5O_{16} \cdot 6H_2O$
	Harmotome	Monoclinic	$BaAl_2Si_6O_{16} \cdot 6H_2O$
Chabazite group	Gmelinite	Hexagonal	$(Na_2,Ca)Al_2Si_4O_{12} \cdot 6H_2O$
	Chabazite	Hexagonal	$(Ca,Na_2)Al_2Si_4O_{12} \cdot 6H_2O$
	Levynite	Hexagonal	$CaAl_2Si_4O_{12} \cdot 6H_2O$
	Faujasite	Cubic	$Na_2Ca[Al_2Si_4O_{12}]_2 \cdot 16H_2O$

The similar mineral analcite (*q.v.*), $NaAlSi_2O_6.H_2O$, sometimes classified as a member of the zeolite family, in this article is regarded as a feldspathoid (*q.v.*). Identification of the different species of zeolite commonly requires careful measurements of their optical properties, and in the case of many fine-grained types, the use of X-ray diffraction. Zeolites in many localities exhibit strikingly developed crystals; whereas they occur in nondescript granular masses or as disseminated grains in many other localities. Most varieties are translucent to white in colour, although a few range through flesh tints, brown, yellow and red. The refractive indices, birefringence, specific gravity (2.0–2.4), and hardness are all relatively low. The zeolites are further distinguished by the fact that they are readily decomposed in hydrochloric acid with the separation of silica.



BY COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY
RADIATING GROUP OF NATROLITE CRYSTALS FOUND IN WEST PATERSON, N.J.

Crystal Structure. — Several striking features of the zeolites are directly controlled by the crystalline make-up. The essential structural scheme for all species is a rather open but tightly linked framework of the silicate [SiO_4] and aluminate [AlO_4] tetrahedral groups or clusters of atoms *(see* MINERALOGY). However, the metal ions, such as sodium or calcium, and the water molecules are relatively loosely bound within the large voids in the frameworks. In most zeolites the voids are interconnected so as to yield well-defined channels on an atomic scale through the crystals. Thus, the low specific gravities are explained by this structural porosity, which also accounts for their ability to serve as molecular sieves.

Zeolitic Dehydration. — The behaviour of the crystal water of zeolites is so distinctive it is commonly referred to as zeolitic dehydration. The amount of water contained in a zeolite depends upon the humidity and temperature of the environment, as well as upon its own composition and structure. At temperatures below about zoo" C. most zeolites lose and regain water reversibly with little or no change in the essential aluminosilicate framework. Most other hydrated crystalline substances, on the other hand, do not exhibit this reversibility and for many the fundamental structure is destroyed if the water is lost.

Base Exchange. — Zeolites also have the property of base exchange. If, for example, a sodium zeolite is placed in a calcium-rich solution the loosely bound sodium atoms tend to diffuse through the zeolitic channels into the solution. Calcium ions tend to diffuse into the crystal. The process is reversible and the original zeolite may be regenerated by replacing the calcium solution by one of sodium. Many other bases such as potassium, strontium. barium, lithium, ammonium, silver and copper are also exchangeable. It is by reason of this property of base exchange that zeolites have been used as water softeners in the permutite process, and as absorbent materials. *(See* also COLLOID: *Ion* Exchange or *Base Exchange;* WATER; WATER SUPPLY AND PURIFICATION: *Softening.*)

Occurrence.—Zeolites apparently are stable under a wide range of conditions in hydrous environments. They are abundantly found as alteration products in igneous and metamorphic rocks, associated mith ore deposits, and in ancient and recent sediments. Zeolites have been made artificially up to very high temperatures and pressures if sufficient water is present. The most notable occurrences of zeolite are the beautifully crystallized cavity linings in basalt and diabase, as at Bergen hill, New Jersey; Westfield, Mass.; and the Lake Superior copper district. Abundant granular zeolites also occur dispersed in such rocks as alterations of feldspar. 'They occur also in feldspathoidal syenites, gneisses and some granites. *See* also CHABAZITE; HEULANDITE; NATROLITE; PHILLIPSITE; SCOLECITE; STILBITE. (D. M. H.)

ZEPHANIAH, the ninth of the minor prophets in the Bible. His 'ancestry is traced to his great-grandfather Hezekiah, who may, in spite of 2 Kings xx. 1S, xxi. 1, be the well-known king of Judah (c. 720–690). This would agree fairly with the title (i. 1) which makes the prophet a contemporary of King Josiah (c. 637), and this in turn appears to agree *(a)* with the internal conditions (i. 4–6, cf. 2 Kings xxiii. 4, 5, 12) which, it is held, are evidently earlier than Josiah's reforms (621); (b) with the denunciation of the royal household, but not of the (young) king himself (i. 8, iii. 3); (c) with the apparent allusion in ch. i. to the invasion of the Scythians (perhaps *c.* 626), and (d) with the anticipated downfall of Assyria and Nineveh (ii. 13, 612 B.C.).

Although one single leading motive runs through the book of Zephaniah there are abrupt transitions which do not depend on modern subjective considerations of logical or smooth thought, but are material and organic changes representing different groups of ideas. The instruments of Yahweh's anger (ch. i.) are not so real or prominent on the political horizon as, for example, in Isaiah, Jeremiah or Habakkuk. The Scythian inroad and its results for Judah and Philistia are less important when it is observed that the doom upon Philistia, the vengeance upon Moab and Ammon, and the promises for Judah (ch. ii.), belong to a large group of prophecies against certain historic enemies (Edom included) who are denounced for their contempt. hostility and intrusion. The prophecies are in large measure associated traditionally with the fall of Jerusalem, and to some such calamity, and not to the inroad of the Scythians, the references to the "remnant" and the "captivity" refer. The anticipation of future events is of course conceivable in itself; but the promises (in ch. ii.) *presuppose* events other and later than those with which the Scythians were connected. On the other hand, a prophecy relating to Scythians may have been re-shaped to apply to later conditions, and on this view it is explicable why the indefinite political convulsions should be adjusted to the exile and why the gloom should be relieved by the promise of a territory extending from the Mediterranean to the Syrian desert (ii. 7, 9). After a period of punishment (cf. book of Lamentations) Yahweh's jealousy against the semi-heathen Judah has become a jealousy for his people, and we appear to move in the thought of Haggai and Zechariah, where the remnant are comforted by Yahweh's return and the dispersed exiles are to be brought back (*cf.* Zech. i. 14–17, viii. 2–17). But in ch. iii. other ideas are maniiest. Israel's enemies have been destroyed, her own God Yahweh has proved *his* loyalty and has iulfilled his promises, but the city remains polluted (*vv.* 1–7, cf. Isa. lviii. seq.; Malachi). Once more doom is threatened, and once more me pass over into a later stage where Yahweh has vindicated his supremacy and Zion is glorified. Instead of the realities of history me have the apocalyptical feature of the gathering of the nations (*v.* 8); the thought may be illustrated irom Zech. xii. 1.–xiii. 6. where Jerusalem is attacked. purged and delivered, and from Zech. xiv. where the city is actually captured and hali the people are removed into captivity (cf. Zeph. iii. 11 purging. 15 removal oi the enemy, 18–20 return of the captivity). The goal is the vindication of Israel and of Israel's God and the establishment of universal monotheism (ii. 11, iii. 9 seq.). The foe which threatened Judah has become the chastiser of Ethiopia and Assyria (ii.) and the prelude to the golden ape (iii., cf. Ezek. xxxviii. seq.).

If Jer. iv. 5–vi. 30 originally reierred to the Scythians, it has been revised to reier to the Chaldeans; also in Ezek. xxxviii. seq. a northern ioe becomes associated mith the great world-judgment. Also, in Isaiah and Zechariah, notably, older and later groups of prophecies are preserved. whereas here the new preludes and new sequels suggest that the original nucleus has passed through the hands oi writers in touch with those vicissitudes of thought which can be studied more completely elsewhere. It is not to be supposed that the elimination of all later passages and traces of revision will give us Zephaniah's prophecies in their original extent. In iact the internal religious and social conditions in i. 4–6 or iii. 1–4 do not compel a date before Josiah's reiorms. The doom of Cush is still in the iuture in Ezek. xxx. 4; and if the impending fall of Nineveh (ii. 13) implies an early date, yet it is found in writings which have later additions (Nahum), or which are essentially later (Jonah, *cf.* Tob. xiv. 4 [LXX.], 8, 10. 15); *cf.* also the use of Xssyria ior Babylon (Ezra vi. 22) or Syria (Zech. x. 10). Historical reierences in prophecies are not always decisive (Ezek. xxxii., ior example. looks upon Edom and Sidon as dead), and while the continued revision of the hook allows the presumption that the tradition ascribing its inception to the time of Josiah may be authentic, it is doubtful how much oi the original nucleus can be safely recognized.

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ZEPHYRINUS, ST., bishop of Rome from about 198 to 217, succeeded Victor I. The controversies on doctrine and discipline that marked his pontificate are associated with the names of Hippolytus and of Calixtus, his principal adviser and afterwards his successor.

ZEPHYRUS, in Greek mythology, the west wind, son of the Titan Astraeus and Eos, the dawn. He was the husband of Chloris, the goddess of flowers, by whom he had a son, Carpus, the pod of fruit (Ovid. *Fasti,* v. 197).

See also FLORA; HARPIES: HYACINTHUS.

ZEPPELIN, FERDINAND, COUNT VON (1838–1917), German airship inventor, was born at Constance. Baden, on July 8. 1838. He served in the Federal army during the American Civil War and while in America made his first balloon ascent. Returning to Germany he saw active service in the Austrian War of 1866 and in the Franco-German War of 1870. In 1891 he retired from the army and devoted his energies to aeronautics.

In 1900 he built an airship. which rose from the ground and remained in the air for 20 minutes, but was wrecked in landing. In 1906 he made two successful flights at a speed of 30 mi. an hour. and in 1907 attained a speed of 36 mi. From that time onward his airship construction made steady progress and many Zeppelin airships took part in World War I. though with heavy losses under attack. *(See* AIRSHIP.) He died at Charlottenburg on March 8. 1917.

See *Eine Festgabe zu seinem 75. Geburtstag von Luftschiffbau Zeppelin* (Stuttgart, 1913).

ZERMATT, a mountain village (5,315 ft. above sea level) at the head of the Visp valley and at the foot of the Matterhorn, in the canton of Valais, Switz. It has (1960) 2.731 permanent inhabitants, German-speaking and Roman Catholics.

Formerly Zermatt was called "Praborgne," and this name is mentioned in the Swiss census of 1888. Its originally Romance population seems to have been Teutonized in the course of the 15th century, the name "Matt" (now written "Zermatt," *i.e.,* the village on the meadows) first occurring in that century.

ZERNIKE, FRITS (1888–), Dutch physicist. awarded the 1953 Nobel prize for physics for his outstanding contributions to optics, and especially for his introduction of the method of phase-contrast microscopy *(see* MICROSCOPE: *Phase Contrast).* He was born in Amsterdam on July 16, 1888. He was educated in the University of Amsterdam, and obtained his doctorate there in 1915. He then worked in the department of astronomy in the University of Groningen as professor extraordinarius of mathematical physics and theoretical mechanics, becoming full professor in 1920. His researches contributed to optics and to other branches of physics. His earliest work in optics was concerned with problems relating to astronomical telescopes. and in 1934 he published a diffraction theory of the Foucault knife-edge test for the figure of telescopic mirrors, this work being notable for the discovery of the so-called polynomials of the phase-contrast method. He quickly realized that this method could be applied to the microscope and its use in microscopy led to revolutionary advances. proving most valuable in medical and biological research. In 1952 Zernike was awarded the Rumford medal of the Royal society. (D. McK.)

ZERO, the figure o in the Arabic notation for numbers meaning nought, or cipher. The Sanskrit name for the figure was *śūnya* (void), and this term passed over into Arabic as *aṣ-ṣifr,* or *ṣṣifr.* The old Latin writers on arithmetic translated or transliterated the Arabic word as *zephyrum;* this in Ital. took on such forms as *zeuero, zepiro,* and became contracted to *zero,* borrowed by F. *zéro,* whence it came late into English. The Spanish form *cifra,* more closely resembling the original Arabic, gave O.Fr. *cifre,* mod. *chiffre,* also used in the sense of monogram, and English "cipher" which is thus a doublet. Although no character for zero is found in India before the 9th century, there is literary evidence for the belief that it was known much earlier. In the Maya inscriptions in Central America there appears a character for zero, but only in connection with the calendar.

ZEROMSKI, STEPHEN (1864–1925), Polish novelist, poet and dramatist, was born at Strawczyn on Nov. 14, 1864. Banished from Poland by the Russian Government early in his life, he first attracted attention by a collection of tragic tales entitled *The Ravens and the Crows are Picking us to Pieces* (1895, Eng. trans. 1906). In the publication of *The Homeless* (1900) Zeromski supplied a generic name for all his Polish heroes. His pessimistic philosophy finds expression in the novel *Aryman takes Revenge* (1904), while the triumph of evil over good is vividly treated in *The Story of Sin* (2 vol., 1906) describing the slow and terrible downfall of a woman of culture. In his epic poem *Ashes* (2 vol., 1904) he delineates the minds of the Polish people after the Partition and their efforts to liberate their country by serving in the Napoleonic legions. During World War I Zeromski published his great trilogy *The Fight with Satan — The Conversion of Judas* (1916), *The Blizzard* (1918), *Charitas* (1919)—a kind of epilogue and synthesis of his previous work and at the same time an autobiography of his own life. After the achievement of national independence, Zeromski wrote his drama, *The Broken Spell* (1924) in which the hero dedicates himself to the services of a resuscitated Poland. He died on Nov. 20, 1925.

See S. Brzozowski, *O Stefan Zeromski* (Warsaw, 1905); W. Jampolski, *Stefan Zeromski, the Spiritual Leader of the Race* (Lwów, 1918).

ZETKIN, KLARA (1857–1933), German communist. was born on June 5, 1857, at Wiederan, Saxony, and educated at the University of Paris, becoming a schoolteacher. She presently became editor of *Gleichheit,* the organ of the Social Democratic party for women. Klara Zetkin was a member of the Communist party from its foundation in 1919 and was one of its most fiery orators. She became a member of the *Reichstag* in 1920.

ZETLAND, 2ND MARQUESS OF: *see* RONALDSHAY, LAWRENCE JOHN LUMLEY DUNDAS.

ZEUS was the sky- and weather-god of the ancient Greeks whose name and functions correspond to those of the Latin Iuppiter (Jupiter) and of the Sanskrit Dyaus-(pitar). Although the ancients did not guess at the etymology of the two names, they recognized the former of these equations. Hence also Zeus was assimilated to the sky-gods of ioreign peoples, and, though he himself was definitely of the weather-sky alone, these other gods included solar deities. This fact accounts, for example, for the repeated assertion that the Egyptians worshiped him—their own god Amon-Re is meant. It is curious that Zeus seems hardly to have been identified at any time with the Hebrew Yahweh, whom he really resembles in many ways, both in his original functions and in his later moral development. (For one or two exceptions, *see* A. B. Cook. *Zeus,* vol. ii, pp. 889. 1197.) Zeus is the one god whom the Greeks certainly brought with them into Greece *(see* GREEK RELIGION*).* It is highly likely that he was their chief god from the beginning, before he became the consort of Hera. or entered the varied pantheon familiar from Homer onward. His original partner. if he had a partner, may have been Dione *(see* DODONA*).* Certainly in Homer he is the father, *i.e.,* the natural ruler, of gods and men alike (the word "father" has no necessary connotation of physical relationship). This position he never loses, at least in theory, although in a given district he is often overshadowed by locally important deities—at Delphi and at Delos, for example, by Xpollo.

Development.—As a sky-god, Zeus develops two principal spheres of activity, one physical, the other moral. As regards his material operations, all meteorological phenomena lie within his province. He is naturally the sender of thunder and lightning, and his traditional weapon is the thunderbolt, that imaginary missile by which the effects of lightning were explained before the nature of electricity was known. He also sends rain and winds and, consequently, calm and fine weather, for like all Greek gods he is bivalent. There was a time when he had no very marked personality. 'Traces of this period are to be found in the occasional cult of a Zeus *Kappotas* ("flown down") or *Kataibates* ("descended"); in other words of a meteoric stone in which the power or mana of the sky was embodied (see H. J. Rose, "The Wiro Sky-god," in Custom is King, 1936). As a rule, however, Zeus is a definite person who can be seen "gathering the clouds" on the hilltops. But Greek thought concerning the gods was not a logical system; thus, other and generally lesser deities are often said to control. or even to be, the winds, or to make the sea stormy, and so forth. But it is around the person of Zeus that his rich mythology gathers. There are especially the many tales of his love affairs, which are but variants of the immemorial theme of the union of Father Sky with Mother Earth, though in the final form of the stories not all his consorts are earth-goddesses. It is thus natural that among his many titles is that of Farmer (Georgos), for obviously the farmer is dependent upon the weather for his crops. It is no less natural that a considerable part of Zeus's ritual has to do with weather magic. His holy place on Mt. Lykaion in Xrcadia, which among other signs of great antiquity retained at least traces of human sacrifice, possessed a spring whose water his priest used to stir with an oak branch in time of drought. (The oak was Zeus's sacred tree; see DODONA.) It is alleged by Pausanias that when this rite was performed with the proper accompaniment of prayer and sacrifice, a mist arose from the spring, became a cloud and sent the desired rain. This idea perhaps also explains why Zeus seems occasionally to quit the sky altogether and visit the earth. He is *Katachthonios*, "subterranean," from Homer onward, and so tends to be identified to some extent with his brother Hades. In Athenian cult his most ancient festival is the Diasia. at which. on Anthesterion 23 (*i.e.*, about March), a pig was sacrificed and the god had the euphemistic title Meilichios. This title, whose approximate meaning is "easily entreated," appears in Ozolian Locris as applied to a group of gods otherwise unnamed who, according to Pausanias. aere worshiped at night. Zeus himself is represented on several monuments in the form of a large snake, a typically underworld creature. Plainly this cult was connected with the fertility of the soil, which. incidentally, explains why it was a feast day. Given that the propitiation of the power in question was properly carried out. good results might reasonably be expected; therefore it was fitting to make merry with one's kin and to give the children little presents. Whatever the original relation between Zeus and Meilichios. their identification brought Zeus a step nearer to becoming a universal god, although he never completely achieved this.

ALINARI

ZEUS REPRESENTED IN ANTIQUE SCULPTURE AS THE ENTHRONED MONARCH WITH AN EAGLE PERCHED ATOP HIS SCEPTRE. IN THE VATICAN MUSEUM, ROME, ITALY

Zeus's moral development, too, was in part the result of his celestial nature. in part, also of his position as head of the divine family. It is characteristic of the sky-gods of many peoples to develop an interest in the conduct of mankind, which they are able to observe from their exalted position, somewhat as a man with good eyesight can observe much that goes on over a fairly aide area if he stands on a hilltop. Sky-gods are besides often credited with prodigiously acute vision involving the possession of multiple eyes and the like; they often also have supernatural powers of hearing. (See R. Pettazzoni, The All-Knowing God, 1956, for examples of this from all over the world.) Zeus shares these powers and characteristics. Now and again he has more than the normal number of eyes; Pausanias testifies to a very old image of him at Argos which had three, two normally placed and the third in the middle of the forehead. But such symbolism is rare, for Greek taste disliked monstrosities, and especially monstrous gods.

In general the Greeks simply state that Zeus sees everything, sees and governs all, beholds and notes all that men do, and the like; or that he has innumerable spies to go about the earth and bring him word of what happens there, or that his daughter Justice (Dike) performs a similar office, reporting misdoings to her father, who punishes the guilty. The earliest and most characteristic form of Zeus's vengeance on the ungodly is to send bad weather, as sky-gods regularly do. Often he hurls a thunderbolt at an offender, thus incidentally furnishing the skeptical with an argument against divine intervention in human affairs, for lightning strikes objects incapable of any wickedness. On occasion, as in Hesiod (Works and Days, 243) he sends an epidemic to punish an erring community. Such an act might still be connected with his weather functions, if the very common ancient idea that disease was caused by certain atmospheric conditions may be supposed to have been already current in the 8th century B.C. But the conception of Zeus as a god who is interested in morality, rewarding good conduct and punishing evil, is of early and rapid development, and surpasses the original, comparatively narrow idea of the god's nature and powers.

By the time of Aeschylus, Zeus is the sternly righteous governor of the world. Aeschylus himself, one of the deepest thinkers of his age, admits the god's name to be conventional, and claims that it is he "who guides men to wisdom, who establishes the law that by what we undergo we shall learn," and is incomparable, like no one but himself (Agamemnon, 176–178; 163–165, see note by H. J. Rose). The Stoics, especially, used the name Zeus to denote the chief god of their system, who alone is unaffected by the recurrent ekpyroseis ("conflagrations") which destroy all else, is immanent in everything, and is to be found everywhere in the universe save in "what the evil do in their folly." These speculations are the nearest purely Greek approach to monotheism; for what may be called exclusive monotheism, that which denies the name of "God" to any but one Being, is foreign to Greek and indeed to all native European thought. Therefore the Greeks continued to worship other gods besides Zeus, although to the most thoughtful minds these tended strongly to become the subordinates of their "father." Indeed, already in Homer's time, Zeus's superiority is so marked that, in the poet's somewhat nai've figure, if there were a tug of war between Zeus and the rest, all the other deities could not with their combined strengths pull him down from heaven, whereas he could pull all of them up to him, and earth and sea with them.

It need hardly be said that such lofty ideas as those involved in monotheistic speculation did not belong either to mythology or to ordinary cult. It is true that in the former Zeus is often a dignified figure. He intervenes in human affairs to guide them according to his will, overa es the lesser gods with his superior power. and is even the author of individual destinies (see FATE). He is also, however, the central character of numerous stories of a kind very little to his credit, for he is involved in innumerable love affairs. These tales anciently reflected a cosmic union of Sky and Earth or a ritual sacred marriage, but their meaning had apparently been forgotten quite early, and this for two reasons. In the first place, the earlier tellers of the myths felt that the gods were not subject to the same rules of conduct as mortals, just as nobles were free from the restrictions applied to commoners. Later storytellers, such as the Alexandrians and their Latin followers. believed in the traditional gods and their doings hardly more than modern Europeans do, and so were unhampered by moral scruples such as those of Pindar, for example. who refuses credence to certain legends which, he feels, attribute unworthy conduct to the gods.

Political Importance.— It is but natural that the "father," "lord" and "king" of the gods should share in the government of human communities. and Zeus is in fact concerned in the organization of every collectivity, from the smallest and simplest to the largest. He, with his consort Hera, is deity of marriage, under the title of Teleios (*i.e.*, "Accomplisher"; feminine form, *Teleia*). Zeus is also worshiped in various capacities as a household god.

In some of these cults, it is likely that he had displaced a less-known deity. Distinct traces of an ancient clan organization survive in classical Greece in the phratry (*phratria,* literally "brotherhood") into which all legitimate children were admitted and which had a common cult of Zeus *Phratrios*. As *Patroios*, Zeus was claimed as an actual ancestor by various groups of real or alleged kin. The title *patroios*, however, is not peculiar to him; it was shared by many gods, notably by Apollo, who is the *patroios* of all Athenians. They. being the ancestors of the Ionians, claimed descent from Ion, son of Apollo. The term *patroios* has another sense, however, in which it is attached especially to Zeus as guardian of the rights of kinship and especially of parentage.

Plato would have any citizen who does not interfere to prevent an assault on a parent or grandparent fall under the curse of Zeus in this capacity. Certain rights of property, also, are under the protection of Zeus as *Klarios* ("He of the estate") and *Horios* ("He of the boundary"); to larger communities he is likewise often *Polieus; i.e.*, god of the city-state. He is, indeed, the patron of several states, including Olympia, but is not the only god to hold such an office. His widest function in this respect is expressed by the title *Panhellenios*, or god of all Greeks. Early evidence for this title is lacking, however, for the most conspicuous temple of Zeus's worship under that epithet dates from the time of the Roman emperor Hadrian, although the hill called Panhellenion on the island of Aegina (Aigina) had an old shrine said to have been founded by Zeus's son Aeacus, ruler of Aegina. Zeus was worshiped as *Bulaios* ("He of the council") in many places, including Athens, where he shared the title with Athena. Finally, as *Horkios* ("He of the oath"), he mas commonly invoked in solemn asseverations. Plainly, some at least of these functions are not without significance for his moral development.

Identifications. — As well as being equated with various foreign sky-gods, Zeus is sometimes found in unexpected conjunction with other types of non-Greek deity. The most remarkable instance of this is the development of the so-called Zeus of Crete. According to all the evidence, this deity should be a god of normal Minoan type; *i.e.*, a sort of embodiment of the year and of its changing vegetation. annually born, growing and dying in order to be reborn the next year. No being less like the immortal weather-god could well be imagined, and how the two came to be identified is a puzzle. (*See* M. P. Nilsson, *The Minoan-Mycenaean Religion*, 2nd ed., pp. 534 ff., 1950.) A minor oddity is the compound deity Zeno-poseidon (*i.e.*, Zeus-Poseidon), worshiped at Mylasa (Milas) in Caria (*see* A. B. Cook, *Zeus*, vol. ii, pp. 582 ff.). He is one of the very few deities in whom a foreign god is equated with more than one Greek divinity.

Zeus in Art. — If certain featureless objects connected with his cult are left out of account, the earliest surviving type of Zeus in art (7th century B.C.) depicts a bearded man, naked, in a striding attitude. his uplifted right hand holding a thunderbolt, while on the extended left arm is perched an eagle, the bird of Zeus. Two chief characteristics are always his in art. He is regularly of human form, a mature man of stalwart build, and his usual, though by no means his only, symbols are the thunderbolt and the eagle. Later (from about 500 B.C.) he is shown now and then in full armour. This does not mean that he was imagined as a war-god, but rather that, being a king, he is on occasion a commander in battle.

But perhaps the most characteristic statues and other representations of Zeus show him seated, holding a sceptre in one hand, often, but not always, his thunderbolt in the other, and regularly with the eagle in attendance. This was the pose on which Phidias based his great chryselephantine statue at Olympia. Pausanias describes this famous image as seated, crowned with an olive wreath, with the personification of Victory in the' right hand and a sceptre with the eagle in the left. In this attitude, of which there were numerous minor variations, Zeus is definitely the enthroned monarch.

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(H. J. R.)

ZEUSS, JOHANN KASPAR (1806–1856), German philologist, who wrote the basic systematic grammar of early Welsh, Cornish, Breton and Irish, was born in Vogtendorf, Upper Franconia, on July 22, 1806, and educated at Munich. His first book, the enduring *Die Deutschen und die Nachbarstämme* (1837), a critical source book of German history, illustrates his great erudition and scholarly judgment.

As a result of his outspoken writings, Zeuss was frustrated in his repeated attempts to secure a university position and turned from Germanic history to Celtic philology. Beginning about 1843 by excerpting and analyzing the oldest Celtic documents, Zeuss produced singlehanded, his masterpiece *Grammatica celtica* (1853).

He died on Nov. 10, 1856.

See F. Shaw, *Studies, an Irish Quarterly Review*, 43:194–206 (1954).
(E. P. H.)

ZEUXIS (fl. near end of 5th century B.C.), one of the best-known Greek painters, described himself as a native of Heraclea, probably the town in south Italy. He was, according to one account, a pupil of Demophilus of Himera in Sicily, the other statement being that he was a pupil of Neseus of Thasos. Afterward he appears to have resided in Ephesus. His recorded works are of the following subjects: Zeus surrounded by deities; Eros crowned with roses; Marsyas bound; Pan; Centaur family; infant Heracles strangling the serpents in presence of his parents, Alcmena and Amphitryon; Alcmena, possibly identical with the previous subject; Helen; Penelope; Menelaus; athlete; old woman; boy with grapes; grapes, not identical with the previous subject. There are also references to someone looking like "a Boreas or a Triton such as Zeuxis drew," and to monochromes and plastic works in clay by him.

In ancient records it is said that Zeuxis, following the initiative of Apollodorus, used shading, as opposed to the older method of outline, with flat washes of colour, such as had been practised by Polygnotus and others of the great fresco painters. The effect would appear strongly realistic, as compared with the older method, and to this was probably due the origin of such stories as the contest in which Zeuxis painted a bunch of grapes so like reality that birds flew toward it. He seems to have been a panel rather than a wall painter, preferring small compositions: often a single figure. (C. M. Rn.)

ZHIKATSE (SHIGATSE), second largest town in Tibet, next in importance to Lhasa. The town, which is a trading centre near the confluence of the Nyang Chhu (Nienchu) and the Brahmaputra (Tsangpo) rivers is the centre of a small farming area. It had an estimated population in 1953 of 20,000 (exclusive of priests). It is about $\frac{3}{4}$ mi. long and $\frac{1}{2}$ mi. broad. Zhikatse was the capital of the Tsang district. administered by a high political officer. North of the town was the self-contained religious-political centre, Trashi Lhiimpo, a large monastery with about 3,300 lamas. The head of the monastery was the panchen lama, sometimes called the Tashi lama, who prior to Chinese military domination and the flight of the dalai lama into India, wielded equal spiritual authority with the dalai, but not temporal power. (*See* TIBET.) A wall surrounds Trashi Lhiimpo and within the enclosure are many temples and dormitories. The former are decorated with gilded roofs and spires, and the images are adorned with jewels and precious metals. A highway joining Zhikatse with Gyangtse and Lhasa was completed in Nov. 1955 and another with Nyanam on the Nepalese border is under construction.

Eight miles northwest of Zhikatse is Nartang, an old cultural centre of Tibet. Its temple is one of three places where the Tibetan Buddhist scripture was printed. The Nartang edition of the Buddhist scripture, printed from wooden blocks, is generally considered more complete than the Lhasa Potala edition.
(T.-L. S.)

ZHITOMIR (JITOMIR), a town in the Ukrainian Soviet Socialist Republic, U.S.S.R.. in 50° 19′ N., 28° 40′ E., on the Teterev river. a left bank tributary of the Dnieper, and at the terminus of a branch railway from Berdichev (1959) 53,000. Pop. (1959) 105,000. There are iron-smelting works and a brewing industry, in connection with which a hop fair is held in early September. Its position on the road west from Kiev gave it early importance and it dates back to the time of the Scandinavian expansion (9th century). The Tatars plundered it in the 13th, 14th and 17th centuries. In 1320 it became part of Lithuania, but was afterward annexed by Poland, and when the Cossacks rose against their chief Bogdan Chmielnicki (1648) they sacked the town. Russia occupied it, along with the rest of the Ukraine, in 1778. During World War II Zhitomir was captured by the Germans in 1941 but was subsequently reoccupied by Soviet troops in 1943.

ZHOB, a river, valley and district in the Quetta division of West Pakistan. The Zhob flows from the hills about 20 mi. N.W. of Ziarat, first eastward then northeastward, until it meets the Gomal river at Khajuri Kach in South Waziristan. The valley is important as the shortest route between Quetta and the northwest frontier districts—? route now followed as far northeast as Fort Sandeman by a narrow-gauge branch of the North-Western railway. Before the Zhob valley expedition of 1884 it was practically unknown to Europeans. In 1889 the Zhob valley and the Gomal valley were taken under British control. and in 1890 the former was the scene of a further punitive expedition.

Zhob District (area 10,478 sq.mi.; pop., 1951, 65,470, mostly Pathans of the Kakar tribe) was formed in 1890 with headquarters at Fort Sandeman (pop., 1951, 6,001). It was much disturbed during the third Afghan war (1919).

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ZHUKOV, GEORGI KONSTANTINOVICH (1896–), Soviet army officer and public official, was born near Moscow in 1896. Conscripted into the tsarist army in World War I. Zhukov joined the Red army upon its formation in 1918 and served as a cavalry commander during the Russian civil war.

Zhukov specialized in armoured operations at Frunze military academy after the civil war and also studied military science in Germany. He won recognition as an expert in the employment of armour during the Soviet-Japanese clashes on the Mongolian-hlanchurian border during the late 1930s.

Appointed chief of the Red army general staff shortly before World War II, Zhukov was relieved to conduct the defense of Moscow. He became the ranking member of Stalin's personal supreme headquarters and figured prominently in the planning or command phase of nearly every major engagement of the war. Zhukov personally commanded the final assault on Berlin and remained in Germany as commander of Soviet occupation forces and Soviet representative on the quadripartite allied control commission for Germany.

Shortly after his triumphal return to Moscow in 1946, Marshal Zhukov was banished by Stalin to a series of regional commands. He returned to prominence as a first deputy defense minister following Stalin's death in 1953, and became defense minister in Feb. 1955. With his election in July 1957 as a full member of the presidium of the Communist party central committee (he had been an alternate member from Feb. 1956), Zhukov attained the highest level of personal authority ever permitted an active Soviet career officer. His political success was short-lived, however; his dismissal as defense minister was announced on Oct. 26. 1957, and he lost his presidium post seven days later. (H. E. Kh.)

ZHUKOVSKY, VASILI ANDREYEVICH (1783–1852), Russian poet, born in the government of Tula. on Jan. 29. 1783, was the earliest of the Russian poets of the golden age of Russian poetry. and a precursor of Pushkin. The volume of his original work is small, consisting of a few beautiful lyrics and elegies. His greatest work was the opening up of the knowledge of English and German poetry in Russia by a series of translations. Briickner (*Gesch. v. Russ. Lit.*) calls him "the most original translator in the world's literature." He began by a translation of Gray's *Elegy;* he went on to the more famous poems of the English romanticists. and it has been asserted that in some cases his versions have greater poetic power than their originals. He turned Fouque's *Undine* into Russian verse. His last great work was a version of the *Odyssey* (1847). Zhukovsky was tutor to Alexander II, and he used his favour at court to help both Pushkin and Gogol. His last years were spent in Germany, and he died at Baden-Baden in 1852.

ZIEGFELD, FLORENZ (1869–1932), U.S. theatrical producer, was born in Chicago. Ill., on March 21, 1869. the son of Florenz Ziegfeld. founder of the Chicago Musical college. He first became active in the entertainment field during the Chicago World's Columbian Exposition of 1893. and later managed Sandow, a famous strongman.

In 1896 he turned to theatrical management. One of his first promotional campaigns was on behalf of a European beauty, Anna Held. Ziegfeld's publicity about Miss Held's milk baths catapulted her to fame and set a pattern of star-making through publicity. In 1907 he produced his first "review." called *The Follies of 1907.* Its combination of seminudity, pageantry and comedy was repeated successfully for more than 20 years. Among the stars developed by Ziegfeld were Marilyn Miller. Will Rogers. Leon Errol. Bert Williams and Eddie Cantor. In addition to the *Follies,* Ziegfeld also produced *Salty* (1920), *Show Boat* (1927), *Rio Rita* (1927) and *Bitter Sweet* (1929).

Ziegfeld married Anna Held in 1897, and after their divorce in 1913 married the actress Billie Burke. He died in Hollywood, Calif., on July 22, 1932. (S. W. H.)

ZIEM, FÉLIX FRANÇOIS GEORGE PHILIBERT (1821–1911), Erench painter, notable for his handling of light and colour, was born at Beaune, Côte d'Or, on Feb. 26, 1821. He studied at Dijon. In 1838 he went to Rome and from 1845 to 1848 traveled in the south of France, Italy and the east. Many of his paintings are in U.S. collections, but two of his finest, "The Doge's Palace in Venice" (1852) and a marine painting, are in Luxembourg, and a "View of Quai St. Jean, Marseilles" at Marseilles. He died in Paris, Nov. 10, 1911.

ZIGABENUS, EUTHYMIUS (fl. 11th/12th century), Byzantine theologian and author of polemical and exegetical works, was a monk of the Peribleptos monastery in Constantinople who was active under Alexius I Comnenus (1081–1118). He wrote commentaries on the Psalms, the Gospels and the Pauline epistles, drawing largely on earlier patristic exegesis. His best known treatise, the *Panoplia dogmatica* against heresies. written at Alexius' request, contains a chapter which is an important source for the history of the Bogomils (*q.v.*).

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ZIGGURAT, in architecture, a common temple form in Chaldea and ancient Babylonia and Assyria, which consists either of a stepped pyramid or of a somewhat similar shape in which the flat terraces of the ordinary stepped pyramid are replaced by an inclined plane ascending spirally from the ground to the summit. Ziggurats were usually great mounds of sun-dried brick with the exterior walls faced with a coating of burned, glazed brick or tile. On the summit there was frequently a shrine to the deity to whom the temple was erected. It is probable that the ziggurat form originated in the attempt to obtain high observatories from which the stars, so important in Chaldean religion and magic, might be observed.

ZIMBABWE, an anglicized form of the Shona word *dzimbahme* (literally "stone houses," modern meaning "chiefs' graves") usually used for the stone ruins about 17 mi. S.E. of Fort Victoria, Southern Rhodesia. More than 100 similar ruins are known from the granite areas of Southern Rhodesia and adjoining areas of Bechuanaland and the Union of South Africa. Every Shona chieftainship has its *dzimbahwe,* a venerated place where tribal representatives gather for intercession with the ancestral spirits. Zimbabwe ruins are in two parts. The floor of a valley is covered with a maze of stone walls about 8 ft. high. At the highest point stands the so-called temple, roughly elliptical and surrounded by a stone wall whose greatest height is 32 ft. and which is 17 ft. thick in places; like all Zimbabwe walling it was built dry without foundations although the ground was leveled before building. Within the temple is the conical tower, a truncated cone of dry stonework, apparently solid, about 18 ft. in diameter at the base and 31 ft. high. Secondly, there are the "acropolis" ruins on the top of a granite hill about 230 ft. high and about ½ mi. N. of the temple. The form of building is determined by the shape of the hill; in effect it is a series of enclosures set end to end along the axis of the hill. The penultimate enclosure eastward is at the foot of boulders 60–70 ft. high, forming a small but impressive natural theatre. This place, according to the son of a chief who lived there in 1890, is the only one properly called Zimbabwe and it was there that the famous soapstone figures of birds (now in museums at Cape Town, Bulawayo, Salisbury and Berlin) stood. They may have been memorials of dead chiefs.

There is little doubt that Zimbabwe was the mast important *dzimbahwe* in the country before the invasion of warlike bands from Zululand in the early 19th century destroyed the Shona confederation. In consequence, Zimbabwe was not spoken of among the Shona and it is almost impossible to obtain any traditional information about the place. Although Portuguese writers of the 16th and 17th centuries mention various places called Zimbaoe, it is very doubtful if any of these refer to Zimbabwe. Zimbabwe must therefore be treated as an archaeological problem, but the disturbances made by treasure seekers in the 1890s added greatly to its complexity. Being but the greatest of many Rhodesian ruins, the general problem can be examined on a broad scale.

Although the ruins were described by C. Mauch in 1874 and investigated by T. Bent in 1891, the first archaeological investigation on modern lines was made by D. Randall-MacIver in 1905. In 1929 G. Caton-Thompson made detailed excavations and from 1947 onward systematic archaeological work mas done on Rhodesian ruins, culminating in excavations at Zimbabwe itself in 1958. The various excavators have shown convincingly that the stone walls at Zimbabwe were often adjuncts to huts built of local clays. so that much of the area was given over to dwellings. In the western enclosure on the "acropolis" the 1958 excavations disclosed layers of huts built one above the ruins of another and overlying still earlier occupation floors. The eastern enclosure of the "acropolis" seems to have had a religious aspect.

Among relics excavated are objects made of talc schist—an easily carved local stone—in the form of bowls, eaglelike birds on tall pillars and stylized human figurines. Of great chronological importance are a few shards of imported wares—Ming Celadon and Nankin porcelain, Persian faïence and Arab glass. Many varieties of imported glass beads were also found. The vast majority of relics were, however, locally made: pottery, copper wire ornaments, iron tools and weapons as well as gold objects.

From the beads Caton-Thompson was able to infer a date for the place as a whole of about the 9th century A.D., which was confirmed by a radiocarbon test on a piece of wood. In 1958 the temple was shown to be much later than other parts—possibly 17th–18th century. Everyone from MacIver onward agreed that these ruins are the product of an African culture and in 1958 some of the later buildings, including the temple, were ascribed to the Rozwi, the tribe under whose hegemony the Shona confederacy flourished in the 18th century. *See* also AFRICA: *Archaeology.*

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ZIMMERMANN, ARTHUR (1859–1940), German diplomat was born May 8, 1859, at Frankenstein. After having been vice-consul at Shanghai and acting consul in 1900 at Tientsin, he entered the foreign office in 1902 and rose by 1910 to be a director of the political section. In 1911 he was appointed under-secretary, and in Nov. 1916 secretary of state in succession to Von Jagow. In this capacity he addressed to America the note of Jan. 31, 1917, on the subject of U-boat warfare. He was also the author of the invitation of Jan. 19. 1917, to Mexico to enter into alliance with Germany and to sound Japan as to her willingness to co-operate. For Mexico the price of this alliance was to be the American States of New Mexico. Texas and Arizona. This proposal. which was sent through the medium of Von Eckhardt. the German minister to Mexico, was intercepted, and Pres. Woodrow Wilson was in a position to publish it on March 1, 1917. The disclosure was one of the primary causes resulting in America's declaration of war upon Germany. Zimmermann retired on Aug. 5, 1917, shortly after the resignation of Bethmann-Hollweg.

ZINC, a metallic element (symbol Zn, atomic number 30, atomic weight 65.38). Zinc was known in Roman times in combination with copper forming the alloy brass, but the individual metal was not isolated until much later. The earliest authenticated use of the word "zinc" to describe the metal is by Paracelsus (*c.* 1490–1541), who described it as a bastard form of copper. In *De re metallica* Georgius Agricola (1494–1555) apparently refers to zinc metal under the name "contrefey" but in other works he uses "zincum" to refer to an ore found in Silesia. The term "spelter," previously employed for commercial grades of zinc, came into use in 1661; it was derived from, the Dutch word *spiauter,* which meant both zinc and pewter.

Occurrence.—Zinc in the metallic state is not known to occur in nature, but zinc minerals are found in quantities economically feasible for mining in many parts of the earth's surface. Among the elements composing the earth's crust, zinc is estimated to rank 24th in order of abundance. The chief ore of zinc is zinc blende or sphalerite (ZnS) and this ore is the source of at least 90% of the metallic zinc produced today. Most commercial deposits of zinc ore occur in limestones and dolomites and are considered to have been formed as cavity fillings or replacements deposited by hydrothermal solutions of igneous origin. Sphalerite is almost always accompanied by galena, the sulfide of lead. It may also be found in association with copper or other base metal sulfides. Oxidation products of sphalerite, smithsonite or calamine ($ZnCO_3$) and hemimorphite ($Zn, [OH]_2SiO_3$), occur in many deposits; and in certain areas, such as north Africa, are worked commercially. Zincite (ZnO), willemite (Zn_2SiO_4) and franklinite ($[Fe, Zn, Mn]O, [FeMn]_2O_3$) are found, but have little economic significance, except at Ogdensburg, N.J., where they form a unique but important commercial deposit. The United States is the main producer of zinc ore, followed fairly closely by Canada. Mexico, Australia and the U.S.S.R. are next in order of importance. Other important sources of supply occur in Peru, Belgian Congo. Poland. Japan, Italy, the German Federal Republic. Spain. Yugoslavia and Sweden. Up to the 1950s small quantities of blende were mined in the United Kingdom, but afterward commercial production practically ceased.

Production.—The established methods of metallic zinc production have relatively heavy treatment costs. In consequence, zinc metal producers demand that the concentrates they treat should be of high grade. After mining. therefore, sphalerite deposits are crushed and concentrated in flotation circuits often of considerable complexity, and every effort is made to separate lead, copper and any other values as separate concentrates. The zinc concentrate finally produced must contain at least 50% zinc, or else it is heavily penalized.

The metallurgy of zinc and hence its history is dominated by the fact that its oxide is not reduced by carbon below the boiling point of the metal. In consequence the metal could not be made in either blast or reverberatory furnaces, the conventional equipment used to produce most other major metals. Until these difficulties were overcome at the beginning of the 18th century, zinc metal as such was unknown in commercial quantities.

Alloyed with copper, in the form of brass, zinc was developed by the Romans. Biblical allusions to brass in the Old Testament are in error and refer to bronze. the alloy of copper and tin. The method the Romans used to produce brass was to heat a mixture of zinc and copper oxides or metallic copper, with carbon in a closed crucible. The zinc vapour produced during the reduction dissolved immediately in the metallic copper present and did not exist separately for any appreciable length of time. This method was used for producing brass in Europe until the beginning of the 18th century.

Credit, as the first European to produce metallic zinc as a separate entity in commercial quantities, must go to William Champion, who in 1738 obtained patent protection for a furnace fitted with an external condenser. He built a small plant at

Warmley, near Bristol, Eng., which eventually contained 31 of these furnaces and, in 1760, produced over 200 tons per year of metallic zinc. Where Champion obtained his initial knowledge is not known. There is evidence that in both China and India the need for an external condenser was recognized, and metallic zinc was produced in quantity prior to the 17th century. The "Malabar tin" described by Libavius in 1597 was apparently zinc. Detailed knowledge of the furnaces used is not available. It is also not known whether Champion obtained his knowledge directly or indirectly from the east. To Champion, therefore, must be given the credit for the first published details of a commercial furnace capable of producing metallic zinc. His furnace consisted of a relatively large crucible fitted with a vertical pipe leading downward to a separate crucible below. Roasted zinc carbonate ore mixed with carbon was heated in the upper crucible. When the temperature was sufficiently high for the reduction of zinc oxide by carbon to take place, zinc vapour was formed and passed down the central tube to condense in the cooler crucible below. This method, termed distillation per *descensum*, was known as the English method. It was used in Great Britain until the middle of the 19th century, when it was displaced by the horizontal retort process developed in Silesia and modified in Belgium, which used less fuel and made less exacting demands on the operating labour. In this process, pipes made of refractory clays, usually oval in section and sealed at one end, are used instead of crucibles. These pipes or retorts are built in horizontal rows in a furnace. In the mouths of the retorts, which protrude through the furnace wall, clay condensers are fitted, which are sufficiently cool to condense the zinc in the vapour leaving the retorts. At the end of each distillation period, usually of 24 hours' duration, the condensers are removed from the mouths of the retorts. The spent charge is pulled out of the retorts. A fresh charge is introduced, the condensers are replaced and the distillation cycle is repeated.

Until about 1880, smithsonite (calamine) was the source of practically all the zinc produced, but then zinc blende began to be used, the sulfide being roasted to oxide before being charged to the retorts. Although zinc sulfide is the most plentiful zinc mineral, in most deposits it is so intimately mixed with other sulfides, particularly galena, that the classical methods of mechanical separation failed to separate the zinc blende. This problem was finally solved by the technique of froth flotation, a process that requires the ore to be first crushed to very fine particles. The froth flotation process depends upon the fact that the minerals—the valuable constituents in an ore—tend to resist wetting by water. The gangue, or earthy constituents, are wetted much more readily. Consequently, when crushed ore is strongly agitated in a suspension of small air bubbles in water, the mineral portion tends to cling to the bubbles and to rise to the surface as a froth. The earthy constituents are wetted and sink to the bottom. Thus a most valuable concentration of the mineral constituents can be made. Most of the commercial zinc concentrates are now produced by this flotation process.

Ordinary hearth roasting of these flotation concentrates produces a very fine calcine, which gives rise to difficulties when treated in horizontal retorts. It was therefore found necessary to agglomerate the roasted product by a sintering process. An alternative procedure sometimes adopted, since 1933, is to roast the concentrates on a moving grate under such conditions that a sintered product is obtained directly.

A large fraction of the world's zinc is still produced from hand-charged horizontal retorts; one furnace may contain hundreds of retorts. Improvements have been made in the furnace construction and methods of firing, and mechanical charging has been introduced at some plants. The process essentially involves, however, a large amount of arduous labour. It produces the zinc in batches and is intermittent in operation.

The construction and operation of large continuously operated retorts offered considerable difficulties, but these were successfully overcome in New Jersey, U.S., where, by 1929, vertical retorts had been developed constructed of silicon-carbide bricks; the charge consisted of briquets made of a mixture of zinc oxide material and bituminous coal.

Another continuous method was perfected in 1931, and a plant was built, based on electrothermic reduction using a novel condenser in which the retort vapours were sucked through molten zinc. A powerful competitor to thermal reduction methods, which is now firmly established, is the electrolytic process by which zinc is deposited from highly purified zinc sulfate solutions. This process has been widely adopted where power is cheap and plentiful, conditions that are essential since the power requirement of the process is considerable. To produce one ton of zinc electrolytically requires a power consumption of approximately 4,500 kw.hr. The rate of increase in use of the electrolytic process can be gauged from the fact that in 1953, 38% of the world's consumption of primary zinc was produced by this method, and 62% by the retort processes. A later advance made in Avonmouth, Eng., has solved the problem of condensing zinc from low tenor gases. This enables blast furnaces to be employed for metallic zinc production for the first time. These furnaces differ from conventional blast furnaces in that the zinc metal is not tapped in the liquid state from the bottom of the furnace, but is obtained by condensation from the gases leaving the top of the furnace.

As with zinc mining, the production of zinc metal is found in many parts of the world. In 1953, 75 smelters and electrolytic plants producing zinc were listed in 21 different countries. The production of the principal zinc-producing countries is listed in Table I.

The application of zinc metal has widened considerably, due to the production of high-purity zinc. This is one of the purest metals produced on a commercial scale and contains over 99.99% zinc. It was first produced electrolytically, and is now made by a number of companies using the electrolytic process and taking precautions to purify the zinc sulfate solution used and to avoid the entrainment of lead by using anodes of a lead-silver alloy giving reduced corrodibility. In 1929 a redistillation method was developed. The furnace consisted essentially of two columns built of silicon-carbide trays placed vertically one above the other. The lower part of the first column is heated. Impure zinc is fed continuously into the upper part of the column and is vaporized as it flows down through the heated trays below. The volatile elements zinc and cadmium are vaporized whereas the less volatile impurities such as iron, lead and copper are run off from the bottom of the column. After a certain amount of further purification by refluxing in the upper, unheated part of the column the vapour, consisting of the zinc now freed from the less volatile impurities but still containing any cadmium present, is passed into a condenser. The metal is fed from this into the upper part of a similarly constructed column. There all the cadmium, since it has a lower boiling point than the zinc, is driven off; and zinc of 99.99% purity is condensed and tapped from the bottom of the column. Furnaces producing 60 tons per day of high-purity metal are in operation in the United States and Europe.

TABLE I.—*World Smelter Production of Zinc*
(in metric tons)

Country	Average 1935–39	Average 1946–50	1956
United States	473,628	774,041	961,474
Mexico	36,515	49,785	56,585
Canada	146,407	176,205	231,946
Argentina		3,246	14,056
Peru	..	916	9,497
Belgium	199,783	144,353	231,584
France	57,590	52,700	110,526
,	165,764	57,343*	191,371*
	31,786	26,241	76,809
Netherlands	19,934	12,024	29,125
Norway	44,751	38,409	48,423
Poland	103,483	77,451	154,530
Spain	7,945	19,886	22,356
United Kingdom	58,604	69,113	83,099
Yugoslavia	3,881	7,126	14,058
Czechoslovakia	6,658	..	..
China	4,389	201	..
Japan	44,054	25,705	136,561
Belgian Congo	..	..	42,247
Northern Rhodesia	15,917	21,558	29,504
Australia	70,231	79,845	107,093
Russian S.F.S.R.	70,261	109,251	306,000
U.S.S.R. (other)	..	..	30,600
Austria	..	..	6,885
Total	1,561,587	1,745,399	2,894,419

*Including both German Federal Republic and German Democratic Republic

TABLE II.—*Commercially Available Grades of Zinc*

Process	Grade	Minimum per cent of zinc
Horizontal retort	Prime western	98.0
Vertical retort	Prime western	99.8
Electrolytic (normal)	Electrolytic	99.95
Electrolytic high grade	High purity zinc	99.99
Refluxing high grade	High purity zinc	99.99

TABLE III.—*Atomic and Physical Properties of Zinc*

Atomic weight	65.38						
Atomic number	30						
Isotopes							
Mass	64	66	67	68	70		
Abundance %	50.9	27.3	3.9	17.4	0.5		
Density at 20° C.	7.133 g./ml.						
Melting point	419.4° C.						
Boiling point	907° C.						
Specific heat rises from 0.092 at 20° C. to 0.109 at 400° C. cal./g./°C.							
Specific heat of liquid	0.12 cal./g./° C.						
Latent heat of fusion at melting point	24.1 cal./g.						
Latent heat of vaporization at boiling point	426 cal./g.						
Electrical resistance at 20" C.							
Parallel to crystal axis	6.00×10^{-6} ohm-cm.						
Perpendicular to crystal axis	5.83×10^{-6} ohm-cm.						
Lattice parameters at 25° C.	$a=2.6649$Å	$c=4.9468$Å					
Linear expansion coefficient 0° to 100° C.							
Parallel to crystal axis	6.0×10^{-5}						
Perpendicular to crystal axis	1.5×10^{-5}						
Electronic structure	1*s*	2*s*	2*p*	3s	3*p*	3*d*	4*s*
	2	2	6	2	6	10	2
Ionization potentials	1st electron 9.36 v.						
	and electron 17.89 v.						
	3rd electron 40.0 v.						
Electrode potential	$Zn = Zn^{++} + 2e^-$	$E^\circ = 0.7620$ v.					

As a result of these varied methods of production. zinc is commercially available in the grades listed in Table II.

Properties.— Freshly cast zinc has a bright silver-blue surface. but on storage in air it becomes grayish oning to the formation of a film of oxide which. being impervious and tenacious, protects the metal from further oxidation. Zinc crystallizes in the hexagonal system. High purity zinc is ductile and can be rolled into sheets and thin foil. Metal of prime western grade is not ductile when cold. but at temperatures above 100° C. it can be rolled into sheets which are flexible at ordinary temperatures. Some of zinc s atomic and physical properties are shown in Table III.

Because of the relatively high electrode potential of zinc. it is anodic to iron. Thus, if iron and zinc in contact are exposed in most corrosive media, the zinc tends to be attacked preferentially and sacrificially. This, coupled with the fact that under atmospheric conditions zinc corrodes far less rapidly than iron, forms the basis for one of the greatest uses of the metal. the protection of steelwork in galvanizing and other protective industries. Commercial zinc of high purity. 99 99+%, is neither attacked by dilute sulfuric or hydrochloric acids nor by boiling water. The other, less pure, grades are attacked by these acids to a degree which increases with increasing impurity content. Boiling water attacks slightly these less pure grades by evolving hydrogen and forming zinc hydroxide ($Zn[OH]_2$). Cold dilute nitric acid dissolves zinc as nitrate with evolution of oxides of nitrogen. Zinc is also soluble in sodium hydroxide and potassium hydroxide solution, but not in ammonium hydroxide.

Applications.— The largest single use for zinc is for the protection of steel against atmospheric corrosion. This use consumes over 40% of the metal made. In the hot-dip process advantage is taken of the readiness with which zinc will alloy with iron. In this process sheets of steel or other steel articles are cleaned and then immersed in a bath of molten zinc. After removal. the steel is covered with a layer of zinc which gives extended protection against atmospheric corrosion. For the same purpose. zinc coatings can be applied by spraying or can be deposited electrolytically. With such coatings, the protective action of the zinc is primarily due to its coherent oxide layer which protects it against further oxidation. This same property is used when zinc sheets are used for roofing and other building purposes. Zinc's ability to protect ferrous materials against corrosion is reinforced by electrolytic action. Zinc is electropositive with respect to iron; therefore, when a galvanized article is subject to atmospheric corrosion, the zinc tends to corrode sacrificially. This principle is also utilized when zinc plates acting as anodes are connected to ships' hulls or underground tanks or pipelines which then are protected cathodically.

The next largest use for zinc is for die-casting alloy. In the die-casting process molten metal is injected. under pressure, into a steel die. In this die. the metal solidifies almost instantaneously, and the die can be opened and the casting ejected with great rapidity. The whole sequence can be operated automatically; therefore the process lends itself to the rapid production of very complicated parts. Zinc forms the basis for one of the best alloys for die-casting when alloyed with 4% aluminum and 0.05% magnesium. It is essential in the formulation of this alloy that only high-purity zinc (99.99+%) is used. and care is taken to prevent contamination by low melting-point metals such as lead or tin; othernise the castings are subject to intercrystalline corrosion. Such an alloy melts easily, is very fluid and does not attack the steel dies into which it is injected. Its shrinkage on solidification is low so that it reproduces with precision the shape of the most complicated dies. The cast parts have good mechanical properties and can be plated or lacquered with little difficulty. For these reasons the automobile industry uses large quantities of zinc die castings, for radiator grills, carburetors, fuel pump and shock absorber bodies. door handles, instrument panels and many other applications. Zinc die castings are also used extensively in electrical appliances, business and light machines, tools. building hardware and toys.

Alloyed with copper. zinc forms the important group of alloys known as the brasses. With variation in the proportion of copper to zinc. these alloys offer a wide choice in physical properties. With copper at 70% and zinc at 30% the structure consists of a single metallographic phase. This material is very ductile, easily fabricated and capable of taking a highly polished finish. As the zinc content is increased a second phase becomes visible in the metallographic structure, and stronger. more rigid alloys can be produced.

Although. in a number of fields, brass is being displaced to some extent by aluminum alloys, it still continues to rank as one of the most important commercial alloys.

Zinc can be readily rolled into sheet and in this form is used in building construction, giving long service at reasonable cost. With slight alloying additions it is used in the form of strip produced in continuous mills, for weather strips and jar caps, but probably the most important use of rolled zinc is in the production of dry battery cans. These cans form the container and one electrode of the Leclanché type of cell. which is the unit upon which most portable dry batteries are based.

Zinc dust is made either by rapidly chilling zinc vapour or by atomizing molten zinc and is used as a reducing agent, in chemical reactions. Apart from its direct application in the manufacture of dyestuffs and other chemicals, it is used in the manufacture of sodium hydrosulfite, which is then used as a reducing agent. Other important uses for zinc dust are in the precipitation of gold from cyanide solutions and. in sprayed form, in protective coating and in paints.

Chemistry.— In addition to its metallic state. zinc exists in the +2 oxidation state in which it forms compounds with the common anions. It is chemically related to cadmium and mercury, the resemblance to cadmium being especially well marked. Zinc is capable of isomorphously replacing many of the bivalent metals (*e.g.*, magnesium. manganese, iron. nickel, cobalt and cadium) in certain salts. The ion Zn^{++} is colourless and has an ionic radius of 0.74A It exists in a hydrated form in neutral and acidic aqueous solutions; but the hydroxide is precipitated in alkaline solution. With excess base the hydroxide redissolves to form zincate ion ZnO_2^{--}. The zinc ion forms many complex ions in aqueous solutions such as $Zn(NH_3)_4^{++}$ and $Zn(CN)_4^{--}$ as well as others.

Zinc oxzde is a white pigment of considerable industrial importance. It is made by two processes, which produce oxides differing somewhat in physical properties. In the direct process a controlled draft of air is passed through a heated bed of mixed roasted ore and coal. This mixture is sometimes in briquet form. Zinc vapour evolves in the bed and is oxidized above the charge by a second current of air. The oxide so formed is caught in filters formed by cotton or woolen bags. In the indirect process metallic zinc is boiled in heated retorts and the vapour issuing from the retorts is burned in a current of air. Oxide from the indirect process usually has better colour and texture although the covering power, when the oxide is used in paint, is not superior to that of the best direct oxide. Pigmentary zinc oxide is crystalline and occurs generally in the form of spherical particles.

By controlling the conditions of production acicular crystals can be produced which give improved brushing characteristics to zinc oxide paint.

Because of its relatively low cost, zinc oxide is widely used as a pigment for both indoor and outdoor application. It has a pigmentary strength somewhat superior to white lead, and has the added advantage of being nonpoisonous and is not discoloured by hydrogen sulfide. It is also used in ceramics, cosmetics, pharmaceuticals and floor coverings.

The rubber industry also consumes considerable quantities of zinc oxide. where it fills a number of uses, particularly in the manufacture of motor car tires. where it provides high thermal conductivity and heat capacity, good adhesive characteristics and resistance to deterioration by sunlight.

The average size of the particles can be controlled by varying the conditions under which the oxide is produced. Normal material has a particle size of 0.2μ. With fine material this may be reduced to 0.1μ. Such material finds application in the rubber industry when fast curing is required. On the other hand, a grade of large particle size ZnO (average particle size 0.4μ) is produced when a slow curing rate is desirable.

A distinctive property of zinc oxide is that when strongly heated it turns yellow, but regains its whiteness on cooling. In the laboratory, it can be readily prepared by heating the nitrate or by heating the chloride in a current of steam. It is insoluble in water, but dissolves readily in all aqueous acids with formation of salts. It also dissolves in aqueous caustic alkalies including ammonia, thus forming zincates (*e.g.*, $Zn[OH]_2$).

Zinc hydroxide, $Zn(OH)_2$, is prepared as a gelatinous precipitate by adding a base to an aqueous solution of zinc chloride. When dried, it is a white powder insoluble in water but soluble in excess of alkali and in acids.

Zinc peroxide is a compound of indefinite composition which contains hydroxide as well as peroxide. It is formed by the addition of hydrogen peroxide to a suspension of zinc hydroxide. It is a valuable antiseptic, being odourless and nonirritant. and is much used in the treatment of skin complaints.

Zinc chloride, $ZnCl_2$, is produced by heating metallic zinc in dry chlorine gas or by heating a mixture of zinc sulfate and sodium chloride. Zinc chloride condenses as a white translucent mass and boils at about 700° C. Its vapour density at goo° C. corresponds to the formula $ZnCl_2$. It is extremely hygroscopic and dissolves readily in water. A solution of zinc chloride is easily produced from the metal and hydrochloric acid; it cannot be evaporated to dryness without considerable decomposition of the hydrated salt into oxychloride and hydrochloric acid, but it may be crystallized as $ZnCl_2.H_2O$. A concentrated solution of zinc chloride dissolves starch, cellulose and a great many other organic substances; hence the application of the fused salt as a caustic in surgery and the impossibility of filtering a strong $ZnCl_2$ solution through paper. Fused zinc chloride has the property of dissolving oxides of many metals, and is thus the basis of a number of fluxes used in metallurgy. For the same reason strong solutions of zinc chloride are used as a flux in soldering. The facility with which zinc chloride dissolves oxides to form oxychlorides is utilized in the manufacture of cements and in the preparation of fillings in dentistry. A solution of the oxide in the chloride has the property of dissolving silk, and hence is employed for removing this fibre from wool in the reprocessing of fabrics. Used alone or with phenol or chromium salts added, zinc chloride is used to preserve and fireproof timber.

Zinc sulfide, ZnS, occurs in nature as blende (*see* SPHALERITE) and is artificially prepared as a white precipitate by adding ammonium or alkali sulfides or hydrogen sulfide to a solution of a zinc salt. It dissolves in mineral acids but is insoluble in acetic acid.

Due to its high refractive index, zinc sulfide forms the pigmentary basis of the white zinc sulfide pigments known as lithopones. which contain up to 60% zinc sulfide and a balance of barium sulfate. These pigments have superior pigmentary strength to zinc oxides and white lead, are nontoxic and do not discolour in the presence of hydrogen sulfide. The grade of lithopone most used contains 28%/30% zinc sulfide with a balance of barium sulfate. It is formed by precipitation at the same time of purified zinc sulfate and barium sulfide solutions followed by calcination of the precipitate at temperatures in excess of 600° C. This calcination causes a growth in particle size to about o 5 mm. and a corresponding development in pigmentary strength. While lithopone, in all its forms, has been superseded in many applications, particularly by titanium dioxide, there are a number of fields such as that of water paints where it is pre-eminent.

Luminescent zinc sulfide can be prepared by heating to high temperatures pure zinc sulfide with small controlled additions of other metals, such as copper or silver.

Zinc sulfate, $ZnSO_4.7H_2O$, or white vitriol, is prepared by dissolving the metallic zinc in dilute sulfuric acid, and then concentrating and cooling the solution. On a commercial scale it is prepared by leaching roasted zinc ore or other zinc-containing materials such as galvanizers' skimmings with sulfuric acid. Insoluble material is removed by filtering. Iron is precipitated by oxidation in neutral solutions. Metals such as copper and cadmium are removed by adding zinc dust. After filtering, the clean purified liquor is concentrated by evaporation and then allowed to crystallize. The hydrated salt crystallizes as colourless orthorhombic prisms which are usually small and needle-shaped. They are stable in air and very soluble in water. On heating, the heptahydrate loses water molecules in successive stages to form finally anhydrous zinc sulfate, which, on further heating above a red heat, is converted into zinc oxide. Zinc sulfate, like magnesium sulfate, unites with the sulfates of the potassium-group metals and of ammonium, to form crystalline double salts $ZnSO_4.R_2SO_4.6H_2O$, which are isomorphous with each other and the magnesium salts.

The main application of zinc sulfate is in the manufacture of rayon where it is used to promote corrugation of the fibre. Another use which is gaining in importance is in agriculture. It is added. when required. to fertilizers for the treatment of soils which are deficient in zinc. As a spray, it is used to control certain plant diseases, particularly those in the citrus industry. Other uses include wood preservation, flotation, as well as uses in the paint and varnish industries.

Zinc carbonate, $ZnCO_3$, occurs in nature as the mineral calamine. The normal carbonate can be prepared by the action of excess carbon dioxide on freshly precipitated zinc hydroxide, but the addition of sodium carbonate to a solution of zinc salts in general produces a white basic carbonate. The basic carbonate is used as a pigment and in the manufacture of porcelain and pottery.

Analysis.—Zinc is precipitated from a neutral solution of its salts, by hydrogen sulfide as the sulfide ZnS, a white precipitate, soluble with difficulty in dilute mineral acids but insoluble in acetic acid. In the case of the acetate, precipitation is quite complete; from a sulfate or chloride solution the greater part of the metal goes into the precipitate; in the presence of a sufficiency of free HCl the metal remains in solution; sulfide of ammonium precipitates the metal completely even in the presence of ammonium salts and free ammonia. The precipitate when heated in air is converted to the oxide. which is yellow when hot and white after cooling; if it is moistened nith cobalt nitrate solution and reheated it exhibits a green colour after cooling.

Zinc can be quantitatively estimated by precipitating it in a formic acid solution containing ammonium formate and ammonium citrate. By this means zinc can be separated from such metals as iron, aluminum and manganese. The precipitated zinc sulfide may then be dried and ignited to form zinc oxide for gravimetric estimation. Zinc may also be precipitated as zinc ammonium phosphate (NH_4ZnPO_4), which is then filtered on a Gooch crucible and dried to a constant neight at 105° C., or ignited and weighed as the pyrophosphate $Zn_2P_2O_7$. Small amounts of zinc may be precipitated as zinc mercuric thiocyanate and weighed as such. Zinc may be determined volumetrically by titration in a dilute mineral acid solution with a standard potassium ferrocyanide solution, using either uranyl acetate as an external indicator or dimethyl naphthidine as an internal indicator.

Various methods, colorimetric, polarographic and spectrographic, are available for determining small quantities of zinc. These three physical methods have largely replaced the standard chemical methods for the routine determination of the small amounts of impurities in zinc metal.

Pharmacology and Therapeutics.—Zinc is used in medicine in the form of various salts, most of which are antiseptic, astringent, irritant. caustic or toxic. Some of the less irritating salts are used as emetics, but, for the most part, internal use of the zinc salts should be avoided except upon a doctor's advice. Zinc preparations are used locally in alcoholic or watery solutions. as washes for eyes, ears, wounds or ulcers. For these purposes zinc sulfate is, as a rule, in dilute solutions of 1% or less. Ointments and dusting powders are made commonly with zinc oxide or stearate. Zinc chloride is made in hard pencils by mixing it with plaster of Paris. These are caustic and are used for the destruction of various abnormal tissues and also for such purposes as destroying horn growth in calves.

The irritant and caustic salts of zinc are very dangerous if taken internally and, unless removed immediately, may cause death or irreparable damage. If taken by mouth in poisonous doses vomiting should be induced immediately by the use of warm oil or soapy water, and, after emesis. lard, butter, oleomargarine, raw eggs, milk, cream, or oil such as is used in salads, should be given. Immediate treatment is essential and a doctor should be summoned without delay.

Zinc is used in medicine in combination with other therapeutic agents or in their preparation. An example is its use in insulin therapy for diabetics.

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ZINCITE, a mineral consisting of zinc oxide, is usually found in platy or granular masses. Its blood-red colour and orange-yellow streak are characteristic, as is also its common association with black franklinite and white calcite. It occurs principally at Franklin and Sterling hill, near Ogdensburg, N.J. (*see* Zinc). Zincite, ZnO, crystallizes in the dihexagonal pyramidal class of the hexagonal system. Distinct crystals are rare; they are hemimorphic and consist of a single basal plane and a hexagonal pyramid. There may be a perfect basal parting. The hardness is 4 to 4.5 and the specific gravity 5.7 Manganese may partially replace zinc. (L. S. Rl.; X.)

ZINDER, a town and former capital of Niger, in former French West Africa. Its ruler was formerly subordinate to Bornu, but with the decline of that kingdom he shook off the yoke of the sultan and on the conquest of that country by Rabah (*q.v.*) seems to have maintained his independence. The country, known as Damerghu, is semifertile and supports horses. sheep and camels. By the Anglo-French agreement of June 1898 it was included in the French sphere. The town was occupied in July 1899. A French post (named Fort Cazemajou) was built outside the town on a mound of huge granite blocks. Subsequently Commandant Gadel mapped and pacified the surrounding region and sent out columns of meharitstes (camel corps) which occupied the oasis of Air and Bilma in 1906. Zinder is surrounded with high earther walls. pierced with seven gates. Pop. (1959) 14.891.

ZINGARELLI, NICCOLO (1752–1837), Italian composer, was horn at Naples on April 4, 1752. His first dramatic work, *I quattro Pazzi,* was produced at the conservatorio in 1768. He gave violin lessons for a time. but in 1781 produced his first opera, *Montesuma,* at the San Carlo and afterwards in Vienna, where it was highly commended by Haydn. He finally settled in Milan, with introductions to the viceregal court, and over a period of 11 years produced a series of operas for La Scala, an oratorio of the Passion, and several cantatas. In 1789 he went to Paris to write an opera for the Académie royale de musique. This work, *L'Antigone,* for which Marmontel provided the libretto, was performed on April 30, 1790, but Paris was no place for Zingarelli during the Revolution, and he fled into Switzerland and returned to Milan early in 1791.

In 1792 he won the appointment, by open competition, of master of the chapel at the cathedral. He first achieved an international reputation by a series of comic operas, beginning with *La secchia rapita* in 1793. His finest work was, however, *Guilietta e Romeo,* played at La Scala in 1796. From 1794–1804 Zingarelli was master of the chapel at Loreto, and during this time, although he also wrote operas, he was chiefly inspired to compose sacred music, contributing largely to the enormous collection of manuscript works, the property of the church, known as the *Annuale di Loreto.* In 1804 he went to Rome as master (*maestro di capella*) of the Sistine chapel and in 1805 produced one of his most successful works, *La distruzione di Gerusalemme,* which held the stage for five years. His last opera, *Berenice,* received a hundred consecutive performances.

At the "king of Rome" celebrations, when Napoleon ordered a *Te Deum* to be sung in Rome. Zingarelli's principles did not allow him to undertake the performance, and on his refusal he was arrested and brought before the emperor in Paris. But Napoleon at once released him and provided him with a pension. Zingarelli's post in Rome had been taken by Fioravanti, but in 1813 he was appointed director of the Real Collegio di Musica at Naples and in 1816 *maestro di cappella* at the cathedral.

ZINGIBERACEAE, the ginger family: a group of tropical plants, including important spices and condiments, mostly native to eastern Asia. The various parts of the plants are usually more or less aromatic. Forty genera and about 900 species are recognized. Among the economic species are ginger (*q.v.; Zingiber officinale*), cardamoms (*q.v.; Elettaria cardamomum* and *Amomum cardamomum*) Melegueta pepper (*Aframomum; see* Grains of Paradise) and turmeric (*q.v.; Curcuma longa*), the latter used in making curry powder. Various species of *Alpinia, Hedychium, Phaeomeria* and other genera are cultivated for ornamental purposes.

ZINNIA, a genus of the family Compositae, containing about 12 species of tender annual or perennial herbs or undershrubs, found wild from the southern United States and Mexico to Chile. The numerous single and double garden forms are mostly derived from *Zinnia elegans* and grow about 2 ft. high, producing flowers of various colours, the double ones being about the size of asters and very handsome. The colours include white, yellow. orange, scarlet, crimson and purple. Zinnias do best in a rich deep loamy soil, in a sunny position. They should be sown on a gentle hotbed at the end of March and planted out only after settled warm weather.

ZINOVIEV, GRIGORI EVSEEVICH (1883–1936), Russian politician, was born in Sept. 1883 at Elisavetgrad (Zinovievsk). He studied chemistry and later law at Berne. He was a revolutionary before he was 20 and in 1903 met Lenin. He was head of the Bolshevik party in Berne and during 1903–4 started Bolshevik propaganda in south Russia. Apart from his activities abroad, he came into prominence in Russia during 1906–8 as a member of the Bolshevik St. Petersburg committee of the Russian Social Democratic party by his organization of the attempted Kronstadt rising after the dispersal of the first Duma, his editorship of the Bolshevik paper *Vpered* ("Forward") and of *The Sociul Democrat,* the central organ of the party. In 1908 he was arrested and imprisoned but was released. He went abroad and did not return until the Revolution in 1917. During these nine years Zinoviev worked hard for his party. He was a member of the central committee, co-editor of the principal Bolshevik publications and representative of the party at the Copenhagen congress of the International. In 1912 he went with Lenin to Galicia to control from the nearest possible point the growing labour movement in Russia. In Galicia he founded the foreign bureau of the central committee, which guided the party work in Russia and the activities of the Bolshevik group in the Duma. Zinoviev edited with Lenin *Against the Tide,* a work of propaganda against World War I; and at the Zimmerwald conference (1915) they began to organize the Communist International. On the outbreak of the March revolution (1917) they returned to Russia and began to prepare the way for the Revolution. Zinoviev was co-editor of *Pravda* and, aiter its suppression, of *The Proletarian* and *The Worker*. He thus became one of the leading figures in Russia. In 1919 he was elected president of the Communist International and after the death of Lenin in 1924 was one of the most zealous upholders of pure "Leninism." But in 1926 he was expelled from the political bureau and in 192; from the Communist party. He was readmitted in 1929; but in Jan. 1935 he and Kamenev (q *v*) were exiled for counterrevolutionary activities. On Aug. 25, 1936, convicted of high treason, he was shot.

ZINZENDORF, NICOLAUS LUDWIG, Count of Zinzendorf and Pottendorf (1700–1760), German religious and social reformer, was born on May 26, 1700, at Dresden. Both his parents belonged to the Pietist circle, and the lad had Philipp Jakob Spener for his godfather. His school days were spent at Halle amid Pietist surroundings, and in 1716 he went to the University of Wittenberg. During a lengthened visit at Castell he fell in love with his cousin Theodora, but her mother objected to the marriage and Theodora married Count Henry of Reuss. Zinzendorf took this rebuff as a call to special work for God, and he now resolved to settle down as a Christian landowner, spending his life on behalf of his tenantry at Berthelsdorf. His intention was to carry into practice the Pietist ideas of Spener.

The "band of four brothers" (Rothe, pastor at Berthelsdorf; Melchior Schaffer, pastor at Gorlitz; Francis von Watteville, a friend from boyhood; and himself) set themselves to create a revival of religion. From the printinghouse at Ebersdorf large quantities of books and tracts, catechisms, collections of hymns and inexpensive Bibles were issued; and a translation of Johann Arndt's *True Christianity* was published for circulation in France. Zinzendorf seems to have doubted the wisdom of Spener's plan of not separating from the Lutheran Church, and began to think that true Christianity could be best promoted by free associations of Christians, which in course of time might grow into churches with no state connection.

Zinzendorf offered an asylum to a number of persecuted wanderers from Moravia and built for them the village of Herrnhut on a corner of his estate of Berthelsdorf. The refugees who came to this asylum (between 1722 and 1732 — the first detachment under christian David) from various regions where persecution raged, belonged to more than one Protestant organization. Zinzendorf devoted himself to them.

Gradually Zinzendorf was able to organize his refugees into something like a *militia Christi,* based not on monastic but on family life. He established a common order of worship in 1727 and soon afterward a common organization. which has been described in the article Moravian Church. He traveled widely on behalf of the Moravians, visiting America in 1741–42 and spending a long time in London in 1750. Missionary colonies had by this time been settled in the West Indies (1732), in Greenland (1733), among the North American Indians (1735); and before Zinzendorf's death the Brethren had sent from Herrnhut missionary colonies to Livonia and the northern shores of the Baltic, to the slaves of North Carolina. to Surinam, to the Negro slaves in several parts of South America. to Travancore in the East Indies, to the Copts in Egypt and to South Africa.

ZION, in the Old Testament a topographical designation of the eastern hill of the two hills of ancient Jerusalem (*q.v.*), the site of the Jebusite city captured by David (II Sam. v, 6–93 and established as his royal capital. Some scholars believe that the name of Zion also belonged to the "stronghold of Zion" taken by David (II Sam. v, 7), which may have been the citadel of the city of Jerusalem. The temple of Solomon was built on the hill north of the city. Josephus in the 1st century A.D. identified Zion with the western hill of Jerusalem, where most of the city lay in his day, and this transfer of the name was retained until modern times. The eastern hill (the modern Ophel) was not included in the walls of the 16th-century fortifications and is still covered with fields and vineyards. It was not until the late 19th and early 20th centuries that the correct identification of the site of Zion was recovered and generally accepted.

Zion appears in the Old Testament 152 times as a title of Jerusalem; over half of these occurrences appear in two books, Isaiah (46 times) and Psalms (38 times). Zion appears seven times in the New Testament; of these occurrences five appear in quotations from the Old Testament. Zion does not appear in the books from Genesis to I Samuel inclusive, Ezra, Nehemiah, Esther, Job. Proverbs, Ecclesiastes, Ezekiel, Hosea, Jonah, Nahum, Habakkuk, Haggai and Malachi. It occurs in the Apocrypha or deuterocanonical Greek books four times in Sirach, three times in Baruch and eight times in I Maccabees.

The name is overwhelmingly a prophetic and poetic designation infrequently used in ordinary prose. It usually has emotional and religious overtones and is rarely neutral. It is not clear why the name Zion rather than the name Jerusalem should carry these overtones, although the name Jerusalem itself is highly charged also. It is possible that the name Zion was a familiar name used by the people of Jerusalem and Judah; central cities sometimes acquire nicknames which connote feeling. "Zion," "the dweller of Zion!" "the sons and daughters of Zion" designate the population of the city and sometimes the entire population of Judah.

The etymology and meaning of the name are obscure. It appears to be a pre-Israelite Canaanite topographical name of the hill upon which Jerusalem was built; the name "mountain of Zion" is common. In biblical usage. however, "Mount Zion" often means the city rather than the hill itself.

The religious and emotional quality of the name arises from the importance of Jerusalem as the royal city and the city of the temple. The city recapitulated in itself several of the basic themes of Israelite belief. Mount Zion is the place where Yahweh dwells (Isa. viii. 18; Ps. lxxiv, 2), the place where He is king (Isa. xxiv, 23; Mic. iv, 7). It is His holy mountain upon which He has installed His king, David (Ps. ii, 6). It is the place where His name is (Isa. xviii, 7), which He has loved (Ps. lxxviii, 68). It is therefore the seat of the action of Yahweh in history. He founded Zion (Isa. xiv, 32), treats Zion kindly (Ps. li, 18), delivers it (Ps. lxix, 35), chose it (Ps. cxxxii, 13), loves its gates (Ps. lxxxvii, 2), has mercy on it (Ps. cii, 13), builds it (Ps. cii, 16), appears on Zion (Ps. lxxxiv, 7), is jealous for it (Zech. viii, 2), blesses from it (Ps. cxxviii, 5; cxxxiv, 3), roars against His enemies from it (Amos i, 2; Joel iii, 16). The deliverance of Israel comes from Zion (Ps. liii, 6). Yahweh's fire, the fire of His anger and judgment, burns on Zion (Isa. xxxi, 9).

The city of Jerusalem is personified as a woman and addressed or spoken of as "the daughter of Zion." This title is always used in a context charged nith feeling. The feeling is aroused by either of two ideas which stand in opposition to each other; the destruction of Jerusalem or its deliverance. The daughter of Zion is left like a booth in a vineyard (Isa. i, 8). Jeremiah hears a shriek of panic; it is the voice of the daughter of Jerusalem crying that she dies at the hands of murderers (Jer. iv, 31). The title appears six times in the second poem of Lamentations (Lam. ii, 1, 4. 8, 10, 13, 18); Yahweh has disgraced the daughter of Zion, she is invited to cry and wail at her downfall, and she is addressed by the pathetic title "virgin daughter of Zion." But it is by the same title that Jerusalem is addressed when her deliverance is announced (Isa. lxii, 11). She scoffs at the Assyrian when he attacks (Isa. xxxvii, 22; II Kings xix, 21). Micah invites her to arise and thresh her enemies (Mic. iv, 13), and Zephaniah calls on her to cry out with joy at her deliverance (Zeph. iii. 14). Zechariah invites her to rejoice that Yahweh is coming to resume His dwelling with her (Zech. ii, 10) and to exult that her king comes to her (Zech ix, 9).

Mount Zion is identified with "the recesses of the north," the mountain of Canaanite mythology where the gods dwell (Ps. xlviii, 2). It is on Zion that Yahneh will "finish His work," His deeds of judgment and salvation (Isa. x, 12), and where He will establish His glory as a protecting canopy (Isa. iv, 5). Hence Mount Zion is a place of security. The nations which attack Mount Zion will be scattered (Isa. xxix, 8) and those on Mount Zion will escape disaster (Isa. xxxvii, 32; II Kings xix, 31; Joel ii, 32; Obad. 17). Those who trust in Yahweh are, like Mount Zion, immovable (Psa. cxxv, 1).

Zion is an object of threat to the pre-exilic prophets. Micah calls it a city built with blood and predicts that it will be plowed like a field (Mic. iii, 10–12), and the oracle was remembered in the time of Jeremiah (Jer. xxvi, 18). The attack upon Jerusalem related in Jer. xxvi shows that in his time Jerusalem and Zion were regarded as inviolable not only from attack but also from the judgment of Yahweh. This superstitious sense of security was shattered by the destruction of Jerusalem by the Babylonians in 586 B.C., and the spiritual crisis of the disaster is reflected in the sadness of Ps. cxxxvii. But, as this Psalm avows, the Israelites could not forget Zion, and in postexilic prophecy it is the scene of Yahweh's messianic salvation. Zion seemed to be a place sought by none (Jer. xxx, 17), and it could say that Yahweh had abandoned it (Isa. xlix, 21). But it is to Zion that the exiles shall be restored (Jer. iii, 14), and there they will find Yahweh (Jer. xxxi, 6). The "Zion songs" of Deutero-Isaiah (xlix, 14–1, 3; li, l–lii, 12) assure the exiles of the restoration of Zion, and the poems of Trito-Isaiah (lx–lxi) describe the glory of the city in almost mythological language. Zion is invited to rouse itself, to put on strength (1 1 1–2). It is in Zion that Yahweh places salvation (Isa. xlvi, 13). Zion is redeemed in judgment (Isa. i, 27), it is filled with judgment and righteousness (Isa. xxxiii, 5). The restored Zion is once again the city of Yahweh, the Zion of the Holy One of Israel (Isa. lx, 14). In a passage attributed to both Isa. (ii, 1–4) and Mic. (iv, 1–3) Zion becomes the highest of all mountains, a place to which all the peoples of the earth throng as to a source of revelation; for instruction comes out of Zion, and the word of Yahweh from Jerusalem.

While the name of Zion is rare in the New Testament, it has been very frequently used in Christian literature and hymns as a designation of the heavenly city or of the earthly city of Christian faith and fraternity. Since the 19th century Zionism is the name given to the movement to establish a national home for the Jews in Palestine, a movement which issued in the establishment of the state of Israel. *See* also JERUSALEM.

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ZIONISM, is a Jewish national movement with the goal of creating a Jewish national state in Palestine, the ancient homeland of the Jews (*q.v.*), which is called in Hebrew *Eretz Israel,* ("the Land of Israel"). Though Zionism originated in eastern and central Europe in the later part of the 19th century, it is in many ways a continuation of the deep-felt nationalist attachment of the Jews and of the Jewish religion to Palestine, the land promised by God to the Jews. This attachment to Zion inspired the Jews throughout the middle ages and found its expression in many important parts of their liturgy.

Early History. — At the end of the middle ages a number of "messiahs" came forward with the claim to lead the Jews back to Palestine, and they were generally received with great enthusiasm by their fellow Jews. The most important of these messiahs were David Reubeni and his disciple Solomon Molcho in the first part of the 16th century and above all in the 17th century Sabbatai Sebi (*see* SABBATAI ZEBI), who proclaimed himself the Messiah in Turkey in 1648. Most European Jews believed in Sabbatai's mission and many continued to do so even after he had become a Moslem.

The age of the Enlightenment in the second half of the 18th century, with its growth of religious toleration and its general universal and liberal ideas, laid the foundations in western Europe and North America for the emancipation of the Jews and their participation as citizens in the life of the nations in the midst of which they lived and whose members they became. The consequence was less emphasis among the Jews on traditional religious attitudes and more on assimilation of western secular culture. This movement emerged also in Germany where Moses Mendelssohn (1729–86), a philosopher and a friend of the great German writer Lessing, emphasized the spiritual and universal aspects of Judaism. He and a group of like-minded fellow Jews, most of them residents of Berlin and Königsberg in Prussia, wished to win the Jews over to modern western civilization. The younger Jewish generation gladly seized the opportunity of intellectual enrichment and civic freedom which the new movement, originally called by the Hebrew name *Haskala* ("enlightenment"), offered to them. Many went the way of complete assimilation, including the abandonment of the faith of their fathers. Others found their place as citizens of the Jewish faith in the new liberal and equalitarian societies emerging in the 19th century in western Europe and North America. Still others applied the new scholarship learned from western civilization to a study of the Jewish past and produced, especially in Germany, works of lasting value in the rediscovery and reinterpretation of the ancient heritage. Some wealthy Jews—among them Sir Moses Montefiore and the Rothschild family—tried to help their coreligionists in less fortunate lands, especially in eastern Europe and in the middle east, by establishing schools for them and by introducing them to agriculture and to various trades. For reasons of religious piety, a small number of Jews, supported by donations from outside, settled in Palestine.

The interest in a return of the Jews to Palestine was kept alive in the first part of the 19th century more by Christian millenarians, especially in Great Britain, than by Jews themselves. Among the few Jews pleading then for a Jewish settlement or state was the American Mordecai Manuel Noah (1785–1851), who in 1813 became U.S. consul in Tunis and later high sheriff and surveyor of the port of New York. In 1825 he acquired Grand Island in the Niagara river and invited the Jews of the whole world to create a Jewish state, Ararat, there. In 1844 he pleaded with the Christian world, in *Discourse on the Restoration of the Jews* to help the Jews resettle in Palestine. More important but not more successful were the attempts by Lord Shaftesbury, Sir Laurence Oliphant and other British individuals to create a Jewish state in Palestine. Some political writers thought of a Jewish state in the Holy Land as a means of assuring the overland route to India. Others were inspired by religious or mystic ideas, "anxious to fulfil the prophecies and bring about the end of the world," as was the eccentric Oliphant, who was accompanied on one of his visits to the middle east by Naftali Herz Imber (1856–1909), a Hebrew poet of Polish origin, famous in the history of Zionism as the author of "Hatikwa" ("The Hope"), which became the Zionist national anthem, and of "Mishmar Hajarden" ("The Watch on the Jordan"), a popular nationalist song.

These early sympathies with the return to Zion in the English-speaking world found their best literary portrayal in George Eliot's novel *Daniel Deronda* (1876). A German socialist, Moses Hess (1812–75), influenced by the example set by the unification of Italy, gave the first theoretical expression to Zionism among Jews, *Rome and Jerusalem* (1862; Eng. trans., 1918). This short book, which contained many thoughts later widely accepted by Jewish nationalists, combined ethical socialism, fervent nationalism and religious conservatism. Hess believed that the historical ideal of the Jewish people could be realized only in their own historic homeland. He insisted that a moral and spiritual regeneration must precede the settlement there. He hoped that France, which he venerated as the home of the Revolution, would protect the Jewish settlement because it would wish to see the bridge across the middle east held by a friendly people. Hess's book attracted no attention when it appeared. Only decades later was it rediscovered by the Zionist movement, which had by then developed in eastern and central Europe.

The Love of Zion Movement. — Whereas in western Europe the Jews became in the 19th century an integral part of the nations whose citizens they were and fully adopted their language and culture, the Jews in eastern Europe, then identical with the Russian empire, lived as a separate community with their own language, Yiddish, their own civilization and their own and distinct economic structure. They did not enjoy political or legal equality with the Russians. Further, under the reactionary regime which set in after the reform age of Tsar Alexander II (18;;–81) all hopes for Jewish emancipation were dashed. A wave of bloody pogroms, instigated or tolerated by the government, threatened Jewish lives and property. As a result large-scale emigration to western Europe and to the United States started. A very small trickle of Jewish youth from Russia also went to Palestine and founded there the first agricultural settlements. In 1882 Leo Pinsker (1821–91), a physician in Odessa, published *Auto-emancipation* (Eng. trans., 1891), an appeal in German to the western European Jews to save the Jewish people from persecution and misery of dispersion. He applied the ideas of 19th-century European nationalism and secularism to the Jews and propagated the necessity of concentrating them territorially, in Palestine or elsewhere. He found no echo among the western European Jews. But in Russia a small group, which took the name *Hovevei* Zion ("Lovers of Zion"), gathered around him and formed a committee in Odessa to promote the settlement of Jewish farmers and artisans in Palestine. Though these early settlements were able to survive only with the help of Baron Edmond de Rothschild of Paris, they laid the loundations of practical Jewish colonization in Palestine,

The most prominent among these early Zionists was Asher Ginzberg (1856–192j), whose essays written under the pen name Ahad Ha-am ("One of the People"), became classics of the modern Hebrew language which they helped to create. Ahad Ha-am denied that the majority of the Jewish people could be settled in Palestine, the smallness of the country and the fact that it was inhabited by a large native population seeming to him to he insurmountable obstacles. But though Palestine according to him could not become a Jewish state, he believed in the creation of a Jewish cultural centre there, a place for the regeneration of Judaism, from which spiritual influences would radiate into all the many lands where Jews continued to live and which would awaken in their hearts a true "love of Zion."

This early Hebrew renaissance in Russia also produced several great Zionist poets: among them Chaim Nachman Bialik (*q.v.*) and Saul Tchernihovsky (18; 5–1943). At the same time the Yiddish language, an eastern European derivation from medieval German not to be confused with the ancient Semitic Hebrew tongue, was raised from a people's vernacular to a medium of art by a number of writers, the first of whom was S. J. Abramowitsch (1835–191j), who wrote under the pen name Mendele Mocher Sforim ("Mendele the bookseller"). (See YIDDISH LANGUAGE AND LITERATURE.)

Political Zionism.—A new impetus was given to Zionism by Theodor Herzl (*q.v.*), an Austrian journalist. In the multinational pre-World War I empire of the Habsburgs with its violent nationality struggles the Jews found themselves in a difficult position. Except for eastern Europe, anti-Semitism (*q.v.*) was nowhere as strong as among the Austrian Germans, especially in Vienna where Herzl lived. The Dreyfus affair of the '90s and its attendant outburst of anti-Semitism (see FRANCE: *History*) which he witnessed in 1895 as a newspaper correspondent in Paris caused him to write a pamphlet, "Der Judenstaat" ("The Jewish State," 1896). He regarded assimilation as most desirable but, in view of anti-Semitism. impossible of realization. Against their own wishes, he believed, the Jews were forced by pressure from outside to form a nation. As such they could lead a normal existence only through concentration in one territory. Herzl had no living ties with Jewish and Hebrew traditional values. He never desired the rebirth of Hebrew as the Jewish national language. In his novel *Altneuland* (1914) he depicted the future Jewish life in Palestine in terms of life as he had known it among the liberal assimilated central European Jews. In this novel, his testament to the movement, he rejected all narrow nationalism and demanded above all brotherly consideration for, and closest co-operation with, the Palestinian natives in a common homeland.

Herzl molded Zionism into a political movement of world-wide signiiicance. He became its indefatigable organizer, propagandist and diplomat. He convened in Aug. 1897 the first Zionist congress at Basel, Switz., which drew up a constitution for the movement. His friend Max Nordau (q.3.) participated in drawing up the "Basel program" of the movement which proclaimed that "Zionism strives to create for the Jewish people a home in Palestine secured by public law." To that end the movement was to promote on suitable lines the colonization of Palestine by Jewish rural and industrial workers; to organize the whole of Jewry by means of appropriate local and international institutions, in accordance with the laws of each country; to strengthen and foster Jewish national sentiment; and to obtain government consent where necessary to the attainment of the Zionist aims.

The centre of the movement was established in Vienna, where Herzl published the official weekly *Die* Welt ("The World"). The congresses met every year until 1901 and then every two years. Meanwhile Herzl entered into negotiations with the Turkish government in order to receive a charter establishing Palestine's autonomy, but the Turkish government rejected the proposals. Only in England did Herzl find sympathy, and for that reason he established the financial instruments of the movement in London. In 1903 the British government offered an area of 6,000 sq.mi. to the Zionist organization in the uninhabited highlands of Uganda. This offer led to violent controversy and even a split in Zionist ranks. A minority under the leadership of Israel Zangwill (*q.v.*) was willing to accept the offer. Members of this minority founded in 1905 the Jewish Territorial organization with the aim of finding an autonomous territory for those Jews who could not or did not wish to remain in the countries in which they lived. The majority of the Zionists, most of them from Russia, insisted on Palestine as the only field of activity for Zionism, and the seventh Zionist congress in 1905 rejected any colonization outside Palestine and its neighbouring countries. In 1904 in the midst of this bitter debate Herzl, only 44 years old, died.

Pre-World **War I Zionism.**—With the death of Herzl the leadership moved from Vienna to Germany, first to Cdlogne then to Berlin. Austrian and German Jews led the movement, but its mass strength came from Russia. At that time only a very small minority of the Jews were organized in the Zionist movement. There mas much opposition to Zionism in Jewish ranks, based partly on the conviction that the Jews had to become, or were already, an integral part of the nations among whom they lived and to which they belonged, partly on religious orthodoxy which expected the return to Palestine only under divine guidance and the strict application of traditional religious laws and partly on the conviction that the Jewish people could exist as a distinct national group in the Diaspora, especially in countries of Jewish mass settlement and Yiddish folk culture. Among the last group was the Bund, a Jewish socialist party: founded in Russia in 1897. Jewish socialists were also organized as Zionists under the name of *Poale* Zion ("Workers of Zion"). Their first world conference was held in The Hague in 1907.

Of greater importance was the question of the position of traditional orthodoxy in the Zionist movement. In 1902 a number of Russian Zionists founded Mizrachi as the party of religiously orthodox Zionists who insisted on the strict observance of Jewish religious laws in Palestinian Jewish life. The ideal of Herzl, on the other hand, had been a modern secular movement. The Zionist organization declared itself neutral in matters of religion, but from time to time the insistence of the religious groups upon observance of Jewish religious precepts caused conflicts within the movement.

Though Zionism represented only a minority of Jews, and in the western lands only a small minority, it was the only world-wide democratically organized part of Jewry. It developed an active propaganda through orators and pamphlets, created its own newspapers in many languages and gave an impetus to what was called a "Jewish renaissance" in letters and the arts. (See HEBREW LITERATURE.) At the same time the failure of the Russian revolution of 1905 and the wave of pogroms and the repressive measures which followed it disillusioned many in regard to Jewish emancipation in eastern Europe. Again as in 1882, but now in growing numbers, Russian Jewish youth emigrated to Palestine to live there as pioneers in newly founded agricultural settlements in which they hoped to realize their nationalist and socialist ideals. They fought against the employment of "foreign" (Arab) labour and insisted on the use of Hebrew as the spoken language.

The growth of the Jewish settlement in Palestine was due to the "practical" Zionists; who were opposed by the "political" Zionists who insisted on the granting of a charter as an essential prerequisite for colonization. With the growing strength of the Young Turk nationalist movement in Turkey, especially after 1908, the prospects of obtaining a charter dimmed considerably. Hut in spite of small financial means, urban development and agricultural settlement among the Jews in Palestine made steady progress. In 1914 there were about 90,000 Jews in Palestine, where the large majority of the population was Arabian. There were 43 Jewish agricultural settlements with 13,000 settlers, many of them supported by Baron Rothschild.

The situation changed with the outbreak of World War I. Zionist work in Palestine came to a standstill. Turkey and Britain were at war. An opportunity offered itself for "political" Zionism to reassert itself and to combine the old British sympathies for Zionism with the opportunities of political warfare. As a result the centre of the Zionist movement shifted from Germany, Turkey's ally. to London. The leadership passed to Jews of Russian origin living in London—among them Chaim Weizmann (*q.v.*) and Nahum Sokolow (*q.v.*). As a result of the Bolshevik Revolution of Nov. 1917 and of the consequent civil war with its pogroms perpetrated by the White armies and because of the intensified nationalism of the various succession states of post-World War I Europe, great misery spread nmong eastern European Jews. From then on the financial and economic strength of Zionism came from Jews in the United States, and the masses of its adherents from 1920 to 1938 came from Poland.

The Balfour **Declaration.**—Chaim Weizmann was instrumental in bringing about a letter written by Arthur James Balfour, then British foreign secretary. to Lord Rothschild on Nov. 2, 1917. declaring that "His Majesty's Government view with favour the establishment in Palestine of a national home for the Jewish people. and will use their best endeavours to facilitate the achievement of this object, it being clearly understood that nothing shall be done which may prejudice the civil and religious rights of existing non-Jewish communities in Palestine. or the rights and political status enjoyed by Jews in any other country."

The British government hoped that a declaration in favour of Zionism would help to rally Jewish opinion, especially in the United States. to the side of the Allies, and that the settlement in Palestine of a Jewish population attached to Britain by ties of sentiment and interest might help to protect the approaches to the Suez canal and the road to India. The Balfour declaration fell short of the expectations of the Zionists. who had asked for the reconstitution of Palestine as "the" Jewish national home. Instead, the Balfour declaration envisaged only the establishment "in" Palestine of "a" national home for the Jewish people. Nevertheless the declaration aroused enthusiastic hopes among Zionists and seemed the fulfillment of Herzl's hopes. It was endorsed by the principal Allied powers, and through its acceptance by the conference of San Remo in 1920 it became an instrument of British and international policy. The council of the League of Nations approved on July 24, 1922, a British mandate over Palestine which included the Balfour declaration in the preamble and various provisions dealing with facilitating Jewish immigration. The mandate had been officially interpreted in a statement of June 3, 1922, in which Winston Churchill, the British colonial secretary, announced that the declaration did not mean "the imposition of a Jewish nationality upon the inhabitants of Palestine as a whole, but the further development of the existing Jewish community, with the assistance of Jews of other parts of the world, in order that it may become a centre in which the Jewish people as a whole may take. on grounds of religion and race. an interest and a pride." His majesty's government, he announced, had not contemplated at any time: as appeared to be feared by the Arabs, "the disappearance or the subordinntion of the Arabic population, language. or culture in Palestine."

From World War I to World War 11.—In the years after 1920 Zionism increasingly concentrated upon building up Jewish urban and rural settlements in Palestine, perfecting autonomous organizations there and solidifying and intensifying Jewish cultural life and Hebrew education. Thus the basis was laid for a full-fledged national life. In March 1925 the Jewish population in Palestine was officially estimated at 108,000 and it was about 300,000 by the end of 193j. The area of land in Jewish possession rose from 177 sq.mi. in 1914 to 500 sq.mi. in 1935, much of it acquired by the Jewish National fund ***(Keren** Kayemeth)* as the perpetual and inalienable property of the Jewish people. More rapid even than the rural expansion was the urban growth. Tel Aviv, founded originally in 1909 as a suburb of Jaffa, had in 1935 a population of more than 100,000 and was a modern purely Jewish city which was also the centre of industrial development made possible by the influx of Jewish capital. The educational system was crowned by the opening of a Hebrew university in Jerusalem and of the institute of technology in Haifa in 1925.

In spite of this growth, Jewish immigration into Palestine remained relatively small until the rise and spread of Hitlerism in Europe. There seemed no prospect of a Jewish majority in Palestine. The birth rate of the Arabs in most years before 1933 was larger than the annual Jewish immigration. Nevertheless the Arab population of Palestine feared a future transformation of Palestine into a Jewish state which would either relegate the Arabs in their own homeland to the position of a minority of second-class citizens or drive them out. Responsible Zionist leaders tried to allay the Arab fears and declared that Zionism did not intend to deprive any Arab or Palestinian of his rights and properties. Some Zionists such as Arthur Ruppin and J. L. Magnes emphasized the necessity of winning the co-operation of the Arabs and hoped for the creation of a binational Palestine which would be the common homeland of both Palestinian Arabs and Jews. Only an extreme nationalist group called revisionists, under the leadership of Vladimir Jabotinsky. demanded the transformation of the whole of Palestine within its largest historical frontiers into a purely Jewish state with an Arab minority. The revisionists agitated also for the creation of Jewish armed forces to fight for the creation of the Jewish state.

From the beginning the Arabs in Palestine bitterly resisted Zionism and the British policy supporting it. Several times they rose in revolt, especially in 1929 and in 1936–39, claiming the right of national self-determination, as they represented the large majority of the inhabitants. and demanding the preservation of Palestine as an Xrab homeland. Therein they were supported by all the other .Arabs. The British repressed the Arab rising for independence: but recognized the genuine character of Arab nationalism and Arab fears. The British government sent various commissions of inquiry and devised various schemes, culminating in the White Paper of May 17, 1939, to reconcile the irreconcilable demands of the Arab population and Zionism for the control of Palestine.

World **War II and** Its **Consequences.**—Hitlerism and the large-scale extermination of European Jews led many Jews: above all in the United States, to embrace Zionism. In 1942 a Zionist conference in New York city demanded the establishment of a Jewish state in the whole of Palestine and unlimited Jewish immigration. This program was endorsed by the Zionist organization. At the same time Xrab nationalists throughout the middle east intensified their demands for Arab rights. Britain submitted the case of Palestine first to Anglo-U.S. discussion for solution and later to the United Nations. which proposed on Nov. 29, 1947, partition of the country into an Arab and a Jewish state and the internationalization of Jerusalem. But the decision came through force of arms in a war between Zionists and Arabs. The state of Israel was proclaimed on May 14, 1948, and immediately recognized by the United States. Armistice lines were negotiated under UN auspices giving Israel more territory than provided by the UN resolution. Thus half a century after the first Zionist congress and 30 years after the Balfour declaration Zionism achieved its aim of establishing a Jewish state in Palestine.

The establishment of the state left several problems unsolved: its boundaries, its economic viability, its relationship to world Jewry, the settlement of the Arab refugees from its territory. its accommodation with the Arab world. The immigration of central

European Jews brought to Palestine many talents, which gave a great impulse to the cultural and artistic life and to the modernization of economy. On the other hand after 1950 most immigrants came from non-European countries and the question arose whether the Jewish people of Israel would be predominantly of a European or of an oriental character. The economic existence of Israel was made possible by the yearly influx of hundreds of millions of dollars, supplied mostly by donations from Jews in the U.S., grants from the U.S. government and German reparation payments. Opposition to Zionism among Jews continued. In the U.S. it found its organized expression in the American Council for Judaism, founded in 1943. But most Jews sympathized with and actively supported Israel, though they rejected the theory propagated by many Jews in Israel that the Jews outside Israel were living in "exile" and could live a full life only in Israel. Meantime the Arabs had in no way accepted the loss of their Palestinian lands. In spite of all these difficulties Israel made rapid progress in the resurrection of a Jewish nation in its ancient homeland. See also PALESTINE; ISRAEL.

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ZION NATIONAL PARK, southwestern Ctah, U.S., was established in 1919 to protect Zion canyon from commercial encroachment The canyon was named by Mormon settlers in the 1850s and explored by them in 1862. In 1937, the almost equally scenic Kolob canyon area adjoining the park on the west and north, was established as Zion National monument. In 1957 the monument. 48.640 ac., was added to the park, bringing the total area to 147.035 ac.

The canyon walls are of sedimentary origin. They grade from rust red at lower elevations to nearly white at the summits. For more than 200,000,000 years the region, of which the park is but a part, has gone through many climatic changes. The rock shows it nas periodically submerged under a shallow sea or lake, then raised and eroded by rivers. At other times desert conditions prevailed. Fossils of fish, shells, dinosaur bones and plant material, as nell as animal tracks, have been found embedded and imprinted in the sandstone. There is also evidence that prehistoric cave dwellers lived in the area.

Zion canyon was carved by the Virgin river. Its floor is approximately 4,000 ft. above sea level and 3,802 ft. below the park's highest point at the top of West Temple. The Great White Throne, a giant monolith which stands close to the river, rises sheer to a height of 2,394 ft.

Mule deer are more in evidence than most other mammals, but the park also provides sanctuary for mountain lions, bobcats, coyotes, marmots and gray foxes. More than 150 species of birds have been recorded in the area. Cottonwood, willow and box elder are dominant trees of the canyon floor, with Utah juniper and pinyon pine in the middle elevations and ponderosa pine and Rocky Mountain juniper dominating at higher levels. (Dx. B.)

ZIRCON, a mineral with the composition zirconium silicate, is a principal source of zirconium. For uses of zircon, see ZIRCONIUM: Uses. It is believed that the name comes from the Arabic *zargun,* and is essentially the same as jargon, the name given to one of the varieties of zircon. Zircon is usually brown, reddish or gray, but may be colourless, blue, green or yellow; sometimes zoned. Common zircon is opaque, but gem varieties are transparent. The high refractive index and the high dispersion cause zircon to approach the diamond in fire and brilliance. A colourless type has been called Matura diamond. Hyacinth or jacinth includes the clear transparent red, orange and yellow varieties, mhile jargon includes the remaining colours. In some cases the colour may be removed by heating coloured stones under oxidizing conditions, mhile heating under reducing conditions may give an attractive blue colour. The gem varieties are found in stream gravels and detrital deposits, especially in Indochina and Ceylon; they are also found in Burma, New South Wales and New Zealand. Common zircon is obtained from beach sands in the United States along the east coast of Florida, and in Australia and French West Africa. It is an accessory constituent of acid igneous rocks and forms an important part of the zircon syenite of southern Norway. It occurs in large crystals in Renfrew county, Que.

Zircon. $ZrSiO_4$ is isomorphous with thorite, $ThSiO_4$. It crystallizes in the tetragonal system, generally in combinations of a simple prism and bipyramid (see CRYSTALLOGRAPHY), and sometimes comes in knee-shaped twins. There is no distinct cleavage. and the fracture is conchoidal. Normally zircon has well-developed crystals and has a hardness of 7.5 and a specific gravity of 4.7. The refractive indexes for normal zircon are $O = 1.93$ and $e = 1.99$. A rare type of zircon is isotropic and amorphous, has lower indexes of refraction, a lower hardness, 6. and the specific gravity may be as low as 3.94. This type is said to be in a metamict condition, that is the loss of crystallinity is attributed to breakdown of the structure, possibly by radioactive bombardment from uranium or thorium impurities. Upon heating, this type may glow nith an orange luminescence and may become crystalline. Because of the lower hardness, it is usually found in rounded grains and pebbles. Intermediate or gradational types of zircon are quite common.

See also GEM: HYACINTH: TARGON. (L. S. RL.: X.)

ZIRCONIUM (symbol Zr) is considered one of the "new" metals. Actually, metallic zirconium, probably an impure product. was made by J. J. Berzelius in 1824, but the next important advance did not come until 1925 when massive, ductile metal was made by two Dutch scientists, A. E. van Arkel and J. H. de Boer. Although the initial market for it was very limited, zirconium in massive form may be considered to have become commercial not long after 1923'. In the middle 1940s, W. J. Kroll developed a cheaper process for making the metal. However, despite its interesting properties, zirconium probably would have remained of minor importance for some years had not its use in nuclear reactors developed shortly before 1950.

Ores. — Although new, zirconium actually is more plentiful than copper and several other common metals. It is obtained principally from two minerals: zircon, a zirconium silicate with the composition $ZrO_2\ SiO_2$ and baddeleyite (brazilite), an oxide mith the formula ZrO_2.

Zircon is found in beach sands in many parts of the world, particularly in the United States, Australia, India and Brazil. Baddeleyite exists in quantity in Brazil. but no other important deposits are known. A mixture of zircon and baddeleyite known commercially as "zirkite" is also shipped from Brazil.

One characteristic of all zirconium ores, regardless of mineral or locality, is that they contain from about 0.7% to several per cent of hafnium, a metal similar in many nays to zirconium. In processing, hafnium (*q.v.*) usually moves mith the zirconium and is found in the metal in about the same proportion as in the ore. It must be removed from zirconium intended for nuclear uses but is seldom objectionable when zirconium is used for other purposes.

Production of Metallic Zirconium. — The steps from ore to metal can be given in outline only. Zircon will be used for illustration of the early stages. The grains containing zircon must be separated from the non-zircon grains of sand by ore-treating equipment such as Wilfley tables, Humphreys spirals and magnetic or electrostatic separators. The zircon portion is then mixed nith carbon and heated in an arc furnace. In this step, the zirconium in the zircon is converted to zirconium carbide and much of the silicon is lost by volatilization. The carbide is then heated in a stream of chlorine and is converted to the tetrachloride, $ZrCl_4$. The $ZrCl_4$ passes out of the chlorinator as a vapour and collects as a white powder in a condenser. The silicon chloride formed from the silicon remaining in the carbide is so volatile that it passes on through the condenser and escapes.

Kroll Process. — The Kroll process of making zirconium is based on the reduction of $ZrCl_4$ with magnesium. A simple apparatus for performing the reduction appears in fig. 1. The largest item is a cylindrical stainless steel vessel on the outside of which are wound several electrical heating units. Inside the vessel are two steel pots, A and B, and baffles that serve as a thermal shield between them. In preparation for a reduction, A is filled with zirconium tetrachloride and B with magnesium. The lower part of the furnace is heated sufficiently to melt the magnesium and the upper part is brought to a temperature that gives a suitable pressure of $ZrCl_4$ vapour. As the vapour from the subliming $ZrCl_4$ fills the vessel: it passes downward and comes in contact with the molten magnesium. The result is the reaction

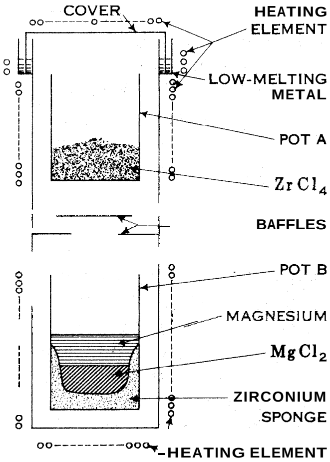

FIG. 1.—KROLL PROCESS FOR MAKING ZIRCONIUM

$$ZrCl_4 + 2Mg \longrightarrow Zr + 2MgCl_2$$

Gradually, the magnesium is converted to $MgCl_2$ and the zirconium formed sinks to the bottom of the pot.

The top of the furnace is not attached tightly but is provided with a skirt that rests in molten metal in a circular channel extending around the top of the vessel. If the internal pressure exceeds atmospheric value. the lid rises and a little vapour escapes. If the internal pressure falls, as when the $ZrCl_4$ supply is exhausted, helium enters automatically from a side container to build up the pressure so the molten metal will not be sucked in.

At the end of the run and after the equipment has cooled, the metal in the annular channel is heated to the melting point, the vessel opened and pot B transferred to another vessel where it is placed in an inverted position. The second vessel is evacuated and then heated so that the magnesium and $MgCl_2$ will drain out of the pot and also be eliminated by volatilization.

Iodide Process.—The iodide deposition process developed by van Arkel and de Boer is essentially a refining operation that is capable of converting impure and often brittle zirconium into ductile metal that can be fabricated readily. The process will be described briefly on the basis of a glass-containing vessel although industrial production usually is carried out in metal containers.

Fig. 2 shows a simple apparatus. The zirconium to be refined is placed between the outside wall and a cylinder of perforated molybdenum sheet. The wire on which the metal is to be deposited is suspended from tungsten electrodes entering through the top. After the charge of impure zirconium has been put in place and the top sealed, the vessel is evacuated and heated for removal of gases. The connecting tube to the pump is then sealed off at A. Next, the iodine, which has been immersed in liquid nitrogen, is heated and driven over into the deposition bulb after which the connecting tube is sealed off at B and the side arm removed completely.

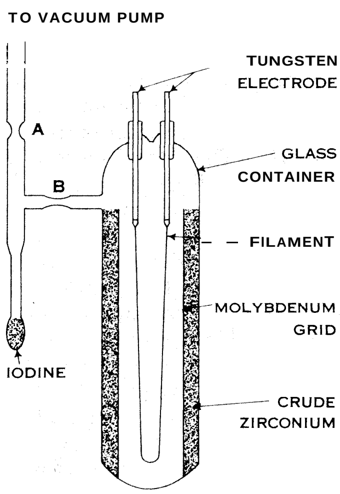

FIG. 2.— IODIDE DEPOSITION PROCESS

The apparatus being ready for operation, the vessel is heated to about 275° C. and the filament to about 1,300" C. Two reactions occur simultaneously: (1) iodine vapour unites with the zirconium charge to form ZrI_4, which is also gaseous; and (2) molecules of ZrI_4 are decomposed on the hot filament with the result that the zirconium atoms attach themselves to the wire and the iodine atoms drift back to the zirconium charge and combine to form more ZrI_4. As the reactions continue, the filament grows into a bar of the desired size. Because of its crystalline appearance. the bar is called a "crystal bar." To remove it, the operator must cut open the glass container.

Other processes for producing zirconium have been used, but, in general, they produce finely divided or granular metal.

Melting and Fabricating.— Zirconium made as described above usually is melted before it is fabricated. In one type of operation, the sponge or crystal bar is formed into a thick bar that acts as one electrode of an arc melting furnace. The other electrode is the water-cooled copper crucible into which the zirconium bar is melted. The arc plays between the bar and the pool of molten metal in the crucible. This method is called "consumable electrode melting." The furnace shell is tight and contains helium, argon or a mixture of these two inert gases at a reduced pressure.

Forging, rolling and most other fabricating processes may be performed on zirconium without difficulty. Ingots are often worked hot in the initial stages. If the temperature does not exceed 700° C. and if the outer layer is subsequently to be removed, the metal may be worked bare. Sometimes pieces to be worked hot are enclosed in a tight envelope of steel or other metal that is removed after the operation. Trouble may be encountered in drawing zirconium into tubes, rods or wire because of its tendency to seize in the dies. Special lubricants have been developed for avoiding this trouble.

Physical, Mechanical, Chemical **Properties.**—Many properties of zirconium are affected in some degree by the presence of contaminating elements. Hydrogen, oxygen and nitrogen are very effective in this respect and all three can he absorbed by zirconium in astonishing amounts. Hafnium has only a minor effect on many properties, but it is extremely detrimental in zirconium that is to be used in construction of nuclear reactors. Other elements also influence the properties of zirconium, but reasonable care during processing will prevent contamination by them.

Some of the more common physical properties are listed below (see Table) ; two properties deserve special mention. One is the change of atomic arrangement at approximately 860° C. Below this temperature, zirconium is hexagonal close-packed with a = 3.231 Å and c = 5.147 Å; above it. the structure is body-centred cubic with a = 3.60 Å. Many properties change value abruptly as zirconium passes through this temperature. For example. the electrical resistance decreases by about 15%. The property that is most important in nuclear uses is the capacity for capturing thermal (slowly moving) neutrons. Zirconium has an absorption cross section of only 0.18 barns (10^{24} barns = 1 $cm.^2$) for thermal neutrons and, accordingly, belongs in the very limited group of metals that have low cross sections and hence are suitable for use in nuclear reactors. However, as hafnium has a much larger cross section of 115 barns, a relatively small contamination with this element can raise the total cross section of zirconium above an acceptable value.

Zirconium has a number of interesting chemical properties. Its high capacity for absorbing several gases has been mentioned. At

Physical and Mechanical Properties of Zirconium*

Density	6.50 $g./cm.^3$
Melting point	1,860° C.
Electrical resistivity at 0" C.	41 x 10^{-6} ohm cm.
Thermal coefficient of resistance	44 x 10^{-4} ohm/ohm/° C.
Thermal coefficient of linear expansion	5.7 cm./cm./° C.
Specific heat	0.066 cal./g./° C.
Hardness	80 on Vickers scale
Tensile strength	25,000 p.s.i.
Yield strength 10.002 offset)	8,000 p.s.i.
Eloneation in 2 in..	50%
hlodulus of elasticity	13,500,000 p.s.i.

*Mechanical values should be considered only as illustrative, since reported measurements vary considerably.

1,000" C., it will absorb oxygen until its volume has increased visibly. Beyond the solubility limit, zirconium combines with oxygen to form ZrO_2. It has such a strong affinity for oxygen that it will attack refractory crucible materials like MgO, Be0 and

ThO_2 by taking their oxygen from them. For this reason, zirconium must be melted in cooled metal crucibles. Although oxygen leaves zirconium untarnished at room temperature, it produces a dark coating at temperatures of a few hundred degrees. Zirconium sponge may react explosively with moisture. The reactions of zirconium with nitrogen are similar but less spectacular. With hydrogen. zirconium reacts rapidly at 800° C. to form the brittle ZrH_2. As a result of the reaction, massive zirconium is converted to a granular condition. The granules can be ground to powder and, if desired. the hydrogen may be pumped off to leave a product suitable for powdered metallurgy processes.

Zirconium has excellent resistance to nitric acid, even at 100° C., and withstands relatively high concentrations of other inorganic acids at room temperature. It is attacked by aqua regia and by moist chlorine and bromine gases. It is almost completely resistant to all but a few organic acids. Its resistance to high-pressure water at 300° C. and above is good if the metal is pure. But some contaminating substances, especially small proportions of nitrogen, reduce its resistance seriously. The addition of 2% or 3% of tin compensates for the bad effect of nitrogen almost completely. Resistance to high-pressure water is important in pressurized water reactors such as the one used in the U.S. submarine *Nautilus*. In general, molten metals attack zirconium, but pure molten sodium has no etiect on it at 500° C. or higher.

Knowledge of the chemical compounds of zirconium has been obtained, perhaps principally, from investigations of methods for making it in the pure state. Besides the Kroll process, several metallothermic reactions have been used for reducing compounds to metal. They are illustrated by the reactions

$$ZrO_2 + 2Ca \longrightarrow Zr + 2CaO$$
$$ZrCl_4 + 4Na \longrightarrow Zr + 4NaCl$$
$$Na_5Zr_2F_{13} + 8Na \longrightarrow 2Zr + 13NaF$$

An excess of reductant metal is used in all three reactions and all three produce zirconium in a powder or granular form. The second reaction has been used particularly for making zirconium to be refined by the iodide deposition method.

Uses.—The most important use for zirconium is in nuclear reactors for jackets for uranium fuel rods and for alloying with uranium. In the sodium-graphite reactor. it has been used as a jacket around the graphite moderator blocks. A much smaller but important use, mainly as a powder, is as a getter for cleaning up residual gases in vacuum tubes. It has minor uses also in the electrical industry.

As an alloying element, zirconium is important in the production of magnesium alloys and is used to a smaller degree as an addition agent to steel.

Two uses of zirconium oxide are as a packed-in electrical insulating material and as an opacifier to reduce the transparency of glazes on ceramic objects and of enamels on metals.

A small amount of oxide is used for crucibles and for laboratory ware.

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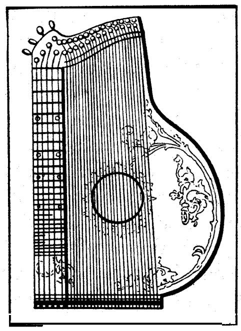
ZIRKEL, FERDINAND (1838–1912), German pioneer in microscopic petrography. born in Bonn, May 20. 1838. Trained as a mining engineer, in 1863 he became professor of mineralogy at Lemberg. His famous *Lehrbuch der Petrographie,* first published in 1366. was written before he had learned the technique of microscopic petrography: which H. C. Sorby was developing in England, but when in 1868 he revisited the British Isles he became acquainted n·ith Sorby. who demonstrated the new technique to him. Returning to Germany. Zirkel busied himself in making thin sections of rocks. In 1870 he published an important work on the microscopic characters of basalts, dedicating it to Sorby.

Named tu the chair of mineralogy in Leipzig in 1870. Zirkel continued his studies in microscopic petrography and in 1873 his *Mikroskopische Beschaffenheit der Mineralien und Gesteine* made the new method of study available to all. Zirkel was engaged by Clarence King to describe the rocks collected on the survey of the 40th parallel in western U.S. Zirkel wrote the fourth volume (1876) of the report of the survey, thus introducing microscopic petrography in the U.S. During his long tenure of the Leipzig chair, Zirkel rewrote his *Lehrbuch* completely and it became one of the classics of geology, reappearing in three large volumes in 1894. Zirkel retired in 1909 and died in Bonn, June 12, 1912.

ZITHER, a name applied to the ancient cithara, to the cittern (*q.v.*) and to a derived instrument which is a kind of psaltery, consisting of a shallow. horizontal sound chest with from 30 to 42 strings stretched above it which are plucked and thrummed, with plectrum and fingers, by the performer. (*See* illustration.) Zithers. which are made in various sizes. are the favourite instruments of the peasants in the Swiss and Bavarian highlands. and are sometimes heard also in the concert halls in Germany. The *Streichzither,* or bowed zither, is another variety of the instrument. There are four strings corresponding to those of the violin or viola. but the tone is nasal and glassy. *See* Lyre. (D. T.)



FROM GROVE, "DICTIONARY OF MUSIC" (MACMILLAN)

THE ZITHER, OR CITHARA, A MUSICAL INSTRUMENT HAVING 36, 38 OR 42 STRINGS

ZITTAU, a town of Germany. in the district of Dresden, on the left bank of the Mandau near its confluence with the Neisse. by rail 48 mi. E.S.E. of the city of Dresden and at the junction of lines to Reichenberg, Hermsdorf. Gorlitz. Oybin and Löbau. Pop. (1959 est.) 43.743. Zittau is of Wendish origin (Chytawa is its Wendish name), and was made a town by Ottocar II of Bohemia. It was one of the six towns of the Lusatian league (1346). at which period it belonged to Bohemia. It suffered severely in the Hussite wars and in the Thirty Years' War.

ZITTEL, KARL ALFRED, Ritter von (1839–1904). German paleontologist who proved that the Sahara desert had been land during the Pleistocene Ice Age, was born at Bahlingen. Baden, on Sept. 25, 1839. Educated at Heidelberg, Paris and Vienna: in 1863 he was appointed assistant in the royal mineral cabinet of Yienna and became professor of mineralogy, geognosy and paleontology at the Polytechnic school, Karlsruhe. In 1866 he was made professor of paleontology at Munich, later becoming professor of geology and conservator of the geological collections until his death at Munich on Jan. 5, 1904.

Zittel's first research dealt with minerals and petrography. In 1873–74 he was geologist of an expedition to Libya, during which he collected material for his proof about the Sahara. His first paleontologic paper appeared in 1861; later he accepted evolution and led in applying it to paleontology, especially in his studies of ammonites. He did not write extensively on theory, however, nor did he accept the neo-Lamarckian doctrines of Alpheus Hyatt and Edward Cope. In 1876 he began his studies of fossil sponges, which established their classification and laid a basis for that of modern forms. His principal contributions to vertebrate paleontology dealt with turtles and pterodactyls of the Bavarian lithographic limestones. One of Zittel's best-known works is the *Geschichte der Geologie und Paläontologie* (1899; Eng. trans., 1901). (C. L. Fe.; M. A. F.; X.)

ŽIŽKA, JOHN (c. 1376–1424), Bohemian general and Hussite leader, was born at Trocnov in Bohemia. He lost an eye in the civil wars under Wenceslaus IY. Connected with the court from his youth, he held the office of chamberlain to Queen Sophia. The Hussite movement first brought him into prominence. When a temporary armistice was concluded between the partisans of King Sigismund and the citizens of Prague, Žižka joined the advanced Hussites at Tabor, helped to organize the new military community and became one of the four "captains of the people" (*hejtmane*) at its head. On receiving an appeal from the citizens of Prague to help against Sigismund, king of the Germans and king of Hungary, who had invaded Bohemia, claiming the crown as the heir of his brother Wenceslaus, the Taborites marched to Prague and on July 14, 1420, largely through Žižka's heroism, repulsed an attack by Sigismund's forces on their position on the Vitkov hill where the suburb of Žižkov now stands, forcing Sigismund to raise the siege. On Aug. 22, 1420, the Taborites left Prague and returned to Tabor.

Žižka was now engaged in constant, and invariably successful, warfare with the partisans of Sigismund, particularly with the powerful Romanist, Ulrich of Rosenberg. At the meeting of the estates of Bohemia and Moravia at Caslav (June 1, 1421), Žižka was elected member for Tabor to the provisional government. He summarily suppressed some disturbances by the Adamite sect, continued his campaigns against the Romanists and adherents of Sigismund, and, having captured a small castle near Litoměřice (Leitmeritz), retained possession of it—the only reward for his great services that he ever received or claimed. According to Hussite custom, he gave the biblical name of "Chalice" to this new possession, and henceforth adopted the signature of "Žižka of the Chalice." In 1421, while besieging the castle of Rbbi, he lost the use of his remaining eye. Though now totally blind, he retained his command, and on Jan. 6, 1422, severely defeated Sigismund at Nebovid, Kutna Hora, and again at Německy Brod (Deutschbrod) on Jan. 10. Early in 1423 internal dissensions among the Hussites led to civil war. Žižka, as leader of the Taborites, defeated the men of Prague and the Utraquist nobles at Hořic on April 27, and when the armistice of Konopist (June 24) was followed by renewed civil war, he once again defeated the Utraquists, under Borek, at Strachov, near Králové Hradec (Aug. 4, 1423).

Žižka now made a brilliant, although unsuccessful attempt to invade Hungary, which was under the rule of his old enemy King Sigismund. In 1424, civil war having again broken out in Bohemia, Žižka decisively defeated the Praguers and Utraquist nobles at Skalic (Jan. 6), and at Malesov (June 7). In September he marched on Prague, but on the 14th of that month peace was concluded between the Hussite parties who agreed to make a combined attack on Moravia, part of which was still held by Sigismund's followers. Žižka was given the command, but before reaching the frontier, he died of the plague at Pribyslav (Oct. 11, 1424).

See Count Lützow, *Bohemia: an Historical Sketch (1896)*; Louis Léger, *Jean Žižka* in *"Nouvelles études Slaves," deuxième série (1886).*

ZLATOUST, a town in the Chelyabinsk *oblast* of the Russian Soviet Federated Socialist Republic, U.S.S.R., 1,925 ft. above sea level on the Ai, a tributary of the Cia, in 55° 10′ N., 59° 40′ E., on the Ufa-Chelyabinsk railway. Pop. (1959) 161,000. The town has smelting works and manufactures machinery; there is a meteorological and magnetic observatory.

ZLOTY, post-war monetary unit of Poland. Following the collapse of the Polish mark, instituted immediately after World War I, the zloty was substituted in 1924. It was then made equivalent to the gold franc, at a parity of 25.22 zlotys to the pound sterling, and was backed partly by gold and gold exchange, and partly by other forms of security. Events soon showed that the new currency had been introduced before the country was ready to support it, and during 1925 and 1926 renewed depreciation set in. In 1927 a second attempt at stabilization was made. A foreign stabilization loan was issued, and the proceeds used to give a gold exchange backing to the new zloty, the value of which was fixed at 43.38 to the £1 sterling; in 1938 it fluctuated between $24\frac{1}{4}$ and $26\frac{3}{4}$ to the £1. In 1950 the Zloty was greatly devalued and put on a par with the Russian ruble. (See CURRENCY.)

ZNOJMO (Znaim), in Brno region, Czech. A settlement is believed to have existed here from prehistoric time. The present town was founded in 1226 on the site of the old capital, destroyed in 1145. Lying at the junction of old granites and tertiary strata Znojmo manufactures clay products and stoneware. It is also famous for its extensive fruit and vegetable farms, which supply bottling factories. Among its old buildings are a 12th century Romanesque castle chapel (the Heiden-Tempel), a 14th century Gothic church and a 1jth century town hall with Gothic tower (250 ft.). Population (1950) 21,696.

ZOBEIR RAHAMA (1830–1913), Egyptian pasha and Sudanese governor, came of the Gemaab section of the Jaalin, and was a member of a family which claims descent from the Koreish tribe through Abbas, uncle of Mohammed. He was the most energetic and intelligent of the Arab ivory and slave traders who about 1860 established themselves on the White Nile and in the Bahr-el-Ghazal. Nominally a subject of Egypt, he raised an army of several thousand well-armed blacks and became a dangerous rival to the Egyptian authorities. At the height of his power Zobeir was visited (1871) by Georg Schweinfurth, who found him "surrounded with a court which was little less than princely in its details" (Heart of Africa, vol. ii, chap. xv). In 1869 an expedition sent from Khartum into the Bahr-el-Ghazal was attacked by Zobeir and completely defeated, its commander being slain. Zobeir represented that he was blameless in this matter, received a "pardon," and was himself appointed governor of the Bahr-el-Ghazal, where he was practically independent. In 1873 he attacked the sultan of Darfur, and the khedive Ismail gave him the rank of bey and sent troops to co-operate. After he had conquered Darfur (1874), Zobeir was made a pasha, but he demanded the governor-generalship of the new province, and went to Cairo in the spring of 1876 to press his title. The Egyptian authorities prevented his return, though he was allowed to go to Constantinople at the outbreak of the Russo-Turkish War. In 1878, however, his son Suleiman, having got possession of the Bahr-el-Ghazal, defied the authority of General Gordon, the new governor-general. Gordon sent Romolo Gessi against Suleiman and his ally Rabah (*q.v.*). Suleiman was subdued after an arduous campaign and executed.

During the campaign Zobeir offered, if he were allowed to return to the Sudan, to restore order and to pay a revenue of £25,000 a year to the khedive. Gordon declined this help, and subsequently, for his instigation of the revolt, Zobeir was condemned to death, but the trial was a farce, the sentence was remitted, and he remained at Cairo, now in high favour with the khedival court. In March 1884, Gordon, who had been sent to Khartum to effect, if possible, the relief of the Egyptian garrisons in the Sudan, astonished Europe by requesting that Zobeir, whose son he had overthrown and whose trade he had ruined, should be sent to Khartum as his successor. Zobeir, described by Sir Reginald Wingate, who knew him well, as "a quiet, far-seeing, thoughtful man of iron will—a born ruler of men" (*Mahdiism and the* Egyptian *Sudan,* book v.), might have been able to stem the mahdist movement. But to reinstate the notorious slave-dealer was regarded in London as too perilous an expedient, even in the extreme circumstances then existing, although Colonel Stewart (Gordon's companion in Khartum), Sir Evelyn Baring and Nubar Pasha in Cairo, and Queen Victoria and Mr. Gladstone, all favoured such a course. In March 1885 Zobeir was arrested in Cairo by order of the British government for treasonable correspondence with the mahdi and other enemies of Egypt, and was interned at Gibraltar. In August 1887 he was allowed to return to Cairo, and after the reconquest of the Sudan was permitted (1899) to settle in his native country. He established himself on his estates at Geili, some 30 m. N. of Khartum, where he died on Jan. 5, 1913.

See GORDON, CHARLES GEORGE, and the authorities there cited.

ZODIAC, in astronomy and astrology a zone of the heavens within which lie the paths of the sun, moon and principal planets. Since the orbits of the planets deviate only slightly from a common plane, an observer on earth sees these celestial bodies moving in a narrow zone of the celestial sphere. The various configurations of the fixed stars were grouped at least as early as 3.000 B C. in Mesopotamia into constellations representing certain objects or animals like the raven, serpent, goat, etc. Since the majority of the constellations which were crossed by the paths of the planets represented animals, the Greeks called this zone *zōdiakos* kyklos, "circle of animals," or *ta zōdia,* "the little animals "

Originally neither the boundaries nor the number of the "zodiacal" constellations was accurately fixed. Some time before the Hellenistic period the development of a mathematical astronomy in Mesopotamia resulted in accurate definitions. The "zodiacal signs," numbering 12, became equal arcs of the apparent orbital circle of the sun, the ecliptic. Their names, taken from the neighbouring constellations, are

Aries, the Ram	♈	Libra, the Balance	♎
Taurus, the Bull	♉	Scorpio, the Scorpion	♏
Gemini, the Twins	♊	Sagittarius, the Archer	♐
Cancer, the Crab	♋	Capricornus, the Goat	♑
Leo, the Lion	♌	Aquarius, the Water Carrier	♒
Virgo, the Virgin	♍	Pisces, the Fishes	♓

The history of the symbols is unknown; they seem to appear first in Greek manuscripts of the late middle ages.

In Babylonian astronomy the boundaries of these 12 signs were defined in such a fashion that the vernal equinox fell in the tenth or in the eighth degree of the first sign. Greek astronomers, however, changed these definitions. Eudoxus of Cnidus (about 360 B.C.) supposedly placed the equinoxes in the middle of the signs. Hipparchus (about 150 B.C.) placed them at the beginning and this practice remains standard in mathematical astronomy: celestial longitudes are counted from the "first of Aries" (0° Aries) eastward. This point is defined by the intersection of ecliptic and equator. Since precession moves this point slowly westward: 'the zodiacal signs counted from the vernal point lost more and more their original relation to the constellations. At present the first of Aries lies in the constellation of Pisces.

The concept of the zodiac and its pictorial representation reached Egypt early under Greek domination (3rd century B.C.). Here it amalgamated with the native sequence of constellations, the so-called 36 decans, each of which came to mean exactly one-third of a zodiacal sign. At about the same time there occurred the rapid development of astrological doctrines which combined Babylonian, Egyptian and Greek elements into one gigantic system of theories about powers of the celestial bodies and their mutual relations to the parts of the zodiac. In this Hellenistic form, the astrological concepts related to the zodiac spread to Rome. then to Byzantium and India. from where they returned, often with new additions, to the Islamic and Christian West. Their role in art and literature became particularly great in the Italian Renaissance. See ASTROLOGY; ASTRONOMY: *Ancient Astronomy: Mesopotamia; Modern* Descriptive *Astronomy*: The *Seasons*. (O. E. N.)

ZODIACAL LIGHT, a band of light in the night sky concentrated along the zodiacal circle referred to by astronomers as the ecliptic. It is seen in the west after twilight and in the east before dawn. It is easily visible in the tropics where the ecliptic is approximately vertical to the horizon. In mid-northern latitudes. it is best seen in the evening in February and March and in the morning in September and October.

The zodiacal light can be followed visually along the ecliptic from a point 30° from the sun to about 90°. Photometric measurements indicate that the band continues along the ecliptic to the region opposite the sun where a slight enhancement called the gegenschein (*q.v.*), or counterglow, is again visible. It is now known that there is some zodiacal light in all parts of the sky, even at the poles of the ecliptic; a part of the coronal light during a solar eclipse is actually the inner part of the zodiacal light. One degree from the limb of the sun its intensity is about 10.000 times as bright as the brightest region observable after twilight, but this intense coronal zodiacal light cannot be observed in the daytime because it is overwhelmed by the scattered light in the day sky. Outside the earth's atmosphere, the zodiacal light would be visible nearly to the surface of the sun.

Zodiacal light probably is the reflection of sunlight from a swarm of meteoric particles concentrated in the plane of the ecliptic. Its measurement at angles greater than 90° from the sun indicates that the swarm extends beyond the earth's orbit. A small part of the zodiacal light is thought to be due to an electron cloud which has a concentration of about 1,000 electrons per cubic centimetre near the earth. The general physical picture suggested is that of a spindle-shaped swarm of meteoric particles concentrated near the fundamental plane of the solar system. Such particles would melt close to the sun and so the concentration probably starts at about $\frac{1}{10}$ astronomical unit. Very small dust particles. smaller than 0.001 mm. in diameter, are blown out of the solar system by radiation pressure; for larger particles. there is a spiraling in toward the sun which in astronomical time would sweep the region free. To maintain the particle swarm against the depletion of radiation pressure and loss by spiraling requires the addition of approximately one ton of dust per second. Possible sources of the dust are the fragmentation of asteroids by collision and the disintegration of comets. (F. E. R.)

ZOFFANY (ZOFFANJI or ZAFFANII, perhaps originally ZAUFFELY), **JOHN** (JOHANN) (1734–1810), Anglo-German painter of portraits, conversation pieces and theatrical scenes, was born in Frankfurt-on-Main and studied in Italy. He went to England about 1761, exhibiting at the Society of Artists from 1762 to 1769 and at the Royal Academy (of which he became a founder-member) from 1770 to 1800. In 1772, at the expense of George III, he went to Florence, returning to England in 1779. From 1783 to 1789 he was in India, where he painted many portraits. His first success was "Garrick in 'The Farmer's Return' " (1762), as a result of mhich he painted a number of scenes of the theatre, many including portraits of David Garrick. The invention of this genre may be due to Zoffany, following a lead given by William Hogarth (*q.v.*).

Among his best-known works are "Queen Charlotte and the Two Eldest Princes" (*c.* 1766), "The Members of the Royal Academy" (1772) and "The Tribuna of the Uffizi Gallery, Florence" (1772–80), all in the royal collection; "Mrs. Oswald" (*c.* 1770). a life-size full-length portrait (exceptional for Zoffany) in the National gallery. London; "Charles Towneley Among His Marbles" (1790) in Burnley (Lancashire) art gallery. Others are in the National Portrait gallery, London, at Edinburgh, Glasgow, Birmingham, Oxford. in the Garrick club, London. and elsewhere. Zoffany died at Strand-on-the-Green, Middlesex, on Nov. 11. 1810.

See Lady Victoria Manners and G. C. Williamson, John *Zoffany* (1920) ; E. K. Waterhouse, *Painting* in *Britain* 1530–1790, ch. 24 (1953). (P. J. MY.)

ZOG I (AHMED BEY ZOGU) (1895–1961), king of the Albanians from 1928 to 1939. was head of the Zogolli, one of the four ruling families of the Mati district. Born in the castle of Burgajet on Oct. 8, 1895. the son of Jemal Pasha. he was educated at a military school at Monastir (Bitola) and in Constantinople. He first distinguished himself as a supporter of the prince of Wied in 1914. During World War I he fought for the Austrians. He became minister of the interior (Jan.–Nov. 1920) and organized resistance to the Yugoslav incursions during the autumn. He was commander in chief of the national forces under the "Sacred Union" cabinet (Oct.–Dec. 1921). and again distinguished himself against the Yugoslavs. As minister of the interior in Jafer Ypi's cabinet (Dec. 1921–Dec. 1922), he suppressed a serious insurrectionary movement in March 1922 and disarmed the lowlanders. Becoming prime minister in Dec. 1922, he governed with ability, pursuing a sound anti-irredentist and constructive policy. Toward the end of 1923 he was accused by the Democratic party of obstructing various progressive and agrarian reforms. After an attempt on his life. he resigned in Feb. 1924. but his influence remained. A revolt against him and his colleagues took place in June, and he sought refuge in Yugoslavia. But skilfully turning Yugoslav policy to his own advantage. he returned to Albania in Dec. 1924 and ousted his successor. Bishop Fan Koli. His election as president of the Albanian republic on Feb. 1, 1925. ushered in a period of internal tranquillity. He was proclaimed king at Tirane on Sept. 1. 1928. On April 27. 1938. he married Countess Geraldine Apponyi of Hungary. A son. Leka. was born to them on April 5. 1939. Three days later, on the Italian occupation of Albania, the king and queen became exiles in Greece. Later they went to France and in 1940 to Great Britain. From London Zog encouraged a national underground movement in Albania. but his hopes mere dashed by the establishment of a people's republic by Enver Hoxha. Zog left London for Cairo in Feb. 1946. He next moved to New York and later to Cannes, France. He died in Paris on April 9, 1961.

ZOÏLUS (*c.* 400–320 B.C.), Greek grammarian of Amphipolis in Macedonia. Zoïlus appears to have been at one time a follower of Isocrates, but subsequently a pupil of Polycrates.

Zoi'lus was chiefly known for the acerbity of his attacks on Homer (which gained him the name of Homeromastix, "scourge of Homer"), chiefly directed against the fabulous element in the Homeric poems. Zoïlus also wrote against Isocrates and Plato, who had attacked the style of Lysias of which he approved.

ZOISITE, a rock-forming mineral of the epidote (*q.v.*) group, composed of calcium aluminum silicate, is a characteristic product of metamorphism, and of hydrothermal alteration of igneous rocks. In rocks rich in plagioclase, such alteration may produce saussurite, a mixture in which zoisite is the predominant mineral and which is characteristic of gabbro (*q.v.*). The usual colour is white or gray, the hardness is 6.j and the specific gravity 3.3. The formula is $Ca_2Al_3(OH)(SiO_4)_3$, and it crystallizes in the orthorhombic system. Crystals are usually prismatic, deeply striated parallel to their length, and have a perfect cleavage [010]. Normal zoisite has the optic plane parallel to the cleavage, while in zoisite containing more than 5% of iron replacing aluminum, a marked change in optical properties occurs. The optic plane becomes [001] and the refractive indices and the birefringence are higher. Substitution of manganese lowers the indices and gives the variety thulite. pink in colour and strongly dichroic. Thulite occurs at Telemark, Nor., and in the Piedmont region, Italy. Zoisite is not so common as clinozoisite and epidote. Its close relationship to these two monoclinic minerals of the epidote group is revealed if the crystallographic orientation of zoisite is changed so that the cleavage is basal [001] and the prism zone made parallel to the *b* axis. (L. S. RL.; X.)

ZOLA, ÉMILE ÉDOUARD CHARLES ANTOINE (1840–1902), French novelist, was born in Paris on April 2, 1840, his father being an engineer, part Italian and part Greek; and his mother a Frenchwoman. The father seems to have been an energetic, visionary man, who, dying while his only son was a little lad, left to his family no better provision than a lawsuit against the municipality of the town of Aix. It was at Aix, which figures as Plassans in so many of his novels, that the boy received the first part of his education. Thence he proceeded, in 1858, to Paris. His first book, *Contes à Ninon,* appeared on Oct. 24, 1864, and attracted some attention, and in Jan. 1866 he determined to abandon clerking and take to literature. Vigorous and aggressive as a critic, his articles on literature and art in Villemessant's paper *L'Événement* created a good deal of interest. So did the gruesome but powerful novel, *Thérèse Raquin* (1867). Meanwhile, with characteristic energy, Zola was projecting something more important: the creation of a world of his own, like that of Balzac's *Comédie Humaine*—the history of a family in its various ramifications during the Second Empire. The history of this family, the Rougon-Macquart, was to be told in a series of novels containing a scientific study of heredity—science was always Zola's *ignis fatuus*—and a picture of French life and society. The first novel of the series, *La Fortune des Rougon,* appeared in book form at the end of 1871. It was followed by *La Curée* (1874), *Le Ventre de Paris* (1874), *La Conquête de Plassans* (1875), *La Faute de l'Abbé Mouret* (1875), *Son Excellence Eugène Rougon* (1876)—all books unquestionably of immense ability, and in a measure successful, but not great popular successes. Then came *L'Assommoir* (1878?), the epic of drink, and the author's fortune was made. Edition followed edition. He became the most discussed, the most read, the most bought novelist in France—the sale of *L'Assommoir* being even exceeded by that of *Nana* (1880) and *La Débâcle* (1892). From the *Fortune des Rougon* to the *Docteur Pascal* (1893) there are some 20 novels in the *Rougon-Macquart* series, the second half of which includes the powerful novels *Germinal* (1885) and *La Terre* (1888). In 1888 Zola departed from his usual vein in the idyllic story of *Le Rêve*. Zola also wrote a series of three romances on cities. *Lourdes, Rome, Paris* (1894–98), novels on the "gospels" of population (*Fécondité*) and work (*Travail*), a volume of plays, and several volumes of criticism.

Zola played a very important part in the Dreyfus affair, which convulsed French politics and social life at the end of the 19th century. At an early stage he came to the conclusion that Dreyfus was the innocent victim of a nefarious conspiracy, and on Jan. 13, 1898. with his usual intrepidity, he published in the *Aurore* newspaper, in the form of a letter beginning with the words *J'accuse,* a terrible denunciation of all those who had had a hand in hounding down that unfortunate officer.

Zola's object was a prosecution for libel, and a judicial inquiry into the whole *affaire,* and at the trial, nhich took place in Paris in February, a fierce flood of light was thrown on the case. The chiefs of the army put forth all their power, and Zola was condemned. He appealed. On April 2, the Cour de Cassation quashed the proceedings.

A second trial took place at Versailles, on July 18, and without awaiting the result Zola, by the advice of his counsel and friends, and for reasons of legal strategy, abruptly left France and took refuge in England. Here he remained in hiding, writing *Fécondité,* until June 4, 1899, when, immediately on hearing that there was to be a revision of the first Dreyfus trial, he returned to Paris.

On the morning of Sept. 29, 1902, Zola was found dead in the bedroom of his Paris house, having been accidentally asphyxiated by the fumes from a defective flue. He received a public funeral, at which Captain Dreyfus was present. Anatole France delivered an impassioned oration at the grave. At the time of his death Zola had just completed a novel, *Vérité,* dealing with the incidents of the Dreyfus trial. A sequel, *Justice,* had been planned, but not executed. Zola's literary position would have more than qualified him for the French academy. He was several times a candidate in vain. (F. T. M.)

See *Émile Zola, Novelist and Reformer* (1904), giving a full account of his life and work, by E. A. Vizetelly, who translated and edited many of his works in English; also P. Alexis, *Émile Zola, Notes d'un ami* (1882); F. Brunetière, *Le Roman Naturaliste* (1883); *Journal des Goncourt* (1888–92), vols. iii, v and vi; E. Hennequin, *Quelques Écrivains français* (1890); R. H. Sherard, *Émile Zola: a biographical and critical study* (1903); A. Laporte, *Émile Zola, l'homme et l'œuvre* (1894), with a bibliography. L. Deffoux and E. Zavie, *Le Groupe de Médan, Émile Zola, Guy de Maupassant, etc.* (1920); R. Oehert, E. *Zola als Theaterdichter* (1920); E. Rostand, *Deux Romanciers de Provence: H. d'Urfé et E. Zola* (1921); E. A. A. L. Seillière, E. *Zola* (1923); A. Baillot, E. *Zola, l'homme, le penseur, le critique* (1924); M. Josephson, *Zola and his Time* (1929). For the proceedings against Zola see *Le Procès Zola* (2 vols., 1898)

ZOLLVEREIN: *see* ECONOMIC UNION; TARIFFS and GERMAN~:*History*.

ZOMBA, the capital of Nyasaland protectorate, was established in 1885 on the lower slopes of Zomba mountain, 3,141 ft. above sea level. near the great slave route which ran from the southern end of Lake Nyasa to the Mozambique coast. The wet season, which follows the hottest months (maximum temperature 97° F.), is from November until March and the coldest months are May, June and July, when the temperature may fall to 40° F. Pop. (1956) 9,331, of which 5,270 were employed African, 800 European and 530 Asian. Area 2.72 sq.mi. Shortly after its establishment, Zomba became the recognized seat of the government. It was proclaimed a township in 1900, lost this status in 1932 and was reconstituted as a township in 1934. The old residency, completed in 1887, was designed to provide fortification against attack by slave raiders. It still stands by the Mulungusi river on the perimeter of the botanical gardens and is used as a hostel for government officers. Adjacent are the government secretariat (rebuilt in 1922) and the legislative council building (1957). There are a European kindergarten school and African and European hospitals. Zomba lies 42 mi. by tarred road northeast of Blantyre and its nearest railway station is at Limbe, about 37 mi. to the southwest. There is also a small airfield about g mi. from Zomba. Most of the town's inhabitants are employed by the government, but many work on the dairy farms and tobacco plantations in the surrounding district,

ZONARAS, JOHN (fl. 1st half of the 12th century), Byzantine historian who provides valuable information on the 11th century. After holding high office in Constantinople under Alexius I Comnenus, he became a monk and retired to a remote island. His world history extends from the creation to 1118. He drew on a rich collection of sources, of which some, notably the first 21 books of Dio Cassius' history, are preserved only through him. A *Lexicon* and theological writings are also attributed to him.

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ZONING. Zoning is the legislative method of controlling the use of land through establishment of standards and requirements concerning the use of land and buildings, the proportion of the lot to be covered by them and the density of population. Primarily applied in urban areas, it is accomplished by division of the city or county land area into zoning districts, each having specific conditions under which land and buildings may be legally developed and used. Inspired by architectural and urban-design controls introduced in European cities toward the end of the 19th century, it has grown in breadth and evolved to become a major arm of the general process of city planning in the United States.

Zoning of this kind is perhaps more widely accepted in the cities of the United States than elsewhere. Its acceptance has come about through constitutionally based interpretation of the state's police power—the power of regulation in the interests of protecting public health, safety and general welfare. The evolution of zoning in the United States has been away from strict architectural and site-planning controls toward regulation of the social functions to which land and buildings are put. Another important development has been toward the establishment of a rational balance between amounts of land for various urban activities, and their distribution in relation to market forces and systems of transportation and vehicular circulation, in the interests of a more comprehensive and creative approach to city planning. While not alone an answer to urban growth problems, it is, combined with other city-planning techniques, a major instrument for gaining greater physical order in cities.

Zoning in European Cities.—In accordance with long-established municipal powers, German and Swedish cities applied zoning regulations about 1875 to new land being urbanized around the older city cores, as a way of controlling the heights and concentrations of buildings to avoid problems of congestion. The German laws were particularly rigid and widespread. and led to a greater spaciousness and uniformity of development than would have occurred under earlier, more primitive building regulations. Much of the orderliness of German and Swedish cities, and the consistent quality of building line and height which is so apparent in contrast with typical U.S. cities, is due to the early establishment of detailed zoning regulations and their widespread application at the time of major building activity growing out of the Industrial Revolution. The detailed site planning by public agencies in advance of development that is typical of northern European cities tends to obviate the need for the kind of zoning legislation developed in the United States.

England.— England's development of zoning regulations stems from the passage of the Town Planning act in 1909, which had for its general object the control of urbanization of new land. Relating almost solely to new building development, and coming at a later date than in Germany, the English law was not as effective in achieving architectural control in the more centrally located sections of cities. The emphasis in the restrictions imposed in the 1909 law, as stated in the original act, was on "securing the amenity of the area," in addition to regulating space, height or character of buildings. These early British zoning regulations, while somewhat effective in controlling industrial locations and in establishing standards for residential development, have been supplanted by more direct government action in new towns and public housing construction and control of development rights.

Latin America.— Few Latin-American cities passed zoning laws based on early European experience. The strong cultural ties with Spain discouraged a flow from other countries of practices related to urban affairs. and Spain, lacking the widespread urban expansion of northern European countries, had only limited experience with zoning. Latin-American cities, on the other hand. were undergoing tremendous growth about the turn of the 20th century. and could well have profited by the German and British experience. During the 1920s, however, many of the larger cities in Latin America began city-planning programs and introduced limited regulations on building height and intensity. patterned somewhat after those of Europe. Thereafter. city growth continued at such a pace and on such a wide scale that the early ordinances primarily governing building design proved insufficient to provide the necessary control over land and building uses. Generally speaking. Latin-American cities in the latter 1950s still had not adopted zoning ordinances that adequately met their particular problems of urban development.

The United States.— In the United States, particularly in California, the need for regulating urban activities that under certain conditions were nuisances, such as the operation of commercial laundries or brickyards, first motivated the early ordinances around the turn of the 20th century. Two cases involving these businesses came before the courts in 1911 and 1915, and out of them grew the acceptance of municipal control over the location of nuisance-creating activities. Meanwhile, in New York city, problems directly related to the height and form of buildings and extent of land coverage gave rise to the passage in 1916 of the first comprehensive zoning ordinance. The New York ordinance went far beyond this "nuisance theory" of zoning, adding to it the idea of architectural control of building form to assure that skyscrapers did not usurp their neighbour's light and air. It also established the basic principle underlying contemporary zoning throughout the United States—the "planning concept of zoning," which views zoning as a positive means of promoting the welfare of the community by guiding physical growth along orderly lines. Accordingly, zoning regulations should be provided consistently throughout all areas of a city and covering all possible types of land uses. In this sense zoning has become a major instrument in the guidance of physical development of private land and the implementation of long-range municipal policies.

An important step in furthering comprehensive zoning was the appointment of the Advisory Committee on Zoning in 1921 by the then secretary of commerce. Herbert Hoover; the model zoning ordinance drafted by this committee was widely adapted. Many states followed its and New York's example. and passed enabling acts to permit cities to establish such zoning ordinances. Among early significant court decisions upholding the ordinances in specific lawsuits brought against the cities by individuals who were affected were the *Lincoln Trust Co. v. Williams Building Corp.* decision. which upheld in 1920 the New York ordinance applying the "nuisance theory"; the case of *Carter v. Harper*, in 1923 in Wisconsin, which clearly set forth a concept of planning behind zoning; and the *Village of Euclid v. Ambler Realty Co.* case in 1926, which was the first decision of the U.S. supreme court on the constitutionality of a comprehensive zoning ordinance.

Accepted almost universally in the United States are the following objectives of zoning: reduction of fire hazards, control of congestion in houses and neighbourhoods, assurance of light and air for comfort and health. conservation of stability of property values, consolidation of commercial districts, provision for off-street parking, control of height and bulk of buildings. position on the lot and. indirectly. control of density of population. Areas of control in which there was experimentation in the latter 1950s included zoning for exclusive agricultural and related land uses to prevent urban sprawl. refinements of proportioning and locating land uses in relation to market forces. greater flexibility to relieve the hardships and monotony caused by some of the earlier arbitrary zoning patterns and restrictions. provision for combining various related land uses in planned unit developments, the offering of incentives for better site design and development standards through award of bonus allowances for floor area in relation to lot size. the concept of zoning by performance standards rather than strictly by permitting or excluding certain specified types of activities and possibilities of zoning for improving the appearance of cities.

Zoning has inherent in it certain limitations. It cannot shape new areas or reshape old ones without other instruments for carrying out official general plans, such as urban redevelopment, subdivision regulations, capital improvement programing and the design and construction of influential public works. Yet, it is an instrument of great potentiality in systematizing urban development, providing a better functional and aesthetic order and, particularly, in carrying out general plans for cities in all parts of the world. *(See* also HOUSING; CITY PLANNING.)

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ZOO: *see* ZOOLOGICAL GARDENS.

ZOOGEOGRAPHY is the study of the geographical distribution of animals. It is concerned with where different animals are on the earth, how they got where they are, how and why geographical patterns have been formed, and what the patterns mean. The study is important since patterns of animal distribution suggest, among other things, fundamental concepts about evolution, about the distribution of land and water and sometimes about climates thousands or even millions of years ago.

A distinction should be made between the zoogeographical and ecological approaches to animal distribution. Zoogeography is concerned with broad geographical patterns; ecology, with local details of distribution and with animals' relations to their environments *(see* ECOLOGY, ANIMAL; ANIMALS, DISTRIBUTION OF). For example, grazing mammals occur in Africa and Australia (as well as elsewhere). How they are adapted for eating grass, and how the distribution of grasses limits the distribution of the different grass eaters in different places are concerns of ecology. But in Africa the grass eaters are zebras and antelopes. etc., and in Australia they are kangaroos; these facts and their explanation are concerns of zoogeography. Although zoogeographers understand the importance of the environment, they usually consider it in a rather general way, in terms of climatic zones and broad areas of forests and deserts; ecologists, on the other hand, are more concerned with local factors and "microclimates." Ultimately, zoogeography utilizes ecology; however, it draws on ecological principles more than on details.

This article is divided into the following sections:

I. HISTORY

Historically, men always have been interested in the distribution of animals they hunted or feared. Zoologists of the 18th and early 19th centuries worked out the broad patterns of distribution of conspicuous vertebrates; however, explanation of the patterns was not possible until Darwin's proof of evolution. In 1858, the year before Darwin published the *Origin of Species*, P. L. Sclater accurately described and analyzed the distribution of birds and divided the world into faunal regions that are still recognized *(see* below), but he thought the regions represented separate "centres of creation." Darwin supplied the true explanation of them, based on evolution.

Geologic Column and Scale of Time Since Triassic

(Ages increase from top downward, as in a sequence of sedimentary rocks)

System and Period	Series and Epoch	Distinctive Records of Life	1000 Years*
		CENOZOIC ERA	
Quaternary	Recent	Modern man	*11*
			>44
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	(21,000)
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	(58,000)
	Paleocene	First placental mammals	70,000
		MESOZOIC ERA	
Cretaceous		Extinction of dinosaurs, floras with modern aspects	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals.	160,000
Triassic		Appearance of dinosaurs	200,000

*Italicized figures are from radiocarbon analyses; figures in parentheses are reliable values from radioactive minerals found in rocks that belong in time divisions indicated; plain figures give estimated dates at start of corresponding time units.

Zoogeography and the discovery and proof of evolution are very closely connected. During the voyage of the "Beagle," Darwin found at different localities and in different habitats in South America species of animals which, though different, were basically alike, as if they had evolved in different parts of South America from common ancestors (as of course they had). And on the Galapagos Darwin found species different from but basically similar to South American species, as if the Galapagos species had evolved from South American ancestors; he also found slightly different species on different islands of the Galapagos archipelago, as if evolution had made many local modifications of a few original stocks. It was these observations more than anything else (although he had other evidence) that first convinced Darwin himself that species had evolved.

Later, having proved the fact of evolution partly by patterns of distribution of animals, Darwin was able to explain the patterns. He showed that they were made by evolution of different animals in different places, and by some of the animals spreading from the places where they first evolved into other parts of the world. Darwin's two chapters on "Geographical Distribution" in the *Origin of Species* are not only historically important but are still pertinent and fascinating essays on zoogeography.

Alfred Russel Wallace, the co-discoverer with Darwin of evolution by natural selection, also deduced the fact of evolution primarily from what he saw of animal distribution, especially in the Malay archipelago. Wallace is recognized as the great zoogeographer. He formally organized the subject in a two volume work, *The Geographical Distribution of Animals*, in 1876. Darwin and Wallace laid the foundations of the subject. Since their time much has been added to the body of facts, but little has been added to the original principles, though zoogeographers are still confirming and extending them.

Zoogeography is of necessity concerned primarily with vertebrates, because they are the best-known animals and because some of them have left revealing fossil records. Therefore, the principles of zoogeography have been worked out primarily by vertebrate evidence. Once formulated, the principles can then be re-examined and tentatively extended to invertebrates, though this has not been done extensively. Since fresh-water fishes, amphibians and mammals have sharply defined and very informative patterns of distribution (mammals especially have an unequaled fossil record), these classes of vertebrates will be specially stressed. Reptiles and birds will be treated more briefly. Distribution on land and in fresh water will be considered first, then distribution in the sea.

The facts of animal distribution can be presented in two ways. The distributions of different groups of animals, (fishes, amphibians, reptiles, etc.) can be treated separately; Wallace called this "geographical zoology." On the other hand, the world can be divided into regions according to animal distribution, and the regions can be treated separately; Wallace called this "zoological geography." It is logical to begin with the distributions and histories of separate groups, and then to divide the world into faunal regions and consider the compositions and histories of the different regional faunas. In the following discussion, the phrase "the main part of the world" is synonymous with the realm Megagea (see Faunal Regions below), which includes Africa, tropical Asia (with adjacent islands), Eurasia and most of North America (except tropical Mexico).

II. THE DISTRIBUTION OF ANIMAL GROUPS

1. Fresh-Water Fishes. — For zoogeographic purposes, fishes that occur in fresh water are placed in three divisions, according to G. S. Myers (1938) : primary, secondary and peripheral.

The primary division consists of families or other groups of fishes that are strictly confined to fresh water. that ordinarily cannot or do not enter the sea, and that have probably been confined to fresh water so long that their present distributions are wholly the result of dispersal through fresh water.

The secondary division consists of families or other groups of fishes that are found chiefly in fresh water but that can enter the sea and survive there for a limited time, or are recently descended from fishes that could do so, so that their distributions may be partly the result of dispersal along coasts or across narrow ocean gaps.

The peripheral division consists of families or other groups that, although found in fresh water, enter the sea freely or have been so recently derived from marine ancestors that their distributions may be largely the result of dispersal through the sea.

Fresh-water fishes of the primary division are as closely confined to land masses as any animals and are therefore very significant in zoogeography.

Existing primary-division fishes are bichirs (Polypteridae), in Africa; paddlefish (Polyodontidae), in China and eastern North America; bowfin (Amiidae), in eastern North America; lungfish (Ceratodontidae), in Australia and (Lepidosirenidae) in Africa and South America (the fishes listed thus far are relicts of old, nonteleost groups): Isospondyli (of half a dozen families) in Africa, mooneyes (Hiodontidae) in eastern North America, and Osteoglossidae widely scattered in the tropics (the osteoglossids are placed in the primary division with doubt) ; Ostariophysi (see below), dominant on all continents except Australia; mud minnows (Umbridae), blackfish (Dalliidae), and pikes and pickerels (Esocidae) in temperate Eurasia and North America; trout perches (Percopsidae) and pirate perches (Aphredoderidae) in North America; and (of spiny-rayed teleosts) fresh-water basses (Centrarchidae) in North America, true perches (Percidae) in temperate Eurasia and North America, Nandidae widely scattered in the tropics, Pristolepidae in tropical Asia, and three families of labyrinth fishes (Anabantoidea) and the spiny eels (Mastacembelidae) in tropical Asia and Africa.

Existing secondary-division fishes are gar pikes (Lepisosteidae) in eastern North America and Central America; top minnows and viviparous minnows (Cyprinodontes, several families) in the warmer parts of Eurasia, Africa and especially the Americas; and Cichlidae in Africa, etc., and tropical and subtropical America.

Peripheral fresh-water fishes include lampreys (Petromyzonidae), sturgeons (Acipenseridae), salmon and trout (Salmonidae), fresh-water eels (Anguillidae) and sticklebacks (Gasterosteidae), all of which occur in temperate Eurasia and North America (some of them elsewhere too) ; and other groups too numerous to list, in all parts of the world.

2. Distribution **of** Fresh-Water Fishes. — Fresh-water fishes of the primary division are virtually confined to the great continents and islands that have recently been connected to the continents. Few or none of these fishes reach old or remote islands (in this article Australia is considered an island). A species of lungfish is localized in southern Queensland, but it is a relict of a very old group, whose unknown remote ancestors may have reached Australia through the sea. One other Australian fish (an osteoglossid) has been placed in the primary division, but it may be derived from a salt-toleranc ancestor that reached Australia more recently through the sea. All other Australian fresh-water fishes are certainly derived from marine or salt-tolerant ancestors that have entered Australian rivers from the sea.

The geographical limits of primary-division fish faunas are very sharply defined. Many Asiatic primary-division fishes reach Sumatra, Java and Borneo (which were attached to Asia during relatively recent geologic time), but none extends across Makassar strait to Celebes (except two or three species probably carried by man), and only a few, mostly small, perhaps slightly salt-tolerant forms extend east of Java (to the Lesser Sunda Islands) or east and north of Borneo (to the southern Philippines). Elsewhere in the world, many primary-division fishes reach the British Isles, Ceylon, Formosa, Japan and (off the northeast coast of South America) Trinidad; these are all recent continental islands which were separated from adjacent continents probably not more than 10,000 years ago.

Although primary-division fishes are numerous in Africa, none occurs on Madagascar, and although they are numerous in both North and South America, none occurs on the West Indies proper (zoogeographically, Trinidad is part of South America, not one of the West Indies). Madagascar and the West Indies as well as the islands from Celebes to Australia have evidently not been connected to the great continents during the dispersal of most existing primary-division fishes.

Secondary-division fishes, which have enough salt tolerance to cross narrow ocean barriers, do reach Madagascar, some of the West Indies and Celebes. Moreover, secondary-division fishes are relatively numerous in Central America, where primary-division fishes are relatively few. This fact suggests that Central America was either an island or a peninsula difficult for fresh-water fishes to reach not long ago.

Although salt-water barriers determine the final limits of distribution of true fresh-water fishes, climate is an additional limiting factor for many groups. Some great groups of fresh-water (as well as marine) fishes are confined to the tropical zone or nearly so. Characins, for example, are primary-division freshwater fishes (including the carnivorous piranhas and many small aquarium fishes) which are numerous in tropical Africa and South America. They scarcely enter the north temperate zone (one extends north to the Rio Grande in North America) and do not even reach the northern edge of the south temperate zone of Africa and South America (below the tropics). Fresh-water (primary division) catfishes, composing another chiefly tropical group, are abundant in the tropics of Asia, Africa and America, and relatively sparse in the temperate zones. Some catfishes do occur in eastern North America — there are nearly 20 species in the Mississippi — but this is exceptional. Most temperate regions have few species or none, whereas (for comparison) more than 450 species are known from the Amazon.

Some other fresh-water fishes (and some marine fishes) are confined to the north temperate zone or nearly so. The pikes and pickerels and the true fresh-water perches are strictly freshwater families which are widely distributed across temperate Eurasia and North America but do not enter the tropics. The distribution of salmon and trout shows the limiting effect of zonal climate even more plainly. Salmonids, which occur in numbers in cool fresh waters around the north temperate zone, extend south to the southern edge of the temperate zone in Africa and in the northwestern corner of Mexico but do not enter the tropics. Since they are peripheral fishes, many of which spend parts of their lives in the sea, they are clearly limited by zonal climate rather than by physical barriers.

Besides salt-water barriers and zonation of climate, one other thing has had a profound effect on the present pattern of distribution of fresh-water fishes, and that is the evolution and dispersal of dominant groups. About seven-eighths of all existing primary-division fresh-water fishes belong to one dominant order, Ostariophysi. This order is divided into two suborders. Cyprinoidea or carplike fishes and Siluroidea or catfishes. The cyprinoids in turn are divided into two principal superfamilies: Characiformes, the characins (see above) and their allies; and Cypriniformes, which include the suckers (Catostomidae), carps and most fresh-water minnows (Cyprinidae) and allied families.

The Ostariophysi as a whole are now dominant in fresh water on all continents except Australia (some catfishes occur in Australian rivers, but they are derived from stocks that have entered, and still occur in, the sea and that have re-entered fresh water in Australia and other isolated places). However the Ostariophysi of different continents are very different, and the differences seem to reflect two main periods of evolution and dispersal.

Ostariophysi apparently originated in the old-world tropics, presumably during the Cretaceous period. Primitive Ostariophysi (characins and catfishes) may then have spread through the fresh waters of at least the warmer parts of all the continents except Australia. They reached South America and radiated there. Then, later. but perhaps still in the Cretaceous, cypriniforms began a second period of evolution and dispersal. They probably originated (from characins) in tropical Asia, and have spread from there in all directions that continuity of land has allowed. They have diversified and multiplied especially in tropical Asia and have spread in numbers to temperate Asia and Europe. apparently replacing most older fishes in these places. The cypriniforms have reached Africa and North Xmerica, where, although they have become numerous. they have not yet replaced other fishes to the extent that they have in Eurasia. These forms have not reached South America. where the older characins and catfishes are still dominant, and of course they have not reached Australia (except as introduced by man).

Salt-water barriers, zonation of climate and evolution and spread — first of primitive Ostariophysi from the old-world tropics and then of cypriniforms from tropical Asia — seem to have been the principal factors that determine the main, existing, world-wide pattern of distribution of fresh-water fishes. The dispersal of successive dominant groups seems to have been most important of all. Because of it, the fresh-water fish faunas of the world form a pattern of concentric but very irregular zones (fig. 1). At the centre of the pattern, in Eurasia, is a zone of cypriniform

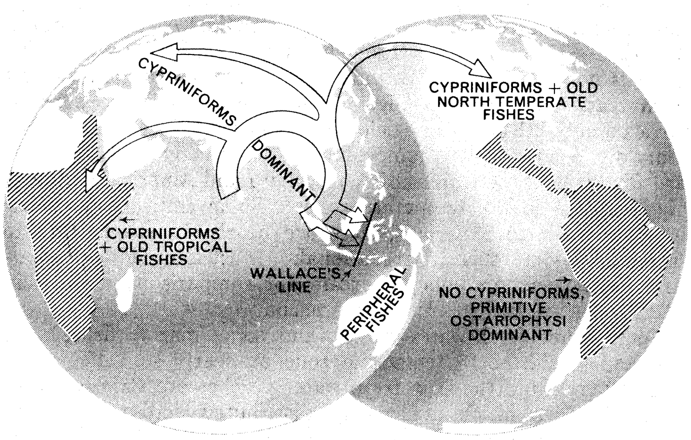

FIG. I.— DISTRIBUTIONOF DOMINANT FRESH-WATER FISHES. ARC AND ARROWS SHOW PLACE OF ORIGIN AND DIRECTIONS OF DISPERSAL OF CYPRINIFORMS: CROSSHATCHING SHOWS PRESENT DISTRIBUTION OF CHARACINS

dominance. Next to the centre, in Africa and North America, is a zone of mixed dominance, where cypriniiorms occur with many other fishes. Farther away, in South America, is a zone which cypriniforms have not reached and which is dominated by more primitive Ostariophysi. And finally Australia. New Guinea and nearby islands (west to and including the Celebes). Zlladagascar, the West Indies (except Trinidad). and all other old or remote islands, lie in a zone which, though not more distant from the dispersal centre than is South Xmerica, is cut off from the centre by salt-water barriers impassable for strictly fresh-water fishes. In this zone the dominant fishes belong to peripheral groups.

The South American lungfish, placed in the same family as the Airican lungfish (the Australian lungfish represents a different, older family), and most other primary-division groups of fishes in South America seem to be related to existing African fishes. Superficially. this fact suggests a former physical union and subsequent separation of the land masses of South America and Africa. But analysis shows that the South American fishes do not represent the whole African fish fauna or any simple part of it; particularly. they do not represent a very ancient part, for. although a lungfish is present in South America, the ancient bichirs (polypterids) and some other presumably old African groups are absent in South America. In fact. South American fresh-water fishes represent fractions of the African fish fauna that are diverse in probable geological age and in ecological requirements. This is not what would be expected if South America and Africa were formerly in contact. but rather what might result if a few fishes reached South America with difficulty, at different times and perhaps in different ways. Nowhere else in the world does the distribution of fresh-water fishes suggest continental drift: there is no relationship between the strictly fresh-water fishes of South America and Australia, or of Africa and Australia, and no indication (from fish fauna) that Madagascar has been connected with any continent. (Small fishes of the family Galaxiidae occur in fresh water in southern South America, southern Australia and the southern tip of Africa, as well as on New Zealand and some other islands. but some of them enter or even breed in salt water, and the family has probably dispersed through the sea.) The distribution of fresh-water fishes, though not consistent with continental drift, is consistent with the history of dispersal of successive dominant groups of Ostariophysi from the old-world tropics outlined above (see fig. 1).

3. Amphibians. — Existing amphibians belong to three orders, all of which are very old (Early Mesozoic or pre-Mesozoic in origin). However, the distributions of the existing forms are probably products of more recent periods, perhaps Late Cretaceous and Tertiary.

Caecilians (order Apoda or Gymnophiona) are wormlike. land-burrowing or aquatic amphibians. They occur in tropical Africa (but not Madagascar); on the Seychelles Islands in the Indian ocean; in tropical Asia, Sumatra, Java, Borneo and the southern Philippines (but not the Australian region); and in tropical America from southern Mexico to northern Argentina. Their geographical history is unknown.

Salamanders and Newts (order Caudata or Urodela) are found principally in the north temperate zone. A few occur in the edge of the tropics in southeastern Asia, and one stock of the northern family Plethodontidae extends through Central America into northern South America south to the Amazon region, but otherwise salamanders are absent in the tropics; they do not occur in the southern hemisphere or on any islands except recent continental ones.

In the north temperate zone, salamanders are very unevenly distributed. Most are concentrated in four separate areas: (1) Europe with adjacent parts of Africa (north of the Atlas mountains) and southwestern Asia; (2) eastern Asia and Japan; (3) western and (4) eastern North America. The geographical relationships of different species of salamanders run in every possible direction in these four areas. Some occur both in Europe and eastern Asia; the plethodontid *Hydromantes,* in Europe and western North America; the family Proteidae, in Europe and eastern North America; one group of *Triturus,* in eastern Asia and western North America; the family Cryptobranchidae, in eastern Asia and eastern North America; and *Ambystoma* and certain members of the family Plethodontidae, in western and eastern North America. The geographical pattern called a relict pattern is formed when an old and diverse, widespread group of animals is depleted and survives in restricted areas. It has two main characteristics. The first is discontinuity: related forms tend to occur in widely separated areas: and fossils may occur far outside the ranges of the living forms (as is the case in some groups of salamanders). The second is diversity of geographical relationships: the geographical ties of surviving forms tend to be diverse and confused. reflecting extinctions and survivals rather than directions of dispersal.

The geographical history of salamanders is unknown, but their relict pattern of distribution shows clearly that they are mainly a declining group. Nevertheless plethodontids have evidently spread into Central and South America in recent geologic time.

Frogs and Toads (order Salientia or Anura) are the dominant existing amphibians. They are almost world-wide in distribution, being absent only in the most extreme arctic regions and on remote islands. That they have reached Australia and many not too remote islands shons that they get across narrow salt-water barriers better than do strictly fresh-water fishes. Islands reached by frogs include not only obviously continental islands but also the West Indies; Madagascar; the Seychelles; all the Malay archipelago. including the Philippines; the Solomon Islands; New Zealand: and perhaps the Fiji Islands.

Although frogs and toads as a group are almost world-wide in distribution. the separate families are more limited. The most primitive existing frogs are *Ascaphus* (one species). in cold brooks in northwestern North America; and *Leiopelma* (two or three species), on New Zealand. These two genera are thought to be the last survivors of an old family that was probably once widely distributed over most of the world. Less primitive but still probably rather old families are Discoglossidae (fire-bellied toads). in Europe and eastern Asia; Pipidae (aquatic-clan ed frogs), in Africa and South America; *Rhinophrynus,* in southern Mexico and Central America; and Pelobatidae (including spadefoot toads). with three subfamilies. in (1) southeastern Asia. Sumatra, Java. Borneo and some of the Philippine Islands; (2) Europe and North America; and (3) the Seychelles Islands.

The distributions of higher families of frogs are significantly interrelated. The ground-living families form one ,geographical series; tree frogs, another. Of primarily ground-living frogs, Leptodactylidae (fig. 2) are numerous only in Australia and tropical America, but one doubtful (relict?) genus occurs in South Africa. and the family is fossil in India. Ranidae are numerous only in Africa, in Eurasia and adjacent islands, and in North America; some species reach New Guinea and the northern edge of Australia, a few reach Central America and one species extends into northern South America; even so, ranids have not yet become dominant in these places. The distributions of these fami-

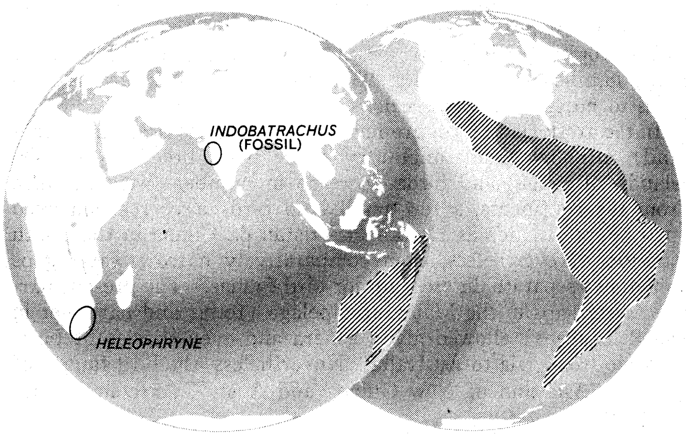

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FIG. 2.— DISTRIBUTION OF FROGS OF FAMILY LEPTODACTYLIDAE

lies suggest that Leptodactylidae were once world-wide but have been replaced by ranids in the main part of the world, leaving the leptodactylids discontinuously distributed, in Australia and South America (fig. 3). Most ranids are confined to the old-world tropics. The single predominant genus *Rana* (which includes most northern common frogs) presumably originated there but species have spread through the whole of Africa, tropical and temperate Eurasia (and into the arctic), North America, and south to the limits given above.

Of other primarily ground-living frogs and toads, atelopodids (Atelopodidae) are mostly in tropical America; brevicipitids (Brevicipitidae) are widely scattered in the warmer parts of the world (often occurring in hidden places, as if withdrawing from open competition nith other frogs); and *Bufo* species (common toads) have spread apparently from the old-world tropics (their

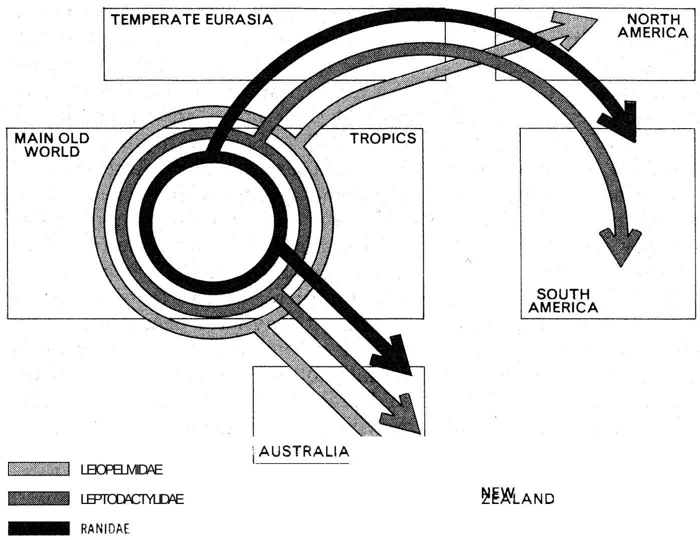

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FIG 3 — DIAGRAM OF (HYPOTHETICAL) SUCCESSIVE DISPERSALS OF THREE FAMILIES OF FROGS

Leiopelmidae, surviving only in New Zeaiand and localized in western North America; Leptodactylidae, surviving principally in Australia and South America; Ranidae, dominant throughout the world and reaching the Australian and Neotropical regions

relatives are in tropical Africa and the Malay region) over all Africa, Eurasia. North and South America, but not Australia. These additional families further complicate the geographical pattern of the leptodactylids and ranids, serving to reinforce it.

Tree frogs belong to two principal families, Hylidae and Rhacophoridae. Hylids, including the genus Hyla, are very numerous in tropical America and extend northward in smaller numbers through temperate North America almost to the arctic. A few Hyla species (perhaps forms of a single species) occur across temperate Asia and Europe and south to North Africa, southern Arabia and Indo-China; they occur again in numbers in New Guinea and tropical and south temperate Australia. However, hylids are absent or nearly so (there are one or two doubtful records) in Africa south of the Sahara and in most of tropical Asia and the western Malay archipelago.

The second group of tree frogs. the rhacophorids, are abundant in the main part of the old-world tropics; they are almost confined to the gap in the range of hylids. These distributions suggest that the family Hylidae or at least Hyla was once world-wide but has been replaced by rhacophorids in the main part of the old-world tropics, leaving the hylids discontinuously distributed.

The obvious old relationship between the fresh-water fishes of Africa and South America (see above)—which seems to be the result of complex changes in fish distributions rather than of a direct land connection—is repeated in one family of frogs. Pipidae, and since pipids are aquatic frogs, they may have had the same geographic history as the fishes. Leptodactylids and hylids now occur chiefly in South America and Australia, but this pattern too seems to be the result of changes in the animals' distribution rather than of direct land connections.

4. Reptiles.— Reptiles are primarily tropical animals. Only one species of lizard and one of snake cross the Arctic circle in northern Europe; elsewhere, reptiles do not reach the arctic, and they are few even in cool north temperate areas. Likewise, they decrease south of the tropics; of the many reptiles in tropical South America, only one genus of lizard reaches the cool southern tip of the continent. On the other hand, reptiles, especially lizards, are more widely distributed on islands than are any other flightless land vertebrates. Snakes occur on some islands too, within the limits of distribution of lizards, and giant land tortoises are noted for their occurrence on islands (see below).

Alligators *and* Crocodiles.—Of existing reptiles, most crocodilians are tropical, but true alligators (genus Alligator) are confined to warm temperate areas: the two existing kinds of alligators are in the southeastern United States and the lower Yangtze valley in China, but fossil species are found in western North America.

Turtles. — Turtles are primarily tropical but extend irregularly into temperate areas; they are rather numerous in eastern North America, fewer elsewhere north of the tropics, and absent in the interior of Asia and in the British Isles. Southward, turtles reach southern Australia but not Tasmania, and northern Argentina.

Among fresh-water and amphibious groups, side-necked turtles occur in Africa, South America and Australia; common turtles (family Emydidae), mostly in Eurasia and North America. One of the two side-necked families, Pelomedusidae, is confined to Africa, Madagascar and South America but has fossil forms in Eurasia and North America (where it may have been replaced by common turtles). One genus of pelomedusids. *Podocnemis,* is now confined to Madagascar and South America. but has fossil forms in Africa as well as in Eurasia and North America. The other side-necked family, Chelydidae, is confined to South America and Australia (including New Guinea) and is not represented by fossils elsewhere. These turtles are aquatic and may have reached Australia from South America through the sea.

The only important existing group of land turtles is the family Testudinidae, of which the principal genus is *Testudo.* Testudinids probably originated in southern Asia early in the Tertiary. Testudo spread over all continents except Australia, disappeared in North America (fossils are present there from the Eocene to the Pleistocene) and survives in Africa and Madagascar, in southern Eurasia and adjacent islands, and in South America. This genus reached South America during the Miocene, while the continent was still cut off from North America, and it has reached many islands. Gigantic species of Testudo still exist, or did so within historic times, on many islands in the Indian ocean (the Seychelles, Mascarenes, etc.) and on the Galapagos; they are present as fossils on some islands of the West Indies and of the Canaries. Some of these turtles, although adapted to live entirely on land, have evidently crossed ocean barriers hundreds of miles wide.

Tuatara.—The tuatara (*Sphenodon*), confined to the remote island of New Zealand, is the last survivor of the order Rhynchocephalia, which was widely distributed in the Early and Middle Mesozoic but is unknown as a fossil later than the Lower Cretaceous (about 135,000,000 years ago).

Lizards.—Existing lizards and snakes (see below) are so numerous that only a few selected families can be mentioned. Lizards reach the following islands beyond the limits of distribution of amphibians: the Mascarene Islands, in the Indian ocean; Fiji, the Tongas, New Caledonia and Samoa, in the western Pacific; New Zealand (where there are at least three stocks of reptiles against one of amphibians); the Galapagos Islands, in the eastern Pacific; and, in the Atlantic, not only all the West Indies (where reptiles are much more diverse than amphibians) hut also Bermuda, the Canaries, Madeira and the Cape Verde Islands. Small lizards occur beyond these limits on still more remote islands, but they have probably been carried there by man.

Lizards of the family Gekkonidae (geckos), abundant throughout the tropics, do not extend far into temperate areas. They show how strictly climate can limit even a dominant group of reptiles. Scincid lizards (skinks) are very numerous in the warmer part of the old world and several old-world genera extend to America, as if the family is invading the new from the old world. Lizards of the family Iguanidae are numerous in the Americas, and two genera occur on Madagascar and one on Fiji, but the family is now absent on the continents of the old world, where the related family Agamidae occurs. This pattern suggests that iguanids were once world-wide and have been replaced by agamids on old-world continents.

Snakes. — The giant constricting snakes (with their smaller relatives) form the family Boidae. The boas proper (subfamily Boinae).are confined to America; pythons (subfamily Pythoninae), to the old world except Madagascar. The Madagascan forms resemble boas but are not really related to them and are placed in a third subfamily (Sanziniinae). Most existing snakes belong to the family Colubridae (common snakes). Colubrids are numerous on all continents except Australia. A few Asian colubrids have reached northeastern Australia in recent geologic time (their distributions show this); they are not numerous there, and much of Australia is still without colubrids. The common Australian snakes are elapids (family Elapidae), which, although poisonous, include many small and inoffensive species as well as some large and dangerous ones. (Outside Australia, elapids are represented by cobras and coral snakes.) This geographical pattern suggests that colubrids are now invading Australia and will perhaps replace most elapids there.

Of the vipers (family Viperidae) true vipers (subfamily Viperinae) are widely distributed in Africa and Eurasia; pit vipers (subfamily Crotalinae), derived from true vipers, have evidently spread from Asia (where they still occur) to America.

These fragments of the recent history of reptiles do not seem to follow any simple pattern, unless possibly one of evolution in the main part of the old world (Europe, Asia, Africa) and movement toward America and Australia.

Extinct Reptiles.—Of ancient, extinct reptiles, dinosaurs are the most significant zoogeographically. They originated early in the Mesozoic era, and both carnivorous and plant-eating groups soon reached all the continents including South America and Australia. Some reached Madagascar, but none is known to have reached New Zealand or Antarctica. Late in the Mesozoic (the Cretaceous period) the plant-eating groups formed a zonal pattern of distribution: sauropods, which were apparently amphibious and adapted to eat only soft water plants, occurred mostly in what is now the tropical zone; and ornithischians. which were more terrestrial and adapted to eat coarser land plants, occurred mostly north of the tropics. These facts suggest that all the habitable continents were accessible in the Mesozoic, as they are now for animals that can cross narrow salt-water barriers, and that climate zones were oriented, at least in the Cretaceous, as they are now.

5. Birds. — Birds are warm-blooded feathered flyers that live in the coldest arctic as well as the hottest tropics; some have reached the most remote islands. Nevertheless, climate and salt-water barriers determine the main pattern of distribution of birds. Birds are much more numerous and diverse in the tropics than elsenhere. It has been estimated that 85% of bird species occur in the tropics (or in the tropics and the south temperate zone); many families are confined to the tropics while very few are confined to north temperate regions.

In the arctic, land birds are few (only 14 species breed in Greenland), although many migratory water birds breed there. On islands, although land birds decrease in numbers uith distance from the continents, a few small land birds have reached even such remote islands as Hawaii or Tristan da Cunha in the South Atlantic. Nevertheless, even comparatively narrow water gaps sometimes separate different major bird faunas. The present narrow water gaps in the Malay archipelago (fewer and narrower in the Pleistocene) allowed many genera and even species of birds to move from Asia to Australia. Nevertheless, the bird faunas of southern Asia and of New Guinea and Australia are in general very different.

Most of the birds of southern Asia belong to families that are more or less widely distributed elsewhere in the world. Some of these families reach Australia, but others (*e.g.,* woodpeckers and true finches) do not. New Guinea and Australia possess other families that are poorly represented or not represented anywhere else: cassowaries (mostly in New Guinea) and emus (Australia), megapodes, frogmouths, lyrebirds (eastern Australia), Australian warblers, honey eaters, bowerbirds and birds of paradise (mostly in New Guinea). New Guinea and Australia also have more than their share of parrots and pigeons, of which several important groups have either evolved in Australia or survived there in partial isolation. South America, which was an island continent through most of the Tertiary, possesses a still larger number of endemic or relict families of birds.

Birds are so numerous, and so widely and complexly dispersed over the world, that their geographical history cannot be treated in detail, but something can be said of the distribution of flightless birds. Various large flightless birds that occur (or have occurred)

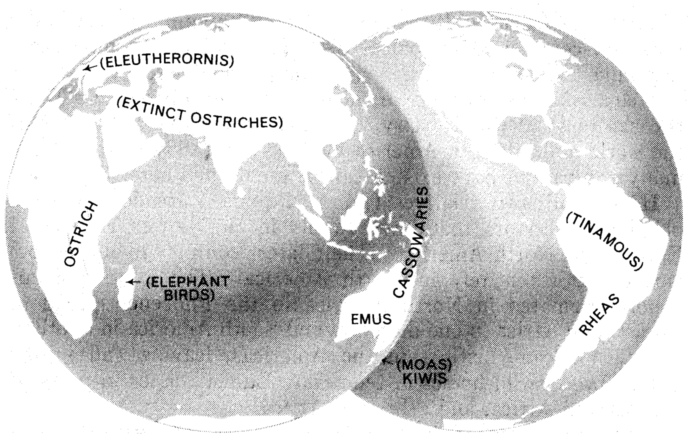

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FIG. 4.—DISTRIBUTION OF FLIGHTLESS (RATITE) BIRDS; ELEUTHERORNIS. POSSIBLE FOSSIL ANCESTOR OF OSTRICHES; AND FLYING TINAMOUS, POSSIBLE RELATIVE OF RHEAS

on different continents and islands were formerly grouped together as "Ratites" (fig. 4), and it was thought that they represented a primarily flightless group that dispersed over old land connections. Further study, however, suggested that these birds were products of convergent evolution. They seem to represent at least five separate groups. derived from different winged ancestors. which independently became flightless and attained large size: (1) the ostrich in Africa (fossils are found across southern Eurasia); (2) extinct elephant birds on Madagascar: (3) cassowaries. emus and their extinct relatives in Australia and New Guinea; (4) extinct moas and existing kiwis on New Zealand; and (5) rheas in South America.

A possible winged ancestor of the ostriches has been found as a fossil in Europe. and the winged tinamous in South and Central America may represent the group from which the rheas were derived. Other smaller flightless birds. derived from a number of different flying ancestors, occur or have occurred (many are extinct) on many islands. but not on continents. New Zealand has had the largest number: not only moas and kiwis but also several flightless rails! a flightless goose, a flightless parrot and an apparently flightless perching bird.

The Mascarene Islands too are notable for their extinct flightless birds. Mauritius had the dodo. and related species were on Reunion and Rodriguez; these birds were derived from a ground-feeding pigeon which presumably lost its power of flight after it reached the different islands. One or more flightless rails occurred on each of the Mascarenes; a supposedly flightless heron was on Rodriguez. an "almost flightless" one on Reunion; and a supposedly flightless parrot was on Mauritius. On other islands the only flightless land birds are rails; they are very widely scattered, having occurred on islands in the Indian ocean, on the Malay archipelago, in the South Pacific and in the South Atlantic (and perhaps on Puerto Rico). In all, 25 or 30 different rails seem to have lost the power of flight on these various islands. Rails in different places are undergoing a process of multiple or convergent wing atrophy like that which probably formerly produced the "Ratites."

6. **Mammals.**—Mammals are warm-blooded animals, some of which can withstand great cold. Nevertheless, zonation of climate profoundly affects their distribution. Mammal faunas are largest and most diverse in the tropics. diminishing northward and southward. Tropical Asia (with Sumatra. Java and Borneo) has between 450 and 500 species of land mammals, including bats; an equal area of temperate eastern Asia, about 250 species; and the Taimyr peninsula of arctic Asia (a smaller area), only 8 species. The tropical fauna includes representatives of many more families than does the temperate fauna. A comparable decrease of mammals from the tropics northward occurs in North America, and from the tropics southward in South America.

Mammals are numerous on recent continental islands, but few reach old or remote islands. Madagascar has a limited fauna of land mammals derived from few ancestors; bats are numerous there. and bats are the only land mammals native to the Seychelles and Mascarene islands. The rich mammal fauna of tropical Asia extends to Sumatra, Java and Borneo: small fractions of it reach Bali, the Celebes and the southern Philippines; but little of it goes farther. except murid rodents and bats. Most placental mammals on the islands between Celebes and Australia may have been carried there by man. Australia has been reached by at least one monotreme, one or more marsupials. several murid rodents and many bats; however. there are no placental mammals except murids and bats (the dingo and "wild" pigs were probably introduced by primitive man). One arboreal genus of marsupials (*Phalanger*) and several rodents have reached the Solomons. but farther east on islands in the western Pacific are only rats probably carried by man, and bats. One group of American rats and one bat are native on the Galapagos Islands. The West Indies have or have had two groups of insectivores, one or two of ground sloths, a few other terrestrial mammals of doubtful history, a number of rodents and many bats. Only bats have reached more remote islands, including New Zealand. the Hawaiian Islands and the Azores. Evidently mammals sometimes cross narrow ocean barriers, but most of them do so with difficulty; rodents get across more often than most mammals; bats, still more often.

Below are summarized the distributions and apparent geographic histories of the principal groups of land mammals. Some minor and inadequately known groups are omitted.

Monotremes (Egg-Laying *Mammals*).—Of monotremes, the platypus occurs in eastern Australia (including Tasmania), and echidnas in Australia (with Tasmania) and New Guinea. These animals have fossil representatives in Australia from the Pleistocene; being unknown before that time in Australia. There is no record of monotremes outside the Australian region at any time. Their geographic history is therefore unknown.

Marsupials (*Pouched Mammals*).—Marsupials (fig. 5) are now almost confined to the Australian region and to South and Central America. with an opossum (*Didelphis*) extending into eastern North America. However, primitive marsupials, apparently suitable to be ancestors of all living ones, are found as fossils in Eurasia and North America in the Late Cretaceous and/or Early Tertiary. It is probable that they reached Australia and South America from Asia and North America respectively and radiated separately on the isolated continents. Some of the products of this radial spread—especially certain wolflike carnivorous marsupials, thylacines in Australia and (fossil) borhyaenids in South America—were superficially similar, apparently as the result of evolutionary convergence of separate mammal lines, rather than direct exchange of animals across a land bridge between Australia and South America.

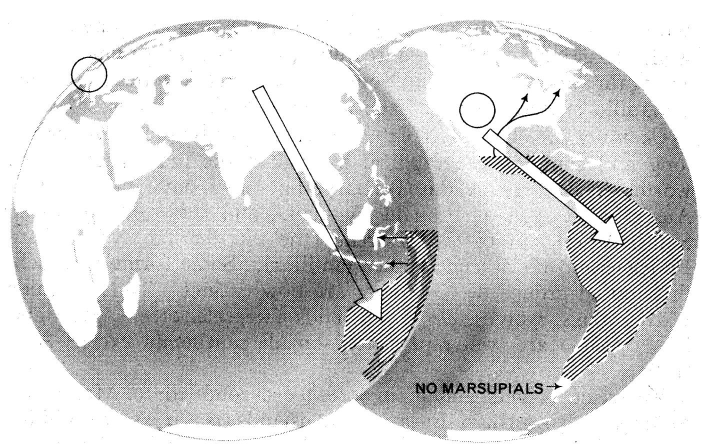

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FIG. 5.— DISTRIBUTION OF MARSUPIALS

Crosshatching shows principal areas inhabited by marsupials; small arrows, extensions of *Phalanger* west of New Guinea and of *Didelphis* into eastern North America; circles, areas where marsupials are fossils in Late Cretaceous and Early Tertiary periods; large arrows, probable directions of dispersal of early marsupials

Insectivores.—Insectivores date from the Upper Cretaceous and have radiated in a complex manner in Africa, Eurasia and North America but have never reached Australia and only one (a shrew) reached South America in recent geologic time. Of existing insectivores, tenrecoids include the family Solenodontidae in the West Indies (Cuba and Hispaniola), Tenrecidae on Madagascar, and the otter shrew in west Africa; these animals are survivors of a group that was widely distributed early in the Tertiary. Shrews proper occur throughout Africa, Eurasia and North America, and a few reach Central America and northern South America. Moles are almost confined to temperate Eurasia and North America. Other existing insectivores are found in Africa and Eurasia.

Primates.--Primates were probably derived from something like tree shrews (which are now confined to tropical Asia, etc.), and they, from something like elephant shrews (which are now confined to Africa). Primitive primates (lemurs and tarsiers) are found as fossils in Eurasia and North America (and presumably occurred elsewhere in the main part of the world) early in the Tertiary. One of them may have reached South America giving rise to the American monkeys, paralleling the evolution of monkeys in the old world; on the other hand, American monkeys may be derived from a more monkeylike ancestor that came from the old world at a later time. In any case American monkeys are very distinct from those of the old world and have evidently been geographically isolated from them for a long time. In the old world, lemurs (or perhaps just one lemur) reached Madagascar and radiated there, producing a variety of lemuroids, many of which still exist on Madagascar. Elsewhere, primitive primates declined. In North America they may not have survived beyond the Eocene. In the old world some still survive in restricted areas in Africa and tropical Asia, etc. But higher monkeys, apes and finally man dispersed and redispersed in a complex manner in Africa and Eurasia during the Middle and Late Tertiary and Pleistocene. Their movements were probably mostly within the tropics, where most of the surviving forms occur.

There was a land connection between northeastern Asia and North America at times in the Tertiary, and higher primates would probably have crossed it if they had extended far into the north temperate zone, but none did cross it until man did so, late in the Pleistocene.

Edentutes ("Toothless" *Mammals*).—Edentates have been confined to South America through almost their whole history, though their ancestor probably came from North America (in the Paleocene). A dominant order in the mammal fauna during the Tertiary of South America, they included gigantic ground sloths and glyptodonts as well as existing groups. When South America became connected to North America at the end of the Tertiary, several stocks of ground sloths and glyptodonts as well as armadillos spread into North America, but the ground sloths and glyptodonts then died out not only in North but in South America as well. Existing edentates — anteaters, tree sloths and armadillos— are again almost confined to South and Central America; only one armadillo extends north to the southern United States.

Carnivores.—The flesh eaters (order Carnivora) have had a long and complex geographical history in the main part of the world since early in the Tertiary, but they have not reached Australia (except as brought by man), and they did not reach South America until the Miocene (the raccoon family) or Late Pliocene and Pleistocene (other families). Some formerly widely distributed groups of Carnivora are now extinct. Today, canids (foxes, dogs, wolves, etc.), mustelids (weasels, otters, etc.) and felids (cats) are well represented on all continents except Australia.

Viverrids (civets and mongooses) are confined to Africa and Madagascar, southern Eurasia, and islands as far as the Philippines and Celebes and perhaps beyond, but not including Australia; they have existed in the warmer part of the old world at least since the Lower Oligocene but have never reached America. Bears now occur in tropical and temperate Eurasia (but not Africa) and North and South (but not Central) America. Other existing families of Carnivora are more restricted in range.

Ungulates (Hoofed *Mammals*) —Hoofed mammals have had a long and complex geographical history on all continents except Australia. Ancestral forms were nidely distributed early in the Tertiary, when one or more of them got to South America. Then. through most of the Tertiary, the ungulates in the main part of the world and in South America evolved separately. Not all the many groups that have existed can be mentioned here.

Horses and their relatives (family Equidae) are derived from primitive ancestors that have fossils in the Lower Eocene of Europe and North America. Their later, complex evolution occurred almost entirely in North America. The existing genus *Equus* originated in North America in the Pliocene, spread to Eurasia and Africa in one direction and South America in another, and then became extinct in the Americas, leaving (all in the genus *Equus*) wild horses in temperate Eurasia, asses in parts of Eurasia and Africa. and zebras in Africa.

Tapirs have existed in Eurasia and North America through much of the Tertiary. They apparently never reached Africa but did reach South America in the Pleistocene. They still existed in Europe, Asia and North as well as South America in the Pleistocene. when they extended into cool climates. Since then, they have been reduced to one species in the Malay region and three in Central and South America. Rhinoceroses have had a complex geographical history in Africa, Eurasia and North America, but they apparently never reached South America. In the Pleistocene they occurred in cold northern regions as well as in the tropics. Now they are reduced to two genera in Africa and two others in tropical Asia, etc.

True pigs (family Suidae) are, and always have been (except as carried by man), confined to Africa, Eurasia and certain southwest Pacific islands; they are not native to America or the Australian region. Peccaries (family Tayassuidae), though probably derived from a Eurasian ancestor and formerly widely distributed in North America, reached South America in the Pleistocene and now occur mainly in tropical America, with one species reaching southern United States.

Existing hippopotamuses in Africa are the last survivors of a superfamily (Anthracotherioidea) that mas widely distributed in Africa, Eurasia and North America during part of the Tertiary. Camelids were confined to North America through most of their long history. In the Pleistocene they spread to Eurasia, etc , and South America and then disappeared in North America. They now survive only in parts of Asia and North Africa (camels) and South America (llamas, etc.). Traguloids (chevrotains, etc.) were numerous in Eurasia and perhaps in Africa in the Middle Tertiary, with relatives in North America; later, they were reduced to *Hyemoschus* in west Africa and *Tragulus* in tropical Asia, etc.

Deer (family Cervidae) have had a complex geographical history probably beginning in Eurasia in the Oligocene but soon extending to North America. They have not reached the main part of Africa but did reach South America in the Pleistocene. They are still numerous in temperate and tropical Eurasia and the Americas. To some extent giraffids have paralleled deer in the old-world tropics. They were once numerous in Asia as well as Africa, and several reached eastern Europe in the Lower Pliocene; later, they were reduced to the giraffe in the more open parts of Africa and the okapi in heavy forests in west Africa. The pronghorn is the last survivor of a family that since its origin in the Miocene has always been confined to North America, chiefly the west.

The Bovidae (antelopes, sheep, goats, cattle) is one of the most recent families of mammals to evolve and disperse. Bovids have had a very complex geographical history in Africa and Eurasia, and a few (including the musk ox, bison. and rocky mountain sheep and goat) reached North America in the Pleistocene or later, but none has reached South America.

Ungulates in South America through most of the Tertiary were entirely different from those elsewhere in the world. They were very numerous and diverse. Known fossil forms are placed in 5 orders, with about 18 families and more than 150 genera. They varied in size, adaptations and probable habits from rodentlike to horse-, camel-, rhinoceros- and elephantlike, though they mere not directly related to any of these animals. But these comparisons are somewhat inexact. Many of the old South American ungulates were not much like anything now alive. All of them are now extinct. having been replaced by ungulates that reached South .America from other parts of the world in the Late Pliocene and I'leistocene.

Proboscideans (Elephants and Fossil Relatives).—Proboscideans originated in Africa early in the Tertiary and extended their area of complex evolution to Eurasia in the Middle Tertiary. From Asia, at least a dozen stocks of them reached North America from the Miocene to the Pleistocene, and three or four reached South America in the Late Pliocene and Pleistocene. In the Pleistocene, proboscideans were still widely distributed on all continents except .Australia, and some extended into cold climates; however, in the short time since then they have been reduced to the two existing elephants, one species in Africa and one in tropical Asia.

Rabbits and Rodents.—Of gnawing mammals, rabbits and their allies (order Lagomorpha) have spread throughout Xfrica. Eurasia and North America since early in the Tertiary, and *Sylvilagus* (American cottontails) reached South America in the I'leistocene. The geographical history of rodents (order Rodentia) has occurred in three partly separate areas. Many different families have dispersed and redispersed in Africa, Eurasia and North America since early in the Tertiary. About five different stocks of mice and rats of one family (Muridae) reached Australia in the Late Tertiary and Pleistocene, and gave rise to the existing Australian rodent fauna, A special suborder of rodents, Hystricomorpha, radiated separately in South America during much of the Tertiary. At the end of the Tertiary, when a land bridge was formed between North and South America, a few South American rodents reached North America. but the only one that survives is the porcupine which, in spite of its tropical American ancestry. found a special niche in northern forests. At the same time cricetid mice and rats (family Cricetidae), squirrels (family Sciuridae) and a few other rodents from Eurasia and North America invaded South America. Cricetids have become very numerous in South America and have probably replaced some hystricomorphs.

Bats.—Of bats, inegachiropterans (fruit bats) have existed at least since the Oligocene and have had a complex geographical history throughout the warmer part of the old world and Australia. They have considerable powers of dispersal and have reached many islands in the Indian and western Pacific oceans, but they have not reached America. Other bats, however, have dispersed in a complex manner over the whole world.

7. Summary of the Distribution of Mammals.— This completes the geographical histories of the principal groups of land mammals. Most major groups except some carnivores (dogs, weasels and cats), a few families of hoofed mammals (pigs, deer. cattle. etc.) and some. rodents and bats have apparently declined since the Miocene or Pliocene. Many large mammals have declined or disappeared in many parts of the world since the Pleistocene. (Man may have been responsible for many of the later disappearances but not for the earlier ones.) These disappearances have created many discontinuities in the distribution of existing mammals.

Although the geographical history of mammals has been very complex, a simple main pattern is evident. At the beginning of the Tertiary. when mammals became dominant. there were two principal groups of mammals ready to radiate: protoinsectivores (placentals) and didelphoids (marsupials). All existing mammals except probably the Australian monotremes. are derived from these two groups. During the Tertiary mammals evolved. more or less separately. in three principal areas. The protoinsectivores produced a diversity of placentals which dispersed in Africa. Eurasia and North America. Marsupials reached Xustralia and radiated separately there. Further, marsupials and a few selected placentals reached and radiated together in South America. Two misconceptions have existed about the native mammal faunas of Australia and South America. One is that they are older than the mammal fauna of the rest of the world, that Australian marsupials, for example, date from a time when marsupials were dominant over the entire world, before the rise of placentals. This is not correct. Placentals are apparently as old in origin as marsupials. The mammal faunas of the different continents evolved at the same time in separate places, not at separate times. The other misconception is that early mammals must have reached Xustralia and South America across (different) land connections. This is at least doubtful. The Australian and South American mammal faunas are not derived from the whole of any known world-wide faunas but from small fractions of the early Tertiary fauna of other parts of the world, and the fractions may have reached the isolated continents across water gaps that the whole faunas could not cross.

III. FAUNAL REGIONS

The continental areas of the world can be divided into regions according to the present distribution of animals. These regions do not. however. represent a common pattern which the distributions of many different animals fit exactly. Different groups of animals (for example. the classes of vertebrates discussed above) are very differently distributed. Together. however. their distributions form an average pattern. The system of faunal regions

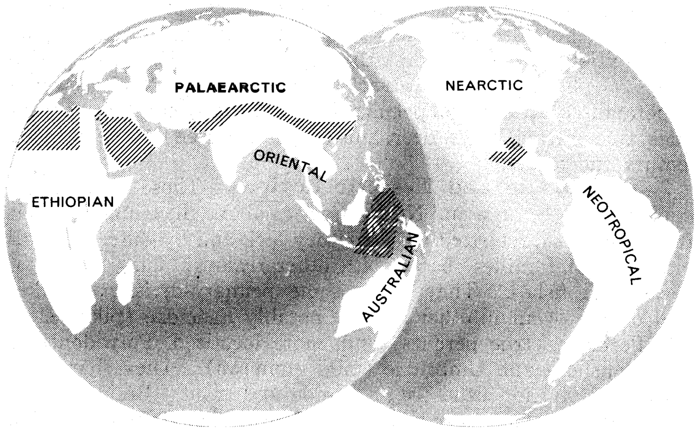

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FIG. 6.— SIX CONTINENTAL FAUNAL REGIONS. CROSSHATCHING SHOWS APPROXIMATE BOUNDARIES AND PRINCIPAL TRANSITION AREAS

corresponds to this pattern. and is the truest simple diagram of animal distribution that zoogeographers have been able to devise.

As mentioned earlier, many groups of animals are spread over Xfrica, temperate and tropical Eurasia and North America but are absent in South .America or Australia or both. Furthermore, South America (with Central America) and Australia (with New Guinea) not only lack the otherwise widely distributed groups but each of these isolated continents has other. important. peculiar groups of its own. Africa. Eurasia and North America are therefore placed in one "realm"; South America and adjacent islands in another; and Xustralia and nearby islands in yet another. The usually accepted realms and regions are these (see fig. 6):

Realm Megagea (Arctogea)

Ethiopian region: Airica below the Sahara, with part of southern Arabia

Oriental region: tropical Asia, with the associated continental islands of Ceylon, Sumatra, Java, Borneo, Formosa and some adjacent smaller islands

Palaearctic region: Eurasia above the tropics. with the temperate northern corner of Africa north of the Atlas mountains

Nearctic region: North America, except the tropical part of Mexico. (The two northern regions [Palaearctic and Nearctic] arc sometimes combined as the Holarctic region or Holarctica)

Realm Neogea

Neotropical region: South and Central America, with the tropical part of Mexico

Realm Notogea

Australian region: Australia and New Guinea, with closely associated smaller islands

1. Ethiopian and Oriental Regions.— These areas. the tno main regions of the old-world tropics, have faunas characterized

by richness and diversity of groups. The faunas are alike in many ways, different in others: they share catfishes and labyrinth fishes; but Africa (the Ethiopian region) alone has bichirs, lungfishes and characins. and the oriental region has more and more diverse cypriniform fishes. In general, Africa seems to have a geologically old fresh-water fish fauna; the orient, a more recent one. Africa and the orient share caecilians and several families of frogs, including rhacophorids; but Africa, and not the orient, has pipids; the orient, and not Africa, pelobatids. Both have crocodiles. land tortoises, soft-shelled turtles and many of the same families of lizards and snakes, including pythons, cobras, true vipers, etc. But of these two regions Africa alone has side-necked turtles; the orient, many emydid turtles; Africa! many chameleons and cordplid and amphisbaenid lizards; the orient, aniliid snakes, many subfamilies of colubrids, and pit vipers. Generally, Africa has more lizards; the orient, more snakes.

Both regions are rich in birds. They share many, often widely distributed families. but there are inequalities: Africa has (for example) more honey guides. true shrikes and sunbirds; the orient, more pheasants, pittas and timalines. Africa has half a dozen endemic families (ostriches, guinea fowls, etc.), whereas the orient has only one (fairy bluebirds). These two regions share also many families of mammals, not only old-world monkeys, apes, big cats, elephants, rhinoceroses, buffalos, antelopes and big fruit bats, but also many less conspicuous groups. Each region has additional mammals that the other lacks: Africa has golden moles, elephant shrews, aardvarks, hyraxes, equids (zebras), hippopotamuses, giraffes and peculiar rodents; the orient, hairy hedgehogs, tree shrews, bears, deer, and (more localized) tarsiers, flying lemurs and tapirs.

2. Palaearctic and Nearctic Regions. — These regions are equivalent to Eurasia and North America above the tropics. Their faunas are characterized by what they lack and by different combinations of families shared with other regions. They are most distinct in fishes. They share some primary-division families that do not occur in other regions, notably Esocidae (pikes, etc.) and Percidae (true perches) and, more localized, Polyodontidae (paddlefishes) and Cmbridae (mud minnows). They share also peripheral-division fishes; *e.g.,* salmon and trout. Besides these, the Palaearctic has many cyprinids but few other primary-division fishes (except some tropical oriental groups that extend into eastern Asia); the Nearctic has fewer cyprinids but has important additional groups especially east of the rockies. Of amphibians. both regions lack caecilians and have many salamanders (a primarily north temperate order) and many species of the widely distributed salientian genera *Rana* (frogs), *Bufo* (toads) and (especially in the Nearctic) Hyla (tree frogs). Additional salientians occur in both regions, *e.g.,* spadefoot toads, but they are numerically unimportant, localized or discontinuously distributed relicts or representatives of tropical families that extend into eastern Asia from the orient or into southern North America from the American tropics.

Of reptiles, birds and mammals, the Palaearctic and Nearctic regions have (compared to the tropics) few species; the species represent few families (most of which are widely distributed in the tropics, too). Many species and genera of birds and some families are strictly Holarctic. Prunellidae (hedge sparrows, 12 species, Palaearctic only); Certhiidae (creepers, 6 species); and subfamilies Tetraoninae (grouse: 18 species) and Bombycillinae (waxwings, 3 species). Mammals confined to north temperate areas are moles (a strictly Holarctic family, except for a slight extension into tropical eastern Asia), pronghorns (one species, in western North America) and several small families of rodents. There are perhaps no families of reptiles which are strictly confined to the north temperate zone.

It is misleading to emphasize the few peculiar families in characterizing the Palaearctic and Nearctic regions. What should be emphasized are the forms absent. The reptile. bird and mammal faunas of these regions are essentially tropical faunas from which much has been subtracted and little added. The Palaearctic and Nearctic faunas are most impoverished and most alike (with many species in common) in the far north; they become progressively richer and more dissimilar southward toward the tropics. They are perhaps most dissimilar in fishes and some amphibians, and in lizards and small migratory, insectivorous birds, of which the Palaearctic forms belong to old-world tropical families and the Nearctic ones to tropical American families.

3. Neotropical Region. — This region has a rich and distinct vertebrate fauna of which the older elements show diverse geographical relationships or have no relationships at all with existing animals elsewhere. Most Neotropical fishes have old African relationships: the fresh-water fishes are dominated by primitive Ostariophysi (characins and catfishes). and include a lungfish. Neotropical amphibians are caecilians, a few plethodontid salamanders and many frogs (of which some are related to frogs now living in Africa, the oriental region and Australia, as well as North America). Neotropical reptiles include crocodiles, caymans, etc.; two families of side-necked turtles (shared with Africa and Australia respectively); common turtles of North American families; giant land tortoises; and many lizards and snakes. Neotropical birds are numerous and include many groups confined to the region, among them toucans, motmots and cotingas. Xeotropical mammals are a mixture of old South American groups (marsupials, edentates, American monkeys and hystricomorph rodents) and new groups received from or through North America and for the most part still existing there (the tapirs and camelids—otherwise "wild" only in Asia—are exceptions). The Neotropical vertebrate fauna is concentrated in South America. Many parts of it extend through Central America to southern Mexico, where there is progressive mixture with Nearctic elements.

4. Australian Region. — The vertebrate fauna of the Australian region (including New Guinea, a recent continental island which was connected to Australia in the Pleistocene), though less rich than the Neotropical fauna is very distinct. Fresh-water fishes are few and of marine origin, except perhaps the lungfish and one osteoglossid. The only amphibians are frogs: only two families of them in the main part of Australia, which are now best represented elsewhere in tropical America; additional families in New Guinea are Asian or old-world tropical. Reptiles are numerous; most have oriental relationships: a few. Neotropical, and perhaps Ethiopian ties. Birds are moderately numerous and diverse; they include unique families as well as families with Asian relationships, but few or no birds show direct relationships with African or South American birds. The mammals are a few monotremes, many marsupials, moderate numbers of murid rodents and bats. Australian marsupials have radiated extraordinarily and now occupy many of the niches filled elsewhere by placental mammals. Different Australian marsupials resemble shrews, weasels, wolverines, wolves, moles. anteaters! rabbits, mice and squirrels. Also present are the large rodentlike wombats and somewhat slothlike koalas. The kangaroos, though superficially unique. are grazing and browsing animals which take the place of hoofed mammals of other regions.

5. Transitional Areas. — Wherever regional faunas meet, there is a transition. In most cases some elements of both faunas stop at an approximately common boundary, whereas various other elements of each fauna extend across the boundary, in opposite directions and for varying distances. For example. many strictly Nearctic and Neotropical animals stop where the temperate plateau of Mexico meets the tropical Mexican lonlands, but other primarily Nearctic animals extend across the boundary into Central or even South America, and some primarily Neotropical animals extend into southern North America. In the Malay archipelago many oriental vertebrates reach a common boundary at the water gap that runs between Bali and Lombok. betneen Borneo and Celebes. and between the Philippines and Moluccas. This common boundary is called Wallace's line (see fig. 1). Wallace thought this line separated the oriental and Australian regions, but in fact. it marks the limit of the full-scale oriental fauna and the beginning of a strikingly impoverished fauna and obvious transition. Another line a little nest of New Guinea (west of the Aru Islands. Misoöl, Waigeo, etc) marks the limit of the nearly pure Australian fauna. Between these lines is a region, now called Wallacea, where the fringes of the oriental and Aus-

tralian faunas meet in complex transition.

IV. ANIMALS ON ISLANDS AND IN SEAS

1. Distribution on Islands.— Wallace recognized only two kinds of islands: continental islands. which he defined as detached fragments of continents, consisting of complex continental rocks and always inhabited by some terrestrial mammals and amphibians; and oceanic islands. which he defined as having originated in the ocean. consisting of volcanic rock and coral and lacking terrestrial mammals and amphibians. Islands and island faunas are, however, much more diverse than this.

Recent continental islands do exist: examples are the British Isles! Japan, Ceylon, Formosa, Sumatra, Java, Borneo, New Guinea. Tasmania and Trinidad. All these islands have recently been detached from adjacent continents. and their faunas include amphibians, terrestrial mammals and (except in Tasmania) strictly fresh-water fishes. (Newfoundland, Greenland and Tierra del Fuego are also continental islands, but their faunas have been limited by cold.) Purely oceanic islands exist too: for example, the volcanic and coral Hawaiian Islands, which have no native terrestrial vertebrates except birds and a bat.

But between these extremes are many islands which are more complex zoogeographically. A significant fact not understood by Wallace is that no old islands have continental faunas. This is true not only of such islands as Madagascar, New Caledonia and New Zealand, but also of the old-island continents. Australia and Tertiary South America. None has. or (so far as is known) ever has had, a fauna that was simply a detached part of the fauna of a larger land mass. Either the old islands have never been attached to continents or, if they were attached, their old continental faunas have been replaced. Madagascar, for example. which during the Mesozoic possessed dinosaurs, has so far as it can be dated, a more recent fauna; *e.g.,* existing Madagascan mammals are descended from a few Tertiary ancestors that evidently reached Madagascar across water. Leiopelmid frogs and *Sphenodon* on New Zealand are Mesozoic animals, but they do not constitute a Mesozoic continental fauna; along with them on New Zealand are two stocks of presumably more recent lizards. All these animals may have reached New Zealand, at different times; from across water.

Certain other islands, *e.g.,* the Philippines and West Indies, form fringing archipelagos that'are not simply of recent continental attachment but that lie close to continents. Vertebrates have reached these archipelagos in proportion to their ability to cross salt water: true fresh-water fishes are very few or absent; amphibians and terrestrial mammals are limited in basic stocks (but some have radiated on the islands) and rodents make up more than the usual proportion of the mammals; lizards are disproportionately numerous; and bats and birds are abundant. Moreover, the animals are distributed in an orderly way, along what seem to be routes of immigration into the archipelagos; old relicts are the exception and not the rule. This and other evidence leads to the general conclusion that, although there are a few old relict vertebrates on some islands, the faunas of all islands (except obviously recent continental ones) have been derived partly if not wholly from across water.

There seems to have been a flow—a broad directional movement—of vertebrates from all the continents to islands, the details of the movement deoending on the widths of water gaps, on the sizes and natures of different islands and on the relative water-crossing ability (not the geological age) of different vertebrates. Flightless land vertebrates presumably cross water mostly by "rafting," i e., by riding on floating islands or on trees or debris carried out to sea by rivers, especially in the tropics.

2. Distribution of **Marine** Animals.— The distribution of marine animals is exceedingly complex, partly because it occurs in three dimensions.

Vertical Distribution.—Where the oceans are deep, faunas are stratified. One great fauna lives in the surface water as far down as light permits the existence of green plants (about 40 fathoms). Another fauna inhabits the mid-waters (roughly 40–2,000 fathomsj, living in darkness and depending ultimately for food on the remains of dead animals and plants falling from the surface. Still another fauna lives on the ocean bottom; it, too, exists in darkness and receives food from the water above.

The surface, or pelagic, fauna includes many delicate: transparent animals. It includes many protozoa such as *Globigerina* and radiolarians; these minute animals are so numerous that their skeletons, falling to the ocean bottom. form deep layers of ooze over great areas. There are also many dinoflagellates (some brilliantly phosphorescent). jellyfishes and polychaete worms. Pelagic crustaceans include immense numbers of copepods. many of which are very small forms subsisting on diatoms. Pelagic mollusks are largely pteropods and cephalopods (squids, etc.). Tunicates (sea squirts, etc.) are abundant. Pelagic fishes include many herrings and allied forms, many mackerels and flying fishes.

The mid-water fauna is necessarily composed of free-swimming animals. It includes certain radiolarians and jellyfishes. Among the crustaceans are many prawns, often bright red in colour. Mollusks include pteropods and squids. Fishes are abundant; many of them have very large eyes; others, very small ones. Many of these fishes have light-producing organs.

The bottom-living or abyssal fauna includes representatives of most of the phyla of animals. Primitive glass sponges (hexactinellids) are nearly confined to this habitat. Many other animals are peculiar in structure and more or less restricted to deep water: the fishes (angler fishes, etc.) are extraordinarily modified. In this fauna. too. light-producing organs are common.

Horizontal Distribution.—The horizontal (true geographical) distribution of marine animals is also ecologically complex. A distinction must be made between the faunas of the deep sea and those of shallow coastal water. The distribution of coastal faunas is influenced by local features such as the nature of the bottom, the salinity and acidity of the water, temperature. currents. etc.

The broadest patterns of distribution of marine animals are determined by temperature and by certain physical barriers. The temperature zones are of course complexly modified by ocean currents; in general, the following zones can be recognized by their faunas (at least in the upper strata of the sea and along coasts): tropical, north and south temperate, and arctic and antarctic. The faunas of great depths are probably much less zoned because the water is almost uniformly cold. The fauna of the tropical zone is interrupted by barriers. The Americas form a continuous barrier of land across the tropical oceans; however. the barrier has less eifect on present distributions than might be expected, Many rather closely related marine animals occur on opposite sides of Central America; evidently, many of them were able to pass through the ocean gap that, until geologically recently, separated North from South America. The deep and wide Pacific ocean has been a more important barrier for shallow-water animals. The reefs and coastal waters between southern Asia and Australia, and eastward into the western Pacific, have an enormously rich fauna, which is much richer than, and in many ways different from! the corresponding fauna of the west coast of North America; evidently the central Pacific made crossings unlikely. Africa now separates the Indo-Pacific fauna from the Xtlantic. Fossils show, however, that much of this fauna once extended through the former Tethys sea from the Indian ocean to the Mediterranean and that the absence of large parts of this fauna from the Xtlantic is the result of progressive extinction and impoverishment during the climatic changes of the Tertiarv.

V. PATTERN OF DISTRIBUTION

1. Factors Directing Distribution.— The present main pattern of distribution of land animals. expressed in the system of realms and faunal regions, has exidently been produced by one main process limited and modified by two phqsical factors. The process has been the evolution of different groups of animals in different places, and the spread of successive dominant groups over part or all of the world. Each new group tended to replace earlier ones which often became discontinuously distributed before they became extinct. Comparatively simple examples of this among fresh-water fishes and frogs have been discussed above (*see* figs. 1, 2, 3). The process among some other vertebrates, including many mammals, has been kaleidoscopically complex. The principal physical factors that have limited and modified the pattern are zonation of climate and barriers of salt water. These factors have affected the distribution of all classes of vertebrates The distribution even of narm-blooded vertebrates is profoundly influenced by climatic zones; and the spread even of flying birds. by water barriers.

2. The Existing Pattern and Its Meaning.— The existing main pattern of distribution of land animals has been determined by modern climates and barriers. not by ancient situations. The existing pattern has evidently been formed by very complex movements of animals over the world approximately as it is now, not over extraordinary land bridges or drifting continents. Nevertheless, properly interpreted, the distributions of animals now and in the past (as shown by fossils) reveal important things about the distribution of climate and land in the past. The distributions of existing animals can reveal only rather recent situations and events. A time limit is set by the ages not of the animals themselves but of their distributions. A group of animals that dates from the Rlesozoic may have redispersed many times since then, and its present distribution may be geologically very recent. with no trace of a Mesozoic pattern left. Strictly fresh-water fishes disperse over land more slowly than any other vertebrates. Their present distribution may still reflect Cretaceous geography: it is doubtful whether the present distributions of any animals reflect a period more ancient than this.

More than 100 years ago Edward Forbes and Darwin showed how the advance and retreat of continental ice sheets during the Pleistocene alternately drove arctic animals southward and then allowed them to return northward again, leaving relict populations of arctic insects. mice. etc., on cold mountain tops in the temperate zone: *e.g.,* on the Alps in Europe and on Mt. Washington in New Hampshire. The existence of these arctic relicts on mountains is one of many details of the present distribution of animals that contribute to the reconstruction of the history of the Pleistocene ice age. The occurrence on islands in many parts of the world of faunas of continental type proves that the islands were recently connected to the continents and is part of the proof of a world-wide lowering of sea level during Pleistocene glaciation. Darwin also deduced, from the present occurrence of related species of plants and animals in temperate Eurasia and North America, that before the Pleistocene the northern parts of the world were warmer than now and that there was probably a land connection between Asia and North America, across Bering strait. Later zoogeographers have confirmed this. G. G. Simpson showed (1947), by comparing successive fossil mammal faunas of Europe, Asia and North Xmerica and finding when exchanges have occurred. not only that the Bering connection existed during much of the Tertiary and Pleistocene but that it was broken and remade at specific times. He showed further that many mammals crossed the connection early in the Tertiary but that fewer and fewer did so in successive epochs; this is part of the evidence that there was a gradual rather than sudden cooling of northern climates before Pleistocene glaciation.

The distribution of mammals now and in the past reveals the Tertiary history of South Xmerica and Australia. There is a good fossil record of mammals in southern South Xmerica through most of the Tertiary. During most of this time South American mammals were so different from those on other continents that South America must have been isolated by water barriers. Almost at the end of the Tertiary, however, numbers of North American mammals suddenly appear in the fossil record in South America, and South American mammals appear in North America. This indicates that South America was an island through most of the Tertiary and that the existing connection with North Xmerica was completed in the Late Pliocene. Australia has yielded almost no record of its Tertiary vertebrates. However, its present lack of placental mammals, except rather récent rodents and bats, and the abundance of fossils of placentals in other parts of the world (including South America) since the beginning of the Tertiary. proves that Australia has been an island at least since then. These facts dispose once and for all of any paleogeographic theory that connects South America or Australia to other continents or to each other during the Tertiary. Zoogeographic evidence of the state of the world before the Tertiary is less decisive. Known facts can be reconciled with a pattern of continents and climatic zones in the Mesozoic arranged as now (with only details different). The facts. however. leave a possibility (not a probability) of a fundamentally different pattern of land, possibly even continental drift, early in the Mesozoic. or before.

Animal distribution gives evidence that evolution has occurred and also indicates where and how it occurs most effectively. Dominant animals: the great groups that evolve and spread and replace older groups, seem to evolve primarily on the great continents and spread to smaller continents and islands. The flow of animals from continents to islands is part of the confirmation. There is certainly a correlation between area and evolution: the larger the area, the more effective the evolution of dominant animals. There is probably a correlation also between climate and evolution of dominant animals, although zoogeographers disagree as to whether dominant groups evolve more in the tropics or in the north temperate zone. Area and climate are correlated with size of faunas, size of populations and structure (at least density) of populations. Zoogeographers hope to use these correlations to discover fundamental things about the evolutionary process and about the situations and population structures that influence it.

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ZOOLOGICAL COLLECTING. The professional collector. who has developed special techniques of animal procurement and preservation will find little information in this article, which is a general treatise directed at the beginning collector and the amateur naturalist.

Land and Fresh-Water Animals.— In the pioneer 18th century, zoological collecting was so much focused on birds and mammals and large reptiles that the early manuals of taxidermy all include the collection of museum specimens of fishes and insects as a matter of course. and refer to the preparation of mammals and birds as mounted specimens as a part of museum collecting.

The nature of the museum specimens used in the study of birds and mammals brings their preparation more directly into the field of taxidermy. and the museum taxidermist may be charged with collecting such specimens as well as specimens required for exhibition. It will fall to the province of museum taxidermists to aid in the preparation, repair and conservation of the bird and mammal skins preserved for study (see TAXIDERMY).

The accumulation of private collections of bird skins is discouraged by the necessary protection of songbirds from indiscriminate and wanton killing. Certain birds, however, like the English sparrow and starling and the various game birds, which can be hunted under legal restrictions, serve for the amateur who wishes to learn to make a study skin. The use of borax as a preservative avoids the necessity of using the dangerous white arsenic.

The essential requirement for such skins is accuracy of record —the locality. date, collector's name, colours of eye. bill, any bare skin, feet, breeding condition and any other notes that contribute to the natural history of the species. The essential data are placed on a label attached to the skin; a good collector will keep a catalogue record of his specimens with additional notes. A considerable series of specimens of each species of bird is a necessity, as the plumages of male and female vary with age and with the season. Nestlings, if collected, should be preserved in alcohol; they should never be collected unless positively identified as to species.

Birds' eggs were formerly greatly in vogue for private collections. All migratory birds in the United States and Canada are now strictly protected by state and federal laws against the collecting of their eggs, which may be taken only by special permit for scientific purposes. Even with such permits. egg collecting is to be discouraged, since large collections exist in almost every museum, and additional specimens are not required for scientific studies.

No restrictions apply to the collecting of small mammals such as mice, gophers, moles and shrews; and the larger game mammals and the fur hearers can also be collected during the legal season for hunting them. which varies from state to state. The study specimen of a mammal includes the cleaned skull with the prepared study skin, and a system of numbered tags required to identify the associated skulls and skins properly. In the study of mammals. specimens preserved in alcohol or formalin may supplement the dry skin and skull, and such specimens are especially important in the bat group. in which the peculiar skin characters of the head and wing membranes are largely lost in drying. Juvenile specimens. especially the newborn young, should be similarly preserved rather than skinned. Skeletons also form a desirable supplement for any adequate study of a species of mammal. and are essential for the use of the taxidermist in the preparation of a mounted specimen. Thus an adequate representation of a single species of mammal. as for birds. will require a considerable series of specimens. For small mammals and birds, powdered borax, liberally applied to the inside of the skin while skinning. will be sufficient as a preservative.

The collecting of mammals involves a great variety of techniques of hunting and trapping. For all small forms the ordinary spring mousetrap is the most essential equipment, but it is essential to use the oversize "museum special." as the ordinary trap is quite certain to strike the animal across the skull and ruin this most essential part of the specimen. Shooting. snaring, capture in live traps, pitfalls and other methods, limited only by the ingenuity of the hunter. will be required for the collection of mammals of different sizes and varying habits.

Fishes, amphibians and reptiles collected for study, except for skeletal material (and except for very large specimens), are preserved by placing the entire animal in alcohol or formalin. For permanent storage it is essential that all formalin specimens be transferred to alcohol. Labeling may consist of numbered tags of metal (pure tin or aluminum), of special waterproof paper or of parchment. Such numbers must be accompanied by a carefully kept catalogue for the corresponding information about locality, etc. Field labels written with soft pencil on slips of bond paper, if wrapped with the specimens so that they cannot rub, are satisfactory. The principal attention required for good preservation of such specimens is that the body cavity and thick muscular parts of the body must either be injected with the preservative. with a large hypodermic needle. or must be opened by means of ample cuts to permit the fluid to enter. Specimens immersed in preservative must be examined for the first few days until they are firm; any portion that remains soft will require further opening or transfer to fresh preservative.

Skulls and skeletons of such large creatures as crocodiles and alligators. large turtles and of large reptiles in general are especially desired by museums. For field collecting such material needs only to have most of the flesh removed. the brains extracted from the skull and the roughed-out skeleton or skull dried. Protection from flies and from offensive decay is accomplished by rapid drying. but in wet climates thorough soaking in horax solution or rubbing with dry borax. drying over fire and packing into sealed containers may be essential. Paper labels for such material must be protected from rubbing.

See *Handbook of Instructions for Collectors*, British Museum *(1921)*; R. M. Anderson, *Methods of Collecting and Preserving Vertebrate Animals*, 2nd ed. *(1948)*. (K. P. S.; X.)

Marine Animals. — Marine collecting presents special problems because of the vastness oi the sea. the great depth at which many of the animals live and the difficulty of caring properly for many of the delicate forms while in the field. The marine collecting area comprises about 71% of the earth's surface, and most parts can be reached only by seagoing vessels. About 77% of the bottom area is covered by water over 9.800 ft. (nearly two miles) in depth, and the greatest depth is over six miles. Animal life is found not only on the bottom but also to some extent throughout the entire water mass, hence collecting on the high seas must be adapted to all of these circumstances, and it is therefore an undertaking for specially organized and equipped expeditions. However, a most important part of marine collecting can be done with simple equipment in the intertidal zone or in shallow coastal waters. Fortunately, also. it is there that the greatest abundance and variety of plant and animal life is produced. The great depths are relatively barren.

The earliest large-scale marine collecting expedition was that of H.M.S. "Challenger," 1873–76. during which time vast areas of the Atlantic and Pacific were explored. Since then much marine collecting has been done by research ships of various nations, and animal life has been collected and studied from many positions in all oceans. but vast coastal and oceanic areas are still unexplored by collectors. In all of these expeditions the collecting has usually not been an end in itself hut rather a necessary part in gathering data of importance to fisheries or to general marine biology (*q.v.*).

Methods and Gear Used in Collecting. — Intertidal and shallow-water collecting for butturn-living animals requires only simple equipment. Where the bottom is composed of mud and sand. a long-handled shovel or rake is needed for digging out the burrowing forms and a screen ior sieving out the smaller animals from the loose material. A mixture of mud and sand usually yields more animals than does a beach of pure sand. The latter. however. is not without its characteristic type of life and sometimes in surprising numbers, especially certain worms (*Thoracophalia*, for example). the little sand crabs (*Emerita*, etc.). the wedge shells *Donax* and. at high-tide level. the sand hoppers. The animals that are found on mud-sand bottoms are numerous and varied. Commonly they are of the burrowing types. such as clams and worms, and their presence is revealed to the collector by little characteristic mounds, holes or markings on the surface of the mud. The best collecting for variety of forms is, however, on rocky or coral reefs. There a strong chisel-edged bar is useful for prying loose limpets, mussels, sea stars and many other forms that are attached to the rocks. or for breaking up old coral and shell encrustations or for rolling over rocks to expose retreats that usually teem with life.

The tide pools left by the receding tide yield many additional forms including nudibranchs. fishes and cephalopods. The attached algal plants should be searched for the many animals that attach to or hide among their fronds. Eel-grass (*Zostera*) beds in shallow water are favorite collecting places. There attached to or living among the leaves can be found an abundance of hydroids, bryozoa and skeleton shrimp, as well as such characteristic eel-grass inhabitants as the sea anemone *Epiactis* and the sessile jellyfish *Haliclystus*. Dip nets or hand seines drawn through .the eel grass are sure to capture a variety of small fish and invertebrates.

Among the more profitable collecting places are the submerged portions of wharf piles or floats where fouling organisms and the animals associated with them can be scraped off with rakes or dip nets. There the wood too should be examined for the destructive wood-boring forms such as the shipworm *Teredo* and the gribble *Limnoria*.

Shallow-water benthic animals are often cast up on the beach by action of waves during storms. and sometimes also pelagic forms normally found only on the high seas are drifted ashore in this way. The collector takes advantage of this and also watches for the many small animals that he can find among the rootlike holdfasts of deep-growing seaweeds that have been torn loose from the bottom and drifted onto the beach.

Deepwater collecting for benthic animals requires special equipment operated from boats provided with winches for reeling in line. The standard equipment includes dredges or trawls. The dredge consists of a strong iron frame to which a bag or net of strong web or wire screen such as hardware cloth is attached. This bag retains the animals that are scooped up from the bottom by the edge of the dredge frame as it is dragged forward over the bottom by a long wire cable or rope operated from a winch aboard a slowly moving ship. The edge of the frame may be constructed with flares or teeth to dig into the bottom. Usually the frame is rectangular and is about two to five feet in length, depending upon the size of boat and winch facilities. The trawl, a modification of the dredge, is designed to fish free in the water or to skim over the bottom rather than to dig into it. There are three main types: the beam, the Agassiz and the otter trawls. In the beam trawl the mouth of the net is held open by a beam of iron or wood so arranged as to glide over the bottom on sledlike runners, while a lead line holds the lower lip of the net in contact with the bottom. The Agassiz trawl is a modification of the beam trawl. In it the mouth of the net has both upper and lower lead lines, hence it fishes properly no matter which side of the trawl is applied to the bottom. For scientific collecting a 10- or 1j-ft. beam is ample but for commercial fishing the beam may be much longer. In the otter trawl the mouth of the net is held open by means of otter boards so arranged that they are forced apart by the water when being towed forward by a line attached to each.

The collecting of pelagic animals may be considered in two parts: (1) the floating animals (zooplankton) and (2) the strong-swimming animals (nekton).

The zooplankton, composed mainly of such feeble snimmers as copepods, euphausiids, chaetognaths, various larvae and the dinoflagellates, is collected in various ways all of which utilize some type of screening device, such as the plankton tow net. In simple form the tow net consists of a ring to which is attached a conical bag of gauze, usually of silk bolting cloth which is so woven that the screening apertures are uniform and not readily changed in size. When the net is drawn through the water, the organisms are screened out and concentrated in a bottle or jar fastened into the apex of the net. There is a great range in-size of plankton organisms, hence the fineness of the net used is determined by the minimum size of the animals to be caught. For general zooplankton collecting a no. 8 type bolting cloth with screening apertures of about 0.205 mm. is practicable, though many of the smallest organisms escape. Some protozoan iorms, for example the smaller ciliates and dinoflagellates, pass through the finest nets. To obtain a quantitative estimate of these small members of the plankton, it is necessary to collect them by means of centrifuging a known quantity of sea water.

For collecting planktonic animals from subsurface levels, closing nets are used. These can be lowered to the desired depth and there opened by means of a special mechanism operated by a "messenger" which glides down the towing wire. When the tow is completed the net can again be similarly closed to prevent any further fishing while it is being hoisted to the surface.

For collecting fishes and other nektonic animals, nets, seines, hooks and harpoon; are used, hut these are best considered under fisheries (*q.v.*), nets and seining.

The use of lights ior attracting and collecting sn-imming animals at night sometimes yields many forms not readily collected during thr daytime. Even some bottom-living forms may swim to the suriace where they can be scooped up with hand nets.

Care of Material Collected.—A definite part of the task of collecting is the care of the material while in the field or en route to its destination in the laboratory, museum or aquarium. Unless means are available for a steady or frequent change of fresh sea water in which to keep the animals, most of them soon die. Benthic animals when crowded into a bucket, as is often done! usually survive best ii covered with wet seaweed rather than with water which soon becomes warm and exhausted of its oxygen or charged with metabolic wastes. If the animals are of a flabby type and need the support of water, a quantity of sea lettuce (*Ulva*) kept in the bucket with them is oi aid. Intertidal and tide-pool animals are the hardiest and should be collected for aquarium specimens in preference t the more delicate forms oi deep water. On expeditions or on long collecting trips most or all of the material will need to be preserved in a manner consistent with its iuture use ior study or display. Alcohol, 70%, is the best general preservative, but formalin is more economical and serves as well where some hardening of the tissues is not deleterious. Five parts formalin to 95 parts sea water is suitable to preserve most small animals. Basic formalin may be used for organisms such as the foraminifera and echinoderm larvae with delicate calcareous skeletons if alcohol is not available.

See H. U. Sverdrup *et al.*, *The Oceans: Their Physics, Chemistry, and General Biology* (1944). (W. J.; X.)

ZOOLOGICAL GARDENS (Zoos), institutions in which live animals are kept in captivity. Zoological collections were in the latter part of the 20th century favourite places of entertainment, relaxation and education with city dwellers in many countries of the world. Usually featured were the more exotic animals, and sometimes birds and fish (see AVIARY AND AVICULTURE and AQUARIUM). As urban children became more and more cut off from natural surroundings, however, and began to think of milk as coming from a bottle and knew the word "lamb" only as a Sunday roast, it became general practice also to display the more common types of domestic animals.

An innovation to many zoos was the children's zoo, a collection of small and tame animals available to juvenile visitors to play with and to feed. These children's zoos usually have one or more attendants, and adults are not allowed to enter without having children with them.

Roadside zoos also became very popular in the 1950s. These were available! along major highways! to motorists for rest and recreation, some of them being very extensive. One game farm at Catskill, N.Y., for instance, exhibited 1,700 animals, including monkeys, giraffes and a large group of kangaroos. Hoofed stock numbered more than 1,000 animals, many of which were hand-raised and could be petted by visitors.

At the same time, zoos in general were growing and increasing. There were no less than 30 in the United States, and such remote regions as Khatmandu in Nepal and Lahore, Pak., were making notable improvements. Attendance and interest also increased. Some zoos, such as those at Tokyo, Japan; Washington, D.C.; and Lincoln park, Chicago, had 4,000,000 or more visitors a year.

History.— The custom of keeping collections of living wild animals is as old as recorded history. In ancient China, Wen, the first king of the Chou dynasty, in the early part of the 12th century B.C. maintained near his palace a "garden of intelligence" in which were exhibited specimens from the various provinces in the empire. In ancient Egypt menageries were kept as adjuncts to the temples, but the Empress Hatasu in the 18th dynasty had a "garden of acclimation" and sent a fleet to the land of Punt (the first expedition for live animals), that brought back dogs, monkeys, leopards and giraffes. An obelisk in the British museum describes the capture of animals by Xshur Akbar, one oi the early kings of Nineveh. The animals were brought to the capital and "by each animal was placed its name." Solomon had his monkeys and peacocks, and Nebuchadrezzar his lions.

Ancient Greeks maintained collections of birds, and later, of mammals; Xristotle kept a collection of live things secured for him by the men of Alexander's army. The Romans had collections far exceeding in numbers anything of today, with hundreds of lions, tigers and leopards. Most of these were used in the arenas in gladiatorial and other combats. In 29 B.C. Octavius Augustus, quite an amateur of natural history, maintained a collection of 420 tigers, 260 lions, 600 African animals including cheetahs, panthers and other carnivores, 1 rhinoceros, 1 hippopotamus, several seals, bears, elephants, eagles, 36 crocodiles and "1 serpent 2j metres long." During medieval times zoos were again restored, sometimes as civic institutions, as in Florence, but more often as private menageries of the nobility. In 797 the caliph of Baghdad, Haroun el Raschid, sent an elephant and some monkeys to the emperor Charlemagne. In the 13th century Marco Polo reported the collection of lions, tigers, leopards, hippopotamus and wild asses in Kubla Khan's palace at Xanadu, and another menagerie with stables for elephants and rhinoceros. Henry I (1100–35) established a royal menagerie at Woodstock, Oxfordshire, Eng. Later this was transferred to the Tower of London. In 1829 the animals were taken over by the Royal Zoological society, and this collection was the origin of the famous zoo at Regent's park, London. Rulers in continental Europe maintained royal menageries at Madrid, Vienna, Versailles and elsewhere. Pope Leo X had a menagerie in the Vatican. Monkeys and civet cats are listed, and he received an elephant as a present from Manuel I of Portugal. Zoos were established in 1554 by the elector Augustus I at Dresden, by Frederick William in 1640 at Potsdam, by Prince Eugene of Savoy at Belvedere, Aus., in 1716; and in 1752 the imperial menagerie was founded at Schönbrunn, Vienna. Louis XIV appropriated £5,400 a year for the upkeep of his menagerie at Versailles, which received presents of animals from numerous French emissaries abroad. Louis XV had little interest in the zoo, although in 1770 a two-horned rhinoceros arrived, the first seen in Europe since Roman times. In 1793 the Jardin des Plantes was established in Paris in connection with the museum of natural history. In the 19th century, zoos were established in numbers throughout the world.

Africa.—In Egypt, the zoological garden at Giza. Cairo, consists of a beautiful park and a large collection, chiefly of African mammals, maintained by the government. The zoological garden at Khartoum. Sudan, is maintained by the municipality and is one of the few old-world zoos to which admission is not charged. The game department of the Sudan controls the collection and from time to time supplies fine specimens to other institutions. The large zoo at Pretoria. U. of S. Af., is supported by the government, and there is an excellent collection also at Johannesburg. After World War II zoos were established at Leopoldville, Stanleyville and Elisabethville in the Belgian Congo.

North America.—Many of the zoos in Mexico, Canada and the Cnited States are of considerable size. In Canada, the Quebec Zoological society exhibits a collection made up chiefly of Canadian species; Toronto includes numerous exotic species. and at the annual Toronto exposition a children's zoo is one of the most attractive features. In Mexico, kings of the Aztecs had zoological collections before the Spanish conquest, and a zoo is still maintained at Chapultepec. There is a new and excellent collection in Havana, Cuba, and a modern zoo in Ciudad Trujillo, Dominican Republic.

In the United States, nearly all large cities have zoological gardens, the first of these. at Philadelphia. having been founded in 1859 and opened to the public in 1874; Cincinnati followed. Some of the larger zoos are in the Bronx (New York city), St. Louis, Detroit, Chicago—one in Lincoln park and a magnificent display at Brookfield—and San Diego. These exhibit some of their collections in open-air, barless pits of the type originated by the Hagenbecks at Stellingen, Ger. These zoos are supported by grants from their respective cities and from funds of local zoological societies. Some charge admission, the proceeds of which are devoted to the institution. The profits from refreshment stands are sometimes used for the purchase of animals. The National Zoological park in Washington, D.C., was established in 1890 by congress "for the advancement of science and the education and recreation of the people," and is supported by the U.S. government. The park itself consists of 17j ac. of hills and woods with Rock creek flowing through. It contains several modern buildings and a large collection of specimens.

South America.—At Buenos Aires there is an extensive collection maintained by the federal district. There are other notable zoos in Chile and a small but beautiful zoological-botanical garden at Belém, Para; Braz., specializing in Amazonian birds and animals, supplements the National zoo in Rio de Janeiro.

Asia.—The zoo at Alipore, Calcutta, was established in 1875 by the government of Bengal and is the largest in India. There is an outstanding zoo at Bombay, and an excellent one at Karachi, Pak.; and many of the princes maintain private collections. Singapore, Batavia and especially Surabaja have interesting zoos. There is a good collection at Johore Bahru. Most of the Asiatic zoos destroyed by bombing in World War II were restored and some were improved after the war. In Japan there are three dozen zoological collections, large and small, as well as numerous private aviaries. Notable ones are at Tokyo, Nagoya; Kyoto, Osaka and Kobe; the last-named is situated on a hill overlooking the city and harbour.

Australia and New Zealand.—There are large zoological gardens at Sydney, Melbourne, Adelaide and Perth in Australia; smaller ones at Brisbane (Austr.) and at Wellington and Auckland in New Zealand. The one at Wellington has a well-selected group of New Zealand fauna.

Europe.—Zoological gardens are favourite public institutions in many cities of Europe. In France a modern and model zoo was built at Vincennes for the Paris exposition in 1937. The Jardin d'Acclimatation was founded in 1858 in the Bois de Boulogne. The old Jardin des Plantes in Paris was improved between 1918 and 1939, with some new buildings and an outstanding vivarium for the smaller creatures. Switzerland has three zoos, at Basle, at Berne and at Zurich; the last is attractively arranged in a series of terraces. In Germany. in the years between World Wars I and II, a great deal of development was done in approximately 20 zoos. The larger ones are at Berlin. Frankfurt-on-Main. Munich (the Geo-Zoo, so-called because the animals were grouped according to continent of origin), Dresden, Leipzig and Cologne. The Hagenbeck Garden at Stellingen became an outstanding show place and animal distributing centre. Smaller but attractive zoos are at Dusseldorf. Wuppertal and Hanover. Several of these were destroyed by bombs during World War II but all were restored, and some improved, after the war, except Dusseldorf. Vienna boasts of the Schonbrunn. the oldest zoo in Europe. Budapest maintained an attractive collection with especially fine groups of European birds. At Antwerp a large menagerie was founded by the Royal Zoological society in 1843. In England the most notable zoo is the garden of the London Zoological society in Regent's park. The park is small but the collection has always been one of the finest. The society also has a large open-air zoo at Whipsnade, where herds are maintained rather than individual specimens. Manchester, Bristol, Chester and Paignton have smaller zoological parks. The Edinburgh zoo, beautifully situated in hilly terrain, is famous for its extensive collection of penguins. The zoo in Dublin is famous for its lions—more than 100 were born there during the 19th century. In both Amsterdam and Rotterdam important zoological gardens were established. the former being larger and with a magnificent collection from the East Indies, as well as a fine aquarium. The Skansen zoo in Stockholm is built on an elevated area reached by an escalator. and limits its exhibits to the fauna of northern Europe. At Moscow is the largest of the 25 zoos in the U S S R., with superb collections of northern animals and a good representation also of exotic species. This zoo is divided into two parts, one of small enclosures, and the other with large paddocks for herds of ruminants. Most of the cities and large towns in Europe have some sort of zoological collection maintained by the cities, by local societies or sometimes as commercial enterprises. In Rome there is a large and very popular zoo with a number of barless pits. Lisbon has a zoo, specializing in the animals of Angola and Mozambique. There are zoos in Spain at Barcelona and Jerez de la Frontera, while in Madrid remain parts of the original royal menagerie.

Management of Zoos.—The first object of a zoological garden is the exhibition of its collection to the public. A few animals well shown are immensely more attractive than great numbers inadequately housed and cared for. Considerable research has been done on conditions leading to the welfare of these animals. Studies in diet, ventilation, lighting, heating. artificial sunlight, glass penetrated by ultraviolet rays, and air conditioning have improved conditions in many zoos. Some maintain biological laboratories for research on various phases of animal life and diseases of animals in captivity, and many volumes of natural history have been based on studies made in zoos. As the welfare of animals depends in general upon the same conditions as the welfare of human beings, some of these studies are of value to medical science. A great deal of work has been done in zoos on experimental animal behaviour. Some zoos are associated with museums that preserve animals which die in the zoo. Many species new to science have been described from captive specimens.

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(W. M. Mn.)

ZOOLOGICAL NOMENCLATURE is the system by which names in Latin form are applied to the various divisions of the animal kingdom, especially those of genera and species. Names of higher groups, such as orders, classes and phyla, are relatively few in number and are often determined by common consent rather than strict rules. Although essentially the same in principle and largely in practice, zoological nomenclature is independent of botanical nomenclature. Therefore. the use of a name in botany does not preclude the acceptance of the same name in zoology. The system is binary and (with rare exceptions) binomial, following its first consistent use by Linnaeus in the 10th edition (1758) of his *Systema Naturae*. Prior to that date animals were designated by single words or by descriptive phrases, the so-called polynomials. The advantages of a two-name system were at once recognized; one name for the genus and one for the species. Thus the genus ***Felis*** included various kinds of cats, such as ***Felis leo, Felis tigris,*** etc. With increased knowledge and refinements of classification, a third name was approved, that of the subspecies or variety to indicate a subdivision (usually geographic) of a species. This produced the trinomial, as ***Felis leo*** *senegalensis*.

In spite of the apparent simplicity of the Linnaean system there was much confusion in its early use, and in 1842 there was issued a set of rules (Stricklandian code) sponsored by the British Association of Science. This laid down certain principles which were still followed in 1945, but complications arose and practice was far from uniform. Other codes appeared, notably those of the Sociéte Zoologique de France and the American Ornithologists' union, the last extensively followed in the United States. The Americans fixed the date 1758 (Linnaeus, 10th ed.) as the beginning of nomenclature, whereas the British used 1766 (12th ed.), thus causing a lack of uniformity.

The need for world-wide agreement was seriously considered at the first International Congress of Zoology (Paris, 1889), but it was not until 1902 that an international code of zoological nomenclature was adopted and published by the congress, following the unanimous recommendation of a commission which had been appointed, consisting of 15 members (later increased to 18) representing ten different nations. The president of the original commission was the French zoologist, R. Blanchard, and the secretary the American, C. W. Stiles. The code was something of a compromise, and power to alter it was restricted to the congress with the commission limited mainly to recommendation and interpretation, but various congresses down to that at Lisbon (1935) made a few amendments, and the powers of the commission were somewhat increased. Zoologists of all countries supported the code and followed its rules so far as possible, but many cases proved so equivocal that they were submitted to the commission, which began to issue a series of "Opinions" (more than 150 by 1945), most of which were accepted and given the force of law. In special cases, the commission was empowered to make arbitrary decisions, and it began the compilation of an *official* list of generic names which was to be inviolate. A serious difficulty was the delay in obtaining decisions because of the infrequency of meetings of the congress.

The basis of the rules is the law of priority: "The name of a genus or species can only be that name under which it was first designated." With the re-examination of literature and the changing concepts of zoological groupings, the rigid application of this law has been difficult and elimination of long current names has often been necessary. However, it has been the spirit of the rules that no name be changed except upon convincing evidence. Personal opinion or preference has been largely outlawed and it has been necessary to disregard inferences as to an author's intention and to make judgment solely on his printed record.

The law of priority is not strictly applied to family names, but they are always formed by adding *idae* to the root of the name of the typical genus, and subfamily names by adding *inae,* as Felidae and Felinae from *Felis*. A subgeneric name is governed by the same rules as those applying to generic names! but when written is enclosed in parentheses after the generic name, *e.g., Felis (Lynx) canadensis.*

A proper name following a specific name is that of the authority or first proposer of the specific name; if his name be in parentheses it indicates that the species was originally described under a generic name different from the one now combined with it; *e.g., Psittacus linnaei* (Wagler *j*.

BIBLIOGRAPHY.—See ***Bulletin of Zoological Nomenclature,*** published by the International Zoological Commission, which may always be reached through the Smithsonian Institution of Washington or the Zoological Society of London. E. T. Schenk and J. H. McMasters, *Procedure in Taxonomy* (Stanford University, Calif., and London, 1935); C. D. Sherborn, *Index Animalium* (London, 1902–32).

(W. H. O.)

ZOOLOGICAL SOCIETIES. International congresses of zoology, entomology and ornithology meet at irregular intervals and at different places. The first International Congress of Zoology met in Paris in 1889; subsequent meeting places were Moscow, 1892; Leiden, 1895; Cambridge, Eng., 1898; Berlin, 1901; Berne, 1904; Boston, 1907; Graz, 1910; Monaco, 1913; Budapest, 1927; Padua, 1930; Lisbon, 1935; Paris, 1948; and Copenhagen (the 14th), 1953. All published one or more volumes of proceedings. The International Congresses of Zoology maintain the International Commission on Zoological Nomenclature as one of their principal functions. The first International Congress of Ornithology was held at Vienna in 1884, with succeeding congresses at Budapest, 1891; Paris, 1900; London, 1905; Berlin, 1910; Copenhagen, 1926; Amsterdam, 1930; Oxford, 1934; Rouen, 1938; and Uppsala, 1950, with published volumes of proceedings. The International Congresses of Entomology began with one in 1910 in Brussels, followed by those of Oxford, 1912; Ziirich, 1925; Ithaca, N.Y., 1928; Paris, 1932; Madrid, 1935; Berlin, 1938; Stockholm, 1948; and Amsterdam, 1951, each with one or more volumes of published proceedings.

Among regional and local zoological societies, those formed to maintain zoological gardens and public aquariums form a unique, though not necessarily exclusive, category. Such societies may have only a minority of zoologists in their membership (or even none at all). Zoological gardens and aquariums, however, form two of the important focuses alike of zoological education and research. Zoological gardens are maintained by the Zoological Society of London at Regent's park and Whipsnade, with an aquarium in Regent's park. The New York Zoological society, with zoological gardens in the Bronx, long maintained an aquarium in lower Manhattan. Examples of other societies maintaining zoological gardens are: Zoological Society of Scotland, with gardens in Edinburgh; Zoological Society of Ireland, with gardens in Dublin; Zoological Society of India, with gardens at Alipore; Zoological Society of Amsterdam; and in the United States, the zoological societies of Philadelphia, San Diego and Chicago. The number of such societies is large.

The more essentially scientific zoological societies fall into two sharply distinguished categories. The first is specifically local, as in London or New York city. These societies may be quite informal groups of local naturalists, like the Baird club of Washington, D.C., or the Kennicott club of Chicago; or they may be well established in buildings of their own, with libraries, museums or zoological gardens and often with a publication, or even with several scientific journals (the Zoological Society of London publishes the invaluable *Zoological Record*).

The second type of zoological society is an association of specialists in a given field, national or international in scope, that changes its address with every change of administration. These societies are frequently formed in order to establish and carry on a journal, often the principal journal in the special field. Such societies do not ordinarily maintain libraries. Examples are the American Ornithologists' union, publishing the Auk, the British Ornithologists' union, with the *Ibis,* and the American Society of Mammalogists, with the *Journal* of *Mammalogy.* National societies for zoology in general are represented by the American Society of Zoologists; the Deutsche Zoologische Gesellschaft; the SociCtC Zoologique de France; the SociCtC Royale Zoologique de Belgique; the Nederlandsche Dierkundige Vereeniging; and the Zoological Society of Japan, all with important journals.

A further category of zoological associations is represented by the acclimatization societies, some of which maintain zoological gardens, like the Royal Zoological and Acclimatization Society of Victoria (Austr.), or a journal, like the Société National d'Acclimatation de France with its *Bulletin,* published since 1854. The acclimatization societies of Australia and New Zealand played an extraordinary role in the establishment of foreign species of animals in those countries, often with the most unexpected and disastrous results. Many such societies were transformed in part into societies for the protection of native animals. Some societies exist for a single species of animal, like the International Society for the Preservation of the Wisent. Others devoted especially to conservation are partly or mainly zoological in their interests.

Ornithological societies are extremely numerous. In addition to the national organizations like the British Ornithologists' union and the American Ornithologists' union, with corresponding societies for most nations of the world, there are state and regional societies, many with publications. Notable among these in North America are the Wilson Ornithological club, which publishes the *Wilson Bulletin,* and the Cooper Ornithological club. with the *Condor*. The National Association of Audubon Societies, with headquarters in New York city, publishes the *Audubon Magazine,* the prototype of many popular or semipopular journals for amateur ornithologists. Among the ornithological groups there are further various avicultural societies, with such notable journals as the *Avicultural Magazine,* published since 1894 by the British Avicultural society.

The nature of the study of insects. with its great initial emphasis on collecting, on the building up of individual collections, and thus on exchanges, has especially favoured the growth of the entomological societies. Entomology, in turn, has been greatly furthered by the societies, especially by their provision of journals as outlets for publication. Some of the principal entomological societies of English-speaking countries, with the dates of their organization, are as follows: the Royal Entomological Society of London (1833); the South London Entomological and Natural History society (1872); the Canadian Entomological society (1868); the Entomological Society of America (1907); the American Entomological society (1859); the Brooklyn Entomological society (1872); the Cambridge Entomological club (1874); the American Association of Economic Entomologists (1889); the Pacific Coast Entomological society (1901); and the Hawaiian Entomological society (1904).

Among the principal German entomological societies are: Deutsche Entomologische Gesellschaft (1855); Entomologischer Verein zu Bremen (1912); Verein fiir Schlesische Insektenkunde (1847); Entomologischer Verein "Iris" (1862); the Internationaler Entomologischer Verein (Frankfurt, 1886); Entomologische Gesellschaft. Halle (1907); Entomologische Gesellschaft fiir Hamburg-Xltona (1899); Entomologische Gesellschaft, Leipzig (1875); Münchner Entomologische Gesellschaft (1905); Deutsche Gesellschaft fiir Angewandte Entomologie (1913); and Entomologischer Verein zu Stettin (1838), the oldest of the entomological societies of Germany. Entomological societies have flourished in France from an early date; the Société Entomologique de France (1832) publishes its *Annales* (from 1832), a *Bulletin* (1896), and continues *L'Abbeille* (1890). All of the remaining countries of Europe support one or more societies devoted to the study of insects: and South America adds several important societies to the list.

Societies for the study of invertebrate animals other than insects are especially those for malacology. like the Xmerican Malacological union (1931); the Conchological Society of Great Britain and Ireland (1876); the Malacological Society of London (1893); the Deutsche Malacologische Gesellschaft (1868); and the Société Irfalacologique de France (1884–90).

There are relatively few societies for invertebrate groups other than insects and mollusks which reflects a general neglect of invertebrate zoology. In the United States there are the American Society of Parasitologists (1914); the Helminthological Society of Washington (1910); and the American Society of Protozoologists (1950).

A nearly complete list of the zoological societies publishing journals, with the libraries where these may be found, is given in the *Cnion List of Serials* (K. P. S.)

ZOOLOGY (ARTICLES ON). The article ZOOLOGY outlines the series of discoveries on which the systematic study of animal life is based. and the methods by which multitudes of species are arrayed into larger, more inclusive evolutionary patterns. Authorities differ in their methods of arranging these groups because of emphasis on different types of evidence. and classifications are subject to change as new findings are made in the laboratory and in the field. However. these working classifications have been an important stimulus to this research, and have brought the relationships between animal groups into increasingly clear focus.

Each of the phyla into which the animal kingdom is divided in ZOOLOGY is discussed in a separate article, and other surveys deal with major subdivisions. To illustrate the method of arrangement, following are examples of articles on the CHORDATE phylum:

The major division of the chordates is treated in VERTEBRATE. Among the articles on vertebrate groups is MAMMALIA. and among the articles on mammalian groups are PRIMATES, which describes the structures that man shares with his arboreal kin, and MAN. EVOLUTION OF. Individual species of primates are treated in BABOON; CHIMPANZEE; GIBBON; GORILLA; LEMUR; MANDRILL; ORANGUTAN; etc.

The flesh-eating mammals are described in CARNIVORE. and individual species in BADGER; FOX; JAGUAR; LION; RACCOON: WALRUS; WEASEL; etc. Similarly, MARSUPIALIA is supplemented by BANDICOOT; KANGAROO; OPOSSUM; WOMBAT; etc.; PROBOSCIDEA by ELEPHANT; MAMMOTH; MASTODON; etc.; RODENTIA by CHINCHILLA; GUINEA PIG: MOUSE; LEMMING; PORCUPINE: etc.: and RUMINANT by ANTELOPE; DEER; GIRAFFE; GOAT; SHEEP. etc. An order of flying mammals is described in BAT.

BIRD, a general survey of the biology of this large division of the vertebrates, is supplemented by SONGBIRD and individual articles on important species. Techniques of bird study and their history are outlined in ORNITHOLOGY. Related articles include AVIARY AND AVICULTURE; BIRD WATCHING; FLIGHT (NATURAL); MIGRATION, BIRD; NEST; WILDLIFE CONSERVATION; etc.

Another major division of the vertebrates is surveyed in FISH and treated in detail in articles on species and genera. such as CHAR; COD; FLATFISH; FLYING FISH; HERRING; PERCH: PILCHARD: SALMON; SALMONIDAE; etc. RAY and SHARK describe these cartilaginous fishes belonging to the class outlined in CHONDRICHTHYES. Related articles include AQUARIUM; FISH CULTURE: FISHERIES; FISHING; ICHTHYOSAUR; OCEAN AND OCEANOGRAPHY: *Biological Oceanography;* etc. REPTILES surveys the group of vertebrates that includes lizard, crocodile, snake and turtle. The group of vertebrates in which the frog, salamander. toad, etc. are included is outlined in AMPHIBIA.

Following is an example of a group of articles from another phylum: ANT surveys the biology of this family of insects, and refers the reader to HYMENOPTERA. a survey of the order that includes the bees. wasps and allied families as well as the ants. One of the references in this article is to SOCIAL INSECTS. which describes the communal organization of certain insect societies. The progression is to INSECT. which outlines the structures by which the various orders of insects are identified. and discusses phenomena and patterns of behaviour. ENTOMOLOGY summarizes the obiectives and methods of the svstematic study of insect life. The phylum to which the insects belong is outlined in ARTHROPODA.

The articles cited in the above paragraphs represent only a fraction of those dealing with two of the phyla, plus a selection of those of general interest. Further examples are given in ANATOMY (ARTICLES ON); BIOLOGY (ARTICLES ON); GEOLOGY (ARTICLES ON); and PHYSIOLOGY (ARTICLES ON).

Since the topic of evolution encompasses the entire world of animal and plant life, it is viewed from various perspectives The evolutionary clues contributed by fossils are discussed. in nontechnical terms, in a section of PALAEONTOLOGY. Another simple introduction, from the point of view of organisms as a whole, is given in a section of BIOLOGY. A comprehensive survey of evolutionary theories. from pre-Darwinian insights to current interpretations, will be found in EVOLUTION, ORGANIC. The contributions of Darain and his successors are outlined against their scientific and social background in DARWINISM. The history of the scientifically obsolete but politically important doctrine of the inheritance of acquired characters is given in LAMARCKISM.

Ecology, the science devoted to examining the interaction between organisms and their environment, is represented by ECOLOGY. ANIMAL and POPULATION ECOLOGY. The contributions of ecological factors to the dynamics of evolution are illustrated in ANIMALS, DISTRIBUTION OF and ZOOGEOGRAPHY. Also, articles on continents, nations and other major areas contain descriptions of animal life.

ANIMAL BEHAVIOUR discusses the study of action patterns, with reference to sensory capacity, inherited responses, intelligence, etc. Related articles include COURTSHIP. ANIMAL; HIBERNATION AND ESTIVATION; INSTINCT; MIGRATION. ANIMAL; PLAY, ANIMAL; PSYCHOLOGY, COMPARATIVE; and SOCIOLOGY, ANIMAL.

GESTATION PERIOD and LIFE SPAN, ANIMAL discuss the dominant biological factors involved, and give statistical tables.

Biographical articles throw light on the backgrounds against which the theories of DARWIN, HAECKEL, HUXLEY, WALLACE and other trail blazers were developed.

The following articles and sections of articles are recommended as a minimal reading list for an introduction to the elementary principles of zoology: ANIMALS. DISTRIBUTION OF; BIOLOGY: ECOLOGY. ANIMAL: *Basic Requirements* of *Animals;* EVOLUTION. ORGANIC; PALAEONTOLOGY: *Evolutionary Evidence;* ZOOGEOGRAPHY; and ZOOLOGY.

The technical terms of zoology need not discourage the general reader; they are essentially devices for compressing a great deal of description into the space of a single word. Even articles that seem at first glance to be overly technical will be found to contain explanations of the elementary principles in nontechnical terms. Whether the reader's objective is extensive study or a quick confirmation of fact, the Index will prove helpful; it shows the heading under which the topic is treated. and lists sections of articles as well as complete ones.

ZOOLOGY, the study of animals. The science of zoology embraces all conceivable modes of study, not only of individual animals but of entire faunas and of the relations of animals with one another, with plants, and with the nonliving environment. Because of its vast scope, zoology is usually broken up into several subsidiary subjects of which the chief ones are: morphology or anatomy, histology and cytology, embryology, paleontology, taxonomy or systematics, genetics and evolution, ecology and physiology. As special articles under these names will be found in the encyclopaedia, only a brief survey can be attempted here of the main findings in the various fields of zoology. with special emphasis on morphology and classification. (See *Organ Systems*, below; PHYSIOLOGY, COMPARATIVE.)

The article is divided into eight main sections, as follows:

I. Morphology
II. Classification
III. The Phyla of the Animal Kingdom
IV. Embryology and Homology of the Germ Layers
V. Embryology and the Theory of Recapitulation
VI. Variation, Heredity and Evolution
VII. Ecology
VIII. Economic Zoology

I. MORPHOLOGY

The study of zoology undoubtedly had its origin from the observation that there are many different kinds of animals. The more obvious and easily discovered characters that distinguish animals from one another are the external ones: differences in body shape, size and colour, character of the skin and its derivatives as scales, hair and feathers, presence of prominent sense organs, such as eyes and ears, and presence of legs or other appendages. But it soon became clear to zoologists that external appearances alone would not provide understanding of the animal kingdom; thus they were driven to a study of internal structure. Anatomical investigations were carried out at first entirely by dissection of the animal's carcass with knives, scissors and other instruments, a technique that, in skillful hands. can yield an astonishing amount of accurate information but which is necessarily incapable of revealing many structures, either because they are too small to be seen or are otherwise undiscoverable. Progress in anatomical investigation, therefore, had to await the introduction of the microscope, toward the end of the 16th century. The possibility of magnifying an animal greatly extended the scope of zoology, since it enabled the structure of very small animals to be investigated and, indeed, revealed the existence of an immense variety of microscopic animals previously unknown because they were too small to be seen with the unaided eye.

Cellular Structure of Animals.— The most important revelation of microscopical study was the discovery. through the efforts of a number of workers toward the end of the 18th century and during the first half of the 19th, that animals (and plants) do not consist of a continuous mass of material. but that their substance is partitioned off by walls and membranes into an immense number of minute units, the cells. The cells of an animal are not all alike: but occur as a number of different kinds with appropriate functions, a condition known as differentiation. Cells also do not in general occur singly; but many of one kind are united in masses or sheets termed tissues. Organs such as the stomach or liver consist of two or more kinds of tissues closely associated. Thus, the body of an animal consists of cells combined to form tissues and organs.

During the last half of the 19th century great progress was made in the study of cells. It was discovered that cells have affinities for dyes similar to those used in dyeing cloth. and that with the aid of such dyes the details of cell structure may be accentuated. Because only very thin objects can be studied with the microscope. a machine! the microtome. was devised by which small animals or pieces of larger ones could be sliced into a series of exceedingly thin sections, and these mounted serially on glass plates for microscopic examination. By the application of such microscopic techniques an understanding was attained of the internal structure of a great variety of animals. That branch of zoology which concerns itself with tissues is termed histology (*q.v.*), and that which studies the fine details of cell structure is called cytology (*q.v.*).

The discovery and study of the cellular structure of animals and plants resulted in the last half of the 19th century in a philosophy termed the cell theory. This theory exaggerated the importance of cells and considered them to be the vital units in which were vested all of the phenomena of life. An animal was regarded not as a functioning whole but merely as a collection of cells and its properties merely as the sum of the properties of the cells. Following a wide acceptance, this theory began to be questioned and discarded by the leading thinkers among zoologists, and is being replaced by the organismal conception. which maintains that the cells are simply constituent parts of an animal and that such phenomena as growth, form. reproduction, development, heredity and evolution are clearly manifestations of the animal as a whole, and cannot be understood merely by studying its cells.

Grades of Structure.— All combined methods of studying the structure of animals show that animals exist in several grades of structure ranging from simple to complex. Such arrangements are, of course, more or less artificial but they assist in enabling one to understand the animal kingdom.

In the first place it was soon discovered that animals are divisible into two great groups, those that are made of cells and those that are not.' The latter group comprises a host of microscopic animals. known as Protozoa, whose substance is not partitioned into cells, and which are thus regarded simply as consisting of one cell. In reality: they are not equivalent to a single cell of other animals but constitute complete little organisms capable of all the functions that distinguish larger animals. Their bodies may be far more elaborately organized than any of the cells of higher animals and may contain contractile and neuroid fibrils, supporting plates and fibres of a skeletal nature, and elaborate food-catching mechanisms. Although sexual processes also occur among the Protozoa. practically all of them can reproduce simply by dividing into two or more parts.

All other animals are composed of cells; although in some cases the cell walls may more or less disappear as the animal matures. These multicellular animals are termed Metazoa. They are not only composed of cells, but their cells are differentiated into a number of different kinds and are associated into tissues and organs for the performance of different functions. A metazoan animal is an individual. a unit whose cells are subordinated to the whole and are not in general capable of an independent existence or of performing all of the necessary functions.

It follows! as a necessary concomitant of the cellular differentiation of the metazoan body. that all such animals must undergo a process of development (see EMBRYOLOGY) during which this complication gradually arises. Although there are a number of cases among the Metazoa in which reproduction occurs by division or budding, much as in Protozoa, the Metazoa generally reproduce sexually. giving rise to female sex cells or eggs; and male sex cells or sperm. The egg is large, provided with food supplies in varying amounts and nonmotile. The spermatozonn is relatively very small and slender and provided with a locomotory apparatus for reaching the egg. When the egg is fertilized by a spermatozoan, *i.e.*, fuses with it, it starts upon a process of development during which it divides to make many cells, and these undergo differentiation. However, many Protozoa also produce eggs and sperm and undergo some degree of development so that the contrast between Protozoa and Metazoa is not as great as assumed during the heyday of the cell theory. There are, further, types of colonial Protozoa that approach the metazoan condition.

Among the Metazoa it is customary to set off one group, the sponges or Porifera, from the others because of their lowly grade of organization and many peculiarities of structure. Sponges are little more than loose aggregations of cells covered over by an epithelium (*q.v.*). Although the cells of sponges show some degree of differentiation, they are mostly variants of amoeboid types and each can perform a number of different functions. Furthermore, sponges have no mouth or proper digestive cavity; they are permeated by systems of canals through which a continuous water current is maintained. On these grounds sponges are separated as a branch Parazoa from other metazoans which are then called Eumetazoa or Metazoa proper.

The Eumetazoa all have a proper mouth and digestive tube; they present many grades of structural complexity of which the lowest is represented by the group Cnidaria (see COELENTERATA). The Cnidaria illustrate the structural plan on which the Eumetazoa are based and from which the more complex members can be theoretically derived. The cnidarians are composed essentially of tissues; *i.e.*, they represent a tissue grade of construction. They consist of two epithelia back to back with some sort of cement or connective tissue between. The outer epithelium! the ectoderm, or better, epidermis. has protective, nervous and sensory functions, and the inner epithelium, the entoderm, or better, gastrodermis, forms a primitive digestive tube. Epidermis and gastrodermis meet at the mouth. Both epithelia may give off muscle fibres that lend the animal a considerable degree of motility. It is characteristic of animals of the tissue grade of construction that they are built on the plan of radial symmetry or some variant thereof (see MORPHOLOGY). Consequently they may be termed radiate animals or Kadiata.

All other Eumetazoa are constructed on the plan of bilateral symmetry, and hence may be collectively termed Bilateria. They show definite differentiation into anterior and posterior ends, and dorsal and ventral suriaces (see MORPHOLOGY). Their tissues are also more or less aggregated into organs so that they may be considered to be of the organ-system grade of construction. Between their outer or ectodermal epithelium and inner or entodermal epithelium they have a mass of mesodermal tissue that gives rise to muscles, connective tissues: and reproductive, circulatory and excretory systems (see EMBRYOLOGY).

It is customary to group the Bilateria on the basis of the number and kinds of internal cavities. The lowest Bilateria, the Platyhelminthes or flatworms, have the same solid construction as the Cnidaria; *i.e.*, there is only one internal cavity, the digestive cavity. In the flatworms the space between epidermis and digestive epithelium is filied with tissues and organs of mesodermal origin. Bilateria having this kind of solid construction are called acoelomate. The remaining Bilateria have an extra space between the digestive tube and the body wall, but it appears that this space is not necessarily the same as to embryonic origin in different groups. When this space is formed by the parting of the mesoderm so that it has mesoderm on both sides of it, the space is considered a true coelom. When, however, this space is a remnant of the blastocoel (see EMBRYOLOGY) and has mesoderm on only one side or on neither side of it, it is considered a false coelom or pseudocoelom. The Bilateria. therefore, exist in acoelomate, pseudocoelomate and coelomate grades.

It is likewise characteristic of all Bilateria, except the Platyhelminthes, that the digestive tube has a rear opening, the anus. The presence of an anus greatly increases the efficiency of the digestive tube, for there is then no mixing of food in various stages of digestion as must be the case where the digestive tube has but one opening, serving for both ingestion of food and ejection of indigestible remnants. Further, in coelomate animals part of the mesoderm attaches to the digestive epithelium, furnishing muscle layers to the latter and conferring motility upon the digestive tube. A feature seen in three groups of higher Bilateria (Annelida, Arthropoda and Chordata) is the segmentation of the body, *i.e.*, the division of the body along its main axis into a series of equal joints or segments, each of which contains a representative of the various body systems (see MORPHOLOGY).

Organ Systems.—As already intimated all of the Bilateria are provided with organ systems; *i.e.*, associations of organs for the performance of specific functions. The organ systems of the higher Bilateria are the following: integumentary, muscular, skeletal, nervous, sensory. digestive, excretory, reproductive, circulatory. respiratory and hormonal. These systems appear gradually in the lower Metazoa and attain their full complexity and functional specialization only in the higher ones.

The integumentary system comprises the skin and its derivatives such as cuticle: scales, feathers, hair and armour (exoskeleton). The essential purpose of this system is protection against the external world and against drying out of internal parts.

The muscular system consists primitively of a layer of muscle fibres running in two or more directions situated just beneath the external covering. Such a system is incapable of complicated movements but serves to shorten and extend the animal and to allow it to bend in various directions. In higher animals the muscle fibres aggregate into definite bundles or muscles that permit much more varied and exact movements.

The skeletal system is closely associated with the muscular system. being in fact derived from the same embryonic source, and functions chiefly as a support for the musculature. The skeleton. properly speaking, is an internal structure and is best illustrated in the vertebrates with their internal assemblage of cartilage and bones. Among the invertebrates, skeletal structures such as the shells of mollusks are chiefly external and, therefore, really belong to the integumentary system. Such exoskeleton also serves for muscle attachment as well as for protection.

The nervous system is a derivative of the surface covering (epidermis) and functions for the correlation of body activities by means of its power of rapid transmission. It consists essentially of nervous tissue aggregated into masses (ganglia) and strands (nerves,). It is characteristic of the nervous system of vertebrates that it is dorsal and hollow whereas that of invertebrates is ventral and solid. In the evolution of animals the nervous system gradually shifts from a superficial position immediately under the epidermis to a deeper position, to the inner side of the muscle layer.

The sensory system is that part of the nervous system that responds to external factors and transmits these responses to the central nervous system where appropriate action is initiated. The sensory system consists of a variety of nerve endings and sensory organs designed to be affected by particular external factors such as light. sound waves, odours, temperature, etc. Whereas the essential sensory part is microscopic. numbers of such parts may be aggregated with accessory structures to form conspicuous organs such as the eye, ear, etc.

The digestive system in its earliest form: as seen in cnidarians, consists simply of the inner epithelial tube, and it has only one opening, the mouth. In the metazoan series, the digestive tube becomes separated from the body wall by the formation of either a pseudocoelomic or a coelomic cavity and at the same time acquires a rear opening. the anus. In coelomate animals part of the mesoderm attaches to the digestive tube, forming muscle layers for the latter which then becomes capable of motility. Various functional regions become differentiated along the digestive tube in different animals, as a crop for storing food, gizzard for grinding hard food. stomach for the main processes of digestion, intestine for absorption, etc.; glands that secrete digestive enzymes or other substances involved in digestion occur either in the wall of the digestive tube or attached to it. Among vertebrates the liver and pancreas are conspicuous glands that embryologically are formed from the lining epithelium of the digestive tube.

The foregoing systems occur in all the Eumetazoa, but the following ones are found only in the Bilateria. The excretory system has the function of regulating the water content of the body and secondarily of removing the useless products of body chemistry, especially nitrogenous products. It consists primitively of secretory tubules the inner ends of mhich may be closed or may open into body spaces. At first the tubules obtain their excretory material directly from body spaces but with the increasing size and complexity of the animal they obtain it from the blood and the internal openings then close up. In vertebrates the tubules are aggregated into organs known as kidneys.

Although sex cells occur in all groups of animals. including some Protozoa, a definite reproductive system n·ith ducts and other differentiated parts is first seen in the lowest Bilateria (flatworms) and is characteristic of the Bilateria in general. Although very simple reproductive systems are seen in many Bilateria, in others the system reaches inexplicable complexity. The complexity is associated with internal fertilization. *i.e.*, the passage of sperm from the male to the female, and seems to indicate that such fertilization is more desirable than the mere shedding of sex cells into the water.

The circulatory system consists of a set of tubes for distributing respiratory gases and food and collecting waste materials; one or more pumping organs usually aid the process. Such a system is obviously necessary only to animals of some size and complexity because in small animals physical diffusion is adequate. Hence, the circulatory system is found only in the larger and higher Bilateria and reaches a complex development only in the vertebrates. It is filled with a fluid. the blood. which may or may not be red, and which travels in a circuit passing through respiratory organs for the exchange of gases and close to the excretory organs for the emission of wastes. The red colouring matter found in vertebrate (and some invertebrate) bloods is concerned with the exchange of gases (*see* RESPIRATION).

The respiratory system is concerned with the exchange of respiratory gases and also occurs only in the larger and more complex Bilateria since such exchange takes place by diffusion in smaller forms. Animals obtain energy for their life processes by means of oxidation; therefore. they must continually absorb oxygen or die. Carbon dioxide is emitted as a result of the oxidation process. A respiratory system is a device for facilitating the absorption of oxygen and the emission of carbon dioxide. Its essential features are a large exposure of surface to the gases and thin walls to permit easy passage of gases. Hence, a respiratory organ is a greatly folded structure of spongy, feathery or booklike appearance. It may project to the outside and is then known as a gill, or it may project into the interior, forming a lung. Gills get their gases from the surrounding medium, usually water, and lungs get theirs from the air. There are often accessory mechanisms for causing water to flow over the gills or for causing air to pass into and out of the lungs. These mechanisms are concerned with external respiration, not to be confused with the true process of respiration, mhich consists of the utilization of oxygen by the body cells.

The hormonal system consists of a number of glands or glandlike bodies that have no ducts and secrete their products. called hormones, directly into the blood. Thus they are called endocrine glands or glands of internal secretion. They are best known in vertebrates where they include the pituitary body of the brain, the thyroid, parathyroid, the islets of Langerhans in the pancreas, the adrenal glands near the kidneys and the sex glands. The secretions of these glands are necessary for the normal growth and health and for the initiation and maintenance of sexual reproduction.

The study of hormone-secreting structures in invertebrates and the role of such hormones in their biology has become in recent years an intensive field of research. In crustaceans, hormones from secretory cells in the central nervous system have been proved to control colour changes, molting and growth and probably reproductive activity. In insects, similar hormones of nervous origin control growth, molting and metamorphosis from larva to pupa and pupa to adult. Histologically similar neurosecretory cells occur in annelids and other invertebrates. *See* HORMONES, INVERTEBRATE.

II. CLASSIFICATION

The knowledge gained through anatomic and microscopic studies, plus the results accumulated in the fields of embryology (*q.v.*) and paleontology (*q.v.*), has enabled zoologists to classify the animal kingdom. Classifications were of course attempted long before the necessary knowledge was available, but only after 1850 was considerable agreement reached about the main subdivisions of the animal kingdom. classification consists essentially of grouping together animals of like structure. Although seemingly simple in principle, zoological classification is exceedingly difficult in actual practice and depends largely on the personal judgment of zoologists. The usual difficulty consists in deciding when a degree of difference is sufficient to justify the making of a different category. The classification of so-called aberrant forms, *i.e.*, individuals or small groups of animals that do not seem to fit into any of the established groups, also raises great difficulty. As a consequence, no two zoologists or zoological texts agree in all details on the scheme of classification. although a considerable amount of agreement will be found. The branch of zoology that deals especially with classification is termed taxonomy (*q.v.*) or systematics but so vast is the number of animals (probably approaching 2,000,000) that any one zoologist must limit himself to the taxonomy of a single group.

The Species.—Classification begins by separating animals into different kinds. Thus. anyone can see that the common horse is very much alike throughout the world and that it is different from the cow. This difference is expressed by regarding the entire population of horses as constituting one category, termed the species; the same is done for cows, and for other animals. Although an exact definition of the species concept has given zoologists much trouble, for practical purposes a species may be defined as a population or populations of animals that are alike in the details of their structure within close but variable limits, and that breed together, or can do so.

In the early days of classification when relatively few specimens were available for study, species seemed to be easily distinguishable from each other. But as more and more specimens were collected. and as zoologists began to study actual populations as they exist in nature, it became apparent that the majority of species do not constitute a' uniform population, but comprise a number of geographically distributed populations that differ from each other in minor details. Thus, the species in many cases really consists of a few too many geographic races or variants, usually termed varieties or subspecies, many of which were formerly considered distinct species because of insufficient collecting. It is therefore evident that to determine the content of a species and to distinguish species from each other, extensive collecting over the entire range of distribution is necessary. The interbreeding test should be applied when possible, although it is often obviously impractical. The breeding test is not. however, conclusive since individuals belonging to what taxonomists regard as distinct species do sometimes interbreed in nature.

It is believed by most zoologists (although denied by some) that the geographical variants of a species represent incipient species, and that they will become distinct species whenever they cease to breed together either because of morphological divergence of their copulatory organs or because of behaviouristic divergence.

The Genus.—The next taxonomic category above the species, referred to as the genus, embraces a number of species of sufficiently similar morphology. In short, after the species are defined and delimited they are grouped together according to similarity and each group of similar species constitutes a genus. It is clear that whereas the species has a real existence in nature, the genus is a more or less arbitrary conception. How much species must resemble each other to justify their grouping into one genus and how much they must differ to justify separating them into different genera are obviously matters of judgment on the part of the taxonomist. As a result, there is a continuous process in taxonomy of transferring species from one genus to another.

The Scientific Name.— Since the days of Linnaeus, who invented the system, it has become obligatory upon zoologists to combine the generic with the specific name to form the accepted' scientific name of the animal. This procedure is termed the binomial system of nomenclature. The generic name is capitalized; the specific name begins with a small letter. For instance, some of the cats have the generic name *Felis*, from the Latin word for cat. The different cats then each have a specific name. thus, *Felis leo*, the lion; *Felis tigris*, the tiger; *Felis pardus*, the leopard; *Felis domesticus*, the domestic cat; etc. The scientific name is constructed in Latinized form and hence is understandable throughout the world, whereas common names are confusing and inexact. and vary with language. The scientific name is, therefore, a very useful tool, since each scientific name can designate only one kind of animal; what is meant by that name is apparent to zoologists throughout the world.

Higher Taxonomic Categories.— By using more and more important characters as a basis for deciding resemblance, larger and larger taxonomic divisions can be constructed. The most important ones in common use are family, order, class and phylum. A family is composed of those genera having certain characters in common; an order is made up of families of similar construction. etc. If it is considered desirable in any particular case, these categories can be subdivided to form subfamilies. suborders, etc., or grouped as superfamilies. etc. Like the scientific name, the names of all taxonomic categories are constructed in Latinized form, usually from Greek and Latin roots. The names of families and subfamilies must be constructed from the name of their principal genus and must end in *idae* and *inae*, respectively. No rules govern the formation of names higher than family although they generally terminate in *a*.

The Phylum.——The highest taxonomic category of all is termed the phylum. which thus constitutes the primary division of the animal kingdom. Each phylum is sharply characterized by a plan of structure in the adult peculiar to it and differing from that of other phyla in such ways that in general phyla are not derivable from each other. As all animals are related to each other by descent (*see* EVOLUTION, ORGANIC), it is evident that at some time in its past history each phylum must have been derived from some pre-existing phylum. and one of the favourite armchair occupations of zoologists, especially in the past, was the surveying of available evidence for indications of phyletic relationships, a field of zoology termed phylogeny. The evidence most useful in such phylogenetic speculation is that drawn from embryology (*q.v.*) and paleontology (*see* PALAEONTOLOGY). The facts. however. arc so scanty that the various schemes of interphyletic relationships that have been advanced must be regarded merely as suggestive. At the present time in the earth's history the different phyla of animals are widely separated from each other in structural plan, and no intermediates between phyla are known except in the case of the phyla Annelida and Arthropoda.

Identification of Animals.— Through his knowledge of the structural characters on which the taxonomic divisions are based, a zoologist when confronted with an unknown animal can usually place it at least to order after a brief examination. However, the determination of the genus and species to which an animal belongs is generally a matter that calls for prolonged study, often with the aid of microscopic examination. because the characters that separate genera and species are usually minute and detailed. In general, only a specialist in the group to which the animal belongs is competent to identify it to genus and species. and identifications should not be attempted by others. The correct identification of an animal is of great importance in zoological research so that zoologists all over the world may know what animal is under discussion. Very often in the history of zoology, heated arguments have arisen over differing research results that in reality were caused by the fact that different species were being used. Experience has shown that results obtained with one species cannot safely be assumed to be applicable to another even closely related. species. Correct identification is also of great importance in the economic relations of zoology, being the first necessary step in the understanding and control of pests and parasites, and in the encouragement of useful animals.

III. THE PHYLA OF THE ANIMAL KINGDOM

The question of the division of the animal kingdom into phyla is one of the greatest importance to the zoologist because such division really expresses the state of his knowledge of animal structure. development and relationships. In the beginning of the era of modern zoology, roughly from the times of Linnaeus, the divisions proposed were highly erroneous, being based chiefly on external appearances. As discussed above, a correct knowledge of animal structure is attained only through dissection and microscopic examination. Embryological studies also are of the greatest importance (*see* below). As knowledge from these sources accumulated. the phyletic arrangement was continuously altered by a succession of zoologists. and cannot be said to have attained a stable condition even to this day. The reasons for this are. first that embryological and morphological information is still far frorn complete, and, second, that opinions differ as to what characters are the most important in defining phyla. Some zoologists tend to lump groups together so as to make a few very inclusive phyla and others tend to separate off various small groups as independent phyla. Consequently any published arrangement of phyla must be understood to represent merely some zoologist's opinion.

The following scheme leans toward the separation of small groups as independent phyla. It is based on the grades of structure discussed above. presence or absence of an anus, kind and number of body spaces, etc. Wholly extinct classes are omitted.

KINGDOM ANIMALIA

Subkingdom I. Protozoa. Animals consisting of one cell or of colonies of like cells.
- Phylum 1. Protozoa
  - Subphylum 1. Flagellata
    - Class 1. Phytomastigophora
    - Class 2. Zoomastigophora
  - Subphylum 2. Sarcodina
    - Class 1. Rhizopoda
    - Class 2. Actinopoda
  - Subphylum 3. Sporozoa
    - Class 1. Telosporidia
    - Class 2. Acnidosporidia
    - Class 3. Cnidosporidia
  - Subphylum 4. Ciliata or Ciliophora
    - Class 1. Holotricha
    - Class 2. Spirotricha

Subkingdom II. Metazoa. Animals composed of unlike cells that may lose their boundaries in the adult state

Branch A. Mesozoa. Parasitic animals composed of a surface layer of epithelial cells enclosing reproductive cells
- Phylum 2. Mesozoa

Branch B. Parazoa. Animals composed of several kinds of differentiated cells somewhat arranged in tissues; without organ systems or mouth; porous
- Phylum 3. Poriiera, the sponges
  - Class 1. Calcarca
  - Class 2. Hexactinellida
  - Class 3. Demospongiae

Branch C. Eumetazoa. Metazoa with cells arranged in tissues; usually also with organ systems; with mouth and digestive tract except when lost by parasitic degeneration; not porous

Grade 1. Radiata. With primary radial symmetry; of the tissue grade of construction
- Phylum 4. Cnidaria or Coelenterata, the coelenterates. Kadiata with nematocysts; no ciliated plates
  - Class 1. Hydrozoa
  - Class 2. Scyphozoa
  - Class 3. Anthozoa
- Phylum 5. Ctenophora, the comb jellies. Without nematocysts; with eight rows of ciliated plates
  - Class 1. Tentaculata
  - Class 2. Nuda

Grade II. Bilateria. Eumetazoa with bilateral symmetry or secondary radial symmetry; with organ systems

Section a. Acoelomata. No space between digestive tube and body wall

Phylum 6. Platyhelminthes, the flatworms. No anus
- Class 1. Turbellaria
- Class 2. Trematoda
- Class 3. Cestoda

Phylum 7. Nemertina or Rhynchocoela, the nemertine worms. With anus; with a protrusible proboscis above the digestive system

Section b. Pseudocoelomata. With pseudocoelom between digestive tract and body wall; usually with anus; body clothed with cuticle

Phylum 8. Acanthocephala, the spiny-headed worms. Parasitic worms with spiny protrusible anterior end; without mouth or digestive tract

Phylum 9. Aschelminthes. Without spiny proboscis, or if so, not parasitic; nearly always with mouth and digestive tract
- Class 1. Rotifera, the rotifers
- Class 2. Gastrotricha
- Class 3. Kinorhyncha or Echinoderida
- Class 4. Priapulida, the priapulid worms
- Class 5. Nematoda, the roundworms
- Class 6. Nematomorpha or Gordiacea, the gordian worms

Phylum 10. Entoprocta. Anterior end bears circle of ciliated tentacles, enclosing mouth and anus

Section c. Eucoelomata. With true coelom; with anus and organ systems

1. With a lophophore, a variously shaped ridge, mostly circular or crescentic, bearing a single row of ciliated tentacles and embracing the mouth but not the anus

Phylum 11. Phoronida. Wormlike

Phylum 12. Ectoprocta (old phylum Bryozoa in large part), the moss animals. Colonial with gelatinous, chitinous, or calcareous encasements.

Phylum 13. Brachiopoda, the lamp shells. Enclosed in a bivalved shell, valves dorsal and ventral.

2. Without a lophophore; coelom a schizocoel, formed by a mesodermal split

a. Body not segmented

Phylum 14. Mollusca. Visceral mass covered by a body fold, the mantle, that secretes an external shell of one or more pieces; coelom usually reduced
- Class 1. Xplacophora
- Class 2. Polyplacophora
- Class 3. Monoplacophora
- Class 4. Gastropoda
- Class 5. Scaphopoda
- Class 6. Pelecypoda
- Class 7. Cephalopoda

Phylum 15. Sipunculida. Wormlike with introversible anterior part; anus anterior, dorsal.

b. Segmented

Phylum 16. Annelida, the annelids. Worms, with long jointed bodies, but without jointed appendages
- Class 1. Archiannelida
- Class 2. Polychaeta
- Class 3. Clitellata
- Class 4. Echiurida

Phylum 17. Arthropoda, the arthropods. Mostly not wormlike, body bears jointed appendages
- Class 1. Onychophora
- Class 2. Tardigrada
- Class 3. Crustacea
- Class 4. Arachnida
- Class 5. Pentastomida or Linguatulida
- Class 6. Pycnogonida or Pantopoda
- Class 7. Pauropoda
- Class 8. Diplopoda
- Class 9. Symphyla
- Class 10. Chilopoda
- Class 11. Insecta

3. Without a lophophore; coelom an enterocoel, formed by outpouchings of the digestive tube

a. With secondary, usually pentamerous radial symmetry; with a water-vascular system

Phylum 18. Echinodermata, the echinoderms
- Class 1. Crinoidea
- Class 2. Holothuroidea
- Class 3. Echinoidea
- Class 4. Asteroidea
- Class 5. Ophiuroidea

b. Bilateral symmetry retained throughout life

Phylum 19. Chaetognatha, the arrow worms. Transparent, pelagic wormlike animals, with grasping spines, without gill slits or endoskeleton.

Phylum 20. Hemichordata. Wormlike, not transparent or pelagic, without grasping spines
- Class 1. Enteropneusta. With gill slits, without tentaculated arms.
- Class 2. Pterobranchia. With or without gill slits, with a pair of tentaculated arms.

Phylum 21. Chordata. Not wormlike, adults with gill slits or vertebral column or both
- Subphylum 1. Urochordata or Tunicata
- Subphylum 2. Cephalochordata or Acrania
- Subphylum 3. Vertebrata or Craniata
  - Class 1. Agnatha
  - Class 2. Placodermi
  - Class 3. Chondiichthyes
  - Class 4. Osteichthyes
  - Class 5. Amphibia
  - Class 6. Reptilia
  - Class 7. Aves
  - Class 8. Mammalia

The systematic position of the three groups, Tardigrada, Onychophora and Pentastomida, here placed under Arthropoda, is still unsettled. By many these groups are considered independent phyla. others would dispose of them as subphyla under Xrthropoda. For further information about the phyla, special articles in the encyclopaedia should be consulted.

IV. EMBRYOLOGY AND THE HOMOLOGY OF THE GERM LAYERS

Animals in general develop from a single cell, the egg, which, after being stimulated by fusion with a sperm, enters upon a remarkable process of embryonic development in which the definitive characters gradually make their appearance. When this process was studied in many diverse animals, zoologists began to realize that certain similarities obtain throughout the animal kingdom. First the egg undergoes cleavage, dividing up into a ball of many cells. A two-layered condition, the gastrula, follows, in which the embryo consists of an outer epithelium, the ectoderm, and an inner epithelium or, in some cases, a solid mass: the entoderm. The manner of origin of the entoderm is varied, but great importance has been attributed by some zoologists, notably Ernst Haeckel, to one particular method. that of invagination, or the bending inward of the outer epithelium. Haeckel, and after him most zoological texts, considered invagination to be the original and primary method and other methods derived and secondary. This proposition is open to grave doubt, but it is probably impractical to ascertain what was the original method of entoderm formation.

Following the establishment of the gastrula stage, the next general step in development is the formation of a tissue between the ectoderm and the entoderm, termed the mesoderm. Here again varied modes of formation of mesoderm are seen in different animal embryos, but most prominence was given in zoological theory to one particular method, the enterocoelous method, in which the mesoderm arises by the outpushing of pockets from the entoderm. Again the primary nature of the enterocoelous method may be seriously questioned, but the determination of the original mode of mesoderm formation is probably an impossibility.

Ectoderm, entoderm and mesoderm are known as the germ layers, and from them all of the tissues and organs of the adult animal are derived, chiefly by processes of folding and migration. Their role in the production of adult structure is generally much the same throughout the animal kingdom. The ectoderm furnishes .the surface covering of the animal (epidermis), and also the nervous system and the nervous part of the sense organs. The entoderm furnishes the lining epithelium (gastrodermis) of the digestive tract and the epithelial cells of various outgrowths of the digestive tract, such as the liver, pancreas and other glands. All the tissues and organs between the epidermis and gastrodermis are of mesodermal origin; *i.e.*, the muscles and connective tissues, the bones and cartilages of the skeleton, and the circulatory, excretory and reproductive systems. In coelomate animals; the mesoderm separates into a somatic part, which furnishes the muscles of the body wall and also the skeleton, and a splanchnic part, which attaches to the viscera and provides their muscular layers. The space between the somatic and splanchnic mesoderm is the coelom.

These facts are certainly very striking and have led to an important zoological theory termed the homology of the germ layers. This theory states that development by means of germ layers is fundamental throughout the multicellular animals; that the germ layers were originally (if not now) formed in the same way throughout the Metazoa; that each of them produces the same organs wherever found; and that in short there is complete morphological correspondence between the same germ layers in different animals. Different grades of construction are regarded as representing different stages in germ-layer formation. The coelenterate or tissue grade corresponds to the gastrula or two-layered stage of development; the acoelomate or flatworm stage corresponds to the stage after the mesoderm has arisen but has not yet divided into somatic and splanchnic layers. etc.

Germ-layer theory prevails in embryological teaching to the present time and certainly constitutes an orderly method of presentation of the subject. The theory has, however, been subject to severe criticism in recent years; and it is not yet clear to what extent it will survive. In regard to early embryonic stages, it must be admitted that the actual modes of formation of the germ layers and the processes of early development are extremely varied, and it is impossible on the available facts either to affirm or deny some original uniform method of germ-layer formation. There is, however, undoubtedly, a marked similarity in the later developmental stages and the manner of formation of many organs among the Bilateria.

The main criticisms of the germ-layer theory come from the field of experimental embryology (*q.v.*). Transplantation experiments hare shown that in early embryonic stages of many animals, pieces of germ layers when transplanted into appropriate sites may be caused to develop into organs that would normally come from some other germ layer. As development proceeds, this is no longer possible, for the fate of embryonic regions becomes more and more fixed and in the case of some animals is fixed at very early stages. These experiments cannot, therefore, be regarded as overthrowing the germ-layer theory. They confirm what observation had shown, namely, that the early stages are labile and do not conform in different animals but that the later stages do show the uniformity of development demanded by the theory. It therefore seems probable that the germ-layer theory in its broader aspects will remain a permanent part of zoological science.

V. EMBRYOLOGY AND THE THEORY OF RECAPITULATION

The similarity of embryological processes throughout the Bilateria suggests some underlying principle! and this principle is to be found in the phenomenon of evolution (*see* EVOLUTION, ORGANIC). The resemblance between lower animals and the embryos of higher ones had, however, been noted long before Charles Darwin enunciated the theory of evolution in 1859, especially by J. F. Meckel. 1821, A. E. R. A. Serres, 1842, and Karl Ernst von Baer. 1828. Baer formulated his observations on development in four "laws," of which the fourth one states that the young stages of higher animals resemble the young stages of lower ones. Following the publication of Darwin's book, *The Origin of Species*, the concept of evolution as an explanation of the embryonic stages through which higher animals pass was first advanced by Fritz Müller, 1864, and advocated by Haeckel, beginning in 1866. Haeckel had a gift for trenchant phrases, and zoology became thoroughly imbued with his formulations of the relation between evolution and development. Haeckel's generalization is, in effect! that an animal in its development passes through stages representing the ancestors it had during its evolution from lower animals. This doctrine is termed recapitulation or the biogenetic law. and was epitomized by Haeckel in such phrases as "ontogeny repeats phylogeny," and "phylogeny is the mechanical cause of ontogeny," etc.

As already noted, the general resemblance of enibryonic stages among animals is not to be doubted, and is particularly marked among the members of a given phylum; neither is it to be doubted that evolution: *i.e.*, descent from a common ancestor, is the explanation. However. there has'been a great deal of argument as to the correctness of Haeckel's theory; *i.e.*, as to whether or not it is true that embryonic stages represent adult ancestors. The accumulated facts and arguments indicate that the relation between evolution and embryology does not follow any one rule but is a combination of several different kinds of rules. In some cases development follows ancestral stages up to a very late period. then adds on a new stage that makes the animal different from its ancestors. This type of development most nearly conforms to Haeckel's recapitulation. In many other cases. however, the development diverges from the ancestral pattern at an earlier time, sometimes very early in development. Or, ancestral stages may be omitted at the end or in the middle or even very early in development. The order of development may also be altered so that events may occur in a different order in the descendant than they did in the ancestor. Finally, many embryos exhibit adaptive structures that have no relation to any ancestor but are concerned with embryonic life.

It appears clear enough that Haeckel's formulation was altogether too narrow, and it is probable that no embryonic stage ever represents an exact duplication of an adult ancestor! although very considerable resemblance may obtain in some cases. It is more common for embryonic stages of the descendant to resemble embryonic stages of the ancestor. Phylogeny is not the cause of ontogeny but rather phylogenetic progress, *i.e.*, the evolution of new types, is brought about by deviation from the ancestral pattern during the course of embryonic development.

Ancestral reminiscence during development is then a general zoological principle; commonly this reminiscence concerns the embryonic or larval stages of the ancestor rather than the ancestor itself. Ancestral reminiscence has been of the greatest value in working out relationships especially among the invertebrates. In vertebrates there is an extensive fossil record and fossil findings have given zoologists a fairly complete story of the evolution of the main vertebrate groups. But invertebrates often have no hard parts preservable as fossils and in general paleontology has been of little value in determining relationships among them. Hence. embryology is the chief tool for elucidating phylogenetic problems in the invertebrates. It is in fact a truism that a group is not understood in its relations to other invertebrate groups until the embryology of several members has been thoroughly worked out. Many examples could be cited of the solving of the taxonomic position of aberrant forms by means of their embryology. Thus *Sacculina* and related forms are very degenerate parasites of crustaceans, being reduced in the adult state to a nearly structureless sac with rootlike extensions into the host's tissue. It would be impossible to determine the taxonomic position of these parasites by study of their anatomy;. but when it is found that their development closely follows that of barnacles, no doubt remains that they are degenerate barnacles.

VI. VARIATION, HEREDITY, AND EVOLUTION

As seen above, hereditary factors play an important role in embryonic development; but as shown by the work in experimental embryology (*q.v.*), environmental influences are also operative. The study of the roles of heredity and environment in the production of the characters of the species and the mechanism of such production constitutes one of the most important branches of zoology, generally termed genetics. Its end and aim may be stated to be an understanding of the mechanism of heredity (*q.v.*) under specific conditions, and thereby of evolution (*see* EVOLUTION, ORGANIC).

Variation. — So two animals, even belonging to the same brood: are alike; although exhibiting a close similarity to their parents and to one another, each mill differ from all others to a small extent or sometimes they may vary considerably in one or many respects. Such differences between individuals of the same species or variety is termed variation and the investigation of the nature and causes of these variations and of the manner and the extent to which they are passed on from one generation to the next is the main subject matter of genetics. The inheritance of variations is studied by breeding experiments; variation as it exists in a given population is studied by mathematical methods of the type known as hiometrical. Measurements are made of various characters in a large number of individuals of a population and the data so obtained are tabulated to show the number of individuals exhibiting each of certain measurements. Such tabulations can then be graphed and a curve obtained. This curve of variation usually conforms to a definite symmetrical shape, rising to a peak and descending again. Such a normal curve of variation means that most of the individuals of a population fall n-ithin certain measurements, as length, for instance, and that especially long or short individuals are fen. in number. The normal curve of variation implies that the variations it records are due to chance events. Deviation from such a normal curve indicates that some factor is operative to distort the curve, or that the population being studied is not uniform but consists of tn-o or more groups. Such studies of animal populations, termed biometry, are of great value in both pure and applied science.

Types of Variation. — It is necessary for the geneticist and the systematist to evaluate properly the variations within a population and to differentiate those associated with age, sex or habitat from hereditary variations that occur by chance without relation to obvious factors. There are in general two sorts of variation: those that do not involve an hereditary alteration, termed phenotypic variation, and those that result from hereditary alteration. termed genotypic.

Phenotypic Variation. — This may concern various stages in the life cycle, seasonal variations in the same individuals and changes impressed on the individual during its life by environmental conditions. Examples of these may be given. Many animals at birth or hatching bear little resemblance to their parents, and in the past were often regarded as distinct species until the life history of the animal in question was worked out and the juvenile or larval form traced to the adult condition. For instance. the common fresh-water eel. *Anguilla*, passes through a transparent ribbonlike oceanic stage termed Leptocephalus. Leptocephalus was considered to be a distinct kind of fish, whose relationship to eels was not suspected, until Johannes Schmidt of Denmark discovered that Leptocephalus is a juvenile stage of *Anguilla*. Crawling caterpillars bear no resemblance to the butterflies or moths into which we know they develop. Parasitic worms may have as many as four different juvenile stages in different hosts. As these juveniles bear no or little resemblance to the adults, mere study of them does not suffice to determine to what adults they belong and such information is assembled only by laborious isolation studies and feeding of juveniles to appropriate parasite-free hosts.

The colours and colour patterns of many animals change with age and sexual maturity. The soft down of feathers or hair at birth or hatching gives way first to the juvenile and later to the adult plumage or pelage, differently coloured or patterned. Some plumage or pelage colour changes result from the wearing off of feather or hair tips. Many male animals assume a resplendent nuptial dress during their breeding season and may also develop structural features that are lost again in the off season, as the horns of some mammals and thickened skin areas termed pearl organs of fishes.

Seasonal changes in colours and shape are of common occurrence. Where several broods are born within a year, as in insects, broods produced at different seasons may differ so much as to be originally regarded as distinct species. Many small animals of open waters have summer and winter forms of different shape; commonly the summer form shows increased body surface as compared to volume and the winter form shows the reverse effect. Thus, water fleas such as *Daphnia* and *Bosmina* tend to develop taller shapes with longer spines in summer, more rounded heads and shorter spines in winter. The factors operative are believed to be quantity of food. and changes in the density and viscosity of the water, requiring new shapes to insure body stability. Seasonal colour changes are well known in arctic animals, such as the varying hare, ermine, ptarmigan and arctic fox that are white in winter, brownish during the summer. Much seasonal variation is related to temperature. Thus the Himalayan rabbit is white except for black ears, feet and tail. If hair is plucked from the white parts and the animal placed in the cold while the new fur is growing out. this comes out black, not white. Conversely. hair plucked from the black parts grows out white if these parts are kept warm by bandages. It is known that fishes tend to have more vertebrae and more scales along the lateral line in the colder parts of their range. The experiments of Mordecai Gabriel demonstrated that if the eggs of the fish *Fundulus* from the same batch are reared at different temperatures, the number of vertebrae formed is greater the lower the temperature. This result probably comes from a slowing down of development by the cold at a critical time.

Members of the same species may show much variation throughout their range as a result of local conditions. This is very true of corals, for instance. since the same species may grow into tall branching shapes in still water, massive rounded shapes in surf. Rlollusks also show great variation of shell form in different environments. These variants, termed ecophenotypes, were formerly regarded as of taxonomic worth and often very many scientific names were created for what are now known to be merely phenotypic variants of the same species.

In the above examples identity of genetic constitution is assumed. The changes recorded are phenotypic changes of the same genotype, that is, of the same hereditary constitution. Whether a given change is phenotypic or not can, however, be determined only by breeding experiments under varieties of environment.

Genotypic Variation; Mendelian **Inheritance.**—Genotypic variations are new alterations that are inheritable. Whether a given variation is genotypic or not cannot be determined by mere inspection of the animal but only by painstaking breeding experiments under controlled environmental conditions. Years of intensive breeding experiments on various plants and animals led to the conclusion that hereditary characters are vested in the chromosomes of the nucleus, in the submicroscopic particles termed genes of which these chromosomes are constituted (*see* HEREDITY). It is these genes that are directly transmitted to the offspring in the nuclei of the egg and the sperm whose fusion begins the new individual. The characters that are represented by these genes are inherited, but they do not come to expression unless the environmental conditions are right for their appearance. Among the better known inheritable characteristics of animals transmitted by genes are eye colour, hair colour, hair shape, skin colour. body form and proportions, length of limbs, hands, feet, tail, and various diseases and defects, as well as varying degrees of immunity to disease.

The manner of inheritance of such characters and of ,genotypic variations in general is that termed Mendelian because it was first formulated by Gregor Mendel, an abbot of Briinn. Aus., in 1865 as a result of his experiments in crossing garden plants in the garden of the monastery. His experiments remained unappreciated until 1900 when they were simultaneously repeated by several biologists. Thereafter an enormous amount of work was done on Mendelian inheritance, for the details of which *see* the articles HEREDITY; VARIATION.

A very striking part of the Mendelian work was the elucidation of the mechanism of sex differentiation. It was found that there is a chromosomal difference between the sexes. In some animals two kinds of eggs and in others two kinds of sperm, as to their chromosomal content, are produced, and whether a given fertilization will result in a male or a female offspring is determined at the time of fertilization by whatever chromosomal combination happens to ensue (for complete explanation *see* articles CYTOLOGY: SEX).

Bisexual reproduction is of the greatest importance in increasing the variability within populations. Geneticists are agreed that nearly all genetic factors are located in the chromosomes and that normal individuals 'of sexually reproducing species have two chromosome sets, one from each parent; *i.e.*, each chromosome occurs in duplicate as a result of the fertilization process. During the formation of the sex cells of an individual the duplicate chromosomes and duplicate genes become segregated in a chance manner into the sex cells, for these have only one chromosome set (*see* CYTOLOGY). Thus an indefinite number of gene combinations is possible. In reference to man with his two sets of 24 chromosomes it is said that exactly the same genic constitution has never appeared in two individuals, except in the case of identical twins that come from one egg.

Heredity and **Environment.**—Every character of an organism is the product equally of its inheritance and of the environment under which the character develops and matures. Some characters reappear regularly in successive generations because the stimuli necessary for their appearance are always operative in their environment. Often certain temperatures are required for the appearance of both phenotypic and genotypic characters. What is really transmitted is the ability to respond to given environmental factors; but the specific response that occurs in a given case is determined by the hereditary constitution.

For exact studies of environmental effects in the individual's life it is necessary to start with material of identical genetic constitution. Some of the best information on the heredity *v.* environment question was accumulated by the study of identical human twins reared apart from early life. Identical human twins come from the same fertilized egg, hence have the same genic constitution. Data were collected by H. H. Newman of The University of Chicago on jo pairs of identical twins reared together and 20 pairs reared apart. Twins reared apart were, on the average, no more different in measurable physical characters than those reared together, except for body weight which was found to depend on food, health and amount of physical exercise. However, the average difference in the I.Q. of twins reared together was 5.3 points and for twins reared apart 8.2 points: an excess of nearly 3 points. The average difference in scholastic achievement for twins reared apart was more than twice as great as for twins reared together, an indication that achievement tests register differences in schooling more accurately than do ability tests. Newman found much evidence that differing environments had resulted in marked personality differences despite identical genetic constitution. These results, although only preliminary, give great encouragement in the direction of human improvement through education and environment.

Inheritance of Acquired Characters.—Since ancient times there has been a general popular belief in the theory that characters acquired during the lifetime of an individual can be inherited. and that thereby an improvement or alteration in a desired direction is possible. This theory is termed Lamarckism because it was expounded particularly by Lamarck in 181j, although it was not exactly original with him. Lamarckism states that every animal tends to change its structure and habits during its individual existence in such ways that it becomes better fitted for life under the conditions to which it is subjected. If the characters so acquired be transmitted to offspring which in turn become modified in the same direction. there will in time arise a group of individuals differing from the original progenitor and better adapted than it was for the conditions in question. The theory thus particularly seeks to explain the origin of adaptive characters. Adaptation is certainly an outstanding phenomenon of nature; that environment can alter the structure and habits of animals within their lifetime is also an established fact and comes under the head of phenotypic variation discussed above. The difficulty of the theory centres around the possibility of the inheritance of such environmentally induced alterations. At the present time such inheritance is believed to be impossible; therefore, the theory of the inheritance of acquired characters has been abandoned by practically all biologists.

Despite the unanirnous rejection by western geneticists of the inheritance of acquired characters from a simple inability to find any evidence in favour of it, the inheritance of acquired characters mas accepted by fiat in the Soviet Union and its satellites after World War II. Mendelian genetics, as developed by western scientists, was officially rejected because of an alleged conflict between it and Marxist teachings. Later it appeared that this extreme position was being somewhat modified (*see* HEREDITY: *Soviet Genetics*). For accounts of the state of genetics in the Soviet Union in the 1950s, see *Death of a Science in Russia*, edited by Conway Zirkle, and *Heredity, East and West*, by Julian Huxley.

Mutations.—Inheritable alteration is now believed to be entirely of the nature of mutation, which is another name for genotypic variation. Mutations, in the present sense of the word, are caused by change, probably chemical, in a single gene, or by chromosomal changes such as losses, multiplications, rearrangements of genes. recombinations, etc. Mutations occur in all degrees from those so slight as to be unnoticeable in ordinary genetic work to conspicuous variations. The cause of mutation is not known, although mutations have been induced by the action of X-rays and other radiations on organisms at critical periods in the ripening of their germ cells. It is firmly believed by geneticists that mutations are of chance nature and have no direct relation to environmental factors. (*See* further VARIATION.)

Evolution; Natural Selection.—The principle of evolution is the most important contribution of zoology to general science and to civilization. Evolution is the doctrine that all organisms are related to each other through common descent and that the differences that now exist between the many species of animals and plants have arisen through hereditary alteration of pre-existing forms. Evolution is defined by Theodore Dobzhansky as a change in the genetic composition of populations so that dissimilarities develop between the ancestral and the descendant populations. Evolution as a constant process of nature is supported by such innumerable facts that it is unanimously accepted by biologists as a fundamental principle of biological science. The principle of evolutionary change has also been incorporated into almost every field of human thought and endeavour, and everywhere has acted as a clariiying leaven. It is necessary to distinguish clearly between evolution as a phenomenon of nature and the mechanism by which evolution takes place. Too often there is confusion in the popular mind between these two matters. Evolution is regarded by biologists as an established fact, but the mechanism by which it occurs is still under investigation.

Although the idea of evolution has been expressed by a long chain of his predecessors, it was first clearly expounded by Darwin in 1859 in his book *The Origin of Species*. Darwin was concerned primarily with finding a mechanism by means of which evolution could occur and. by analogy with selection practised by man in breeding domestic animals. Darwin postulated a selective action of nature. Darwin based his theory of evolution by natural selection on the observed facts of variation and of excessive reproduction in nature. As already noted every species tends to vary within limits; also, every species tries to reproduce in unlimited numbers so that if unchecked. even slowly reproducing animals would in a relatively short time populate the earth. As this does not occur, there must be factors limiting the survival of offspring, and these factors consist of competition for food and space. depletion by enemies and parasites. etc. In this struggle for existence it seemed to Darn-in that variations, even slight ones. might play a decisive role in preserving some individuals while others perished. Any (genotypic) variation that is at all advantageous will have survival value and the individual possessing it will have more chance to live and to pass on its advantageous variation to its offspring than will individuals lacking such variation. In this way there is an accumulation of variations, and this eventually leads to the establishment of new varieties and species. providing isolation occurs to prevent the wiping out of the new characters by crossbreeding with the old population. By isolation is meant any factor that prevents crossbreeding. Such isolation may consist of physiographical features such as mountains or water courses that form barriers against interbreeding; or it may consist of variations in the sexual apparatus or in sexual behaviour that make mating physically or psychologically impossible.

After the theory of evolution by natural selection had suffered some decline, selection again came into promirience as a factor in evolution. Acceptable evidence was found of the actual operation of natural selection in wild populations. Natural selection operating on chance genotypic variations remains the best explanation of adaptation. The modem view of evolution holds that it is the joint product of mutation and selection plus isolating mechanisms (ecological, geographical or sexual) that prevent the new gene patterns from being swamped by interbreeding nith the old. Population size has also been shown to be an important factor. and restricted populations appear to be most favourable for progressive evolution. The study of population dynamics is becoming of increasing interest and importance in the fields of genetics and evolution. See further EVOLUTION, ORGANIC.

VII. ECOLOGY

What is generally termed natural history or observation of the habits and behaviour of animals in nature has undoubtedly interested man from the dawn of civilization. But toward the end of the 19th century this type of zoological study more or less fell into disrepute as not sufficiently scientific. Zoologists were more or less divided into two camps: those that studied morphology and taxonomy, and those that were experimentalists subjecting animals or their parts to laboratory study. The latter increased rapidly at the expense of the former and neither left much room for natural history in its old form. At the beginning of the 20th century there emerged, however, ecology (also called bionomics), which has been defined as scientific natural history and which has progressively increased in importance. (See ECOLOGY. ANIMAL; POPULATION ECOLOGY.) Ecology is the study of animals as they exist in their natural environment. The subject naturally divides itself into two parts: the study of the environment and the study of the animal in its environment.

Environments. — Evidently the complete study of environments is a complicated matter, depending in many cases on the availability of appropriate methods and apparatus. The environment is composed of physical, chemical, geological, geographical and meteorological factors as well as biological factors in the form of other plants and animals and their products. These factors require to be studied not only at any one time but also through daily. seasonal and annual cycles.

Environments are broadly classifiable into marine, fresh-water and terrestrial; each of these of course comprises numerous subsidiary environments. The study of the marine environment has reached the status of a branch of zoology, termed oceanography (see OCEAN AND OCEANOGRAPHY). It involves such matters as currents and circulation, depths and bottom contours. types of bottom, temperature at various regions and depths. penetration of light with reference to depth. dissolved gases at various depths. salinity and chemical composition in general and variations of organic substances or material produced by biological action. Many of these changes need to be followed through daily, seasonal and annual cycles. The animal life of the ocean is divisible into the pelagic forms living free in the water and the benthonic forms inhabiting the bottom. Each of these is again subdivisible on the basis of depth. Thus the pelagic animals fall into epipelagic, inhabiting surface waters to moderate depths, and bathypelagic, or deepwater, categories. The ocean bottom is usually divided into the littoral zone (shore to 200 m.), the archibenthal (200 to 1,000 m.), and the abyssal zone or deep bottom.

Brackish water or water of lowered salinity at the mouths of rivers offers special ecological problems. Animals inhabiting such areas must be able to endure great changes of salinity and osmotic pressure. Study of the mechanism of such adjustment may throw light on how marine animals mere able to enter fresh waters and establish themselves therein.

Fresh-water habitats are of two general types, standing or lentic waters and running or lotic waters. The former embraces the large lake, small lake! pond, swamp, pool series: and the latter the brook, stream, river series. Here, too, of course, there are numerous localized environments as a rapids in a stream. Seasonal changes are of particular importance in the lentic series and many fresh-water animals show marked annual cycles that contrast with the uniformity of existence in the sea.

Terrestrial environments are more varied and present more difficult conditions for animals than do aquatic environments, and vegetation plays a predominant role in them. In fact, the subdivisions of land faunas practically coincide with those of the flora, and the latter in turn depend upon climatic and physiographical features, notably temperature. rainfall and quality of the soil. Land habitats vary from bare areas such as sand dunes. rock outcrops, snow fields and glaciers, the Arctic and Antarctic circles and alpine summits, through areas of scant vegetation such as deserts, subalpine zones, high latitudes and treeless areas (grasslands, prairies. plains, steppes), to regions of small trees (thornbush, etc.) and forests. Each terrestrial habitat is of course zoned horizontally into such strata as the air, taller vegetation, shorter vegetation, ground surface and subterranean stratum.

Faunas. — The sum total of the animals inhabiting an area is termed the fauna. The ocean has the richest and most varied fauna, presumably because of the uniformity of conditions therein. The ocean fauna is broadly characterized by an inability to withstand extreme changes of conditions. by the lack of protective devices against exposure, such as cysts, by the frequency, especially among pelagic animals, of a delicate. transparent construction, and by the frequent production of free larval stages. Fresh-water animals must be able to withstand much greater ranges of conditions than do marine animals, especially temperature, evaporation, and alterations of acidity and alkalinity. Further, the fresh-water medium has a lower osmotic pressure than that of the body fluids of fresh-water animals, and means must be present to prevent excessive hydration of the body. Fresh-water animals provide against extremes of temperature and drought by protective devices such as encystment or production of hard-shelled eggs or other reproductive bodies, or by habits of hibernation or estivation; free larval stages are in general absent. Air-breathing types are common among fresh-water animals but rare in the ocean. Fresh-water animals also are subjected to greater turbidity and more concentrated organic decay than are marine fauna. and many are adapted for living in muck practically devoid of oxygen. Conditions encountered by land fauna are even more difficult, despite the advantage of abundant oxygen. The great danger is that of water loss so that land animals. unless they live in very humid places, must be protected against evaporation; hence the characteristic coverings of scales, hairs, fur. etc., or the hardened exterior as in insects. They must also be adjusted to a wide range of temperature or else have developed a mechanism for maintaining constant body temperature; habits of hibernation and estivation also play a role here. Lacking the support of water, terrestrial animals must have a generally stronger build than aquatic ones, and they are also capable of efficient types of locomotion depending upon stronger build, such as walking. running, leaping and flight. Although the terrestrial fauna is less rich in species and groups than are aquatic faunas, it displays a much greater variety of associations, many strikingly adapted.

Animal Communities. — The fauna of a restricted area throughout which very similar conditions prevail, such as a meadow or a pond, forms an animal community or association. Such an association usually consists of large numbers of individuals of one or a few species that form the dominant animals, and small numbers of a considerable number of other species. Many of the animals of an association show striking structural and behaviouristic adaptations to the conditions of the habitat. Very complex relations generally obtain between the members of a community. These are usually in the nature of food relationships. and in general every community contains herbivorous, carnivorous and scavenging animals. In a community each species generally occupies a particular part of the habitat and of the food chain; such a position in the community is termed an ecological niche.

The animals of the same kind of habitat are usually of different species or are even quite difierent taxonomically in different parts of the world. but they generally show ecological similarity; *i.e.,* structural and behaviouristic resemblance. Such corresponding forms have been termed ecotypes. Thus, the animals of steppes and prairies are generally long-legged, swift-running types, as the bison and pronghorn of the Great Plains of North America, the zebras and various kinds of antelopes of the African plains and the deer of the Argentine pampas.

Ecological Succession. — The old adage that nothing is permanent except change is peculiarly applicable to ecological study because environments change and with them the flora and fauna. Under ordinary conditions, these changes follow an orderly arrangement. termed ecological succession. Succession is naturally chiefly a phenomenon of fresh-water and land habitats and the littoral zone of the ocean. Thus, ponds fill and become meadow, meadow becomes invaded by shrubs and eventually trees, and finally a forest occupies the site of the original pond. In general all fresh-water and land habitats tend toward a certain floral association termed the climax. The climax formation varies in different areas of the earth, primarily in association with rainfall and temperature.

Animal **Behaviour.**—The reactions and activities of an animal in its environment is termed animal behaviour. This field at first was part of the subject of psychology, and experiments on animal behaviour were carried out chiefly in psychological laboratories. The setups employed in these laboratories mere mostly without relation to the natural habitat of the animal and the object was more or less anthropomorphic—to discover the learning abilities, intelligence and reasoning power of the lower animals, chiefly birds and mammals other than man, and the effect upon these powers on the central nervous system. The animal was frequently set to solve problems remote from its normal life. At the same time ecologists were studying the behaviour of animals, chiefly invertebrates and cold-blooded vertebrates, from a different angle, that of subjecting the animal in turn to single factors of its environment such as light, temperature, etc. This procedure usually made use of a gradient tank or box in which the intensity of the factor being investigated was uniformly graded from one end to the other of the apparatus. Animals were placed in the apparatus and the part of the gradient in which the majority of the animals came to rest after random wanderings was considered to represent the intensity of the factor most suitable to the animal, and the one affecting its distribution in nature.

Although valuable results were yielded by both types of inquiry, their artificial nature has gradually become recognized, and there is a decided return at present to studies of the type of the old natural history but more exact. critical and better controlled. Especially in Europe after the early 1950s, under the leadership of K. Lorenz and N. Tinbergen, there was an immense revival of interest in animal behaviour and many students throughout the western world were attracted to this field of zoology. An outstanding concept developed by the Lorenz-Tinbergen school is that of the innate releasing mechanism. By field observations and laboratory experiments under conditions simulating the natural environment, they discovered that each behavioural act of the type usually called instinctive is evoked by a specific stimulus or combination of stimuli that they called the releaser or sign stimulus. For instance a large dark moving object on the edge of the nest (in nature one of the parents) causes baby birds to erect their head and gape for food and this reaction can be evoked by an inanimate object with the same characteristics. These workers also showed that bright and conspicuous colour patches on male fishes and birds are sign stimuli that evoke fighting behaviour in other males and that crude models bearing the colour patch evoke fighting behaviour equally well. In addition to such instinctive behaviour evoked by sign stimuli there is of course also learned behaviour such as the well-known conditioned type in which, for instance. an animal can be taught to come to food by the sound of a bell. There is further increased interest: partly as bearing on man in mass behaviour and social relations, in the behaviour of individuals in a herd or flock with reference to each other. (See SOCIOLOGY, ANIMAL: Social *Instinct.)*

Limiting Factors.—The study of animal behaviour by means of the gradient setup mentioned above showed that a given animal tends to avoid certain intensities of surrounding factors and to seek others. The distribution of a given animal in nature is therefore limited by responses of this type. Thus, an animal that avoids bright light and dryness may be expected to occur in nature in dark humid places as under stones or logs. Such an animal will obviously be limited in its distribution by the availability of this kind of habitat. By these reactions of avoidance animals come to occupy and to remain in certain small niches of a given environment.

Zoological Distribution.——.As noted above, animals of similar but geographically separated ecological regions exhibit similarity of appearance and behaviour but are usually taxonomically different. This suggests that the fauna of each part of the world is peculiar to that region and that it might be possible to divide up the world into zoological regions, each with its own set of species. Various attempts of this sort have been made of which the most accepted scheme recognizes the following regions: palearctic, including Europe, most of Asia. and Africa north of the Sahara; nearctic, comprising North America; neotropical, comprising South and Central America and the West Indies; Ethiopian. Africa south of the Sahara and Madagascar; oriental, southern Asia, Malay archipelago and some islands of Indonesia; and Australian, including Australia: New Zealand and the rest of Indonesia. Each of these areas does in fact have a characteristic fauna. As is well known, the Australian region is characterized by its primitive mammals, such as the duckbill! kangaroo and other marsupials, and curious birds like the kiwi, emu and cassowary, none of which is found elsewhere. However, many facts of animal distribution are not explained on the basis that each part of the world has its own peculiar constellation of species, for the reason that animals have not necessarily evolved in the region that they now occupy. Although isolation or inability to emigrate because of water or other barriers accounts for some facts of distribution like the peculiarities of the Australian fauna, emigrations, both recent and in past geological ages, are also an important factor in explaining present distribution. In fact, the distribution of animals constitutes important evidence for the existence of land connections in the past that later vanished. Emigrations over land bridges later eliminated by geologic change account for the occurrence of closely related animals in distant parts of the earth with no representatives in the intervening area. Such facts can also be explained on the assumption of an originally wide distribution with the wiping out of relatives in intermediate areas through geologic and climatic changes. (See also ZOOGEOGRAPHY.)

Animal Interrelationships.—Study of the relationships between animals constitutes an important part of ecological research. Such relationships within a species vary all the way from the relation of sexual pairs in courtship, mating and rearing of young to studies of populations. Here belongs also competition between the individuals of a species for mates, living and breeding places, and food. Relationships between animals of different species, apart from such general matters as competition for food and space, mostly fall into three categories: relationships of predator and prey. relations of mutual assistance and relations of one-sided benefit. Many animals are provided with protective or defensive devices, such as armour, horns, hoofs, stings, spines, venoms, or exhibit protective behaviour, as hiding, burrowing, rolling up into a ball or playing dead, as a means of avoiding being captured and eaten by carnivorous animals; conversely. the predator often has special structural devices or exhibits special behaviour enabling it to capture other animals as food, often specific animals. One common mode of avoiding capture is through resemblance to surroundings (protective resemblance) or through resemblance to some other animal that is distasteful (mimicry). Volumes have been written on whether protective resemblance or mimicry actually protect and how they have come about. It now appears quite certain that they do have protective value, and natural selection acting on chance variations is the accepted explanation of their origin.

Associations of animals of different species with mutual benefit is termed mutualism. Many examples of such relationship, often intimate, are known. Thus, ants protect and care for aphids and in return get a sweet fluid secreted by the aphids. Hermit crabs carry anemones on their backs, securing the protection afforded by the stinging bodies of the anemone and furnishing the latter with free transport and better oxygenation. Many such relationships are extremely intimate, in that one partner may live inside the other, as in the case of the termites and their intestinal Protozoa; the former protect the latter and the protozoans digest cellulose for the termites.

Relations of one-sided benefit range from harmless association (commensalism) to parasitism. Small animals may habitually live in or on or near larger ones or accompany them, for protection or to obtain bits of food. Anthills and other types of burrows frequently harbour other animals, usually of specific kinds, termed inquilines or guests; these get protection and steal bits of the host's food, but are probably otherwise harmless. Such habits, however, gradually lead to parasitism, a relation in which one animal benefits and the other is harmed. Parasites are divisible into ectoparasites such as lice, mites and ticks, that live on the surface of animal bodies! eating hair, feathers, or bits of skin or sucking blood; and entoparasites, including worms of various kinds and protozoans, that inhabit interior organs, sucking blood or body fluids or devouring cells, or, in case they lack a digestive tract, imbibing nutriment through the surface. Parasitism leads to extensive structural changes in the parasite: reduction of sense organs and the nervous system; loss of locomotory organs; reduction and eventual loss of mouth and digestive system; development of clinging organs such as hooks and suckers: excessive development of the reproductive system with production of immense numbers of eggs; and complicated life cycles involving some stage adapted for spreading the parasite.

VIII. ECONOMIC ZOOLOGY

This name is applied to the utilization of zoology in the interests of human welfare. The breeding of domestic animals is a great industry that has been extraordinarily successful in producing breeds of sheep, cattle, horses, dogs, poultry, etc., fitted for all contiitions and uses. Practised in the past mainly by empirical methods, animal breeding came to be greatly advanced by the application of modern genetics. Among recent trends is the practice of artificial insemination by which the semen of fine male horses; cattle. etc., may be shipped considerable distances for the improvement of stock. Fisheries present numerous complex problems falling within the province of the zoologist, such as the study of variations of the catch from season to season. depletions of breeding stock, development of new fishing grounds and the improvement of pisciculture. Work of this type involves fishes and other aquatic food animals such as oysters, shrimp and lobsters.

The damage that animal pests, especially insects, do to crops is tremendous; these ravages can be controlled only by methods laid down by zoologists. The establishment of these methods depends on a full investigation of the life history and habits of the pest, and of all the factors in its surroundings that influence it. such as climatic conditions, alternative sources of food, the efficiency and mode of application of poisons. parasites and diseases of the pest and the discovery of animals that prey upon it. Some of the greatest triumphs of economic entomology have been achieved through finding a suitable predator to prey upon a particular insect pest. (See ENTOMOLOGY.)

The investigation and control of animal-borne diseases of man. such as malaria, yellow fever! etc., is a zoological matter as is also the study of the animal parasites of man.

A present important trend in economic zoology concerns conservation which aims toward the preservation of animals beneficial to man and in general toward restoring the balance of nature that has been upset by human activities. Through ignorance and greed man has succeeded in destroying many useful animals and in seriously depleting the stocks of others. The destruction of any one species may have far-reaching effects because of the complicated interrelationships of animals, especially as regards food cycles. These food cycles always involve plants, so that a whole train of evil consequences may result. Thus, elimination of predators such as the mountain lion or birds of prey permits the excessive increase of herbivorous animals that serve as their prey and are normally kept in check by them: and this results in overgrazing oi grasslands and forests. Only intensive studies of plant and animal interrelationships can teach man how to avoid wholesale destruction and interference with natural balance that, if continued, will also destroy him.

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(L. H. H.)

ZORACH, WILLIAM (1887–). U.S. sculptor, whose figure compositions have a formal, monumental character, was born in Eurburg, Lithuania, on Feb. 28, 1887. At an early age he was taken to the U.S., his large, poor family settling eventually in Cleveland. O. Zorach intermittently attended public school, worked and helped his father collect and sell junk. He early exhibited an aptitude for art, and at 15 began to learn lithography, studying evenings at the Cleveland School of Art. He later studied at the National Academy of Design, New York city, and in Paris. At first a painter, he won prizes for his water colours. as well as his sculpture. "The Dance," cast in aluminum. was placed in Radio City Music hall, New York city, and his later "Head of Christ" in black granite in the Museum of Modern Art, New York city. Zorach was a strong advocate of direct carving. In 1947 he published a popular account of sculpture techniques. *Zorach Explains Sculpture*.

See Paul S. Wingert, *The Sculpture of William Zorach* (1938).

ZORN, ANDERS LEONARD (1860–1920), a popular Swedish painter, etcher and sculptor, was born at Utmeland, near Mora. on Feb. 18, 1860. He entered the Stockholm academy to study sculpture, but soon turned to water-colour painting. In the 1880s he traveled widely in Europe, north Africa and the near east. In 1882–85 he was in London, learning the technique of etching from his fellow countryman Axel Haig. In 1887–88 he lived at St. Ives. Cornwall, where he made his first oil paintings. Zorn settled in Paris in 1888. His style, an amalgam of Manet, Degas and Spanish painting, was very acceptable to popular taste, and Zorn quickly won considerable but ephemeral success. He was well known as a portrait painter, especially in the United States, which he frequently visited. From 1896 until his death on Aug. 22, 1920, Zorn lived at Mora, painting nudes and peasant subjects in a sentimental, loosely handled, realist manner.

See K. Asplund, *Anders Zorn: His Life and Work* (1921). (A. Bs.)

ZOROASTER, the founder of the national religion of the Iranian people from the time of the Achaemenidae to the close of the Sassanian period. The name (Ζωροάστρης) is the corrupt Greek form of the Iranian Zavathustra (new Persian, Zardushi). Its signification is obscure. Zoroaster was famous in antiquity as the iounder of the wisdom of the Magi. His name occurs first in a fragment of Xanthus (29), and in the *Alcibiades* of Plato (i, p. 122), who calls him the son of Oromazdes. Occidental writers sometimes call him a Bactrian, sometimes a Median or

Persian (*cf.* Jackson, Zoroaster, 186). According to Pliny (*Nat. Hist.* vii. 1 j), he laughed on the very day of his birth—a statement found also in the *Zardusht-Nāma*—and lived in the wilderness upon cheese (xi. 97). Plutarch speaks of his intercourse with the deity, and compares him with Lycurgus and Numa (*Numa,* 4). Dio Chrysostom, Plutarch's contemporary, declares that neither Homer nor Hesiod sang of the chariot and horses of Zeus so worthily as Zoroaster, of whom the Persians tell that, out of love to wisdom and righteousness, he withdrew himself from men, and lived in solitude upon a mountain. The mountain was consumed by fire, but Zoroaster escaped uninjured and spoke to the multitude (vol. ii. p. 60). Plutarch, drauing partly on Theopompus, speaks of his religion in his *Isis and Osiris* (cc. 46–47). He gives a faithful sketch of the doctrines, mythology and dualistic system of the Magian Zoroaster.

Agathias remarks (ii. 24), with truth, that it is no longer possible to determine with any certainty when he lived and legislated. "The Persians," he adds, "say that Zoroaster lived under Hystaspes, but do not make it clear mhether by this name they mean the father of Darius or another Hystaspes. But. whatever his date, he was their teacher and instructor in the Magian religion, modified their former religious customs, and introduced a variegated and composite belief."

He is nowhere mentioned in the cuneiform inscriptions of the Achaemenidae, although Darius and his successors were Zoroastrians. The Avesta, our principal source for the doctrine of Zoroaster. is comparatively reticent; on the subject of his person and his life with regard to his date it is, naturally enough, absolutely silent. The 13th section, or Spend *Nask*, which was mainly consecrated to the description of his life, has perished; while the biographies founded upon it in the 7th book of the Dinkard (9th century A D), the *Shāh-Nāma,* and the *Zardusht-Nāma* (13th century) are full of wonders and fabulous histories and miraculous deliverances.

The personality of Zoroaster is historic, but in the later Avesta. and in writings of more recent date, he is presented in a legendary light and endowed with superhuman powers. At his appearing all nature rejoices (Yasht, 13, 93); he enters into conflict with the demons and rids the earth of their presence (*Yasht,* 17, 19); Satan approaches him as tempter to make him renounce his faith (*Vendidad,* 19, 6).

The Gāthās alone within the Avesta claim to be the *ipsissima* verba of the prophet, and are expressly called "the Gāthās of the holy Zoroaster" (Yasna, 57, 8), his actual expressions in presence of the assembled congregation, the last genuine survivals of the doctrinal discourses with which—as the promulgator of a new religion—he appeared at the court of King Vīshtāspa.

The person of the Zoroaster in these hymns is a mere man, standing always on the solid ground of reality, whose only arms are trust in his God and the protection of his powerful allies He had to face forms of outward opposition, the unbelief and lukewarmness of adherents. even his own misgivings as to the truth and final victory of his cause. The range of the emotions which find their immediate expression in these hymns is wide and the whole breathes originality, is psychologically accurate and just. so that in the Gāthās we have the beginnings of the Zoroastrian religion. They give no historical account of the life and teaching of their prophet, but are general admonitions, asseverations. solemn prophecies, directed to the faithful or to the princes, and are generally dialogues with God and the arch-angels, whom he repeatedly invokes as witnesses to his veracity with many allusions to personal events which later generations have forgotten. Their extent is limited and their meaning is frequently dubious and obscure

The Person of the **Prophet.**—As to his birthplace the testimonies are conflicting According to the Avesta (*Yasna,* 9, 17), Airyanem Vaējō, on the river Dāitya, the old sacred country of the gods. was the home of Zoroaster. There on the river Dāreja, if the passage (Vend. 19, 4) is correctly interpreted. stood the house of his father; and the *Bundahish* (20, 32 and 24, 1 j) says expressly that the river Dāreja lay in Airan Vej. on its bank was the dwelling of his father, and that there Zoroaster was born. According to the Bundahish (29, 12), Airan Vej was situated in the direction of Atropatene, and consequently Airyanem Vaējō is generally identified with the district of Arrān on the river Aras (Araxes), close by the north-western frontier of Media. Other traditions make him a native of Rai (Ragha, Ῥάγαι). According to Yasna, 19. 18, the *zarathushtrōtema,* or supreme head of the Zoroastrian priesthood lived in Sassanian times, in Ragha. The Arabic writer Shahrastānī endeavours to reconcile the two traditions by the theory that his father lived at Atropatene, while the mother was from Rai. In his home he is said to have enjoyed the celestial visions and the conversations with the arch-angels and Ormazd mentioned in the Gāthās. There, too, according to Yasht, j, 105, he prayed that he might convert King Vīshtāspa. He then appears to have quitted his native district. On this point the Avesta is wholly silent; an obscure passage (Vasne, 53, 9) intimates that he found an ill reception in Rai. Finally, in the person of Vīshtāspa, a prince resident in east Iran, he gained the pomerful protector and faithful disciple of the new religion whom he desired—after almost superhuman dangers and difficulties, which the later books depict in lively colours. In the epic legend, Vīshtāspa was king of Bactria; in the later Avesta he became a half-mythical figure, the last in the series of heroes of east Iranian legend. In the Gāthās he appears as a quite historical personage; to his power and good example the prophet is indebted for his success. In *Yasna,* j3, 2, he is spoken of as a pioneer of the doctrine revealed by Ormazd. In the relation between Zoroaster and Vīshtāspa lies the germ of the state church which afterwards became subservient to the dynasty and sought its protection from it.

Among the grandees of the court of Vīshtāspa were two brothers, Frashaoshtra and Jāmāspa, both. according to the later legend, vizirs of Vīshtāspa. Zoroaster's wife, Hvōvi, was the daughter of Frashaoshtra, and the husband of his daughter, Pourucista, was Jāmāspa. The rôle of intermediary was played by the pious queen Hutaosa. Apart from this, the new prophet relies especially upon his own kindred (*hvaētush*). His first disciple, Maidhyōimāongha, was his cousin: his father was, according to the later Avesta, Pourushaspa, his mother Dughdōvā, his great-grandfather Haēcataspa, and the ancestor of the whole family Spitama, for which reason Zarathushtra usually bears this surname His sons and daughters are repeatedly spoken of. His death is nowhere mentioned in the Avesta; in the *Shāh-Nāma* he is said to have been murdered at the altar by the Turanians in the storming of Balkh.

As to the date of Zoroaster; King Vishtaspa has no place in any historical chronology, and the Gāthās give no hint on the subject. According to the Arda Vīrāf, 1, 2, Zoroaster taught some 300 years before the invasion of Alexander. Assyrian inscriptions relegate him to a more ancient period. Eduard Meyer (see Ancient Persia). conjecturally puts the date of Zoroaster at 1000 B C., with Duncker (Geschichte des *Altertums,* 4, 78). This may be too high: but, in any case, Zoroaster belongs to a prehistoric era. Probably he belonged to the old school of Median Magi, and appeared first in Media as the prophet of a new faith, but met with sacerdotal opposition. and turned his steps eastward. In the east of Iran the novel creed first acquired a solid footing, and subsequently reacted with success upon the West.

Zoroastrianism.—Zoroaster taught a new religion rooted in the old Iranian—or Aryan—folk-religion, of which me can form some representation by comparison with the religion of the Veda. The Aryan folk-religion was polytheistic. Worship was paid to popular divinities, such as the war-god and dragon-slayer Indra, to natural forces and elements such as fire, but the Aryans also believed in the ruling of moral powers and of an eternal law in nature. On solemn occasions the inspiring drink soma (*haoma*) was consumed by the devout. Numerous coincidences with the Indian religion survive in Zoroastrianism, side by side with astonishing diversities.

In the Avesta the evil spirits are called *daēva* (Modern Persian *dīv*), while the Aryans of India gave the name of *dēva* to their good spirits, the spirits of light. An alternative designation for deity in the *Rig-Veda* is *asura.* In the later hymns of the Rig-

Veda and in later India, only evil spirits are called *asuras,* while in Iran the corresponding word ahura was, and is, the designation of God the Lord. *Ahura* indicates the more sublime and awful divine character, for which man entertains reverence and fear: *daēva* denotes the kind gods of light, the anthropomorphic deities. Zoroaster elevated the conception of the *Ahura,* and he degraded the daivas (*daēvas*) to the rank of malicious powers and devils. In one *Ahura,* he concentrated the whole of the divine character; and conferred upon it the epithet of "the wise" (*mazdāo*). The Wise Lord (*Ahurō Mazdāo*—later *Ormazd*) is the primaeval spiritual being, the All-father, who was existent before ever the world arose, From him that world has emanated, and its course is governed by his foreseeing eye. His guiding spirit is the Holy Spirit, which wills the good: yet it is not free, but restricted, in this temporal epoch, by its antagonist and own twin-brother (*Yasna,* 30, 3), the Evil Spirit (*angrō mainyush,* Ahriman), who in the beginning was banished by the Good Spirit by means of the famous ban contained in Yasna, 45, 2, and since then drags out his existence in the darkness of Hell as the principle of ill. In the Gāthās the Good Spirit of Mazda and the Evil Spirit are the two great opposing forces in the world, and Ormazd himself is to a certain extent placed above them both. Later the Holy Spirit is made directly equivalent to Ormazd; and then the great watchword is: "Here Ormazd, there Ahriman!" The very *daēvas* are only the inferior instruments, the corrupted children of Ahriman, from whom come all that is evil in the world. The *daēvas,* attacked by Zoroaster as the enemies of mankind, are still, in the Gāthās, the perfectly definite gods of old popular belief—the idols of the people. Zoroaster regarded them as spurious deities, and their priests and votaries as idolaters and heretics. In the later, developed, system the *daēvas* are the evil spirits in general, and their number has increased to millions. Some have names; and among them the old Aryan divinities emerge here and there, *e.g.,* Indra and Nāonhaitya. With some, of course, such as the god of fire—the connection with the good deity was indissoluble. Other powers of light, such as Mitra the god of day (Iranian Mithra), survived in popular belief till the later system incorporated them in the angelic body. The authentic doctrine of the Gāthās had no room either for the cult of Mithra or for that of the Haoma. Beyond the Lord and his Fire, the Gāthās only recognize the archangels and certain ministers of Ormazd, who are personifications of abstract ideas. The essence of Ormazd is Truth and Law (*asha*=Vedic *rta*): this quality he embodies, and its personification (though conceived as sexless) is always his constant companion. The essence of the wicked spirit is falsehood: and falsehood, as the embodiment of the evil principle, is more frequently mentioned in the Gāthās than Ahriman himself.

Zoroaster says that he had received from God a commission to purify religion (Yasna, 44, g) from the grossly sensual elements of *daēva* worship. This self-contained theory of the universe and logical dualistic principle were destined to terminate in monotheism. Later sects sought to rise from it to a higher unity in other ways. Thus the Zarvanites represented Ormazd and Ahriman as twin sons proceeding from the fundamental principle of all—*Zrvana Akarana,* or limitless time.

Ethically, too, the new doctrine stands on a higher plane, and represents, in its moral laws, a superior civilization. It is the religion of the settled grazier and the peasant, while the ruder *daēva*-cult holds its ground among the uncivilized nomadic tribes, who sacrificed the cow, the gift of Ormazd to man, a sacred animal.

The Doctrine ot Zoroaster may be summarized as follows:—At the beginning of things there existed the two spirits who represented good and evil (Yasna, 30, 3). Both spirits possess creative power, which manifests itself positively in the one and negatively in the other. Ormazd is light and life, and creates all that is pure and good—in the ethical world of law, order and truth. His antithesis is darkness, filth, death and produces all that is evil in the world. Until then the two spirits had counterbalanced one another. The ultimate triumph of the good spirit is an ethical demand of the religious consciousness and the quintessence of Zoroaster's religion.

The evil spirit with his wicked hosts appears in the Gāthās much less endowed with the attributes of personality and individuality than does Ahura Mazda. Within the world of the good Ormazd is Lord and God alone. In this sense Zoroastrianism is often referred to as the faith of Ormazd or as Mazdaism. Ormazd in his exalted majesty, the ideal figure of an Oriental king. has in conjunction uith himself a number of genii—for the most part personifications of ethical ideas. These are his creatures, his instruments, servants and assistants. They are comprehended under the general name of *ameshā* spent5 ("immortal holy ones") and are the prototypes of the seven *amshaspands* of a later date. These are—(I) Vohu Manō (εὔνοια), good sense, *i.e.,* the good principle, the idea of the good, the principle that works in man inclining him to what is good; (2) Ashem, afterwords Ashem Vahishtem (Plutarch's ἀλήθεια), the genius of truth and the embodiment of all that is true, good and right, upright law and rule—ideas practically identical for Zoroaster; (3) Khshathrem, afterwards Khshathrem Vairīm (εὐνομία), the power and kingdom of Ormazd, which have subsisted from the first but not in integral completeness, the evil having crept in like tares among the wheat: the time is yet to come when it shall be fully manifested in all its unclouded majesty; (4) Ārmaiti (θοψία), due reverence for the divine, verecundia, spoken of as daughter of Ormazd and regarded as having her abode upon the earth; (5) Haurvatāt (πλοῦτος), perfection; (6) Ameretāt, immortality. Other ministering angels are Gēush Urvan ("the genius and defender of animals"), and Sraosha, the genius of obedience.

As soon as the two separate spirits (cf. Bundahish, 1, 4) encounter one another, their creative activity and at the same time their permanent conflict begin. The history of this conflict is the history of the world All creation divides itself into that which is Ahura's and that which is Ahriman's.

In the soul of man is the object of the war. Man is a creation of Ormazd, who therefore has the right to call him to account. But Ormazd created him free in his determinations and in his actions, wherefore he is accessible to the influences of the evil Powers. Man takes part in this conflict by all his life and activity in the world. By a true confession of faith, by every good deed, word and thought, by continually keeping pure his body and his soul, he impairs the power of Satan and strengthens the might of goodness, and establishes a claim for reward upon Ormazd; by a false confession, by every evil deed, word and thought and defilement, he increases the evil and renders service to Satan.

The life of man falls into two parts—its earthly portion and that shich is lived after death. The lot assigned to him after death is the result and consequence of his life upon earth. On the works of men here below a strict reckoning will he held in heaven (according to later representations, by Rashnu, the genius of justice, and Mithra). All the thoughts, words and deeds of each are entered in the book of life as separate items—all the evil works, etc., as debts. Wicked actions cannot be undone, but in the heavenly account can be counterbalanced by a surplus of good works. Only in this sense can an evil deed be atoned for by a good deed. Of a real remission of sins the old doctrine of Zoroaster knows nothing, whilst the later Zoroastrian Church admits repentance, expiation and remission. After death the soul arrives at the *cinvatō peretu,* or accountant's bridge, over which lies the way to heaven. Here the statement of his life account is made out. If he has a balance of good works in his favour, he passes forthwith into paradise (Gar6 *demāna*) and the blessed life. If his evil works outweigh his good, he falls finally under the power of Satan, and the pains of hell are his portion for ever. Should the evil and the good be equally balanced, the soul passes into an intermediary stage of existence (the *Hamēstakāns* of the Pahlavi books) and its final lot is not decided until the last judgment. This court of reckoning is called *ākā.* The course of law cannot be turned aside by sacrifi'ce, nor by the grace of God.

In the Gāthās Zoroaster speaks usually in general terms of the divine commands and of good and evil uorks, of the renunciation of Satan, adoration of Ormazd, purity of soul and body, and care of the cow. Ceremonial worship is hardly mentioned The Gāthās contain revelations concerning the last things and the future lot, whether bliss or woe, of human souls, promises for true believers, threatenings for misbelievers, and Zoroaster's firm confidence as to the future triumph of the good.

Zoroaster believed that the calling of a prophet took place precisely when it did with special reason. It was, he held, the final appeal of Ormazd to mankind at large. The fulness of time was near, the kingdom of heaven was at hand. Through the whole of the Gāthās runs the pious hope that the end of the present world is not far distant. He himself hopes, with his followers, to live to see the decisive turn of things, the dawn of the new and better aeon. Ormazd will summon together all his powers for a final decisive struggle and break the power of evil for ever; by his help the faithful will achieve the victory over their detested enemies, the *daēva* worshippers. Thereupon Ormazd will hold a general ordeal. Forthwith begins the one undivided kingdom of God in heaven and on earth. This is called, sometimes the good kingdom, sometimes simply the kingdom. Here the sun will for ever shine, and all the pious and faithful will live a happy life, which no evil power can disturb, in the eternal fellowship of Ormazd and his angels. Every believer will receive as his guerdon the inexhaustible cow and the gracious gifts of the Vohu Manō.

Later Development. — For most of the people Zoroaster's doctrine was too abstract. In the later Avesta are Mithra and popular divinities like the angel of victory, Verethraghna, Anāhita (Anāitis), the goddess of the water, Tishrya (Sirius). and other heavenly bodies, invoked with special preference. The Gāthās know nothing of the belief in the *Fravashi*, or guardian angels of the faithful. *Fravashi* properly means "coniession of faith," and when personified comes to be regarded as a protecting spirit. With the new teaching arose a widely spread priesthood (*āthravanō*) who systematized its doctrines, organized and carried on its worship, and laid down the minutely elaborate laws of the Vendidad for the purifying and keeping clean of soul and body, such as the numerous ablutions, bodily chastisements, love of truth, beneficial works, support of comrades in the faith, alms, chastity, improvement of the land, arboriculture, breeding of cattle, agriculture, protection of useful animals, as the dog, the destruction of noxious animals, and the prohibition either to burn or to bury the dead. These are to be left on the appointed places (*dakhmas*) and exposed to the vultures and wild dogs. In the worship the drink prepared from the *haoma* (Indian *soma*) plant had a prominent place. Worship in the Zoroastrian Church was devoid of pomp; it was independent of temples. Its centre was the holy fire on the altar. The fire altars afterwards developed to fire temples. In the sanctuary of these temples the various sacrifices and high and low masses were celebrated. As offerings meat, milk, show-bread, fruits, flowers and consecrated water were used. The priests were the privileged keepers and teachers of religion. They only performed the sacrifices (Herodotus, i. 132), educated the young clergy, imposed the penances; they in person executed the ceremonies of purification and exercised a spiritual guardianship and pastoral care of the laymen. Every young believer in Mazda, after haling been received into the religious community by being girt with the holy lace, chose a spiritual guide (*ratu*).

In eschatology a change took place. The last things and the end of the world are relegated to the close of a long period of time (3,000 years after Zoroaster), when a new Saoshyant is to be born of the seed of the prophet, the dead come to life, and a new incorruptible world begins.

Zoroastrianism was the national religion of Iran, and was professed by Turanians as well. The worship of the Persian gods spread to Armenia and Cappadocia and over the whole of the Near East (Strabo, xv. 3, 14; xi. 8, 4; 14, 76). Of the Zoroastrian Church under the Achaemenides and Aeracides little is known. After the overthrow of the dynasty of the Achaemenides a period of decay set in. Yet the Aeracides and the Indo-Scythian kings as well as the Achaemenides were believers in Mazda. The national restoration of the Sassanides brought new life to the Zoroastrian religion and long-lasting sway to the Church. Protected by this dynasty, the priesthood developed into a completely organized state church, which employed the power of the state in enforcing strict compliance with the religious law-book hitherto enjoined by their unaided efforts only. The head of the Church (Zarathushtrōtema) had his seat at Rai in Media and was the first person in the state next to the king. The formation of sects was at this period not infrequent (*cf.* MANICHAEISM). The Mohammedan invasion (636), with the persecutions of the following centuries. was the death-blow of Zoroastrianism. In Iran itself only a few followers of Zoroaster are now found (in Kerman and Yezd). The PARSEES (*q.v.*) in and around Bombay hold by Zoroaster as their prophet and by the ancient religious usages, but their doctrine is a pure monotheism.

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ZORRILLA, JOSE (1817–1893), Spanish poet and dramatist, was born at Valladolid and read law at the University of Toledo, but after a year of idleness there, he fled to Madrid and started a paper which was suppressed by the Government. He then fell into great poverty, but was brought into notice by an elegiac poem, declaimed at Larra's funeral in Feb. 1837. His *Cantos del trooador* (1841), a collection of national legends versified with infinite spirit, secured for the author the place next to Espronceda in popular esteem. National legends also supply the themes of his dramas, though in this department Zorrilla somewhat compromised his reputation for originality by adapting older plays which had fallen out of fashion. For example, in El *Zapatcro y el Rey* he recasts *El montañés Juan Pascual* by Juan de la Hoz y Mota; in *Don Juan Tenorio* he adapts from Zamora's *S o hay dezrda que no se pague, y Convidado de piedra,* and from the elder Dumas's *Dolt Juan de Marana* (which itself derives from *Les âmes* du *purgatoire* of Prosper Mérimée). But his rearrangements usually contain original elements, and in *Sancho Garcia,* El *Rey loco,* and *El Alcalde Ronquillo* he apparently owes little to any predecessor. In 1855 he emigrated to Mexico where he was protected by the Emperor Maximilian. He returned in 1366 to find himself a half-forgotten classic. His old fertility was gone, and new standards of taste were coming into fashion. He was always poor, and for some 12 years after 1871 he was in the direst straits. A small pension secured him from actual want in his old age, and the reaction in his favour became an apotheosis. In 1889 he was publicly crowned at Granada as the national laureate.

ZOSIMUS, SAINT (d. 418), pope from 417 to 418. a Greek by birth. succeeded Innocent I on March 18. 417. His designation of Bishop Patroclus of Arles as papal vicar touched off dissatisfaction in Gaul. while his entertaining an appeal by the Pelagian Celestius led to debate with the African hierarchy and a definitive papal judgment against Pelagianism in 418. Zosimus died Dec. 26, 418. and his feast is celebrated on the anniversary.

See E. Amann in *Dictionnaire de Théologie Catholique,* vol. xv, pt. 2, col. 3708–16 (1950); P. Paschini, in *Enciclopedia Cattolica,* vol. xii, col. 1823 ff. (1954). (H. G. J. B.)

ZOSTEROPS, a genus of birds inhabiting various parts of the old world and especially common in Australia and New Zealand. In New Zealand. the most familiar species (*Z. caerulescens*) is called white eye or blightbird, the last an allusion to its clearing the fruit trees from blight.

ZOUAVE, the name given to certain infantry regiments in the French army. The corps was first raised in Algeria in 1831 with one and later two battalions, and recruited solely from the Zouaves. a tribe of Berbers, dwelling in the mountains of the Jurjura range (*see* KABYLES). In 1838 a third battalion was raised and the regiment thus formed was commanded by Lamoricière (*q.v.*). Shortly afterward the formation of the *Tirailleurs algériens*, the Turcos, as the corps for natives, changed the enlistment for the Zouave battalions, and they became, as they remained. a purely French body. Three regiments were formed in 1852. and a fourth, the Zouaves of the imperial guard, in 1854. The Crimean War was the first service the regiments saw outside Algeria. The Zouaves were noted for their strict discipline. fighting ability and exotic, oriental costumes.

In 1859 Elmer E. Ellsworth (1837–61) organized and trained in Chicago. Ill., a volunteer militia company patterned after the original Zouaves. On the outbreak of the Civil War. Ellsworth recruited a regiment of New York firemen which was mustered into the Union service in May 1861 as the 1st New York Fire Zouaves. Thereafter various Zouave regiments were organized. but the disadvantages of their colourful uniforms in battle were apparent. and were abandoned.

In 1860 the Papal Zouaves were formed in defense of the papal states by Lamoricière, who had been banished from France. After the occupation of Rome by Victor Emmanuel II in 1870. the Papal Zouaves served the government of national defense in France during the Franco-Prussian War, and were disbanded during the siege of Paris.

ZOUCHE, RICHARD (1590–1661). English jurist. one of the founder3 of modern international Ian-. was born at Ansty in Wiltshire. He became regius professor of civil law at Oxford. where he took part in drafting the Laudian statutes of the university in 1620. and practised successfully in London. being appointed a judge of the court of admiralty in 1641. He was tn-ice returned as member of parliament for Hythe. A royalist and a negotiator of the surrender of Oxford to the Commonwealth forces in 1616. he was deprived of his judgeship in 1649. but retained his professorship. In 1654 he sat on a special tribunal which tried Don Pantaleone Sa, the brother of the Portuguese ambassador. for murder. He was reappointed to his judgeship after the Restoration. but died one month later. on March 1. 1661.

Zouche i remembered for his treatise *Juris et Judicii fecialis sive Juris inter gentes explicatio* (1650). the first scientific manual covering the whole field of international law. Giving a far larger place to custom and modern precedents than did earlier writers. Zouche may fairly claim to he the hrit of the positivists. Though he did not coin the phrase *jus inter gentes* for international law he first adopted it as an npter title for the subject than *jus gentium* (*see* ROMAN LAW). Finally, he first placed the law of peace before that of war. (C. H. M. W.)

ZOYSIA are warm-season, perennial turf grasses with strong rhizomes, used on lawns. golf courses. parks, highways and recreational areas. Three main species exist in the United States: (1) Japanese lawn grass (*Z. japonica*), coarse. fibrous. winter-hardy into Canada; (2) Manila grass (*Z. matrella*), fine-bladed, semitropics!. not winter-hardy north of Washington, D.C.; (3) Mascarene grass (*Z. tenuifolia*), extremely fine-bladed, tropical. exotic. Zoysia respond to good care but tolerate neglect, drought. low fertility, insects and diseases. Under good treatment they are permanent and virtually weed free. They lose colour after hard frosts but retain a dense resilient turf. Improved types are planted vegetatively by plugs, sprigs or sods. (F. V. G.)

ZRINYI, MIKLÓS (1620–1664), Hungarian statesman. military leader and author of a famous Hungarian epic. was born at Csákvár, on Jan. 5. 1620. into an extremely wealthy aristocratic family. His chief concern was the driving out of the Turkish conquerors, the unification of the dismembered country and the organization of a modern absolutist state. He was appointed *bán*, or viceroy, of Croatia in 1647. Spending all his life in fighting the Turks. he became the outstanding Hungarian military leader of his century. He wanted to see his country free not only from Turkish but also from Habshurg rule. In 1664 he started laying the foundations of a far-reaching anti-Habsburg organization, but on Nov. 18 of the same year he was killed by a wild boar.

His chief literary work is *Szigeti Veszedelem* (1635–46)—the first and finest epic in Hungarian literature—which deals with the heroic deiense of the iortress of Szigetvár (1566) against the armies of the sultan Suleiman II. The commander of the fortress, the central figure of the epic, is the poet's great-grandfather. who fell during the siege. This historical event was projected by the poet against the background of the world-wide conflict of Christians and Turks. He used elements belonging to the heroic epic tradition and also the heroic lays of the Hungarian and Croatian peoples. The work excels in its poetic form and the characterization of its heroes.

Zrinyi's prose essays on military science and on political questions are also of great value: *Vitéz Hadnagy* ("The Brave Commander." 1650–53); *Mátyás Király* ("King Matthias," 1656–57); *Török áfium elleni orvosság* ("Remedy Against the Turkish Opium." 1660–61), are an application of Machiavelli's ideas to contemporary Hungarian conditions. These works are remarkable not only for their content, but also for their style; they are outstanding examples of Hungarian didactic and scientific prose.

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ZSIGMONDY, RICHARD (1865–1929), Austrian chemist awarded the Nobel prize in chemistry in 1925 for fundamental work in colloid chemistry, was born on April 1. 1865. in Vienna. Receiving his Ph.D. from Munich in 1889. he became a research assistant in Berlin and Graz. In 1898 he was employed in the Schott and Genossen glassworks at Jena where his interest in the ruby glass produced by colloidal gold led to his discovery of water suspensions or sols of gold which were submicroscopic in size. His belief that the suspended particles were kept apart by means of electric charges which they carried was generally accepted. With H. Siedentopf of the Zeiss works at Jena. Zsigmondy developed the ultramicroscope for the detection of particles of a diameter of three millimicrons. Zsigmondy was able to count these particles in a given volume and to estimate their magnitude indirectly. This began the systematic investigation of colloids as a subdivision of matter. a study of theoretical and practical benefit to the understanding of all sols. smokes. fogs, foams and films. The dependence of colours of a solution upon the size of the solute. protective colloids and coagulation of colloids by electrolytes were examined by Zsigmondy, the acknowledged leader in this field for 30 years. His conclusions clarified problems in biochemistry. bacteriology and soil physics. Zsigmondy n-rote an account of his life work in a volume entitled *Zur Erkenntnis der Kolloide.* From 1908 to 1929 he was professor of inorganic chemistry at Göttingen, where he died Sept. 23. 1029. (V. BW.)

ZUCCARELLI, FRANCESCO (1702–1788), Italian painter, who influenced markedly English landscape painting. was born at Pitigliano, Tuscany, on Aug. 15, 1702. He seems to have begun his artistic training very early under Paolo Anesi and later worked in Rome under G. Morandi and his pupil P. Nelli. After returning briefly to Florence he moved to Venice in about 1732 and was thenceforward associated with the Venetian school. The pastoral character of his conventional Arcadian landscapes made an especial appeal to the English, and through the instrumentality of Joseph Smith, British consul at Venice, he twice visited England. He arrived for the first time at the end of 1752 and remained for ten years. practising as a landscape painter with great success. During his second visit (1765–71) he was elected a foundation member of the Royal Academy (1768) and became one of George III's favourite painters. He had been elected to the Venetian academy in 1763 and became its president in 1772. In addition to doing much work at Bergamo, he was for a time in Paris. and in the last two years of his life he returned to Rome, and afternard to Tuscany, dying at Florence on Dec. 30, 1788. He executed innumerable drawings, a few religious paintings. engravings and tapestry designs. About 1750 he is said to have persuaded Richard Wilson to abandon figure painting for landscape painting.

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ZUCCARO (ZUCCHERO, ZUCCARI), the name of two Italian painters, brothers. leaders of the Roman Mannerist school. Their father was an obscure painter, Ottaviano Zuccaro.

TADDEO ZUCCARO (1529–66) was born at S. Angelo in Vado, near Urbino. on Sept. 1, 1929. Largely self-trained at Rome, from the early 1550s he executed many decorative frescoes for façades and interiors of palaces and a few religious works. From 1559 until his death (in Rome, on Sept. 1 or 2. 1566) he was in charge of his greatest commission. the frescoes and stucco decorations of the Palazzo Farnese at Caprarola, still the most splendid ornamented rooms of their time. Other frescoes are in the Villa di Papa Giulio, Rome, and the Sala Regia at the Vatican.

FEDERIGO ZUCCARO (1539/43–1609) was the younger brother and, from 1550, helper and pupil of Taddeo. His independent work began in 1561. He visited Venice. 1563–65, and worked under Giorgio Vasari in Florence in 1565. He became the central figure of the Roman Mannerist school, and after Titian's death (1576) was perhaps the most famous painter in Europe. He codified the theory of Mannerism in *L'Idea de' pittori, scultori, ed avchitetfi* (1607) and in a series of frescoes in his own house in Rome. In 1593 he became first president of the Academy of St. Luke in Rome, which is to some extent the parent body of modern art academies. He completed some of Taddeo's work at Caprarola and traveled through France and the Netherlands in 1574.

He spent a few months in England in 1575, where he painted portraits of Queen Elizabeth I and the earl of Leicester (and probably no one else). His chief later commissions were the painting of the dome of Florence cathedral (1575–79), a large work in the Doges' palace at Venice in 1582 and much work for the Escorial in Spain (1585–88). His latest paintings are much quieter and less mannered in style, and he lived to see Mannerism extinct. He died at Ancona on July 20, 1609. His drawings seem much more lively today than his enormous machines, which have outlived their reputation. but his historical importance remains. The hundreds of portraits which bear his name in English houses are ascribed n·ithout foundation. (E. K. WE.)

ZUG, the smallest undivided canton of Switzerland, is centrally situated. Of its 92 sq.mi., 83.6% are productive, forests covering 20.1 sq.mi. Of the unproductive area, 12.6 sq.mi. are covered by lakes, 2.8 by the Aegeri See (wholly within the canton) and the balance by part of the Lake of Zug. The pear-shaped Rossberg mass. with its central summit (Wildspitz, 5,197 ft.). thrusts its pointed end (Zugerberg. 3.255 ft.) north-northwest into the canton. Its steep western flanks fall to the Lake of Zug, the less steep eastern slopes descend to the basin and waters of the Aegeri See. Still eastward. the land rises to the Hohe Rone mass (4.042 ft.) near its eastern boundary. From Aegeri a gorge carries the river Lorze to the lowland at the north end of the Zugerberg, round which it curves to enter the lower end of the Lake of Zug. The Lorze leaves this lake slightly west of its point of entrance and flows north-northwest. over fertile lowlands. to its junction with the Reuss river—the latter stream forming the northwest boundary of the canton. East of the lake is Morgarten, the site of the great victory of the Confederates over the Habsburgs (1315). In 1950 the population was 42.239; in 1930, 34,395. After 1928 the canton formed part of the diocese of Basel. All to\\-us are small. Zug (pop. 14,488) is the largest: north of it is Baar, and west-northwest is Cham. which are merely large villages. The canton forms a single administrative district and contains 11 communes. By the constitution of 1814 the "Landsgemeinde," or primitive democratic assembly, which had existed since 1376, became an electoral body to choose a cantonal council. In 1848 the remaining functions of the Landsgemeinde were abolished.

The 1873–76 cantonal constitution was largely replaced by the present one in 1894.

The earlier history of the canton is closely linked with that of its capital. Zug (*see* below): subsequently violent disputes about the distribution of the French pensions took place (1728–38). In 1798 its inhabitants opposed the French, and during the period of the Helvetia republic it was one of the districts of the huge canton of the Waldstätten. hut became a separate canton again on the fall of the republic (1803). As one of the six Catholic cantons. it joined the Sonderbund (1845) and shared in the war of 1817. In 1848. and again in 1874. it voted against the acceptance of the proposed federal constitution.

ZUG, capital of the Swiss canton of that name. a picturesque little town at the northeast corner of the lake of Zug, and at the foot of the Zugerberg (3,255 ft.), which rises gradually, its lower slopes thickly covered with fruit trees.

Pop. (1950) 14.485.

The town, first mentioned in 1240, is called an *oppidum* in 1242 and a *castrum* in 1255. In 1273 it was bought by Rudolph of Habsburg from Anna, the heiress of Kyburg. After this it was governed by a bailiff. appointed by the Habsburgs. and a council, and was much favoured by that family. Several country districts (Baar, Menzingen and Aegerij had each its own "Landsgemeinde" but were governed by one bailiff, also appointed by the Habsburgs; these were known as the "Aeusser Amt." and were always favourably disposed to the Confederates. On June 27, 1352, both the town of Zug and the Aeusser Amt entered the Swiss Confederation; but in Sept. 1352, Zug had to acknowledge its own lords again, and in 1355 to break off its connection with the league. About 1364 the town and the Xeusser Xmt were recoverkd for the league by the men of Schwyz, and from this time Zug took part as a full member in all the acts of the league. In 1379 the German king Wenceslaus exempted Zug from all external jurisdictions, and in 1389 the Habsburgs renounced their claims, reserving only an annual payment of 20 silver marks, and this came to an end in 1415. In 1385 Zug joined the league of the Swabian cities against Leopold of Habsburg, and shared in the victory of Sempach. Between 1379 (Walchwil) and 1477 (Cham), Zug had acquired various districts in its own neighbourhood, principally to the north and the west. which were ruled till 1798 by the town alone as subject lands. At the time of the Reformation, Zug clung to the old faith and was a member of the "Christliche Vereinigung" of 1529. In 1jS6 it became a member of the Golden league.

ZUG, LAKE OF, one of the minor Swiss lakes, north of that of Lucerne. It is formed by the Aa. which enters the southern extremity of the lake. The Lorze enters at its northern end. but $1\frac{1}{4}$ mi. farther W. issues from the lake to pursue its course toward the Reuss. The lake has an area of about 1j sq.mi., is about 9 mi. long. $2\frac{1}{2}$ mi. wide and has a maximum depth of 650 ft., while its surface is 1,358 ft. above sea level. Most of the lake is in the canton of Zug. but $3\frac{3}{4}$ sq.mi. at the southern end is in Schwyz, while $\frac{3}{4}$ sq.mi. to the N. of Immensee is in Lucerne.

ZUHAIR (ZUHAIR IBN ABI SULMA RABI' A AL-MUZANI) (6th century), one of the six great Arabian pre-Islamic poets. Of his life practically nothing is known except that he belonged to a family of poetic power; his stepfather Aus ibn Hajar, his sister Khansa and his son Kab ibn Zuhair were all poets of eminence. He is said to have lived long. and at the age of 100 to have met Mohammed. His home was in the land of the Bani Ghatafan. His poems are characterized by their peaceful nature and a sententious moralizing. One of them is in the *Moallakat.*

All of his poems were published by W. Ahlwardt in The *Diwans* of *the Six Ancient Arabic* Poets (London, 1870); and with the commentary of al-Alam (d. 1083) by Count Landberg in his *Primeurs arabes* (Leyden, 1889). (G. W. T.)

ZUIDER ZEE, a shallow gulf. penetrating far into the northern Netherlands, communicating with the North sea but almost cut off irom it at low water by the Frisian Islands (Texel, etc.) and the sandbanks of the Waddenzee. It is probable that in the middle ages the coast line to the north of the Zuider Zee was an almost continuous series of dunes. but before the 14th century the Zuider Zee acquired something of its present form. The greater part of the water-covered area had a depth of less than 15 ft. at low water. An area of more than 12.000 ac. was reclaimed in the neighbourhood of Amsterdam, at the time of the building of the North sea ship canal. 1870–76, by the construction of a sea dike and locks cutting off Amsterdam from the Zuider Zce. Earliest plans for reclaiming the Zuider Zee date from the 17th century but it was not until 1918 that the sanction of the legislature was obtained for carrying out a vast scheme of reclamation commenced in 1920.

On the former sea area of 1.380 sq.mi., it was planned to convert about 560 sq.mi. into a fresh-water lake (IJssel lake) and 750 sq.mi. into rich polderland. The dike shutting out the North sea, $18\frac{1}{2}$ mi. long between north Holland and Friesland, was completed in 1932. Locks permit the passage of large Rhine barges. Occupation of the northwest polder began on completion of the dike. Work on the northeast polder started in 1936 and the first farms were occupied in 1947. The dam between the northwest polder and the lake was breached in World War II. but reclamation of the area was completed before the end of 1945. Work begun on the southeast polder in 1950 was completed in 1956. See also HOLLAND. (N. G. G.; T. HER.)

ZULOAGA (Y ZABALETA), IGNACIO (1870–1945), Spanish painter, was born at Eibar in the Basque province of Guipuzcoa on July 26, 1870. His earliest paintings were copies of works by El Greco and Velazquez in the Prado museum. Madrid. In 1889 he went to Rome, and later to Paris, where he exhibited at the Salon of 1890, describing himself as a pupil of his father (a well-known metalworker and damascener) and of Henri Gervex. Though he professed a distaste for modern art, he was obviously affected by current trends, from Impressionism to poster art and *art nouveau,* and was particularly influenced by Gauguin and Toulouse-Lautrec. He consciously sought inspiration from earlier Spanish painters—El Greco (whom he was one of the first to "rediscover"), Velazquez and Goya. He spent most of his life in Paris and Spain, and died in Madrid on Oct. 31, 1945.

It mas not until the 1920s, when the fame he had enjoyed abroad since the end of the 19th century was on the wane, that his fellow countrymen—who had criticized his art as unpatriotic—acclaimed him. His popularity abroad rested chiefly on his characteristic representations of Spanish subjects, satisfying a taste for the exotic—gypsies, dancers, bullfighters and other popular national types. He also painted landscapes, female nudes and fashionable portraits. The vigorous style of his maturity, with strong forms and vivid colours, gave his subjects a dramatic vitality; but it developed into a mannered formula in which realism was sacrificed to theatrical effect. Zuloaga is represented in many public galleries throughout the world. (E. Hs.)

ZULULAND, a region of southeastern Africa, forming the northeastern section of the province of Natal in the Union of South Africa. It was incorporated with Natal in Dec. 1897, from which time until the formation of the Union it was known as the province of Zululand. It lies between 26° 50′ and 29° 15′ S. and 30° 40′ and 33° E. and is bounded on the southeast by the Indian ocean, on the north and northeast by the Utrecht and Vryheid districts of Natal and by Swaziland. The region has an area of 10,362 sq.mi. including Amatongaland, Zaambauland and Ingwavuma district, territories not part of the former Zulu domains. Population (1951) 423,230, comprising 409.343 natives, 8,497 Europeans, 3,950 Asians and 1,440 coloured. European settlement was restricted by the prevalence of malaria and of the tsetse fly, which aerial spraying after 1945 substantially reduced. For an account of physical features, geology, climate, flora, fauna and general geography, see under NATAL and SOUTH AFRICA. UNION OF.

Crown reserves of land for native use, although considerably reduced, form about three-fifths of Zululand, 3,882,000 ac. having been set aside in 21 districts as the Zululand native trust. Large areas in Zululand have been planted with sugar cane. Completion of the Swazi border railway opened up much country for the cultivation of cotton. The completion of the Empangeni-Nkwaleni railroad began the opening up of large and fertile areas. The important irrigation scheme at Mkuzi was expected further to facilitate agriculture, as was also a similar project, estimated to cost £250,000, on the Pongola river. Coal deposits are believed to underlie much of the southern sections of Zululand.

History.—The Zulu are a tribe of the Nguni group of the Bantu people. It is not certain by what route or at what point in time the Nguni entered southeastern Africa, but Zulu legend. reinforced by travellers' tales. establishes that the Zulu were a separate tribe settled in the valley of the White Mfolosi river by the end of the 17th century. In 1756 they were described by shipwrecked Europeans as very proud, careful in the preparation of food, very cleanly in their person and jealous of their women. Though they were a distinct social group, the Zulu were at the beginning of the 19th century still an unimportant tribe numbering little more than 2.000. The dominant tribe in Zululund was that of the Mtetwa people, who lived northeast of the Tugela river round the St. Lucia lagoon. Their chief was Dingiswayo (1807–18) son of Jobe. It was probably Dingiswayo nho converted the erstwhile circumcision guilds (*ama Buto*) into the basis of a regimental system for military. as distinct from social. purposes. He began to convert the horned-crescent formation of the ceremonial hunting into a military tactic. while the introduction of the short stabbing assegai—possibly invented by the refugee Shaka—was to lead to the development of a primitive counterpart of a bayonet charge. As Dingiswayo opened up relations with Portuguese traders of Delagoa bay, he may be described as fumbling toward building a state. His was the example that Shaka followed.

Shaka.—It was in Mtetwaland that Shaka (or Chaka) the Zulu and Nandi his mother found refuge when they fled from the kraal of Shaka's father, Senzangakona (1757–1816). Shaka, enrolled in the izi-Cwe guild, won the admiration of Dingiswayo, nho is said to have contrived the death of Senzangakona and engineered the succession of Shaka to the Zulu throne, though he was not the rightful heir. The paramountcy of Dingiswayo, lord of 30 chiefs, was meantime threatened by Zwide, chief of the Ndwandwes of Zululand; Dingiswayo rvas caught by treachery and murdered. Shaka, moving up to his rescue, was warned in time and escaped Zwide's clutches. For a time the inevitable duel between Zwide and Shaka the Zulu was postponed. In the interim, Shaka built a royal kraal; impounded a choice herd of white cattle from Madlokovu of the Mfute; and imported cooks from Mtetwaland and expert brewers from the ema-Qungebeni. He assumed control over the drifting and divided Mtetwa, subdued several smaller tribes and perfected the military system of Dingiswayo. The rule of celibacy was ruthlessly imposed on the regiments (impis); the use of the stabbing assegai was made general; shields were improved, as too were the tactics of a highly mobile army (said to be able to cover as much as 40 mi. in a single day). Characteristic of Shaka's campaigns were the efficient use of spies and scouts, the use of decoys and what is best described as the scorched-earth retreat. In his first encounter with Zwide, Shaka narrowly escaped defeat. In 1819 Zwide attacked again; but, warned by his spies, Shaka retreated. burning up unconsumed supplies as he fled. When the Ndwandwes reached the Tugela they were starving and exhausted. In a three-day fight, Shaka overwhelmed them in the Mhlatuze valley, turning the flanks of the enemy by speedy moves of his young warriors. Zwide escaped, to die in exile. Those of his followers who mere not massacred were incorporated in Shaka's army.

It was not until 1821 that Shaka began systematically to conquer Natal and very largely to depopulate it. It is estimated that by forcible recruiting he had 1j regiments by 1824 and ruled over 50,000 people. That his foes were men of no mean calibre is proven by the careers of those who escaped his vengeance. To the north fled Mzilikazi (Umsilikazi, Mosilikatze). who colonized Matabeleland, and Soshangane of the Ndwandwes. who conquered Portuguese East Africa. For a generation their offshoots terrorized central Africa. The other main line of flight was southward: refugee Tembus and Fingoes fled via Pondoland. and on all of them Matiwane preyed until his power was broken by an expedition from the harassed Cape Colony. This shunting of tribes not only left Natal deserted but also dislocated the whole Cape frontier. By relentless cruelty erected into a system by ability of no mean order, Shaka the outcast had avenged the insults of his youth and built an empire. He was Africa's Attila.

Shaka first came into contact with Europeans in 1824, when he was visited by F. G. Farewell, H. F. Fynn and party. Fynn, who became a fluent linguist and who had some knowledge of medicine. treated Shaka for an assegai wound. Shaka, on his recovery, made a formal grant of Port Natal and its hinterland to Farewell and his assigns and, until his assassination, extended his erratic and exacting patronage to the traders. He wished to send an embassy to England, but the Cape government turned back his envoy. Again Shaka sent chiefs to Capetown, but before their arrival he had been murdered (Sept. 23, 1828) at a kraal on the Umvoti, about jo mi. from Port Natal. Shaka mas a victim to a conspiracy by his half-brothers Dingaan and Mhlangana, and a short time afterward

Dingaan murdered Mhlangana and made himself king.

Dingaan.—Bloodstained as had been Shaka's rule, that of Dingaan (Dingane) appears to have exceeded it in wanton cruelty. In 1835 Dingaan permitted the British settlers at Port Natal to establish missionary stations in the country in return for a promise made by the settlers not to harbour fugitives from his dominions. In 1836 American missionaries were also allowed to open stations; in Nov. 1837 Dingaan received Piet Retief, the leader of the first party of Boer immigrants to enter Natal. The story of Retief's mission, the massacre of the Boer leader and the fighting which followed is told in the article NATAL. In the result Dingaan's army mas totally defeated on Dec. 16, 1838 ("Dingaan's day"), by a Boer force under Andries Pretorius. A year later he was overthrown, the Boers in Natal (Jan. 1840) supporting his brother Mpande (usually called Panda) in rebellion against him. Dingaan passed into Swaziland in advance of his retreating forces and was there murdered, while Panda was crowned king of Zululand by the Boers.

Panda *and Cetewayo.*—When in 1843 the British succeeded the Boers as masters of Natal they entered into a treaty with Panda, who gave up to the British the country between the upper Tugela and the Buffalo rivers and also the district of St. Lucia bay (which, however, was not then occupied). Less warlike than Shaka and Dingaan, Panda remained throughout at peace with the government of Natal. Bishop Schreuder, a Norwegian missionary long resident in Zululand, gave Sir Bartle Frere the following estimate of the three brothers who successively reigned over the Zulu: "Chaka was a really great man, cruel and unscrupulous but with many great qualities. Dingaan was simply a beast on two legs. Panda was a weaker and less able man, but kindly and really grateful, a very rare quality among Zulus. He used to kill sometimes, but never wantonly or continuously." In 1856 war broke out between two of Panda's sons, Cetewayo (Cetshwayo) and Mbulazi, who were rival claimants for the succession. A battle was fought between them on the banks of the Tugela in Dec. 1856, in which Mbulazi and most of his followers were slain. The government of Natal in 1861 authorized Theophilus Shepstone to proclaim Cetewayo Panda's sole heir. Panda died in Oct. 1872 and Cetewayo (*q.v.*) was solemnly crowned by Shepstone.

Border disputes with the Transvaal Bders were fairly frequent during Panda's reign. The Boers had obtained from Panda in 1854 a cession of the Utrecht district: in 1860 they tried to get from the king a road to the sea at St. Lucia bay. In 1860 his brothers Mtonga and Mgidlana had escaped to the Transvaal when Cetewayo organized a roundup and murder of probable rivals. Cetewayo offered the Boers a strip of land if they would surrender hftonga. This they did on condition that Mtonga's life be spared. The Boers got a strip of land from Rorkesdrift to the Pongola river and beaconed it off in 1863. When, however, in 1865, Mtonga fled to Natal, Cetewayo declared that he had lost his part of the bargain, for he feared that Mtonga might be used to supplant him. He thereupon caused the boundary beacons to be removed and, on the ground that the Swazis were vassals of the Zulu and had no right to alienate, put forward a counterclaim to lands north of the Pongola that the Swazis had alienated to Lydenburg.

Such was the position when by his father's death Cetewayo became absolute ruler of the Zulu. As far as possible he revived the military methods of his uncle Shaka. His rule over his own people was tyrannous. By Bishop Schreuder he was described as "an able man, but for cold, selfish pride, cruelty and untruthfulness worse than any of his predecessors." The tension between Cetewayo and the Transvaal over border disputes continued and when in 1877 Great Britain annexed the Transvaal the disputes were transferred to the new owners of the country. A commission appointed by the lieutenant governor of Natal reported in July 1878 and found almost entirely in favour of the Zulu on the boundary disputes. But Sir Bartle Frere, the high commissioner, was convinced that, in the interests of Natal and of the Transvaal in particular and of South Africa in general, Cetewayo ought to be controlled. He accepted the report of the boundary commission but coupled with it demands for compensation for frontier incidents, together with political demands calculated to destroy the Zulu military system under the eye of a British resident. Presented on Dec. 11, the virtual ultimatum as to the structure of Zululand was to expire 30 days later.

The Zulu War.—Cetewayo returned no answer, and in Jan. 1879 a British force under Gen. Lord Chelmsford (F. A. Thesiger) invaded Zululand. Chelmsford had a force of 5,000 Europeans and 8,200 natives; Cetewayo an army of fully 40,000 men. Chelinsford divided his force into three columns — their entry was unopposed—which were to converge on Ulundi, the royal kraal. On Jan. 22 the centre column (1,600 Europeans, 2,500 natives), which had advanced from Rorkesdrift, was somen-hat casually encamped near Isandhlwana. It was neither entrenched nor in laager. On the morning of that day Chelmsford moved out with a small force to support a reconnoitring party. After he had left, the camp, in charge of Col. A. W. Durnford, was surprised by a Zulu army nearly 10,000 strong. The British were overwhelmed and almost every man killed, the casualties being 806 Europeans (more than half belonging to the 24th regiment) and 471 natives. The reconnoitring party returned to hnd the camp deserted: next day they retreated to Rorkesdrift, which had been the scene of a heroic and successful defense. After the victory at Isandhlwana, two impis oi the Zulu army had moved to the drift. The garrison stationed there, under Lieuts. J. R. M. Chard and G. Bromhead, numbered about 80 men of the 24th regiment, and they had in hospital betn-een 30 and 40 men. Late in the afternoon they were attacked. On six occasions the Zulus got within the entrenchments, to be driven track each time at bayonet's point. At dawn the Zulus withdrew, leaving 350 dead. The British loss was 17 killed and 10 wounded.

The other two columns merely held their ground. Col. C. K. Pearson was besieged at Eshowe until April, when, after a sharply contested victory at Ginginhlove, Chelmsford relieved Eshowe. In the northwest, Col. Evelyn Wood had evaded encirclement at Hlobane mountain, fallen back on fortified headquarters at Kambula and repulsed the pick of Cetewayo's army (March).

Kambula and Ginginhlove marked the turning point. Chelmsford could now afford to wait. When ample reinforcements were at hand, Chelmsford again ordered a general advance, designed, as in January, to focus on the royal kraal at Ulundi, though on this occasion the main thrust was made from the northwest. The death of the former prince imperial of the French, Napoleon III's son, while out with a reconnoitring party, was a tragic incident in a brilliant campaign. The White Mfolosi was crossed on July 4. With an estimated force of 4,200 Europeans and 100 natives and well-placed artillery, Lord Chelmsford fought and won a brilliant victory at Ulundi three days before Sir Garnet Wolseley arrived to supersede him.

Cetewayo's Downfall.—Ulundi broke the military resistance of the Zulus, and the fugitive Cetewayo was captured and exiled. Wolseley planned the reorganization of Zululand, dividing it into 13 artificial tribal units. A British resident was appointed, without adequate military or civil staff to control the situation, when the chiefs (known to Natalians as "Wolseley's Kilkenny cats") plunged into civil war. The main conflict was between the Usutu group (who were loyal to Cetewayo) and Zihebu (or Usibepu). The restoration of Cetewayo in Jan. 1883 made confusion worse confounded. The land between the Tugela and the Umlatusi, assigned by Wolseley to John Dunn (a white trader) and Hluhi (a Basuto refugee), was now set aside as a reserve, a haven and a buffer. But since Zibebu was installed as a counterpoise to Cetewayo, conflict was inevitable. In July 1883, assisted by white hunters and adventurers, Zibehu pounced on Cetewayo at Ulundi. Cetewayo, wounded and his power shattered, escaped to Eshowe, where he died in Feb. 1884.

Dinizulu and British Annexation.—Cetewayo's son Dinizulu turned to a group of Transvaal Boers for assistance, bartering territory against alliance. With their help he defeated Zibebu and drove him and his followers into the reserve. As reward for their support, the Boer surveyors claimed the whole of the northern territories (Vryheid district) together with a belt of land to St. Lucia bay, the only harbour between Durban and Lourenço Marques. Great Britain successfully contested this on the legal grounds of the treaty of 1843 with Panda (see above) but in 1886 recognized the new Republic of Vryheid—shorn, however, of its road to the coast. Two years later, Vryheid was incorporated in the Transvaal. (These northern districts of Zululand were to be retroceded to Natal after the South African War, without displacement of the then occupiers.)

The British government annexed Zululand to the crown in 1887 and placed it under a commissioner responsible to the governor of Natal. In the following year Dinizulu rebelled. After a sharp campaign (June–August, 1888), Dinizulu fled into the Transvaal. He surrendered to the British in November; in April 1889 he and two of his uncles were found guilty of high treason and were exiled to St. Helena.

Cnder the administration of the successive commissioners, Sir Melmoth Osborn and Sir Marshal Clarke and of the district magistrates, the Zulu became reconciled to British rule.

At the close of 1897 Zululand. in which Tongaland had been incorporated, was handed over by the imperial government to Natal. In 1898 Dinizulu was allowed to return and was made a "government induna." Officially one of several chiefs he was. in fact, regarded by most of the Zulu as the head of their nation.

The substitution of colonial for crown control in 1897 caused much uneasiness in Zululand, where lung sickness, rinderpest and east coast fever were killing cattle so rapidly that it looked as if the Zulu social structure was threatened. The taking of the first census and the appointment of a delimitation commission in 1902 contributed further to rumours and malaise. Word went round that the Zulu were to break their European cooking pots and to kill off all pigs and white fowl. This raised expectation of a general rising against the whites; and this expectation was fostered by alleged missionaries of the Ethiopian Church and by the rurnour (found as far north as central Africa) that a magic charm to make black men invulnerable to bullets had been discovered. Against this background of fact and fable, the imposition of the poll tax of 1905 precipitated rebellion when the tax fell due for collection in 1906. Tet it was in Natal (*q.v.*), not in Zululand. that armed resistance first occurred. The ringleader Bambata (of the Mpanza district) was, however, in touch with Dinizulu; it was into Zululand that he fled; and it was Lunyana, the keeper of Cetewayo's grave. who persuaded Sigananda to assist Bambata's revolt. Only prompt action by the colonial force averted what threatened to be a major rebellion with its racial and military hub in Zululand. The brief but exciting campaign was over by July 1906. In Dec. 1907 the Natal government felt justilied in charging Dinizulu with high treason. murder and other crimes. A military force entered Zululand and Dinizulu surrendered without opposition. He was brought to trial in Nov. 1908 and in March 1909 was found guilty of harbouring rebels. The more serious charges against him were not proved. Sentenced to four years imprisonment, he was released on the establishment of the Gnion in 1910 by Gen. Louis Botha. Dinizulu was settled on a farm in the Transvaal, where he died in Oct. 1913.

Administration.—While no major disturbance of public order occurred after 1906, many problems exposed by the South African Native Affairs commission (1903) and by the Natal Native Affairs commission (which followed the revolt) were nevertheless, by the niiddle of the 20th century, little nearer solution than they had been at the beginning. For purposes of administration, Zululand is an integral part of the province of Natal. It is divided into 11 magisterial districts. subdivided into tribal districts where chiefs exercise primary jurisdiction and assist the administration. At the head of the structure is the chief native commissioner, Natal. From the beginning, native law, where not repugnant to humanity or to public interest! has been recognized, at first on a customary basis and then by the extension of the Natal native code. In civil cases appeal lies to the native appeal court, northeast division, and in criminal cases to the native high court, Natal.

The radical problem in Zululand is the land question. The dclimitation commission, appointed in 1902, envisaged three types of land: an area set aside for European settlement; an area for native locations (reserves); and crown land to be broken up at a later date. Little of this was alienated, but in the course of the 20th century much was occupied by native squatters, whom some think to have a prescriptive claim. Proposals were made to break up crown land for development by white settlement. especially in the Ingwavuma corridor. But although, apart from some congestion in the districts of Eshowe, Nkandla and Nqutu, there was in Zululand more land per head for natives than elsewhere in the Lnion of South Africa. parts of that land were quite unsuitable for tillage and parts remained still malaria-ridden. The Zulu therefore were not overendowed. Since. moreover, the Cnion government did not attempt a thorough revision of Natal native administration (which, whenever possible. was based on tribal structures), it was considered that it would be unwise to cut down native lands either directly. by partition. or indirectly, by depriving an expanding population of an overflow into crown lands. For the Zulu tribal society, through which the administration worked, turned on the ownership of land and on the possession of cattle. But it was equally clear that the well-being of the Union as a mhole depended on the developing of scientific agriculture and on the maintenance of a labour supply both for rural and urban industries; and the Zululand system militated against this.

The Union government took two steps that were bound to change the position. It extended the drive (begun by the Natal Native trust) to improve native farming on a national scale through the appointment of agricultural officers and native demonstrators grouped under the district commissioners. In parts of Zululand considerable progress was clearly made. In 1953, modifying proposals put forward in 1934, the Cnion government proposed to substitute its own control for provincial control of native education. The avowed object, apart from financial and administrative convenience, was to provide increased facilities for native education as well as a new educational approach (neither mission schools nor provincial schools were numerically adequate, though devoted work had been done). As the periodical drift to the towns and to the mines had already weakened patriarchal control, systematic education on almost any plan could be expected to change the sociological and therefore the administrative pattern of Zululand. The South African government's Bantu Education act (1954) transferred the control of native education from all provincial administrations to the department of native affairs.

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ZUMALACÁRREGUI Y DE IMAZ, TOMÁS DE (1788–1835), Spanish Carlist general, was born at Ormáiztegui, Guipuzcoa, Dec. 29, 1788. In his youth he served under Gaspar de Jáuregui, one of the minor guerrilla leaders. He then entered the army, but was disgraced for his support of Don Carlos.

Appointed commander in chief in Navarre by Don Carlos, he escaped from Paniplona on the night of Oct. 29. 1833, and took command the next day at Huarte-Araquil of the few hundred ill-armed and dispirited *guerrilleros* that constituted his whole force. In a few months Zumalacárregui had organized the Carlist forces into a regular ariny. Whether as a guerrilla leader or as a general conducting regular war in the mountains, he proved unconquerable. By July 1834 he had made it safe for Don Carlos to join his headquarters. The pretender, bigoted and narrow-minded. was afraid of Zumalacárregui's personal influence with the soldiers. and Zumalacárregui was hampered by the intrigues of the court. Yet by June 1835 he had made the Carlist cause triumphant to the north of the Ebro; had he been allowed to march on Madrid, he might well have put Don Carlos in possession of the capital. He reluctantly obeyed the order to besiege Bilbao, was wounded in the leg on June 15, 1835, attended by Don Carlos' physicians, and died on June 24, 1835, as a result of a quack's operation.

ZUÑI, an American Indian pueblo (*q.v.*), south of Gallup, N.M. In 1950 it had 2.563 inhabitants. The Zufii speak an independent language, and their origins and early history are unknown. Nor does mythology clarify these problems, for it pictures their ancestors as emerging from underground and wandering to their present location.

Zuñi was discovered in 1539 by Esteban, a Negro scout for Marcos de Niza, who preceded Coronado. The Indians were then living in Hawikuh, and five or six other towns. Collectively. these came to be called the Seven Cities of Cibola. After the Pueblo rebellion in 1680 the populace crowded into one multistoried masonry pueblo.

'Thirteen matrilineal clans comprise Zufii society, but the main officers are male. The principal masculine occupation is maize farming, although some men have become excellent silversmiths and turquoise workers. Basketry and pottery are the main feminine crafts.

Like other Pueblo Indians the Zufii are generally nonaggressive and deeply religious, with a complex ceremonial organization. Men often wear masks and costumes, in which they impersonate those gods or spirits called katcinas. One spectacular impersonation is Shalako, a gigantic katcina that appears annually in December. Under the impetus, primarily, of neighbours and returning veterans, native customs are rapidly changing to conform to white American ways. Nevertheless, much traditional Zuñi culture still remains.

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ZUNZ, LEOPOLD (1794–1886), Jewish scholar, was born at Detmold, Ger., in 1794, and died in Berlin in 1886. He was the founder of what has been termed the "science of Judaism." the critical investigation of Jewish literature, hymnology and ritual. His *Gottesdienstliclze Vorträge dev Juden* lays down principles for the investigation of the rabbinic exegesis (Midrash, *q.v.*) and of the prayer book of the synagogue. Zunz's other principal works are *Synagogale Poesie des Mittelalters* (1855); and *Literaturgeschichte der Synagogalen Poesie* (1865; supp. vol., 1867).

ZURARA, GOMES EANES DE (*c.* 1410–1474), the second notable Portuguese chronicler in order of date (Fernão Lopes being the first), and the first to describe the Portuguese voyages of discovery which pioneered the overseas expansion of Europe. He entered the royal archives as assistant to Lopes (*q.v.*) and succeeded him as chief chronicler in 1454, His *Crónica da Tomada de Ceuta* ("Chronicle of the Capture of Ceuta"), a supplement to the *Crdnica de* D. *Joam* ("Chronicle of King John I") by Lopes, dates from 1450, and his *Crónica dos feitos de Guiné* ("Chronicles of the Deeds of Guinea"), more usually known as *Crónica do descobrimento* e *conquista de Guiné* ("Chronicle of the Discovery and Conquest of Guinea"), on which his reputation rests, was completed several years after the death of Prince Henry the Navigator in 1460. He also wrote a history of Tangier and other works. Modern research has disclosed that Zurara's accuracy in his *Crónica de Guiné* leaves much to be desired, the part played by Prince Henry being exaggerated at the expense of more important factors. His erudition is mainly secondhand, but with all its faults the *Crónica* remains the primary source for the subject. It is all the more regrettable that there is no adequate edition of the text in any language, the obsolescent translation by C. R. Beazley and E. Prestage for the Hakluyt society, 2 vol. (1896–98), being still the most useful.

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ZURBARÁN, FRANCISCO DE (1598–1664), Spanish painter, was born at Fuente de Cantos, Badajoz province, Extremadura (baptized Nov. 7). He was apprenticed in 1614–16 to Pedro Diaz de Villanueva, a painter of images, in Seville, where he was also possibly a pupil of Juan de las Roelas.

Zurbarin's personal style, based on Caravaggesque naturalism and tenebrism. was already formed in Seville by 1629 ("St. Peter Nolasco," Prado; "St. Bonaventura," Louvre, etc.) and its development was probably stimulated by the early works of Velázquez and by the works of Jusepe de Ribera (*q.v.*). It was a style that lent itself well to portraiture and still life; but it found its most characteristic expression in his religious subjects. Indeed Zurbarán uses naturalism more convincingly than other exponents for the expression of intense religious devotion. He renders traditional personages—apostles, saints, monks—with portraitlike heads, with almost sculptural modeling and with emphasis on the minutiae of their dress, so as to impart verisimilitude to their miracles, visions and ecstasies. This distinctive combination of realism and religious sensibility relates the art of Zurbarán to the practical mysticism of the Jesuits. His art was popular with monastic orders in Seville and the neighbouring provinces and he had several followers, whose works have been confused with his. Of the many large cycles for which he received commissions the legends of St. Jerome and of Jeronymite monks (1638–39) that decorate the chapel and sacristy of the monastery at Guadalupe are the only ones that have remained *in situ*. Little is known of his production in the 1640s apart from the altarpiece at Zafra (1643–44) and records of a large number of paintings destined for Lima, Peru (1647). By 1658 both the style and the content of Zurbarán's paintings had suffered a change that can be attributed to the influence of Bartolomé Murillo (*q.v.*). In his late devotional pictures, like the "Holy Family" and "Immaculate Conception" (1659 and 1661, Budapest), the figures have become more idealized and less plastic in form; and their expression of religious emotion is tinged with sentimentality. Zurbarán died in Madrid on Aug. 27, 1664.

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ZÜRICH, the canton of northeastern Switzerland which ranks officially first in the confederation. Its total area is 668 sq.mi., of which the high proportion of 90.4% is reckoned as "pro.. ductive" (forests, 184.9 sq.mi., and vineyards 4.6 sq.mi.). Of the rest, 27.8 sq.mi. are occupied by lake waters; chiefly part of the Lake of Zurich, but wholly within the canton are the Lakes of Greifen ($3\frac{1}{3}$ sq.mi.) and Pfaffikon ($1\frac{1}{4}$ sq.mi.). The canton joined the confederation in 1351. Its irregularity of shape arises from its continued growth, up to 1803, by the additions of acquisitions made by the capital. As far back as 1362 the whole of the lower part of the lake was added, and by the purchase of Winterthur (1467) from the Habsburgs, it reached the Rhine. Today it extends from its enclave in Baden, on the right bank of the Rhine (above the Thur junction to below the Töss junction) to some 8 mi. S.W. of Pfaffikon See. It consists of shallow river valleys draining toward the Rhine and separated from one another by northwest to southeast ridges. The most important valley is that of the Linth, which expands into the Lake by Zurich and is continued as the Limmat; the ridge to the east is low and then successively eastward are the valley of the river Aa-Glatt, which flows through the Greifen See; a higher ridge separating it from the more gorge-like Toss valley, and finally the highest ridge along the east boundary separating the Toss from the Toggenburg (*q.v.*). On the last ridge, Hornli reaches 3,717 ft. West of the Lake of Zurich is the strikinglj parallel valley of the Sihl, bounded farther west by the Albis range, with Albishorn (3,000 ft.) as its highest point. Pop. (1950) 777,002. The capital of the canton is Zurich (pop. 1950, 390,0201, but. Winterthur (66,925) is the only other considerable town. Uster (12,350), east of Greifen See, is an industrial town, while Thalwil (8,787), Horgen (10,118) and Wädenswil (10,155), all on the western shore of the Lake of Zurich, are of note as industrial centres. Though the land is highly cultivated, yet the canton is essentially a great manufacturing area, especially of machinery and railway rolling stock. Silk weaving and cotton weaving are widely spread, and the products of the former industry have a large foreign market. The canton is divided into 11 administrative districts containing 186 communes. In 1869 the cantonal constitution was revised. and no material changes have been made since. There is an executive (*regierungsrat*) of seven members and a legislature (*kantonsrat*) of 180 deputies (distributed among the electoral circles on a population basis, which varies from census to census). Each body holds office for four years and is elected by a method making use of the principle of proportional representation. The compulsory referendum exists, and all laws and all financial decisions involving a total sum over 250,000 Fr., or an annual sum of 20.000 Fr., must be submitted to a popular vote. Any 5,000 voters can employ the "initiative" to force the government to submit to the people any legislative or constitutional matter. (See SWITZERLAND.)

(W. E. WH.)

ZÜRICH, the capital of the Swiss canton of the same name and the largest town in Switzerland. is situated 1,345 ft. above sea level at the foot of Lake Zurich on both banks of the Limmat river and of its tributary, the Sihl. Although it is an industrial and commercial centre, it is one of Europe's most beautiful cities, ringed by wooded hills, with, on clear days, a panoramic view of the Alps at the southern end of the lake. The quays which line the lake and the river, the 16th- and 17th-century guildhouses on the river banks and the feeling of light. space and cleanliness of its modern streets all contribute to its charm. Pop. (1950) 390,020, (1956 est.) 422,012, of whom 261,751 were Protestant. 144.879 Roman Catholic and 6,075 Jewish, 11960) 440.170. German is the principal language spoken, sometimes in the dialect form known as "Schweizerdeutsch."

History. — The earliest, prehistoric inhabitants of the site of Ziirich were lake dwellers living in pile huts at the foot of the lake. (*See* LAKE DWELLINGS.) Later the Celtic Helvetii had a fortified settlement there and the name is probably derived from the Celtic *dur*, meaning water. In c. 58 B.C. the settlement fell to the Romans who adapted its name to Turicum and made it a customs station. It was fortified in the 4th century but was invaded by the Alamanni from the north and was later conquered by the Franks, who made it a royal residence. Charlemagne's grandson. Louis the German; established a Benedictine abbey and installed his daughter as abbess in 853. Subsequent abbesses acquired extensive rights and privileges. sharing administration of the town with the emperor's deputy. Side by side with this clerical and political development went the growth of the trading community. who settled there because of the town's position at the foot of the lake, at a river crossing, on the trade routes from France to eastern Europe and from Germany and the north to Italy. and who had acquired market rights by the year 1000. The town gained great prosperity from its silk industry and was for a long time one of the few silk centres north of the Alps.

In 1218 Zurich became a free imperial city and in 1351 joined the Swiss confederation under the leadership of the patrician burgomaster, Rudolf Brun, who in 1336 had given the city its first constitution, dividing government between the patricians and the guilds. It had acquired its independence of the abbey in the 13th century, and in 1400 bought its freedom from the emperor. Gradually the guilds acquired more and more power and the city became virtual ruler of considerable lands. This involved conflict with other city states. leading to the Old Zurich war (1436–50) between Zurich, supported by Austria, and the rest of the Swiss league, in which Zurich was defeated. The city gained leadership in the league. however, under the burgomaster Hans Waldmann (1436–89), who led the Swiss to victory in the Burgundian war (battle of Morat, 1476) but whose dictatorial internal policy caused a peasants' revolt, in which he was beheaded in 1489.

The city's character and importance were profoundly affected by the reformer Huldreich Zwingli (*q.v.*), a priest at the Grossmunster whose series of sermons there, begun on New Year's day, 1519, inaugurated the Swiss reformation. The history of the city's support for the Reformation belongs to the history of Switzerland and of Protestantism, but its internal effects were seen in the development of a plainer style of building in accordance with puritan principles, in the strengthening of a patriarchal system of government, with emphasis on almsgiving and the setting up of social services: and in the city's growing importance as a home of humanism. It provided a refuge for English Protestants persecuted by Mary Tudor, and later for French Huguenots. and in the 18th and 19th centuries became an intellectual centre for German-speaking Europe, and the home of such scholars and writers as J. J. Bodmer and J. J. Breitinger, Salomon Gessner, Gottfried Keller, C. F. Meyer. J. K. Lavater and Heinrich Pestalozzi. Despite the French occupation during the Revolutionary Wars (Massèna beat the Russians there in 1799), it continued to prosper, its success being largely due to its textile industry. From 1831 it acquired a more democratic constitution (completely liberalized in 1869) and during the 1830s the town walls and ramparts were destroyed by a town council intent on asserting the rights of the radical peasants against the conservative city governors. The foundation of the university in 1833, of the Federal Institute of Technology in 18jj (among whose famous pupils were Wilhelm Roentgen and Albert Einstein), and of the theatre, the Hottingen Literary circle and the concert hall soon after, were signs of the city's cultural growth, paralleled by the expansion into the surrounding countryside, the absorption of the outlying districts (1893 and 1934) and the increasing organization of its industry, all of which have made it a modern capital.

The Town. — Old Zurich may be said to have had three main centres: the twin-towered, Romanesque Grossmunster (cathedral), on the right bank of the Limmat, supposed to have been founded by Charlemagne. of which the present building dates from c. 1090–1180 and c. 1225–1300; the Fraumunster on the left bank founded as an abbey in 853, dating mainly from the 13th and 14th centuries; and the Lindenhof also on the left bank. a mound occupied successively by a Helvetian settlement, a Roman castrum and the imperial palace, now a public park with a good view over the city and the lake. With Zurich's expansion, however, the city's focal point has changed. so that the lake and the broad shopping street leading to it from the main railway station, which follows the line of the old western moat, have become the social centre.

The cathedral is dedicated to the 3rd-century Christian missionaries, SS. Felix, Regula and Exuperantius, patron saints of Ziirich, who are buried in one of its chapels. On the site of their martyrdom, between the cathedral and the river, is the Wasserkirche (1478–88), which was used as a city library from 1631 to 1917, but reopened as a church in 1942. Zurich's oldest church is the 13th-century St. Peter's, on the left bank; nearby is the Prediger-Kirche (13th–14th centuries) where the cantonal archives are kept. The oldest houses are in the narrow streets round the Grossmunster but old Zurich's special character depends more on the 17th- and 18th-century guildhouses (often now containing restaurantsj lining the quays, and on the beautifully proportioned 18th-century patricians' houses, some of which are now used for exhibitions and civic functions. Of the many bridges over the Limmat the oldest is the Rathausbrucke, at one end of which is one of the city's many 16th-century fountains. The Rathaus (1694–98) is a Renaissance building with much ornamentation showing baroque influence.

The Swiss National museum, opened in 1898, contains an excellent collection of Swiss historic objects and antiquities, art treasures, etc. It is the chief of many artistic and scientific collections. The Federal Institute of Technology occupies a commanding position on the site of the old ramparts, and the university (completed in 1914), dominated by a central tower, also stands on high ground. The university buildings and the art gallery (1911) are freely decorated with sculpture. Zurich has two theatres. a music school, a concert hall and modern hospitals. There are also a number of sports grounds and public gardens. Two great annual festivals take place: the *Sechseläuten*, on the third Monday in April. which culminates in a procession of the guilds and the burning of a snowman in front of the Stadttheater; and the *Knabenschiessen*, in September, when boys compete in rifle shooting. The suburbs spread across the whole valley and up the slopes of the Zürichberg (2,285 ft.) to the east and the Uettiberg to the southwest, two mountains which can be ascended by funicular railway.

Communications and Industry. — Zurich lies on a river crossing and at the meeting place of two great roads (see *History* above). It is also an important railway centre and is connected to most of the major towns of the world by airlines operating from Kloten airport, 7½ mi. outside the city.

As well as being the Swiss centre of banking and insurance, Zurich is the country's leading industrial town. Since the middle ages it has been a centre of the silk industry and this still holds true of textiles, but far outweighing anything else in importance are the heavy industries making electro-technical equipment, electric locomotives, machine tools, turbines, etc.

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ZURICH, LAKE OF, a Swiss lake, extending southeast of the town of Zurich. Its basin was formed by glacial erosion and it shows interesting phases of damming by moraines. The river Linth flows into it and the Limmat out of it. Its area is about 34 sq.mi., extreme length 2j mi., greatest breadth 2½ mi., greatest depth 469 ft., surface 1,332 ft. above sea level. The greater portion is in the canton of Zurich, but 8¾ sq.mi. S.E. is in Schwyz, and 4 sq.mi. N.E. in St. Gall. The great dam of masonry, carrying the railway line and motor road from Rapperswil to Pfäffikon. cuts off the extreme eastern part of the lake and is passed only by small boats; steamers do not go beyond the dam. as the part beyond is shallow. West of this dam is the island of Ufenau, where in 1j23 Ulrich von Hutten took refuge and died. Zurich stands at the north end of the lake. On the west shore are Thalwil, Horgen. Wädenswil, Richterswil. Pfaffikon and Lachen. On the opposite shore are Meilen (near which the first lake dwellings were discovered in 1853–54). Stafa and Rapperswil, the castle of which shelters a Polish museum. Schmerikon and Uznach are near the eastern end.

ZUTPHEN or ZUTFEN, a town in the province of Gelderland, Neth., on the right bank of the Ysel at the influx of the Berkel, and a junction station 18 mi. N.N.E. of Arnhem by rail. Pop. (1947) 21,915. In the middle ages it was the seat of a line of counts which became extinct in the 12th century. Having been fortified, the town stood several sieges, especially during the wars of freedom waged by the Dutch. the most celebrated fight under its walls being the one in Sept. 1586 when Sir Philip Sidney was mortally wounded. Taken by the Spaniards in 1587, Zutphen was recovered by Maurice, prince of Orange, in 1591, and except for two short periods, one in 1672 and the other during the French Revolutionary Wars. it then remained a part of the United Netherlands. German troops occupied it in World War II.

The most important building is the *Groote Kerk* of St. Walpurgis, which dates from the 12th century and contains monuments of the former counts of Zutphen, and other objects of interest. The chapter house contains a pre-Reformation library which includes some valuable mss. and *incunabula.* There are some remains of the old town walls. The place has an active trade, especially in grain and in the timber floated down from the Black forest by the Rhine and the Ysel; the industries include tanning, weaving and oil and paper manufactures. About 3 mi. to the north of Zutphen is the agricultural colony of Nederlandsch-Mettray, founded by a private benefactor for the education of poor friendless boys in 1851. At 3 mi. distance, in the picturesque "Achterhoek," are the mediaeval castles of Ruurloo and Vorden.

ZUTUHIL, an Indian tribe inhabiting the territory south of Lake Atitlan in Guatemala. Its tongue, one of the "metropolitan'.' Maya dialects, is spoken today in Atitlan. San Pedro la Laguna, San Lucas Tolimán and San Antonio Suchitepéquez. The Zutuhil number about 14,000.

The part the Zutuhil played in the wars with the Quiché and Cakchiquel is described in the annals of those tribes, which make it clear that the Zutuhil were only slightly less powerful than these enemy neighbours, and they appear never to have been completely subdued. The Zutuhil capital was picturesquely located above Lake Atitlan. Near by stood a strongly fortified position, reduced by the Spaniards under Pedro de Alvarado in 1525 only with the greatest difficulty. Today the Zutuhil work, often under a system of peonage, on the big coffee estates. Their costumes, of local cotton covered with embroidery, are noted for their brilliant colours.

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ZWEIBRÜCKEN, a town of Germany, in the Rhineland Palatinate, on the Schwarzbach, and on the railway between Germersheim and Saarbrucken. Pop. (1950) 25,766.

Zweibrucken ("two bridges") is the Latin *Bipontinum;* it appears in early documents also as *Geminus Pons,* and was called by the French *Deux-Ponts.* The independent territory was at first a countship, half of which Count Eberhard sold in 1385 to the count palatine of the Rhine, holding the other half as his feudatory. Louis (d. 1489) founded the line of the dukes of Zweibrücken which became extinct in 1731, when the duchy passed to the Birkenfeld branch. At the peace of Lunéville Zweibrucken was ceded to France; on its reunion with Germany in 1814 the greater part of the territory was given to Bavaria, the remainder to Oldenburg and Prussia. Zweibrücken was known to scholars for its early editions of the Greek and Latin classics. Its war factories were bombed in World War II.

ZWICKAU, a town of Germany, in the Karl-Marx-Stadt district, situated on the left bank of the Zwickauer Mulde, 41 mi. S. of Leipzig and 20 mi. S.W. of Chemnitz on the main line of railway Dresden-Hof and at the junction of several other lines. Pop. (1950) 138,844.

Zwickau is of Slavonic origin, and is mentioned, in 1118 as a trading place. Zwickau was an imperial possession, but was pledged to Henry the Illustrious, margrave of Meissen. It passed to the electors of Saxony as successors of the margraves of Meissen. The discovery of silver in the Schneeberg in 1470 brought it much wealth. The Anabaptist movement of 1525 began at Zwickau under the inspiration of the "Zwickau prophets." Robert Schumann (*q.v.*) was born there.

Among the nine churches, the Gothic Church of St. Mary (1451–1536 and restored 1885–91) is remarkable. Other noteworthy buildings are the town hall of 1581, with the municipal archives, including documents dating back to the 13th century and an autograph ms. of the works of Hans Sachs, and the late Gothic *Gewandhaus* (cloth merchants' hall), built 1522-24 and now in part converted into a theatre. The manufactures of Zwickau include spinning and weaving, machinery, chemicals, porcelain, paper, glass, dyestuffs, wire goods, aluminum, lacquer, embroidery, stockings and curtains. The adjacent coalfield has been actively worked only since 1823, during which time the population has increased more than tenfold.

ZWINGLI, HULDREICH (1484–1531), Swiss reformer, was born on Jan. 1, 1484, at Wildhaus in the Toggenburg valley, St. Gall, Switzerland. He came of a free peasant stock, his father being *amtmann* of the village; his mother, Margaret Meili, was the sister of the abbot of Fischingen in Thurgau. His uncle, Bartholomew Zwingli, afterward *dekan* or *superintendent* of Wesen, had been elected parish priest of Wildhaus. He went to school at Wesen, then at Basle, and finally at Berne, where his master, Heinrich Wolflin, inspired him with an enthusiasm for the classics. In 1500 he was sent to the university of Vienna to study philosophy. He then returned to Basle, where he graduated in the university and taught classics in the school of St. Martin's church. At 22 Zwingli was ordained by the bishop of Constance and elected parish priest of Glarus. The ten years which Zwingli spent at Glarus laid the foundations of his work as a reformer. He there began the study of Greek that he might "learn the teaching of Christ from the original sources," and gave some attention to Hebrew. He read also the older church fathers and his skill in the classics led his friends to hail him as "the undoubted Cicero of our age." He entered into correspondence with Erasmus, and received a somewhat chilling patronage; whilst the brilliant humanist, Pico della Mirandola (1463–94), taught him to criticize Catholic doctrine. His first publications, which appeared as rhymed allegories, were political rather than religious; they were directed against the Swiss practice of hiring out mercenaries in the European wars. In 1521 he prevailed upon the authorities of the canton of Zurich to renounce the practice altogether. Especially did he oppose alliances with France; but the French party in Glarus was strong, and it retaliated so fiercely that in 1516 Zwingli was glad to accept the post of people's priest at Einsiedeln. He dated his arrival at evangelical truth from the three years (1516–19) which he spent in this place. There he studied the New Testament in the editions of Erasmus and began to found his preaching on "the Gospel," which he declared to be simple and easy to understand.

Reform Propaganda. — Zwingli began to preach "the Gospel" in 1516, but a contemporary says that he did it so cunningly (*listiglich*) that none could suspect his drift. He began his work without saying much about corruptions in the Roman Church, and it was his political denunciation of the fratricidal wars into which the pope, not less than others, was drawing his fellow-countrymen, that first led to rupture with the papal see. Three visits which he had paid to Italy as army chaplain opened his eyes to the worldly character of the papal rule, and he began to attack at Einsiedeln the superstitions which attended the great pilgrimages made to that place. Zwingli denounced the publication of plenary indulgence to all visitors to the shrine. When in August 1518 the Franciscan monk Bernardin Samson appeared in Switzerland with a commission to sell indulgences, Zwingli persuaded the council to forbid his entrance into Ziirich.

Zwingli now became (1518) people's priest at the Great Minster of Zurich. In the beginning of 1519 he began a series of discourses on St. Matthew's Gospel, the Acts of the Apostles, and the Pauline epistles; and with these it may be said that the Reformation was fairly begun in Zurich. His correspondence of this year shows him jealous of the growing influence of Luther. He claimed to have discovered the Gospel before ever Luther was heard of in Switzerland. Towards the end of September he fell ill with the plague; his illness sobered his spirit and brought into his message a deeper note than that merely moral and common-sense one with which, as a polite humanist, he had hitherto been content. He began to preach against fasting, saint worship and the celibacy of priests. People were found eating flesh in Lent, and the bishop of Constance accused them before the council of Zürich. Zwingli was heard in their defence and the accusation was abandoned. His first Reformation tract, April 1522, dealt with this subject: *Von Erkiesen und Fryheit der Spysen.* The matter of the celibacy of the clergy was more serious. Zwingli had joined in an address to the bishop of Constance calling on him no longer to endure the scandal of harlotry, but to allow the priests to marry wives, or, at least, to wink at their marriages. Pope Adrian VI. interfered and asked the Zurichers to abandon Zwingli, but the reformer persuaded the council to allow a public disputation (1523), when he produced sixty-seven theses and vindicated his position so strongly that the council decided to uphold their preacher and to separate the canton from the bishopric of Constance. Thus legal sanction was given in Zurich to the Reformation. In 1522 Zwingli produced his first considerable writing, the *Architeles*, "the beginning and the end," in which he sought by a single blow to win his spiritual freedom from the control of the bishops, and in a sermon of that year he contended that only the Holy Spirit is requisite to make the Word intelligible, and that there is no need of Church, council, or pope in the matter.

Victory of Reform.--There was a strong opposition to the Reformation, especially in the five Forest Cantons: Lucerne, Zug, Schwyz, Uri and Unterwalden; and the Ziirichers felt it necessary to form a league in its defence. They were especially anxious to gain Berne. and Zwingli challenged the Romanists to a public disputation in that city. The pleadings began on Jan. 2, 1523, and lasted nineteen days. Zwingli and his cornpanions undertook to defend the following propositions: —

(1) That the Holy Christian Church, of which Christ is the only Head, is born of the Word of God, abides therein, and does not listen to the voice of a stranger; (2) that this Church imposes no laws on the conscience of people without the sanction of the Word of God, and that the laws of the Church are binding only in so far as they agree with the Word; (3) that Christ alone is our righteousness and our salvation, and that to trust to any other merit or satisfaction is to deny Him; (4) that it cannot be proved from the Holy Scripture that the body and blood of Christ are corporeally present in the bread and in the wine of the Lord's Supper; (5) that the mass, in which Christ is offered to God the Father for the sins of the living and of the dead, is contrary to Scripture and a gross affront to the sacrifice and death of the Saviour; (6) that we should not pray to dead mediators and intercessors, but to Jesus Christ alone; (7) that there is no trace of purgatory in Scripture; (8) that to set up pictures and to adore them is also contrary to Scripture, and that images and pictures ought to be destroyed where there is danger of giving them adoration; (9) that marriage is lawful to all, to the clergy as well as to the laity; (10) that shameful living is more disgraceful among the clergy than among the laity.

The result of the discussion was that Berne was won over to the side of the reformer. He had maintained that the congregation, and not the hierarchy, was the representative of the Church; and he sought to reorganize the Swiss constitution on the principles of representative democracy so as to reduce the disproportionate voting power of the Forest Cantons.

On April 2, 1524 the marriage of Zwingli with Anna Reinhard was publicly celebrated in the cathedral. In August of that year Zwingli printed a pamphlet in which he set forth his views of the Eucharist. They proved the occasion of a conflict with Luther which was never settled, but more attention was attracted by Zwingli's denunciation of the worship of images and of the Roman doctrine of the mass. These points were discussed at a fresh congress where about 900 persons were present, and where Vadian (Joachim von Watt, the reformer of St. Gall) presided. It was decided that images are forbidden by Scripture and that the mass is not a sacrifice. Images were removed from the churches, and many ceremonies and festivals were abolished. Zurich was threatened with exclusion from the union, and she began to make preparations for war.

Divergence from Luther.——At this point the controversy between Luther and Zwingli became more serious. In March 1525 Zwingli brought out his *Commentary on the True and False Religion.* He declined to accept Luther's teaching that Christ's words of institution required the belief that the real flesh and blood of Christ co-exist in and with the natural elements. He declared that Luther was in a fog, and that Christ had proclaimed that by faith alone could His presence be received in a feast which He designed to be commemorative and symbolical. The landgrave of Hesse brought the two Reformers together in vain at Marburg in October 1529, and the whole Protestant movement broke into two camps. At home the long-felt strain between opposing cantons led at last to civil war. In February 1531 Zwingli himself urged the Evangelical Swiss to attack the Five Cantons, and on Oct. 10 there was fought at Kappel a battle, disastrous to the Protestant cause and fatal to its leader. Zwingli, who as chaplain was carrying the banner, was struck to the ground, and was later despatched in cold blood. His corpse was quartered by the public hangman, and burnt with dung by the soldiers. A great boulder, roughly squared, standing a little way off the road, marks the place where Zwingli fell. It is inscribed, "'They may kill the body but not the soul': so spoke on this spot Ulrich Zwingli, who for truth and the freedom of the Christian Church died a hero's death, Oct. 11, 1531."

Zwingli's theological views are expressed succinctly in the sixty-seven theses published at Ziirich in 1523, and at greater length in the *First Helaetic Confession,* compiled in 1536 by a number of his disciples[1]. They contain the elements of Reformed as distinguished from Lutheran doctrine. As opposed to Luther, Zwingli insisted more firmly on the supreme authority of Scripture, and broke more thoroughly and radically with the mediaeval Church. Luther was content with changes in one or two fundamental doctrines; Zwingli aimed at a reformation of government

[1]P. Schaff, *Creeds of the Evangelical Protestant Churches,* p. 211

and discipline as well as of theology. Zwingli held that there should be no government in the Church separate from the civil government which ruled the commonwealth. All rules and regulations about the public worship, doctrines and discipline of the Church were made in Zwingli's time, and with his consent, by the council of Ziirich, the supreme civil authority in the State. This was the ground of his quarrel with the Swiss Anabaptists, fnr the main idea in the minds of these greatly maligned men was the modern thought of a free Church in a free State. Like all the Reformers, he was strictly Augustinian in theology, but he dwelt chiefly on the positive side of predestination — the election to salvation — and he insisted upon the salvation of infants and of the pious heathen. His most distinctive doctrine is perhaps his theory of the sacrament, which involved him and his followers in a long and, on Luther's part, an acrimonious dispute. He held that the Eucharist was not the *repetition* of the sacrifice of Christ, but the faithful *remembrance* that that sacrifice had been made once for all. His theological opinions were set aside in Switzerland for the somewhat profounder views of Calvin. The publication of the Ziirich Consensus (*Consensus Tigurinus*) in 1549 marks the adherence of the Swiss to Calvinist theology.

Zwingli's most important writings are — Von *Erkiesen und Fryheit der Spysen* (April 1522); *De Canone Missae Epichiresis* (September 1523); *Commentarius de Vera et Falsa Religione* (1525); *Vonz Touf, vonz Wiedertouf, und vom Kindertouf* (152j); *Ein klare Unterrichtung vonz Nachtmal Chvisti* (1526); *De Providentia Dei* (1530); and *Christianae Fidei Expositio* (1531). For a full bibliography *see* G. Finsler, *Zwingli-Bibliographie* (Ziirich, 1897).

Works.—Collected editions, 4 vols. (Zurich, 1545, 1581); by M. Schuler and Joh. Schulthess, 8 vols. (Ziirich, 1828–42, with "supplementorum fasciculus," 1861); by E. Egli and G. Finsler in "Corpus Reformatorum" (Berlin, 1905 *sqq.*).

Lives. — 0. Myconius (1532); H. Bullinger's *Reformationsgeschichte* (ed. Hottinger and Voegli, 1838); J. M. Schuler (1818); R. Christoffel (1857, Enp. tr. by J. Cochran, Edinburgh, 1858); J. C. Moriköfer, 2 vols. (Leipzig, 1867–69); R. Stahelin, 2 vols. (Basle, 1895–97); S. M. Jackson in *Heroes of the Reformation* (New York and London, 1901); Prof. Egli's articles in Hauck-Herzog's *Realencyklopädie für prot. Theologie u. Kirche,* and *Zwingliana,* published at Zurich.

S. M. Jackson's book gives a chapter on Zwingli's Theology by Prof. F. H. Foster, and also full details of further information on the subject, together with a list of modern English translations of Zwingli's works.

ZWITTERION. In chemistry, a molecule containing both acidic and basic groups may be expected to neutralize itself with the production of an internal salt or, as it is commonly called, a zwitterion (from the German *Zwitter,* "hybrid" or "hermaphrodite," plus *ion*). Thus glycine may be expected not to have the amino acid structure I, with the acidic carboxyl group COOH and the basic amino group NH_2, but rather the zwitterionic structure II.

$$\underset{\text{I}}{H_2N.CH_2.COOH} \qquad\qquad \underset{\text{II}}{\overset{+}{H_3N}.CH_2.COO^-}$$

In general: amino acids and proteins (*q.v.*) at their isoelectric points, as well as betaines (*see* CHOLINE) exist largely if not entirely in the form of zwitterions.

ZWOLLE, the capital of the province of Overijssel, Netherlands, on the Zwarte Water, and a junction station $24\frac{1}{2}$ mi. N.E. of Harderwyk. Pop. (1957 est.) 54,087 (mun.). It is the centre of the whole northern and eastern canal systems, and by means of the short canal, the Willemsvaart, which joins the Zwarte water and the Ysel. has regular steamboat communication with Kampen and Amsterdam.

Three miles from Zwolle on the Agnietenberg, once stood the Augustinian convent in which Thomas a Kempis spent the greatest part of his life. Zwolle has a considerable trade by river, a large fish market and the most important cattle market in Holland after Rotterdam.

ZYGADENUS (ZIGADENUS), a genus of plants of the lily family (Liliaceae, *q.v.*), containing about 12 species. all North American except one found in Siberia. They are smooth perennial herbs, springing mostly from coated bulbs, with erect stems. usually six inches to four feet high, very narrow leaves and conspicuous flowers in terminal clusters. About ten species occur in the United States and Canada. Alkali grass (*Z. elegans*), with greenish flowers, is found from New Brunswick to Alaska and southward to New Mexico. The poisonous zygadene or death camass (*Z. venenosus*), with yellow flowers, occurs in the northwestern and Pacific states.

ZYGOPHYLLACEAE, a family of herbs, shrubs and trees, characteristic of the drier parts of temperate and tropical regions in both hemispheres. There are 26 genera and about 225 species. Large genera are *Fagonia,* with about 40 species in southern North America, Chile and Mediterranean countries; and *Zygophyllum,* with 80 species in the drier parts of Asia, Africa and Australia. *Guaiacum* of tropical America, produces the very hard wood known as lignum vitae, the resin of which is also used in the practice of medicine. The South American species of *Bulnesia* also yield a very hard wood. (E. D. ML.; X.)

ZYGOTE, the biological term for the fertilized egg or ovum. (*See* FERTILIZATION; EMBRYOLOGY.)

END OF VOLUME TWENTY-THREE

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